Environmental Impact Assessment (EIA) for the Proposed 50 MW Power Plant at Araihazar Economic Zone including Substation, Electricity Transmission Line and Gas Transmission Line from the Haripur TBS to Dighi Barabo CGS

February 2019

Prepared For

Bangladesh Economic Zones Authority

Level 12, Monem Business District 111, Bir Uttam C.R. Dutta Road, Karwanbazar, Dhaka-1205

Prepared By

EQMS Consulting Limited

House# 53, Road# 04, Block# C, Banani, Dhaka-1213, Website: www.eqms.com.bd

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ABBREVIATION

AEZ	:	Araihazar Economic Zone
AIDS	:	Acquired Immune Deficiency Syndrome
ANSI	:	American National Standard Institute
APHA	:	American Public Health Association
AZE	:	Alliance for Zero Extinction
BARC	:	Bangladesh Agricultural Research Council
BBS	:	Bangladesh Bureau of Statistics
BEZA	:	Bangladesh Economic Zone Authority
BFDC	:	Bangladesh Forest Department Corporation
BFRI	:	Bangladesh Forest Research Institute
BIWTA	:	Bangladesh Inland Water Transport Authority
BMD	:	Bangladesh Meteorological Department
BNH	:	Bangladesh National Herbarium
BOD	:	Biological Oxygen Demand
BOO	:	Build-Own-Operate
BPDB	:	Bangladesh Power Development Board
BS	:	British Standards
BWDB	:	Bangladesh Water Development Board
CBOs	:	Community- Based Organizations
CEMS	:	Continuous Emission Monitoring System
CETP	:	Central Effluent Treatment Plant
CGS	:	Commercial Gas Stations
CO	:	Carbon Monoxide
CO_2	:	Carbon Dioxides
COD	:	Chemical Oxygen Demand
CNG	:	Compressed Natural Gas
CR	:	Critical
CSR	:	Corporate Social Responsibility
DC	:	Deputy Commissioner
DD	:	Data Deficient
DE	:	Diesel Engine
DEM	:	Digital Elevation Model
DG	:	Director General
DOE	:	Department of Environment
DoF	:	Department of Fisheries
DPHE	:	Department of Public Health and Engineering
DTWs	:	Deep Tubewells
ECA	:	Environmental Critical Area
ECC	:	Environmental Clearance Certificate
ECR	:	Environmental Conservation Rules
EHS	:	Environment, Health, and Safety

EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
EN	:	Endangered
EPZ	:	Export Processing Zone
EQS	:	Environmental Quality Standards
EQMS	:	Environmental Quality and Management System
EZ	:	Economic Zone
FDIPP	:	Foreign Direct Investment Promotion Project
FGD	:	Focus Group Discussion
GHG	:	Green House Gas
GoB	:	Government of Bangladesh
GTCL	:	Gas Transmission Company Limited
GT	:	Gas Turbine
GTCC	:	Gas Turbine Combined Cycle
HHs	:	Households
HFO	:	Heavy Fuel Oil
HIV	:	Human Immunodeficiency Virus
HTW	:	Hand Tubewell
HSMP	:	Health and Safety Management Plan
IEE	:	Initial Environmental Examination
IESCs	:	Important Environmental and Social Components
IFC	:	International Finance Corporation
IPP	:	Independent Power Plant
ISO	:	International Standard Organization
IUCN	:	International Union for Conservation of Nature
JICA	:	Japan International Cooperation Agency
kWh	:	Kilowatt Hour
LC	:	Least Concern
LGED	:	Local Government and Engineering Department
LNG	:	Liquefied Natural Gas
MMCFD	:	Million Cubic Feet per Day
MSL	:	Mean Sea Level
NAAQS	:	National Ambient Air Quality Standard
NEMAP	:	National Environmental Management Action Plan
NEP	:	National Energy Policy
NGO	:	Non-Government Organization
NOx	:	Oxides of Nitrogen
NT	:	Near Threatened
OEM	:	Original Equipment Manufacturer
OHS	:	Occupational Health and Safety
O&M	:	Operation and Maintenance
PAPS	:	Project Affected Persons
PAHs	:	Project Affected Households

PGCB	:	Power Grid Company of Bangladesh
PSMP	:	Power System Master Plan
RAP	:	Resettlement Action Plan
REB	:	Rural Electrification Board
RHD	:	Roads and Highway Department
ROW	:	Right of Way
SAPI	:	Special Assistance for Project Implementation
SES	:	Socio-Economic Survey
SIPP	:	Small Independent Power Producers
SO_2	:	Sulphur Dioxide
SPM	:	Suspended Particulate Matter
SRDI	:	Soil Resources Development Institute
STD	:	Sexually Transmitted Disease
STI	:	Sexually Transmitted Infection
STP	:	Sewage Treatment Plant
STW	:	Shallow Tube wells
TBS	:	Town Bordering Station
TDS	:	Total Dissolved Solid
TGTDCL	:	Titas Gas Transmission Distribution Company Limited
ToR	:	Terms of Reference
TWs	:	Tubewells
USEPA	:	United States Environmental Protection Agency
VOCs	:	Volatile Organic Compounds
VU	:	Vulnerable
WHO	:	World Health Organization
WTB	:	Wildlife Trust of Bangladesh
WTP	:	Water Treatment Plant

EXECUTIVE SUMMARY

E-1 Introduction

Bangladesh Economic Zone Authority (BEZA) is going to establish an economic zone namely Araihazar Economic Zone on 218.84 ha land at Araihazar Upazila under Narayanganj district that could meet international standard. Different types of industry will be set up in the economic zone. As per the plan, the economic zone will be started in 2022. However, as per the study conducted by JICA SAPI team on existing electricity supply of the country. The grid frequency fluctuation level is high in Bangladesh and not suitable for most manufacturing processes; therefore, the EZ require an uninterrupted electricity supply. Considering the current grid situation, proposed EZ has a provision to install a power plant. Initially, 5 MW power will be required for the industries operation. The proposed power plant will be installed to serve uninterrupted electricity for operation of different industries within the economic zone. The total capacity of Power plant is approximately 46MW on ISO conditions, i.e., 40MW on Bangladesh site conditions during the full operation of operation phase. The power plant would also provide power to the national grid, which could have a potential impact on stabilization of the national economy.

Two TITAS gas pipelines are passing through the economic zone area. At the initial stage, the gas requirement of the economic zone has been estimated as 5 mmcfd. The initial gas requirement can be meet up by the Madhobdi TBS by hot tapping from the existing 20"diameter x 1000 psig x Naringdi-Sidhirganj transmission line passing through the economic zone and constructing a CGS/TBS at economic zone site. Gas demand will be increased to 10 mmcfd in 2023, and it will increase periodically. Increased gas demand will not be possible to meet up by TGTDCL from the Madhobdi TBS as many downstream industries are getting gas from Madhobdi TBS. If TGTDCL provides the increased demand gas to economic zone; as a result, downstream users will be experienced a shortage of gas. Now Bangladesh is facing a natural gas shortage. Therefore, Bangladesh has decided to import LNG. To provide the increased gas demand of economic zone, TGTDCL will have to rely on LNG supply into the TGTDCL gas network. Gas Transmission Company Limited (GTCL) has planned to construct a 30" diameter X 1000 psig transmission line from Bakhrabad (Kutumbapur) to Meghnaghat TBS. TGTDCL, BEZA have requested to Petrobangla and GTCL for extending this line up to Horipur TBS. Pertobangla & GTCL have been agreed on this proposal. Noteworthy that for additional quantum of gas supply to economic zone, a 20" diameter x 1000 psig x 5.825 km transmission line from Horipur TBS to Dighibarabo CGS from this 30" transmission line will be constructed.

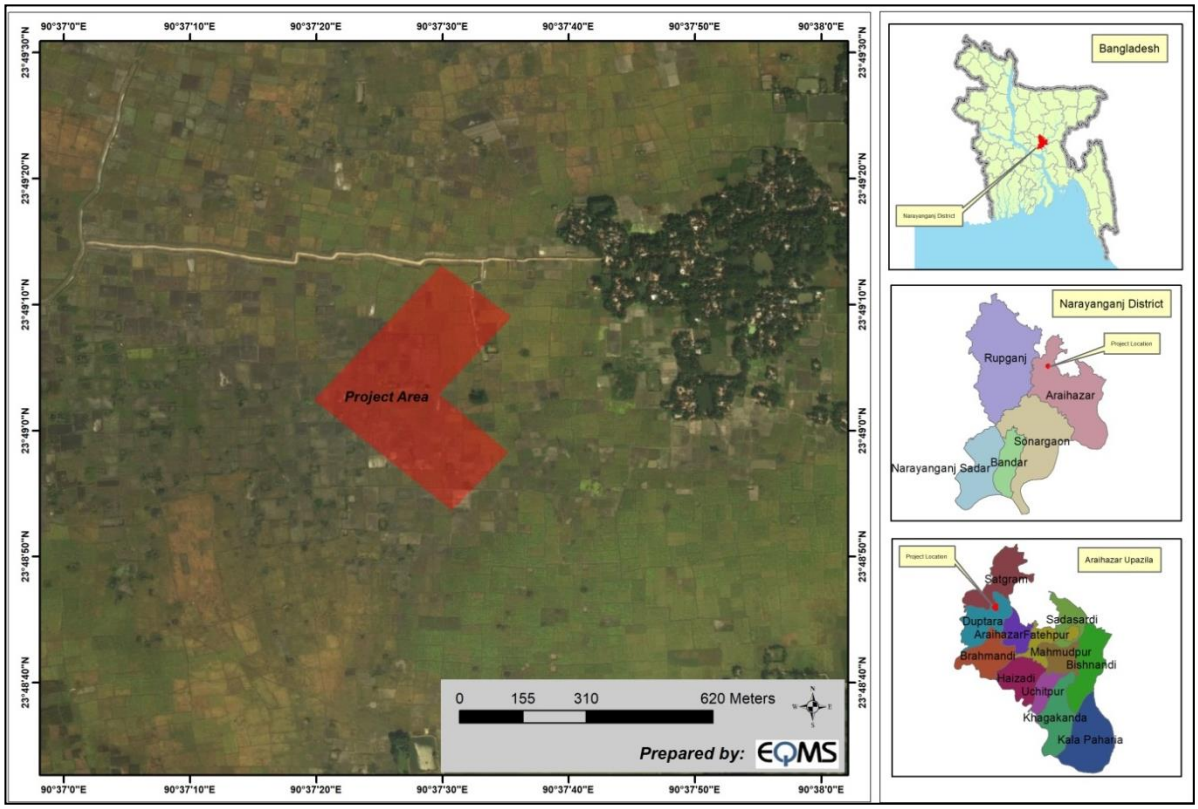
E2 Project Description

The project is consist of two major components as follows

- Power plant including substation and transmission line
- A 5.58 km gas transmission pipeline

Table 1: Summary of Power plant, Sub-station and transmission line

Power plant, Sub-station, and Transmission	
Location and district	Union: Duptara, Upazila: Araihazar, District: Narayanganj; Adjacent to the Dhaka–Sylhet Highway. The total land of the project area is 9.28 ha. The proposed site is bounded with existing agricultural land & Settlement on the northeast direction, agricultural land & settlement on southeast Side, Settlement and Agricultural Land on the north-west and Sonpara village & Agricultural Land in the west.
Mouza	Panchrukhi, Panchgaon



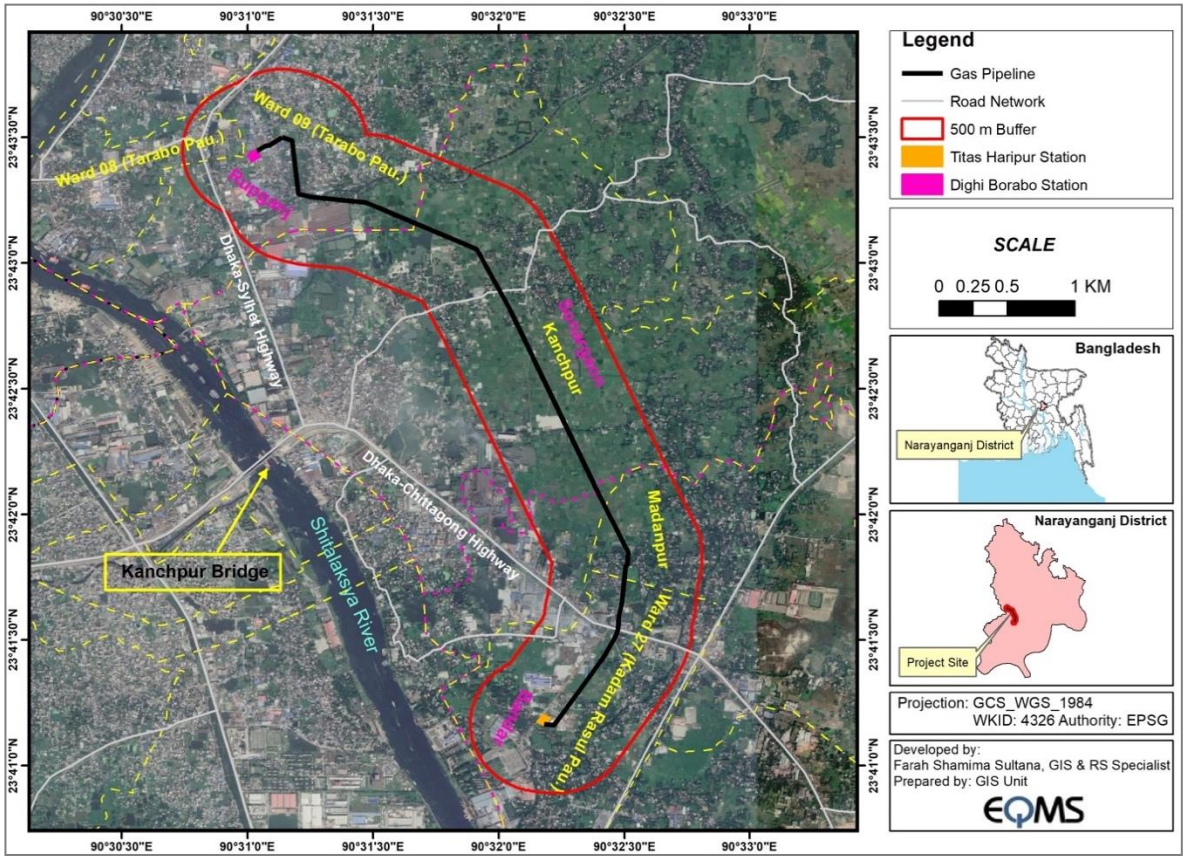
Location of Proposed Power Plant

Development area	9.28 ha
Landuse	Farmland, single or double cropping
Site preparation	Embankment: 0.6- 2.6m (Avg.1.6m), Land elevation: Approx.6-m above MSL, Flood water level due to rivers of Shitalakhya and Meghna: Approx.7.52m (1/100), Elevation of land preparation: 8.0m. EIA for the site preparation (land development) has already been conducted and approved by DoE. The site preparation work for the power plant will not be within the scope of this EIA.
Environmental and social conditions	Resettlement Action Plan study has been conducted, and it has confirmed no resettlement of houses and people in the power plant project site. No precious ecology and cultural heritage sites exist.
Development Concept and Advantages	Since power demand of AEZ is small at the beginning of EZ operation, a small capacity Diesel Engine will supply power to EZ during the period. In accordance with power demand increase, medium capacity GEs, then a large capacity GT will supply power to the EZ accordingly. During low power demand of AEZ, remaining generated power will be expected to be sold to the national grid in order to optimize its power generation productivity. The following combination of generation systems was selected. a) GT: 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only. b) GE: 2 sets of 6MW GE

	c) DE: 1 set of 3MW DE: used for the following occasions; For starting GT during blackout / Emergency power supply / Shortage of gas fuel supply / Continuous power supply during low power demand of EZ operation, etc. The total capacity of Power plant is approximately 46MW on ISO conditions, i.e., 40MW on Bangladesh site conditions.

Table 2: Summary of the Gas Transmission Line

Gas Transmission Line	
Location and district	Union: Rupganj, Sonargaon, and Bandar, Upazila: Araihazar, District: Narayanganj
Mouza	Dighi Barabo, Jatramura, Behakair, Nagar Kanchpur, Manohar Khanerbagh, Uttar Chandpur, Fular



source: google map (partially modified by SAPI survey team)

Location Map of the Proposed Gas Transmission Line and Surrounding Area

Development area	Required Land Acquisition: approximately 3.5 ha [20 feet by 5.825 km = 6.01 meter by 5,825 meter = appx 35,000 square meters] Required Land Requisition: approximately 3.28 ha [20 feet by 5.825 km = 6.01 meter by 5,460 meter = appx 32,800 square meters] Some part of the alignment may use the existing RoW. Some area may not require land requisition due to the adjacent terrain or existing structure, or

	to minimize impact. After detail site assessment and detailed design by TITAS construction team and engineers, there may be a minor modification.
Landuse	Mainly farmland, double cropping, partially industrial
Site preparation	Not required but land acquisition and requisition must be completed before construction.
Environmental and social conditions	Resettlement of houses and people is expected. There will be 255 affected landowners. Details are presented in the RAP. Several factories will be affected No precious ecology, and cultural heritage sites exist.
Development Concept and Advantages	An initial agreement has been signed between TITAS and BEZA to supply 100 MMCFD gas for the proposed Araihazar Economic Zone. The main portion of this component is the approximated length of 5.8 km long, 1,000 psig and 20-inch diameter gas pipeline constructed from the Horipur TBS to Dighibarabo CGS in order to connect to existing gas transmission pipelines that go through AEZ. The existing gas transmission line cannot supply sufficient pressure of the gas to AEZ; thus the existing line must be connected to another line (the proposed gas transmission line) at Dighibarabo CGS to supply gas to AEZ. Thus the project also requires; Off-take modification of Horipur TBS and Dighibarabo CGS The metering arrangement at Dighibarabo CGS Cathodic Protection

E-3 Baseline Environmental Condition

The physical environmental status around the proposed power plant project site and gas transmission pipeline were analyzed for valued environmental components viz., climate, topography, geology, air, water, land, noise, and soil in a 5 km radial radius around the site. The baseline provides the basis for assessment of impact (likely changes in the baseline conditions) due to the proposed interventions.

Table 3: Environmental Setting for Power plant & Gas Transmission Pipeline Project

Particulars	Details
Location	The power plant site is located at Union: Duptara, Upazila: Araihajar, District: Narayanganj Gas transmission pipeline site is located at Union: Word-9 at Tarabo paurashava, Word no-27 at Bandar Paurashava and Kanchpur at Shonargong upazila under District: Narayanganj
Mouza	Power Plant: Panchrukhi & Panchgaon Gas Transmission Pipeline: Dighi Barabo, Jatramura, Behakair, Nagar Kanchpur, Manohar Khanerbagh, Uttar Chandpur, Fular
Project Area	Proposed Power plan area approximately 9.28 ha or 22.93 acres Approximately 8.65 acres of land need to be acquired, and 8.11 acres land will be leased for construction of the gas pipeline.
Road Access	Adjacent Dhaka-Sylhet Highway
River Access	The proposed Power plant is Approx. 1.5 km from Brahmaputra River The proposed Power plant is Approx. 5.5 km from Shitalakhya River Gas transmission pipeline Haripur station is Approx. 740 meters from

Particulars	Details
	Shitalakhya River
Nearest Airport	The proposed Power plant is Approx. 30.2 km from Hazrat Shah Jalal International Airport (Dhaka)
Nearest Railway Station	The proposed Power plant is Approx. 30.3 km from Kamalapur Railway Station, Dhaka
Climatic conditions	Avg. Monthly wind speed– 2-5 m/s; Avg. Monthly Min. Temp. – 19.0°C January 1991; Avg. Monthly Max. Temp. – 40.2°C in April 2014; Annual Avg. Rainfall – 1994.6 mm; Average maximum humidity ranges – 94% to 97%; Average minimum average ranges – 31% to 64%;
Seismic Zone	Zone II
Forests / National Parks	None within 5 km
Archaeologically important places/monuments	No Archaeologically important places/monuments near to the site

E-3.1 Climate

E-3.1.1 Temperature

The data analysis of the last 30 years (1986-2016) indicates that monthly maximum temperature varies from 30.0°C to 40.2°C whereas monthly minimum temperature varies from 13.4°C to 26.6°C.

E-3.1.2 Humidity

The average maximum humidity ranges from 94% to 97%, whereas the minimum average ranges from 31% to 64%.

E-3.1.3 Rainfall

The annual average of total rainfall recorded as 1,994.6 mm/year. According to the analysis of the historical data, the monthly average of total rainfall occurs in July at 1,049 mm whereas monthly minimum rainfall is recorded during the winter season.

E-3.1.4 Evaporation

In Dhaka, evapotranspiration varies from 60 to 147 mm/day, and yearly evapotranspiration in Dhaka is 1245 mm/day.

E-3.1.5 Wind Speed & Direction

As per BMD, the windiest month is May with an average wind speed of 2.6 knots and the least windy month is October with an average wind speed of 0.6 knots.

E-3.1.6 Sun-shine Hours

The monthly average sunshine hour in Dhaka varies from 3.7 to 8.3 hour/day in a year. Highest average sunshine hours recorded in the month of March.

E-3.2 Environmental Quality

E-3.2.1 Ambient Air Quality

The existing ambient air quality of the study area monitored at eight (4) locations of which five locations for the power plant and three locations for the gas transmission line during the monitoring period. All the monitoring locations result was within the National Ambient Air Quality Standard (NAAQS) in Bangladesh.

E-3.2.2 Ambient Noise Level

Noise levels were recorded at seven (7) locations for the power plant and six (6) locations for Gas pipeline during the monitoring period. The noise level at NL1 and NL2 locations of power plant study area exceeded the standard due to the monitoring locations present near to the Dhaka-Sylhet highway. Noise levels of the gas pipeline were well within the standard limit of ECR'97 (subsequent amendment in 2006).

E-3.2.3 Surface Water Quality

Three (3) samples of surface water were collected from the canal near power plant site, and another three (3) samples of surface water were collected from the pond near Gas pipeline alignment.

The concentration level of BOD of canal water has been found above the Bangladesh Standard. Water quality of pond in the gas pipeline area was found good in condition.

E-3.2.4 Ground Water Quality

A total Four (4) groundwater samples were collected from different locations of the power plant area. In addition, total Two (2) groundwater samples were collected from different locations of Gas Pipeline area.

The concentration level of Manganese (Mn) of all tube wells were found above the standard set by the DOE, GoB for drinking water. But the levels of pH, TDS, As, Ca, COD, Chloride, Fluoride, Fe, Pb, Phosphate, Sulphate, TSS and turbidity were found to be within the limit set by the DOE, GoB for drinking water.

E-3.2.5 Soil Quality

Total five-soil samples were collected from the study area of which three samples were collected from the power plant area and two from gas pipeline area. Iron, Copper, Zinc, Lead, and Manganese has detected in the soil samples.

E-3.3 Biological Environment

The power plant area and gas pipeline area falls under the Brahmaputra-Jamuna Floodplain (Bio-Ecological Zone 4c) Zone. An ecological study was conducted around five kilometers of the power plant and two kilometers of the gas pipeline.

E-3.3.1 Terrestrial Flora

A total of 53 species, 48 genera belongs to 31 families were represented by terrestrial flora. Coconut (*Cocos nucifera),* Eucalyptus *(Eucalyptus citriodora),* Mango *(Mangifera indica),* Guava *(Psidium guajava),* Litchi (*Lichi chinensis),* Kul-boroi *(Ziziphus mauritiana),* Pepe *(Carica papaya),* Sajna*(Moringa oleifera),* Jambura*(Citrus aurantifolia),* Mahogani *(Sweitenia mahagoni),* Banana (*Musa sapientum),* Kachkola (*Musa paradisiac),* Kathal *(Atrocarpus heterophyllus)* and Acasia *(Acacia nilotica)* were recorded most commonly occurring trees.

E-3.3.2 Terrestrial fauna

Mammals

Nine species of terrestrial mammals belonging to the 8 genera of 6 families were recorded during the study period. Golden Jackal (*Canis aureus*), Bengal Fox (*Vulpes bengalensis*) and Indian Gray Mongoose (*Herpestes edwardsii*) were seen at Sonpara during the field survey by the ecology team. Jungle Cat (*Felis chaus*) was reported to be seen by locals during field consultations in agricultural and homestead plantation areas. None of the species is reported to be listed in RED category of IUCN 2015 v2. However, Indian Gray Mongoose (*Herpestes edwardsii*), Jungle Cat (*Felis chaus*) and Asian House Shrew (*Suncus murinus*) are reported to be listed in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capturing.

Avifauna

A total of 45 species belonging to 37 genera of 27 families were observed to be in the study area during field survey by ecology team on 22-23 October 2017. These species are present in the variety of habitats from Grassland, homestead plantation, agriculture plantation, and aquatic habitat. The proposed project site has many harbors species such as Red-vented Bulbul, Red Watted Lapwing, Black Kite, Black Drongo, Rock Pigeon, Long-tailed Shrike, and Common Myna. These species are common in the area, and sufficient habitats are available within area once the construction and operation activities are commenced. None of the species was listed as threatened as per IUCN classification.

Herpeto-fauna

Nineteen (19) species belonging to 17 genera of 14 families are reported from the area. Out of these House Lizard (*Hemidactylus flaviviridis),* Indian Rat Snake (*Ptyas mucosa*) and Checkered Keelback (*Xenochropis piscator*) were observed by ecology team during a field survey in October 2017. Rests of the reptilian fauna were reported to be observed by locals during field consultations in the villages of the project area. Among the 9, Bengal Monitor (*Varanus benghalensis*) and Spotted Flapshell Turtle (*Lissemys punctata*) are reported to be listed in Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capturing.

E-3.3.2 Aquatic fauna

Macro-invertebrate Fauna

Macroinvertebrate species such as water spiders (*Argyroneta aquatic*), Common Apple snail (*Pila globosa*), Disk Snail (*Macrochlamys sequax*), River Snail (*Bellamya begalensis*), Brotia Snail (*Brotia costula*), Lymneid Snail (*Lymnaea luteola*), Freshwater Mussels species such as (*Lamellidens corrianus*), (*Lamellidens marginalis*), (*Lamellidens jenkinsianus*) were observed in the study area. None of the species observed is of conservational significance.

Fish

The Sonakahli and Dhawrakhali canal interconnected with each other while they are connected to Old-Brahmaputra River. 31 species of 25 genera belonging to 17 families are reported from the canal and river. Among of them 4 species are in endangered, and 2 species are vulnerable, and 3 are near-threatened according to the Red List of IUCN (2015, Vol.3).

E-3.3.3 Protected Area (PA)

No PA exists at or near the project site.

E-3.3.4 Wildlife Sanctuary (WS)

No WS exists at or near the study areas.

E-3.3.5 Ecologically Critical Area (ECA)

In 2009, the Bangladesh Government declared the four rivers, such as Buriganga, Sitalakhaya, Turag, and Balu around Dhaka city as ECAs. The sitalakhya river is located 5.5 km from the proposed power plant area and 740 meters from the proposed gas pipeline.

E-3.3.6 Cultural Heritage

Nothing found in the development area would be affected by the development.

E-3.4 Socio-economic Condition

E-3.4.1 Population and Demography

In the 5-kilometer study area of the proposed power plant, there are 159,785 households (HHs) including squatters with a total population of 534,281 whereas 500 m study area of the gas transmission line, 39622 households including squatters with a total population of 115099. Population density per square km of the study area is 2,973 and 4128, which are very much higher than the national figure of 976 per square km. The average sex ratios are 107 in the power plant area and 111 in the gas transmission area against the national figure of 100, which depicts a higher male population than the female population. Moreover, where national household size is 4.44, the average household size of the study area is slightly higher 4.7 in the power plant area and 4.0 in the gas transmission area.

Demographic Profile of Affected Population

A detail RAP study was conducted for the Araihazar Economic Zone area. The proposed power plant will be established within the EZ area. Economic zone EIA study has already been prepared considering the land acquisition of total economic zone area. Therefore, in this study, the land acquisition issue does not consider.

On the other hand, land acquisition will be carried out for the gas transmission line. 100% census and the socio-economic survey was carried out in the project surroundings area. A total of 253 households with a Project Affected Persons (PAPs) of 1092 were identified and surveyed in Gas Pipeline Project area. The average household size is 4.3 which is more or less similar to the national average. The national average household size is 4.4.

E-3.4.2 Ethnic Composition

According to population and housing census (2011), only 10 ethnic households consisting 31 populations are found in the Union lied within the 2 km radius boundary from the power plant site. These ethnic groups are Marma, Chakma, and Others.

According to the population and housing census (2011), total household of the gas transmission pipeline study area in Tarabo Paurashava, Sonargaon and Kadam Rasul Upazilla total 139 ethnic community household has been found. Only Chakma and Rakhain ethnic community have been found. The major ethnic community like Garo, Barmon, and Coach has not found in the proposed study area.

E-3.4.3 Religion

As per BBS, Population and Census (2011), the population of the power plant project study area primarily consists of Muslims constituting almost 94.4% of the total population. The remaining 5.6% is primarily comprised of Hindus with Christians, Buddhists, and others comprising far lesser percentages whereas almost 97.2% of the total population is Muslim in the gas pipeline area. The remaining 4.3% is Hindu.

E-3.4.4 Education

The population and housing census (2011) shows that the concentration of literate people in underlying unions of selected Upazilas is 49% which is lower than the national average of 51.8%.

Based on census and socioeconomic data of gas pipeline study area, it was revealed that majority (63.8%) of affected persons had completed primary level education. About 175 (16%) and 78 (7.1%) have passed secondary and higher secondary level education respectively while only 50 (4.5%) identified as privileged of having tertiary level education.

E-3.4.5 Settlement & Housing

Predominant structure of the power plant study area is kutcha (71.7%) followed by Semi-pucka (21.1%), Pucka (6.7%) and Jhupri (0.5%). Housing tenancy of the study area is owned by (49.6%), rented (46.6 %) and Rent free (3.8%).

The predominant structure of the gas pipeline study area is Kutcha (40.5%) followed by Pucka (12.2%), Semi-pucka and jhupri (46.8% and 0.5%). Housing tenancy of the study area is owned by (40.1%), rented (56.7%) and rent free 3.2%).

E-3.4.6 Water Supply

At the project study area of the power plant, the major source of drinking water is tube-well where about 93.8% population use tube-wells water. About 3.2% people have access to tap water. Other 3.0% people have access neither tube-well nor tap water.

At the project study area of gas pipeline, the major source of drinking water is tube-well where about 92.9% population use tube-wells water. 2.9 % population use tap water. Other 4.3% people have access neither tube-well nor tap water.

E-3.4.7 Electricity

In the power plant project study area, 91.8% of the households have grid electricity connection whereas 98.8% of households have electricity connection in the gas pipeline study area.

E-3.4.8 Sanitation

In the power plant study area, only about 11.1% and 44.7% of households use respectively water sealed and non-water-sealed sanitary latrine facility, which represents the 55.8% of households in the study area. 36.7% of households use non-sanitary facilities.

In the gas pipeline study area, about 11.0% and 74.9% of households use water sealed and non-water-sealed sanitary latrine facility, respectively, whereas about 13.8% of households use non-sanitary facilities.

E-3.4.9 Economy & Employment

About 45.0% of the total population followed by 79.9% of male and 10.1% of the female population of selected Unions are engaged in economic activities. 36% of the total population is engaged in domestic work where majority female of the total female population (71.6%) are doing domestic work. All over 18.6% population, do not work whereas only 0.3% population is looking for work.

E-4 Scoping & Terms of Reference

Scoping was conducted toward the power plant and gas pipeline project. In order to assess the likely significant environmental and social impacts, potential environmental and social impacts of the Project were preliminarily identified based on the project description and overall environmental and social conditions in and around power plant and Gas transmission pipeline Project. These impacts were evaluated in each of the three phases separately, namely: pre-construction, construction phase, and operation phase. Scoping Matrix of the Proposed project is given in Chapter 7.

In order to fulfill the requirements of the JICA Environmental Guidelines and advisory instructions given by JICA Environmental and Social Consideration Advisory Committee, the JICA Survey Team prepared a term of reference (TOR) for identified uncertain impacts summarized for the EIA study and RAP study.

E-5 Environmental & Social Impacts

On these 30 items, baseline survey, project impact prediction and, if the impact is considered either negligible or severe, environmental management planning including monitoring plan was established as bellow.

Environmental Pollution

1. Air Pollution
2. Water Pollution
3. Waste
4. Soil Pollution
5. Noise & Vibration
6. Ground Subsidence
7. Offensive odors
8. Sediment Quality

Natural Environment

9. Protected areas
10. Ecosystems
11. Hydrology
12. Topography and Geology

Social Environment

13. Involuntary Resettlement
14. Vulnerable Group
15. Indigenous and ethnic people
16. Local Economics, Such as Employment, Livelihood
17. Land Use and Utilization of local resources
18. Water Usage
19. Existing Social Infrastructures and Services
20. Social Institutions Such as Social Infrastructure and Local Decision-making institutions
21. Misdistribution of Benefits and Damages
22. Local Conflict of Interest
23. Cultural Heritage
24. Landscape
25. Gender
26. Children's Right
27. Infectious Diseases
28. Occupational Health and Safety

Others

29. Accidents
30. Transboundary impact and climate change

E-6 Environmental Management Plan

A summary of mitigation measures identified for the pre-construction, construction & operation phases of the power plant and gas transmission project is presented in below Table 4 and Table 5. This also identifies lead responsibility for implementing the mitigation measures and sources of funds for such implementation.

Table 4: Environmental Mitigation and Management Plan for Power plant during Construction & Operation Phase

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Construction Phase							
Environmental Pollution	Air Pollution	B-	• Earthworks construction, site clearing, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, and hauling of materials will generate dust • Construction machinery and transportation vehicles will be generated SO_2, NOx, smoke, soot, and earth, sand and dust particles	• Periodic inspection and maintenance will be conducted to reduce exhaust from construction machines and vehicles. • The sprinkling of water at the construction site and haul roads • Raw materials excavated soil, and other debris should be stored under covered sheds • Generators, compressors, and other equipment to be shut down when not infuse; • Low sulfur diesel should be used for running construction equipment and vehicles; • Air emission monitoring programme to be undertaken as per the monitoring plan;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Water Pollution	B-	• Effluent resulting from washing the equipment, sewage, and sanitary wastewater will be generated during the work; • Waste will also be produced from the washing of aggregate and sand; • Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the	• Avoid excavation activities during rains; • Prevent piling up of excavated soil, raw material, and construction debris at the site by proper management and disposal; • Maintaining the appropriate flow of water sprinklers at the site; • Construction of storm water drains along with sedimentation tanks with sandbags as partition as a barrier for direct flow of runoff to the canal;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		surface water quality.	• Construction of soak pits/septic tanks to dispose-off the domestic wastewater generated from labor camps to prevent disposal of sewage in surface water bodies; • No debris/construction material should enter the water body in the area. • No sewage or wastewater should be accumulated in any unlined structure; • Timely disposal of the construction/chemical/hazardous waste so as to prevent leaching of any pollutant to the ground; • The groundwater quality should comply with Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines;			
Waste	B-	• If Solid Waste resulting from the construction work and campsite is inadequately handled, underground water and surface water will be contaminated	• Segregate waste to minimize waste material; • Waste should be segregated and disposed of in the separate place; • Reuse as much as possible with consideration of soil property;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Soil Pollution	B-	• Excavation work for structures, earth, and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. • Storage of raw material, fuel, and construction	• Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management practices to prevent any spillage of raw materials; • Waste from labor camps can be	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		debris may contaminate the soil. • Soil may also contaminate through spills and leaks of fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.	segregated at the site. Food waste/wet waste should be composted in pits within the campsite; • Recyclable waste should be sold to the authorized dealers ensuring environmentally friendly, and the remaining should be disposed of at designated sites through local agencies responsible for waste management in the area;			
Noise	B-	• Noise will be generated from the construction machinery, equipment, and transportation vehicles;	• Vehicles and machinery should be regularly serviced and check for pollution control; • The worker who will be work high noise area should provide earplug; • No noise generating activity shall be carried out in the night; • Use low noise generating equipment; • Temporary noise barriers should be provided near the high noise generating areas like metal or tiles cutting sites, generator room, etc.; • Regular noise monitoring, especially at the school and residential area located close to the project site should be carried out;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Sediment Quality	B-	• Inadequate handling of domestic solid waste, raw material, hazardous waste, and lubricants may pollute the adjacent topsoil and	• Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			characteristics of the adjacent streambeds.	practices to prevent any spillage of raw materials;			
Natural Environment	Ecosystems	B-	• Extensive use of vehicle horns, civil construction, and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. • Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies.	• No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labor camps and prevent its disposal in the water body; • Vehicle washing/equipment cleaning should not be allowed near canal/ drains; • Temporary storm water drainage system should be developed at the site to channelize the stormwater away from the debris storage area and raw material storage area; • Diesel, paints, cement, etc. should not be stored near the water bodies and drain;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Hydrology	B-	• During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds.	• Natural drainage pattern should be maintained. Run-off assessment shall be made of the catchment area, and peripheral/garland drains shall be constructed around the power plant based on the assessment of catchment area (frequency, and storage area);	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	B-	• The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities	• Provide unskilled jobs and employment opportunities for vulnerable people. • Organizing women in self-help group to operate canteens in the construction campsite; • Implementation of social welfare programs targeted at vulnerable groups.	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Water Usage	B-	• The surrounding wells may be affected by the reduction of underground water level resulting from underground water intake during the construction work and labor camps.	• Regular inspections at the site to monitor leakages in water storage tanks; • Creating awareness among construction workers about the importance of water conservation; • Storing the curing run-off and wastewater from other construction activity and using the same for sprinkling;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Gender	B-	• Female laborers may be discriminated in wage at the construction site	• Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Children's Right	B-	• Underage employment may occur at the construction stage.	• Child labor at the construction site during the project implementation shall be strictly prohibited since such practices are banned by both Bangladesh laws and JICA guidelines; • BEZA shall regularly monitor project sites to guide contractors and their related firms to discourage child labor;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Infectious Diseases	B-	• Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers.	• Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; • Provide the awareness program to the workers and surrounding community people; • Educating project personnel and residents on risks, prevention, and available treatment;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Working conditions, including occupational safety	B-	**Occupational Health & Safety** • Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dust, fumes, vapors, liquids are the major hazards which are harmful to workers health; • Road Accident	• Provide adequate health care facilities and first aid within construction sites; • Provide OHS training program and information on basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure; • Establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • Identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
		Community Health & Safety • Traffic congestions on roads and possible disruption to the community usage	• Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area; • Creating awareness among the	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item		Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			during peak movement hours; • Inconvenience to the community in terms of air and noise pollution caused by the movement of vehicles; • Fire Safety from the construction activities which may include handling and storage of flammable chemicals and materials; • Improper disposal and migration of sewage into the surroundings;	drivers about speed, traffic safety, use of horns, etc. while driving through settlement areas; • Covering of trucks while carrying soil, sand, cement, aggregates, etc. to minimize the spread of dust and spill over; • Avoiding unnecessary movement of the vehicle through the settlement area to minimise disturbance and traffic safety related issues; • Creating awareness among children, women, and old age people in particular and the community in general on traffic safety by using existing mediums such as school, women self-help groups, village union, and religious occasions;			
Others	Accidents	B-	• Accidents may occur due to the operation and movement of heavy equipment, vehicle, and machinery.	• Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; • Provision of traffic signs, road mark, bump, zebra mark, guardrail and pole, and curbstones, etc.;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Operational Phase							
Environmental Pollution	Air Pollution	B-	• The exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution (SO_2 or NOx) without proper technologies	• Latest technology, methodology, and machinery involving minimal air emissions should be adopted for Power Plant; • Process emission if any shall be controlled with the installation of	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		and maintenance.	adequate air pollution control systems; • It is suggested to install a high stack to minimize the impact. • Air pollution monitoring should be carried out by the power plant to check the air pollution level; • Check leakage and reduce fugitive emission of gas from the distribution pipeline system. • Power Plant should obtain clearance from DoE, Bangladesh. • Periodic renewal of ECC should be obtained by the Power Plant;			
Water Pollution	B-	• Plant effluent and domestic wastewater will be generated, and waste will also be produced. If inadequately handled, surface water and groundwater will be contaminated.	• The power plant has to arrange a pre-treatment facility to treat their processed effluent and sewage they generate to meet a certain level of pollution load set by the operator; • Pre-treated wastewater will be treated in CETP/STP to meet national wastewater discharge standards as well as an international standard set forth by BEZA; • Storm and industrial wastewater will be collected in separate pipe networks to prevent contamination of stormwater draining to natural wetlands; • River/canal water quality shall be monitored periodically;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
Waste	B-	• The plant waste produced	• For the waste produced in the	EHS team of	BEZA/Power	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		during the operation includes the waste oil and sludge from the wastewater treatment equipment. • The office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated;	process of operation of the power plant, the waste management program including the reduction, reuse, and recycling of the waste will be worked out; • Site drainage controls to isolate potentially contaminated areas from discharge to the environment; • Environmental training and awareness programs for plant workers should be required;	Plant Operation Company	Plant Operation Company	
Soil Pollution	B-	• Improper storage, handling, disposal of diesel fuel, lubricants, solid and hazardous waste may lead to contamination of the soil.	• Treatment of the effluents and sewage and ensuring proper disposal; • Segregate non-hazardous solid waste from hazardous one and dispose of properly; • Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; • Common waste storage areas shall be designated for plant domestic waste; • Recyclable waste should be sent to authorize vendors for recycling and rejected waste should be disposed of as per the norms specified by DoE for the particular waste.	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
Noise	A-	• The noise generation source during the operation includes the power plant operation, worker's commutation and traffic of vehicles for carrying the	• Pumps should be fitted in the acoustic enclosure to reduce the noise generation; • Install the silencer with the GE and DE; • Noise barriers will be mandatory for	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			periodic inspection materials. Vehicles movement will create noise pollution; • The inhabitants of the surrounding area may have a noise problem.	the factories generating a lot of noise during operations; • Plantation should be developed along the roads and boundary to form a continuous barrier that will reduce the noise level significantly; • Regular noise monitoring, especially at the school and residential area; • Use of ear-muffs and ear-plugs by power plant personnel working in the generator and turbine facilities of the power plant. • The building, Noise enclosure, Silencer and/or insulation lagging for Gas Turbine.			
Natural Environment	Ecosystems	B-	• Plant's gaseous emission and excessive noise may disturb to the surrounding inhabiting floral and faunal species. • Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.	• Periodic monitoring shall be carried out as per the monitoring plan for air, water, noise, and soil and ensure that no impact; • No waste shall be discharged in water bodies, i.e., canal and agricultural land, etc. • WTP should be installed to treat the effluent generated and to re-use and recycle. • Native tree species will only be planted in the region;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
Social Environment	Water Usage	B-	• Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes • Excessive withdrawal of	• No objection certificate must be obtained from WARPO prior to install/use the deep well. • Water efficient technologies will be adopted in central utility service	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		groundwater may lead to depletion of aquifers without proper assessment of the depth of the existing wells and installed groundwater wells with supply capacities. • Total water consumption is 160 m^3/day of which 80 m^3/day will be used for gas turbine cooling, and rest 80 m^3/day will use for gas booster compressor;	divisions and also at the plant process level; • Adoption of best management practices to prevent water wastage and minimize water loss; • Usage of water conservation fixtures to minimize water consumption; • Installation of the leakage detection system to minimize water loss; • Regular monitoring of groundwater level in the area should be carried out. Estimated should be made to calculate the draught and recharge of the groundwater aquifers. More green space will be planted to foster aquifer recharge; • Groundwater aquifer assessment studies may be undertaken to assess the groundwater potential. • Treated effluent will be recycled;			
Infectious Disease	B-	• There is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.	• Conduct mitigation measures stipulated in the international guidelines such as EHS Guidelines of IFC • To conduct Information, Education and Consultation Communication (IEC) campaign periodically to staff, employees, and immediate local communication concerning the risks, dangers and impact and appropriate avoidance behavior with respect to, of Sexually Transmitted Disease	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			(STD) or Sexually Transmitted Infection (STI) in general and HIV/AIDS in particular.			
Working Conditions, including Occupational Safety	B-	**Occupational Health and Safety** • Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dust, fumes, vapors, liquids are the major hazards which are harmful to workers health.	• Provide adequate health care facilities and first aid within operation sites of the power plant; • Provide OHS training program and information on basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure; • Provide adequate supplies and easy access to drinking water with a sanitary means to provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; • Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labeling of equipment, communicate hazard codes, electrical; • Identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
		Community Health and Safety • The health and safety risks in the plant during operations include the	• Adequate provision for suppression of dust and particulate matter originating at the source; • Developing a disaster management plan and community health and safety plan to deal with emergency	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		potential for respiratory diseases, burns, allergies and industrial accidents among the employees and immediate neighboring communities • Emission & Noise generated from the operation of the power plant activities. • Fire & Explosion Hazards;	situations; • Regular training of plant personnel on health and safety aspects; • Creating awareness among the general public around the plant about possible emergency situations and way to respond to them;			
		Risk of fire • Risk of fire would increase due to the economic activities of the power plants and population growth in and around the project area. • Electrical systems that are overloaded, resulting in hotwiring or connections or failed components might occur at operation phase. • Discarded cigarettes can cause fires • Improper use of equipment • The most common causes of fires in the workplace are human error.	• The power plant shall install and maintain an effective fire alarm system and firefighting system for each building in the plot, and implement emergency drill with reference to the rule and regulation; • Implement a program that includes preparation, prevention, and recognition of fire Risk; • Proper handling of combustible and flammable material; • Do not smoke in the project site; • Install approved smoke detectors on each floor.	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
Others	Accident	B-	• Road accidents may occur due to plant vehicles and motorbikes. • Gas distribution line has risk	• Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			due to the bursting of pipes or leakage.	• Provision of traffic signs, road mark, bump, zebra mark, guardrail and pole, and curbstones, etc			
	Transboundary impact and climate change	B-	• Emissions of GHGs are generated from vehicle traffic and power plant operations.	• Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Table 5: Environmental Mitigation and Management Plan for Gas Transmission pipeline (Preconstruction, Construction & Operation Phase)

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Preconstruction Phase							
Environmental Pollution	Air Pollution	**B-**	• During the clearing of RoW removal of the existing structure will create some dust • Movement of heavy vehicles may generate dust and gas emission	• Selecting short and direct routes for all traffic; • Wetting onsite areas • Vegetation clearance during dry weather periods; • Maintaining generator engines and other heavy-duty engines in good repair, to reduce exhaust emissions;	Appointed Contractor	BEZA	Contractor Cost
	Noise	**B-**	• With the progress of construction work, the noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration • Disturbance to religious performance	• Traffic to and from the site to be controlled with respect to routing of vehicles and timing of vehicle movements (i.e., working hours); • Site activities during preconstruction works will to the extent practicable be limited to daytime working • Equipment will be maintained in good	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				working order where appropriate; • Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc.) to minimize noise levels at offsite receptor locations.			
Natural Environment	Ecosystems	B-	• The gas Pipeline project has very limited impact on trees. A total of 225 fruits trees were identified of which 147 were large, 37 were medium, and 2 were and saplings. There were 29 large size timber trees and only 10 banana trees to be cut down due to the project. • Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. • Loss of species diversity • Loss of species due to the disposal of petroleum oil lubricants and toxic refuse	• Vegetation clearance will be minimized; • The site will be fenced, and site access will be strictly controlled; • Damage to habitat in non-work areas will be encouraged to re-grow to as near as possible its original condition. • Traffic to and from the site to be controlled with respect to routing of vehicles and timing of vehicle movements (i.e., working hours);	Appointed Contractor	BEZA	Contractor Cost
Social Environment	Involuntary Resettlement	A-	• The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. The entire land is privately owned and needs to be acquired. A total of 253 households with	• The proper implementation of the resettlement action Plan (RAP); • Provide adequate compensation in time to PAPs; • The authority should be careful and take necessary measures that every displaced people can be resettled as	Appointed Contractor	DC office/ BEZA	DC office

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		populations of 1092 will be affected by the project due to the land acquisition. • Value of surrounding land that is not acquired will decrease as the construction of structures is prohibited within a certain distance from the RoW. • Requisition of land for the project will also affect people of the project area. • The soil becomes compacted and will not be suitable for cultivation at least one crop season.	per the law of the land; • Backfill the land properly; • Need proper action to restore the agricultural land in the previous condition;			
Local economies, such as employment, livelihood, etc.	B-	• PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. • Some industries' operation will be temporarily closed for the pipeline installation. Workers of the factories will lose their job temporary.	• Income and livelihood restoration program can be provided to those who need a different job. • Compensation should be provided to the employees of the affected factory if they will lose income. • The standing crop should be compensated as per RAP	BEZA	BEZA	BEZA
Misdistribution of Benefits and Damages	B-	• Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation.	• Establish GRC. • Establish external monitoring committee or assign external monitoring consultant.	Appointed Contractor	BEZA	Contractor Cost
Construction Phase						

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Environmental Pollution	Air Pollution	B-	• Emission of dust • Movement of heavy vehicles will emit a small amount of SOx, NOx, and CO2	• The sprinkling of water at the construction site and haul roads • Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; • Provision of the face mask to workers to minimize inhalation of dust particles • Maintaining generator engines and other heavy-duty engines in good condition, to reduce exhaust emissions; • Good housekeeping (i.e., strict fuel/chemical inventory and minimization of spillages, to reduce fugitive vapor emissions).	Appointed Contractor	BEZA	Contractor Cost
	Water Pollution	B-	• Surface water will be contaminated • Leaks and spills of oil, lubricants, fuel may impact on surface water • Improper handling of sewage and chemical	• Avoid excavation and backfilling activities during rains; • Construction of storm water drains along with sedimentation tanks with sandbags as partition as a barrier for direct flow of runoff to canal or river; • Proper collection, management, and disposal of construction and municipal waste from the site to prevent mixing of the waste in run-off and entering the water bodies; • The facilities shall be designed and operated to ensure that the risks of accidental releases and spills of environmentally hazardous compounds are minimized;	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Waste	B-	• Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass, and waste oil • The domestic solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. • Hazardous waste may contaminate surface and groundwater as well as soil quality	• Segregate waste to minimize waste material • Waste should be disposed of in the designated dumping site; • Recycled as possible with consideration of soil property; • Use bean at campsite;	Appointed Contractor	BEZA	Contractor Cost
Soil Pollution	B-	• Vehicular oil and lubricants also pollute the soil quality. • Soil stability and compactness • Temporary loss of soil fertility • Storage of raw material, equipment fuel, and construction debris may contaminate the soil.	• Restoration of disturbed soil to its original use or to an approved use; • Installing adequate runoff drainage channels to prevent flooding, inundation and silting; • Provision of a test separator and flare system sufficient to prevent accidental releases from equipment and vehicles during construction activities; • Raw material will be stored under covered sheds and paved surface; • Construction debris should be stored under covered sheds, and paved surface and should be disposed of regularly to designated sites;	Appointed Contractor	BEZA	Contractor Cost
Noise	B-	• Noise from generators • Noise will be generated from the construction	• Vehicles and machinery should be regularly serviced and check for pollution control;	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		machinery and transportation vehicles. • Disturbance to religious performance • Exposure of employees to high noise level (above 85dB) continuous for 8 hours per days may result in a noise-induced hearing loss;	• Equipment will be maintained in good working order where appropriate acoustic hoods will be provided; • Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc.) to minimize noise levels at offsite receptor locations. • The worker who will be work high noise area should provide earplug; • No noise generating activity shall be carried out in the night; • No construction activities to be undertaken during night hours to prevent any disturbance to nearby residents and labors in labor camps; • Regular noise monitoring, especially at the school and residential area. • Machinery to be used should comply with the noise standards prescribed by DoE as well as EHS IFC Guideline 2007;			
Offensive Odors	B-	• The amount of domestic solid waste will increase due to the inflow of a great number of workers. If such waste is inadequately handled, the odor may be produced by putrefaction;	• Before starting the construction work, the workers will be instructed to classify and collect garbage; • Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction;	Appointed Contractor	BEZA	Contractor Cost
Sediment Quality	B-	• The bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the	• Construction of storm water drains along with sedimentation tanks with sandbags as partition as a barrier for direct flow of runoff to canal or river;	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			crossing activities. • The waste lubricants will not only pollute the sediments of water bodies;	• Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management practices to prevent any spillage of raw materials or waste lubricants;			
Natural Environment	Ecosystems	B-	• Extensive use of vehicle horns, civil construction, and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. • Many species of flora and fauna would frighten easily by vehicle horns and civil works that may become distressed. • Water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent waterbodies • Many species of wildlife are easily by vehicle horn and may become Distressed.	• Plantation of local trees to mitigate the loss of vegetation which will enhance the availability of breeding and roosting space for wildlife, especially birds. • The use of air horns to be limited to emergencies whilst near colonies inhabitants. Many species of birds or other wildlife; • The site will be fenced, and site access will be strictly controlled; • Damage to habitat in non-work areas will be encouraged to re-grow to as near as possible its original condition. • No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labor camps and prevent its disposal in the water body; • Toilets should be provided at the site to prevent contamination of water due to open defecation in nearby areas; • Vehicle washing/equipment cleaning	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			should not be allowed near canal/drains; • Temporary storm water drainage system should be developed at the site to channelize the stormwater away from the excavation/filling area, debris storage area and raw material storage area;			
Hydrology	B-	• For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW. • Damage of irrigation networks	• Ensure completion of pipeline construction and backfilling work during the dry season. • Keep provision of the bypass drainage system, if the major streams are obstructed by the alignment during gas pipeline installation. • Construction of new culvert/pipe connection on the temporary road to drain out the overland flow in the critical crossing point. • Removal of spoiled earth of the RoW • If any irrigation canals are damaged or disrupted during project work, immediately the canals should be repaired or re-established. Loss of existing source of irrigation should be replaced by another source. • The interventions in the ponds should be completed within the shortest possible time;	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	B-	• In the Gas Pipeline project, out 253 households a total of 58 (22.92%) households were identified as vulnerable. Among them 20 are female-headed having no male income earner, 13 are elderly headed, and 25 were identified as extremely poor. • The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities • The vulnerable people who involved in agricultural and fishing work will be affected most by this project;	• Provide unskilled jobs and employment opportunities for the vulnerable group. • Giving preference in physically less demanding jobs in the worker camp/ construction such as cleaning, office assistant, etc.; • Ensure the non-exploitation of women in terms of equal wage, opportunity, participation in decision-making, etc. • Implementation of social welfare programs including ILRP targeted at vulnerable groups including women-headed households, old aged, physically handicapped, etc. • Provide a special allowance to support livelihood.	Appointed Contractor	BEZA	Contractor Cost
	Local Economics, such as employment, livelihood	B-	• Only one (1) persons were identified as sharecroppers in the project area. A total of 52 workers will lose their livelihood earning source. • PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. • Some industries' operation will be temporarily closed for the pipeline installation.	• If the agricultural crops are at the ripe stage, the project work may be delayed for allowing the farmers to harvest their crops. If the crops are damaged, farmers should be given financial compensation. • Give proper compensation to farmers and sharecroppers as per LAP • Keep the fish habitats as natural as possible by avoiding the construction of any concrete structure; • Income loss can be mitigated by	BEZA/ Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		Workers of the factories will lose their job temporary. • On the other hand, an increase of job opportunity as construction workers or commercial opportunity to the workers is expected.	providing alternative job opportunities for PAPs; • All direct income loss must be adequately compensated within the RAP; • Provision of proper training to all workers for handling the construction activities;			
Land Use and Utilization of local resources	B-	• The Gas Pipeline requires approximately 8.86 acres of land. A large portion (8.17 acres) of land selected for gas pipeline project is found as an agricultural category, though at many places the owners of land developed the land for homestead purposes. • Impact on agriculture activities/ resources is anticipated; • Factory building will be damaged.	• The agricultural area which will be tentatively occupied during construction will be restored to the original state and returned to the landowner after construction. • Backfilling of soil should be done properly. • Soil should be kept clear from contamination during construction work. • Proper compensation for loss of structure should be ensured	Appointed Contractor	BEZA	Contractor Cost
Misdistribution of Benefits and Damages	B-	• Affected Landowners, factory workers, may not find the same income source.	• Give proper compensation to PAPs. • Establish GRC to support PAPs. • Provide ILRP to help PAPs to restore source of income • Assign external monitoring committee or consultant. • Provide job opportunity for PAPs during construction.	BEZA/Appointed Contractor	BEZA	Contractor Cost
Gender	B-	• Wives of those men who lose their land or jobs may	• Monitoring of payment to workers by the contractor shall be implemented	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		suffer from adverse effects on their household economy. • Female laborers may be discriminated in wage at the construction site.	not to allow payment gaps between male and female • Monitoring of gender equality should be conducted.			
Children's Right	B-	• Impact on the educational opportunity on school children in PAHs of the Project; • Underage employment may occur at the construction stage.	• Child labor at the construction site shall be strictly prohibited • BEZA shall regularly monitor project sites to guide contractors and their related firms to discourage child labor; • Social Support of sending children to school; • Introducing them to assistance organizations such as NGO and so forth	Appointed Contractor	BEZA	Contractor Cost
Infectious Diseases	B-	• Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers or the neighboring community.	• The separate arrangement of accommodation for local workers with the direction of the necessary 'code of conduct' is recommended. • To provide surveillance for worker's health; • Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; • To provide treatment through standard case management in on-site and community health care facilities as necessary; • Educating project personnel and area	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			residents on risks, prevention, and available treatment about infectious diseases;			
Working conditions, including occupational safety	B-	• Noise and vibration cause of the movement of vehicles, heavy equipment, and Lorries will impact on workers health as well as surrounding people. • Welding sparks and radiation from radioisotopes which are harmful to the human body will impact on the health of the workers; • Fire and explosion will impact the project personnel, neighbors; • The improper arrangement of sanitation and drinking water will impact on the health of the project personnel and workers. • May insect and snake bite in the labor camp; • Road Accident may occur	• Care should be taken to move/ operate and maintenance of vehicles, lorries and heavy construction equipment to minimize the level of noise and vibration; • The welding activities should be done in a restricted area. • The arrangement of adequate firefighting equipment, accessories. • Ensure all precautionary measures, i.e., proper storing and other flammable materials to reduce the possibility and risk of fire and explosion. • Enhance regular monitoring to the work site. • Adequate sanitation facilities and supply of pure drinking water will need to be ensured at the site and camps. • To provide adequate health care facilities and first aid within construction sites; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure; • To arrange for the provision of clean eating areas where workers are not	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				exposed to hazardous or noxious substances; • To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • Establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
Others	Accidents	B-	• Risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle, and machinery. • Road accident may occur	• Need contingency fund for affected neighboring people to address accidental issues during the implementation period, • Need proper danger signs/ posters, road marks, poles, fences, etc. to avoid the accident at the pipeline installation site, • Proper awareness program about possible accidents should be ensured for the neighboring people; • Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors;	Appointed Contractor	BEZA	Contractor Cost
Operational Phase							
	Soil Pollution	B-	• Pigging of the pipe for	• Solid and liquid wastes should not be	TITAS	TITAS/BEZA	O&M

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			cleaning purposes may generate hazardous pollutants from TBS/CGS etc., If these pollutants are not safely disposed of, then the soils of the project areas will be polluted. • During maintenance, vehicles and machinery lubricant will be spilled over the soils • Handling, storage, transport and disposal of all hazardous materials have an impact on soils	spread over the project site. These are to be kept in containers for safe disposal elsewhere. • Segregate non-hazardous solid waste from hazardous one and dispose of properly; • Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; • Some chemicals like odorants, battery fluids, etc. at control station plants and the radioactive isotopes which are occasionally used/ hired for NDT in pipeline O&M purposes are to be carefully handled, transported only in properly signed vehicles			
Social Environment	Working Conditions, including Occupational Safety	B-	• Leakage of high-pressure gas may create fire and other disasters during the operation phase • Human Safety • Handling, storage, transport and disposal of all hazardous materials have the impact to soils or ground/ surface water as a result as a result of leakages or spills during use • Fugitive emission of gas from the pipeline system	• Sharing information related possible risk and hazard; • Establish a network of information dissemination; • Organize training sessions for local people to train them in emergency response against possible disaster. • To provide adequate health care facilities and first aid within the operation site; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure;	TITAS	TITAS/BEZA	O&M
Others	Accident	B-	• Possible accidents may include leakage of light oil	• Creating and implementing a safety education program	TITAS	TITAS/BEZA	O&M

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		as a standby fuel or breakage of the gas pipeline in terms of equipment. • The possible accident may be breakage of the transmission line due to the earthquake and other natural disasters.	• Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities • Management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program • Installation of fire prevention equipment and facilities; • Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning, and facilities; • Working out safety regulations.			

E-6.1 Cost Estimation for Environmental Mitigation Measures and Monitoring

Considering the management cost, environmental management cost has been proposed for both power plant and gas transmission line. Besides the management plan, an environmental monitoring plan has been proposed for power plant and gas transmission line. The estimated environmental management cost for power plant during the construction and operation phase as 950, 000 BDT and 350,000 BDT respectively. Whereas, the management plan budget for gas transmission line estimated as 900,000 BDT and 100,000 BDT during construction and operation phase. The environmental monitoring costs for the power plant and gas transmission line have been estimated as during the construction and operation phase have been estimated as 4,680,000 BDT and 1,245,000 BDT.

E-7 Consultation with Stakeholders/Public Consultation

Several focus group discussion and public consultation meetings were conducted for power plant and gas transmission line project. Local people were more concern about the land acquisition and resettlement issue. People gave their consent to develop the power plant and gas transmission line as the economic zone will enhance national economic development as well as provide job opportunity. They express their willingness with the project if proper compensation and resettlement provide the affected household.

E-8 Conclusion and Recommendations

Due to the scarcity of electricity, BEZA has intended to construct power plant at Araihazar Economic Zone and installed Gas transmission pipeline from Haripur TBS to Dighi Barabo CGS with the requirement of Economic Zone. From the social and economic point of view, the project is very much important. Therefore, there is no doubt about the establishment of the power plant and Gas Transmission Pipeline. However, the question arises how the plant will be established in an environmentally friendly manner at the proposed site. The environmental studies reveal the possible environmental issues and mitigation measures to reduce the environmental impacts of the project.

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

Thus, the proposed Gas pipeline project activities have also no significant adverse environmental impact so far as a time-bound execution program with the application of advanced environment-friendly construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the pipeline system. Benefits in the project area will not be that significant except for some short-term employment and business opportunities during the construction phase.

As such, the execution of the project would stand environmentally sound and socio-economically sustainable with due adoption of the recommended mitigation measures and environmental management and monitoring processes.

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

CHAPTER 1: INTRODUCTION

1 INTRODUCTION

1.1 Background

The government of Bangladesh has announced that no new EPZ is needed, but instead, it has launched a new policy to establish "Economic Zones (EZs)" to reinforce the enter-industrial relationship of export industry and domestic industry, and to optimize the domestic market. Under these circumstances, the government of Bangladesh has requested the government of Japan to provide Yen loan for "the Foreign Direct Investment Promotion Project (hereinafter FDIPP)" in order to establish a new EZ mainly targeting Japanese companies and to further facilitate investments from Japan. Certain number of Japanese companies are hesitant to invest in Bangladesh due to the lack of stable power, gas and road infrastructure, and uncertainties towards the investment promotion policies and the implementation capability of the Bangladesh government.

Planned and appropriate use of power is one of the pre-conditions for economic development of Bangladesh. There is a huge demand for electricity in our day-to-day life as well as in various sectors of the economy. The total power produced in the country is not enough to ensure adequate access to electricity. As of now, only 62 percent of the total population has access to electricity. Per capita, electricity generation is only 321 kWh (BPDB, 2014), which is very low compared to that of other developing countries. In order to improve this situation, the Government has given the highest priority to power sector development and is committed to making electricity available to all by 2021. Several programmes have already been taken up to implement short, medium and long-term plans for the balanced development of the power sector to scale up electricity generation. FY July 2018, a total of 16,102 MW net energy (8845 MW in the public sector and 7257 MW in the private sector including (IPP, SIPP, Rental, and REB) was generated. Of the total generation, the public-sector power plants generated 54 percent while private sector generated 46 percent. The share of gas, hydro, coal, Diesel and Furnace oil-based energy generation was 60.32 percent, 1.43 percent, 3.25 percent, 8.57 percent, and 22.31 percent respectively.

Bangladesh Economic Zone Authority (BEZA) has proposed to set up a Gas Turbine Combined Cycle (GTCC), Gas Engine (GE) and Diesel Engine (DE) based Power Plant at Araihazar EZ as per the decision of the Government toward awarding the task in favor of the proponent. BEZA hence seeks to construct and operate the above-proposed power plant at Araihazar EZ in the district of Narayanganj that is adjacent to the Dhaka-Sylhet Highway.

The original requirement of a power station was to provide a backup supply for the grid power, and its capacity was to be 40MW on Bangladesh site conditions. 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only. 2 sets of 6MW GE and 1 set of 3MW DE. For starting GT during the blackout, the emergency power supply including a shortage of gas fuel supply and continuous power supply during low power demand of EZ during operations, etc. The total capacity of Power plant is approximately 46MW on ISO conditions, i.e., 40MW on Bangladesh site conditions. Total 22.93 acres land will be required for setup the proposed power plant.

PGCB agreed that the EZ would receive power from either a 132kV or a 230kV transmission line as an exceptional case considering it as a government project of EZ by BEZA. PGCB System Planning Division advised that the EZ should receive power from the 230kV transmission line having enough capacity since the 132kV transmission line may not have enough capacity considering the Phase 2 expansion. 230kV Transmission line passes over the south corner of the location of the substation. For connecting the new substation with the 230kV Transmission line, branch towers and terminal towers will be newly installed.

A 5.825 km Gas transmission pipeline will be constructed from Haripur TBS located at Word No-27 under Kadam-Rasul Paurashava to Dighi Barabo CGS at ward No-9 under Tarabo Paurashava. The proposed gas pipeline will be installed mostly following the open cut method. The gas pipeline needs to cross the Dhaka-Chittagong highway and a canal. The road will be crossed using the thrust boring method whereas the canal will be crossed following the open cut method. Approximately 8.65 acres of land need to be acquired, and 8.11 acres land will be leased for construction of the gas pipeline.

The proposed power plant and Gas transmission pipeline falls under "red category" and requires carrying out EIA in accordance with the Environment Conservation Act 1995 and the Environment Conservation Rules 1997 (ECR, 1997). The EIA of the proposed power plant project presented in this report has been carried out considering the ToR provided by the BEZA, the guidelines of the Department of Environment (DoE) of GoB (GoB, 1997) and JICA.

1.2 Brief Description

The proposed power plant site is located at Duptara Union, Araihazar upazila under Narayanganj District adjacent to the Dhaka–Sylhet Highway. The total land of the project area is 9.28 ha or 22.93 acres. The proposed power plant project has been bounded with existing agricultural land & Settlement on the northeast direction, agricultural land & settlement on southeast Side, Settlement and Agricultural Land on the north-west and Sonpara village & Agricultural Land in the west. A 6 km Gas transmission pipeline will be constructed from Haripur TBS located at Word no-9 under Kadam-Rasul Paurashava to Dighi Barabo CGS at Tarabo Paurashava. The proposed gas pipeline will be installed mostly following the open cut method. The gas pipeline needs to cross the Dhaka-Chittagong highway and a canal. The road will be crossed using the thrust boring method whereas the canal will be crossed following the open cut method. Approximately 8.65 acres of land need to be acquired, and 8.11 acres land will be leased for construction of the gas pipeline.

The original requirement of a power station was to provide a backup supply for the grid power, and its capacity was to be 40MW on Bangladesh site conditions. 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only. 2 sets of 6MW GE and 1 set of 3MW DE. For starting GT during the blackout, the emergency power supply including the shortage of gas fuel supply and continuous power supply during low power demand of EZ during operations, etc. The total capacity of Power plant is approximately 46MW on ISO conditions, i.e., 40MW on Bangladesh site conditions.

PGCB agreed that the EZ would receive power from either a 132kV or a 230kV transmission line as an exceptional case considering it as a government project of EZ by BEZA. PGCB System Planning Division advised that the EZ should receive power from the 230kV transmission line having enough capacity since the 132kV transmission line may not have enough capacity considering the Phase 2 expansion. 230kV Transmission line passes over the south corner of the location of the substation. For connecting the new substation with the 230kV Transmission line, branch towers and terminal towers will be newly installed.

1.3 Scope of Study

The scope of the study covers the environmental legislative, regulatory & policy guidelines and considerations relating to the implementation of the proposed power plant & gas transmission pipeline Project including the following:

1. Carried EIA Study according to the DoE and JICA Guidelines;
2. Data collection
    - Project planning information
    - Physical, geological and land use information of the project area
    - Ecological survey; and
    - Socioeconomic data.
3. Investigation and survey
    - Water quality data collection and analysis;
    - Meteorological, air quality and noise level investigation;
    - Soil investigation; and
4. Establishment of the environmental and social baseline condition in respect to the followings:
    - Physical;
    - Biological; and
    - Socio-economic condition.
5. Public consultations and disclosure
6. Impact assessment
    a. Identification of potential environmental impacts;
    b. Identification of potential socio-economic impacts; and
    c. Evaluation of identified impacts.
7. Identification of suitable control measures for emissions
    a. Control measures for NOx, CO2
    b. Exhaust stack requirements
8. Preparation of Environmental Management Plan (EMP) along with the Monitoring Plan.

1.4 Methodology

The EIA of Proposed 40 MW power plant to be constructed at the location of Duptara Union under Araihazar upazila and 6 km Gas transmission pipeline Haripur TBS located at Word no-9 under Kadam-Rasul Paurashava to Dighi Barabo CGS at Tarabo Paurashava has been conducted following the JICA and EIA Guidelines for Industries, prepared by the DoE in 1997 in accordance with the requirement of the Environment Conservation Rules, 1997 under the Environment Conservation Act 1995. EIA process involves identification of the key impacts on the natural and social environment and evaluation of the significant impacts along with the recommendation of measures as well as the listing of unresolved environmental issues. The EIA includes the collection of baseline information, the indication of important environmental and social components through the scoping session, setting up of spatial and temporal boundaries for assessing impacts, impact assessment and evaluation, the suggestion of mitigation measures and providing an environmental management plan. The EIA methodology follows the overall impact assessment approach illustrated in **Figure 1-1.**

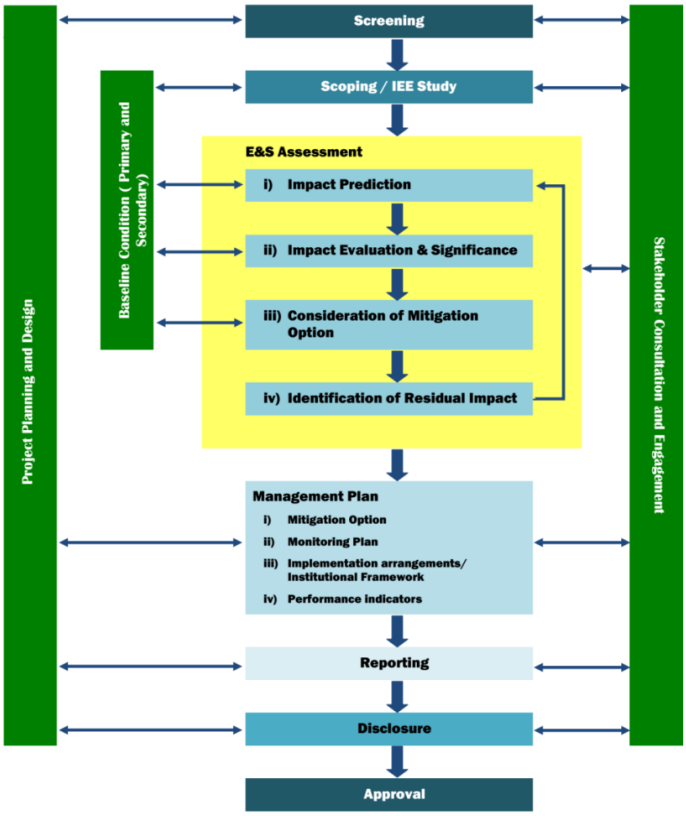


Figure 1-1: Impact Assessment Process

The initial step of an EIA is the collection of primary and secondary data. Reviews of available literature from various sources, interviews of local stakeholders and site visits are the steps to collect baseline information for the project as well as for the study area (Area account for 5 km radius from the periphery of project boundary). Important environmental and social components (IESCs) are indicated through scoping session based on the physical investigation, local stakeholder's opinion, and specification of the power plant. Setting up of boundaries is an important step, and the elements used for the scoping were the geographical boundary, affected groups, etc. The scoping covered all the phases of project implementation. Impacts caused due to the construction of the plant are evaluated following the international method. Mitigation measures of the identified significant impacts have been suggested, and a comprehensive Environmental Management Plan (EMP) has been proposed for the EIA study. The unresolved critical issues and resolution of issues have been discussed in the EMP.

The EIA report of the 40 MW power plant at the above location has been prepared based on the findings from the field observation and consultation with local people. This study was initiated with the collection of environmental and socio-economic data from secondary sources. The primary data and public opinions have been collected from the project site and the study area. However, most of the data, which have been used for outlining baseline condition, have been collected from secondary sources. Remotely sensed satellite images have been procured, processed, ground truth and interpreted for the enrichment of EIA study of 40 MW power plant.

The baseline has covered a detail description of the physical environment, water resources, land resources, agriculture, fisheries, ecosystems and socio-economic condition including identification of problems in respect of the resources. Field visits were carried out in the project site as well as in the whole study area. The main objectives of these visits were observation, assessment and professional justification. These have been conducted to identify the Important Environmental and Social

Components (IECs/ISCs) through a scoping process including scoping sessions with the stakeholders. The visits also aimed for public consultation and disclosures as suggested in the EIA guidelines of DoE. Important parameters such as soil criteria, surface and groundwater quality, noise, air quality etc. of the baseline situations have been generated from long-term data collected from different organizations like: Soil Resources Development Institute(SRDI), Bangladesh Water Development Board (BWDB), Bangladesh Inland Water Transport Authority, Department of Fisheries (DoF), Department of Public Health and Engineering (DPHE), Upazila Offices of different agencies, Bangladesh Meteorological Department (BMD) and Department of Environment (DoE). Most of the social and economic data have been generated from field survey and BBS censuses. Moreover, EQMS has its own database for different resource sectors, which also helped in conducting the EIA study.

Data from secondary as well as primary sources on the physical environment, water resources, land resources, agriculture, fisheries, ecosystems and socio-economic condition have been collected for assessing the environmental and social impact of the proposed project and establishing an environmental management plan.

1.5 Limitation

The present EIA Report has been prepared based on the Primary field investigations/ assessment, and secondary data from data collected from Department of Public Health and Engineering (DPHE), Bangladesh Meteorological Department (BMD), Department of Environment, Bangladesh (DoEB) and published journals, and books, public consultation and site observations. The environmental and social assessment is based on the information collected from the various agencies, community consultations, and observations. Professional judgment and subjective interpretation of facts and observations have been applied for the preparation of the EIA Report.

Additionally, gas line alignments are not fixed till date; thus assessment is made on the basis of preliminary information available from JICA and for all the options which could be explored. The area (power plant area detailed planning will be carried out by the prospective private developer) information are available limited to feasibility assessment.

1.6 EIA Team

EQMS has formed a multidisciplinary team of professionals having experiences of conducting an Initial Environmental Examination as well as Environmental and Social Impact Assessment of large-scale industrial and infrastructural development projects. ***Table 1-1*** presents the names with the positions of the professional.

Table 1-1: Team composition

Sl. No.	Name of Professional	Position Assigned
1	Kazi Farhed Iqubal	Team Leader/Environmental Expert
2	Abdul Halim	Sociologist
3	Tauhidul Hasan	Sr. Environmental Expert
4	Abu Mohammad Nasir Uddin	Jr. Sociologist
5	Mirza SA Habib	Ecologist
6	Farah Shamima Sultana	GIS Expert
7	Najmul Hossain Nahid	Jr. Environmental Engineer
8	Toffazzal Hossain	Field Coordinator

1.7 References

List of secondary data used for carrying out EIA study and preparation of EIA report is given in ***Table 1-2*** below.

Table 1-2: Reference Used for EIA Study

Sl#	Reference
Government Departments	
1.	Bangladesh Agriculture Research Council
2.	Bangladesh Economic Zone Authority
3.	Bangladesh Water Development Board
4.	Bangladesh Rice Research Institute
5.	Bangladesh Meteorological Department
6.	Bangladesh Bureau of Statistics
7.	Bangladesh Food & Agriculture Department (FAO, Bangladesh)
8.	Geological Survey of Bangladesh
9.	Disaster Management Bureau (DMB)
10.	Department of Disaster Management (DDM)
11.	Department of Agriculture Extension
12.	Department of Environment
13.	Department of Fisheries
14.	Land & Revenue Department, Narayanganj
15.	Ministry of Land
16.	Ministry of Power, Energy & Mineral Resources
17.	Petrobangla
18.	Titas Gas Transmission and Distribution Company Limited
Journals, Books & Existing Studies	
1.	Hossain, S; Das, N. G.; Sarker, S; Rahaman, Z, National Institute of Oceanography and Fisheries (Egyptian Journal of Aquatic Research), Fish Diversity and Habitat Relationship with Environmental Variables at Meghna River Estuary, Bangladesh, December 2012
2.	Maps from Bangladesh Agriculture Research Council
3.	Bio-ecological Zones of Bangladesh, IUCN
4.	District Statistics, 2011, Narayanganj, December 2013, BBS, Statistics and Information Division, Ministry of Planning, Govt. of the people's republic of Bangladesh
5.	Fisheries Statistical Yearbook of Bangladesh, 2012-2013, Department of Fisheries, Bangladesh, Ministry of Fisheries and Livestock
6.	Sarker, S, U& Sarker, N, J, Department of Zoology, University of Dhaka, 1985, Migratory Raptorial Birds of Bangladesh
7.	Amin, S, M, N; Ara, B; Rahman, M, A; Nahar, S; Haldar, G, C & Mazid, M, A, 2006, Catch Per Unit Effort (Cpue) and Hydrological Aspect of Major Spawning Site of Hilsa, Tenualosa Ilisha in Bangladesh
8.	Annual Report 2010-2011, Bangladesh Agriculture Development Corporation Monitoring Division
9.	National Land Zoning Project, December 2016, Araihazar Upazila, District: Narayanganj.

Sl#	Reference
Website	
1.	Google maps
2.	http://www.bangladeshtourismdirectory.com/bangladesh-archaeological-sites list.html
3.	Google earth imageries
4.	http://www.saarc-sadkn.org/countries/bangladesh/disaster_mgt.aspx (Bangladesh Disaster Knowledge Network)
5.	http://www.fao.org/docrep/field/003/AC360E/AC360E03.htm#anxA
Others	
1.	Site visits
2.	Project for development of economic zones and capacity enhancement of Bangladesh economic zones authority, JICA 2017
3.	Environmental Impact Assessment (EIA) study of Araihazar Economic Zone at Araihazar, Narayanganj
4.	Resettlement Action Plan for Gas Transmission Line from Haripur to Dighiborabo Substation.

CHAPTER 2: LEGISLATIVE, REGULATION AND POLICY CONSIDERATION

2 LEGISLATIVE, REGULATION AND POLICY CONSIDERATION

2.1 Introduction

The proposed 40 MW Power Plant will implement in compliance with applicable environmental laws and regulations. Bangladesh has a wide range of laws and regulations related to environmental protection, natural resources conservation as well as social issues, which are mostly cross-sectoral and would be applicable to the proposed project. The applicable, relevant environmental laws and policies are described in the following sections.

2.2 Environment Related Policies in Bangladesh

2.2.1 National Environmental Policy, 1992

Bangladesh National Environmental Policy (GoB, 1992) was approved in May 1992, and sets out the basic framework for environmental action, together with a set of broad sectoral action guidelines. Key elements of the policy are:

- Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment;
- Protection of the country against natural disasters;
- Identification and regulation of all types of activities which pollute and degrade the environment;
- Ensuring sustainable utilization of all natural resources;
- Active association with all environmental related international initiatives.

The environmental policy contains the following specific objectives with respect to the industrial sector:

- To adopt corrective measures in phases in industries that cause pollution;
- To conduct Environmental Impact Assessments (EIAs) for all new public and private industries;
- To ban the establishment of any industry that produces goods that cause environmental pollution, closure of such existing industries in phases and discouragement of the use of such goods through the development and/or introduction of environmentally sound substitutes;
- To ensure sustainable use of raw materials in industries and to prevent their wastage.

The environmental policy also promulgation that EIA's should be conducted before the project is undertaken and all Environmental Impact Assessments are directed to review and approve by DoE.

2.2.2 National Environmental Management Action Plan, 1995

National Environmental Management Action Plan, also referred to as NEMAP (GoB, 1995) is a wide-ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005 and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP was developed to achieve the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of nature and built environment;

- Conservation of habitats and biodiversity;
- Promotion of sustainable development;
- Improvement in the quality of life of the people.

One of the key elements of NEMAP is that sectoral environmental concerns are identified. In outline, the environmental issues of the industrial sector include the following:

- Pollution arising from various industrial processes and plants throughout the country causing varying degrees of degradation of the receiving environment (Air, Water, and Land);
- There is a general absence of pollution abatement in terms of waste minimization and treatment;
- Low level of environmental awareness amongst industrialists and entrepreneurs;
- Lack of technology, appropriate to the efficient use of resources and waste minimization leading to unnecessary pollution loading in the environment;
- Economic constraints on pollution abatement and waste minimization such as the cost of new technology, the competitiveness of labor, and intensive production methods as compared to more modern methods;
- The concentration of industry and hence pollution in specific areas which exacerbate localized environmental degradation and exceed the carrying capacity of the receiving bodies;
- Unplanned industrial development has resulted in several industries located within or close to residential areas which adversely affects human health and quality of the human environment;
- Establishment of industries at the cost of good agricultural lands and in the residential areas;
- Lack of incentives to industrialists to incorporate emission/discharge treatment plant in their industries.

2.2.3 National Conservation Strategy, 1992

National Conservation Strategy (GoB/IUCN, 1992) was drafted in late 1991 and submitted to the Government in early 1992. Meanwhile, it underwent a number of modifications over the last five years. For sustainable development in the industrial sector, the report offered various recommendations; some of those are as follows:

- Industries based on nonrenewable resources should be made to adopt technology which conserves raw materials, and existing industries should be given incentives to install technical fixes to reduce wastage rate;
- All industries, especially those based on imported raw materials, should be subjected to EIA and adoption of pollution prevention/control technologies should be enforced;
- No hazardous or toxic materials/wastes should be imported for use as raw material;
- Import of appropriate and environmentally sound technology should be ensured;
- Complete dependence on imported technology and machinery for industrial development should gradually be reduced, so that industrial development is sustainable with local skills and resources.

2.3 Environment and Social Related Legislation in Bangladesh

2.3.1 Environmental Conservation Act, 1995 and Amendment, 2000, 2002, 2010

The provisions of the Act authorize the Director General of Department of Environment (DoE) to undertake any activity that is deemed fit and necessary to conserve and enhance the quality of the environment and to control, prevent and mitigate pollution. The main highlights of the act are:

- Declaration of Ecologically Critical Areas;
- Obtaining Environmental Clearance Certificate;

- Regulation with respect to vehicles emitting smoke harmful for the environment;
- Regulation of development activities from an environmental perspective;
- Promulgation of standards for quality of air, water, noise, and soils for different areas and for different purposes;
- Promulgation of acceptable limits for discharging and emitting waste; and
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation, and improvement of the environment.

The Act is being implemented by the Department of Environment (DOE). DOE is under the Ministry of Environment and Forest and is headed by a Director General (DG). The DG has complete control over the DOE. The power of DG has been indicated in this act.

The Environmental Conservation Act (Amendment 2000)

The Bangladesh Environment Conservation Act (Amendment 2000) focuses on ascertaining responsibility for compensation in cases of damage to ecosystems. It allows for the increased provision of punitive measures both for fines and imprisonment, and the authority for nominated officials to record the details of alleged offences and to prosecute the offenders.

The Environmental Conservation Act (Amendment 2002)

The 2002 Amendment of the ECA elaborates on the following parts of the Act:

- Restrictions on automobile emissions;
- Restrictions on the sale and production of environmentally harmful items like polythene bags;
- Assistance from law enforcement agencies for environmental actions; and
- Authority to try environmental cases in court (also supported by the Environmental Court Act, 2000).

The Environmental Conservation Act (Amendment 2010)

The amendment of ECA'95 has been published on 5 October 2010 as Bangladesh Environmental Conservation Act, 2010. Some changes and inclusions have been made in different clauses particularly in defining the Ecological Critical Area, farming certain rules and conditions in cutting and/or razing hills, handling disposal of hazardous wastes, managing ship braking industries & wetlands, fixing responsibilities of environmental and safety management, obligations of obtaining and issuance of environmental clearance certificates and imposing penalties for violations including but not limited to filing cases for compensations, fixing fees and framing different rules under this Act.

2.3.2 Environmental Conservation Rules, 1997 and Subsequent Amendment, 2002 & 2006

The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter alia, the following:

- The National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise, and vehicular exhaust;
- Categorization of industries, development projects, and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load;
- Procedure for obtaining environmental clearance;
- Requirements for undertaking IEE and EIA's as well as formulating EMP's according to categories of industries/development projects/activities; and
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

Depending upon the location, size, and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories:

Green, Orange A, Orange B, and Red respectively as nil, minor, medium and severe impacts on important environmental components (IECs).

2.4 National Policies and Laws Related to Power Generation

2.4.1 Bangladesh Energy Regulatory Commission Act, 2003 (Amended 2005, 2010)

In order to create an atmosphere conducive to private investment in the generation of electricity and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors and to protect consumers' interest and to promote the creation of a competitive market an independent and impartial regulatory commission was established through this act. The functions of the commission pertinent to electricity generation are as follows:

- to determine efficiency and standard of the machinery and appliances of the institutions using energy;
- to ensure efficient use, quality services, determine tariff and safety enhancement of electricity generation
- to issue, cancel, amend and determine conditions of licenses, exemption of licenses and to determine the conditions to be followed by such exempted persons;
- to approve schemes on the basis of the overall program of the licensee and to take the decision in this regard taking into consideration the load forecast and financial status;
- to collect, review, maintain and publish statistics of energy;
- to frame codes and standards and make enforcement of those compulsory with a view to ensuring the quality of service;
- to develop uniform methods of accounting for all licensees;
- to encourage to create a congenial atmosphere to promote competition amongst the licensees;
- to extend co-operation and advice to the Government, if necessary, regarding electricity generation
- to resolve disputes between the licensees, and between licensees and consumers, and refer those to arbitration if considered necessary;
- to ensure an appropriate remedy for consumer disputes, dishonest business practices or monopoly;
- to ensure control of environmental standard of energy under existing laws; and
- to perform any incidental functions if considered appropriate by the Commission for the fulfillment of the objectives of this Act for electricity generation, quality of services, tariff fixation and safety improvement

2.4.2 Power System Master Plan, 2016

The Power System Master Plan (PSMP) 2016, sponsored by Japan International Cooperation Agency (JICA) aims at assisting Bangladesh in formulating extensive energy and power development plan up to the year 2041, covering energy balance, power balance, and tariff strategies. Bangladesh has an aspiration to become a high-income country by 2041. The development of energy and power infrastructure, therefore, pursues not only the quantity but also the quality to realize the long-term economic development. Since Bangladesh is facing to the depletion of domestic gas supply, various issues such as sustainable development harmonizing with economic optimization, improvement of power quality for the forthcoming high-tech industries, and the discipline of operation and maintenance (O&M) for power plants need to be addressed holistically. Furthermore, energy subsidy

is also a tough challenge, because there's always a concern that the drastic increase in fuel and electricity prices may trigger another negative effect on the national economy. A meticulous analysis is required to find the best pathway to attain the sustainability of the energy and power sectors in balancing with economic growth. The new PSMP study covers all the aforementioned challenges comprehensively, and come up with feasible proposals and action plans for Bangladesh to implement.

2.4.3 Power System Master Plan, 2010

A Master Plan for the attainment of stable power supply in the People's Republic of Bangladesh up to the year 2030 has been developed in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan, and identification of the potential power plant sites based on the fuel diversification study. The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from the natural gas of the country and rest by hydroelectricity and coal. The power sector master plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel, etc. as well as renewable energy sources. In this Master Plan, the target composition of the power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such as oil, nuclear power, and renewable energy.

2.4.4 Electricity (Amendment) Act, 2012

This act lays out the responsibilities of the utilities entrusted to generate electricity (for capacities not below 25 MW). As per this act, the duties of a generating utility shall be to establish, operate and maintain generating stations, tie-lines or interconnection lines, and associated sub-stations, to supply electricity to any licensee in accordance with the provisions of this Act or the rules or regulations made under the act, submit technical details regarding its generating stations to the Commission, coordinate with the Transmission Utility, for transmission of the electricity generated by it; and liaise with the ISO for dispatch of electricity generated by each of its generating stations. It shall also be the duty of every generation utility to develop a time-bound plan to diversify its fuel source and to ensure that the electric energy it sells to consumers is generated using a diverse range of fuels and technologies, including renewable technologies under a pre-determined principle of least-cost generation.

2.4.5 Private Sector Power Generation Policy of Bangladesh 1996 (Revised 2004)

The Recognizing that the likelihood of securing the substantially high volume of investment for power generation requirements for future alone through the public sector is remote and that there are competing demands on government resources and declining levels of external assistance from multilateral/bilateral donor agencies for public investment in the power sector, GoB amended its industrial policy to enable private investment in the power sector and to promote private sector participation in the generation of electricity in order to attain higher economic efficiency. In this policy, the Government has expressed its commitment to attracting private investment for installing new power generation capacity on a build-own-operate (BOO) basis. The modalities of implementation, the tariff for bulk purchase of power, financial incentives for the private sector and foreign investors are laid out in this policy. The Power Cell has the mandate to lead private power development, recommend power sector reforms & restructuring, conduct study on tariffs and formulation of a regulatory framework for the power sector. The Power Cell shall facilitate all stages of promotion, development, implementation, commissioning, and operations of private power generation projects and suitably address the concerns of project sponsors. It will also assist project sponsors to secure necessary consents and permits from GoB where such consents and permits would be needed.

2.4.6 National Energy Policy 1996 and 2004

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 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 socioeconomic 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 the establishment of power generation plants and networks for transmission and distribution of electricity" (GoB 2004:1).

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 the 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).

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 the 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 an economically viable environment-friendly technology is to be promoted;
c. Use of fuelwood 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 the 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 the use of Catalytic Converter and Diesel Particulate Filter will be encouraged to reduce vehicular emissions;
j. For improving the environmental condition in the country, producing energy from wastes will be encouraged.

2.4.7 Policy Guideline for Small Power Plant (SPP) in the private sector, 1998 (revised 2008)

This document outlines the guidelines for private sector investors to establish Small Power Plants (SPP) on a fast track basis, for generation of electricity for own use and sell the surplus to other users. The plant size could be in the order of 10 MW, which could be built up in stages as necessary, and depending on the potential market and load growth. However, if required, permission may be accorded by the government for setting up higher size plant. The SPPs will be developed on a Build-Own-Operate basis. The summary of the guidelines is as follows:

- The type of plant is open, and the sponsor will be allowed to select plant of any configuration provided the electrical characteristics of the plant match that of the power system in Bangladesh.
- Where available, a subsidiary of Petrobangla may supply natural gas to the sponsor on a commercial basis at a price determined by the Energy Regulatory Commission. Alternatively, the sponsor may arrange his own fuel.
- It will be the responsibility of the sponsor to find customers for electricity. The distribution system required for the supply of electricity to the contracted customers may be built by the sponsors themselves, or they can use the existing transmission and distribution systems if there is adequate capacity.
- In areas covered by BPDB/DESA/REB, the tariff announced by GoB from time to time shall apply.
- As per the Electricity Act, 1910, the Sponsors will be required to obtain the license from the GoB. The SPP will need to comply with all laws of Bangladesh including Environmental Standards.
- GoB support will be provided on "First Come First Serve" basis. Necessary advice and other assistance will be provided by the Power Cell for the establishment of SPPs.
- The sponsors under this policy including the Captive Independent Power Producer and the sponsors of Captive Power Generation who will set up power plants within a period of three years from the date of its statutory notification under this policy will enjoy the "Fiscal Incentives" and "Other Facilities and Incentives for Foreign Investors" provided under Section 5.0 and 6.0 respectively of the "Private Sector Power Generation Policy of Bangladesh"

2.4.8 Bangladesh Natural Gas Safety Rules (1991)

The *Mineral Gas Safety Rules* are derived mainly from the American Society of Mechanical Engineers (ASME), American National Standard Institute (ANSI) and British Standards (BS) codes and practices, as well as the provisions of the *Petroleum Act*. The Rules deal with the design and construction of gas pipelines in areas including:

- Selection of materials;
- Specifications for pipeline crossings of other infrastructure such as railways;
- Testing and commissioning of pipelines;
- Pipeline operation and maintenance; and
- Reporting of accidents.

The Rules are largely prescriptive and include stipulations as to the separation distances between pipelines and public properties and thoroughfares. The provisions of the rules have been updated most recently through an amendment which was gazetted in 2003.

In section 31 of the rules stated for the gas pipeline safety. The following safety distances from protected works shall be maintained for all high-pressure pipelines to be operated above 10 kg/cm^2.

The outside diameter of pipe, cm	Maximum allowable working pressure, kg/cm^2				
	10 to 14	15 to 24	25 to 36	37 to 50	51 and above
	Safest distance (meter)				
Not exceeding 10	3.0	4.0	5.0	7.0	7.5
11-20	6.0	8.0	10.0	13.0	14.0
21-40	6.5	8.5	10.5	13.5	14.5
41-60	7.0	9.0	11.0	14.0	15.0
61-80	7.5	9.5	11.5	14.5	16.0
81 and above	8.0	10.0	12.0	15.0	17.0

The chief inspector may relax the safety distances under sub-rule (1) upon a request from the operator subject to observance of safety measure as per rule 39(1).

A 20" diameter of Haripur TBS-Dighi Barabo CGS high-pressure gas pipeline will be installed to support AEZ as well as Araihazar Power plant. The BEZA/TGTDCL should have to follow the above mentioned safer distance as per the rules to build any structure or consult with respective authority for their consent.

2.5 Administrative Set up Related to Environment

The Ministry of Environment and Forest (MoEF) is responsible for the supervision of all environmental matters relating to national environmental policy and regulatory issues in the country. The MoEF oversees the following technical/implementing agencies:

- Department of Environment (DoE);
- Forest Department (FD);
- Bangladesh Forest Department Corporation (BFDC);
- Bangladesh Forest Research Institute (BFRI); and
- Bangladesh National Herbarium (BNH)

2.5.1 Department of Environment

The DOE has been placed under the MoEF as its technical wing and is statutorily responsible for the implementation of the Environment Conservation Act, 1995. The Department was created in 1989, to ensure sustainable development and to conserve and manage the environment of Bangladesh. The principal activities of the DOE are:

- Defining EIA procedures and issuing environmental clearance permits - the latter being the legal requirement before the proposed Project can be implemented;
- Providing advice or taking direct action to prevent the degradation of the environment;
- Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution;
- Setting the Quality Standards for environmental parameters;
- Declaring Ecologically Critical Areas (ECAs), where the ecosystem has been degraded to a critical state; and
- Review and evaluation of Initial Environmental Examinations (IEEs) and EIAs prepared for projects in Bangladesh.

Procedure for obtaining Environmental Clearance from DoE, Bangladesh

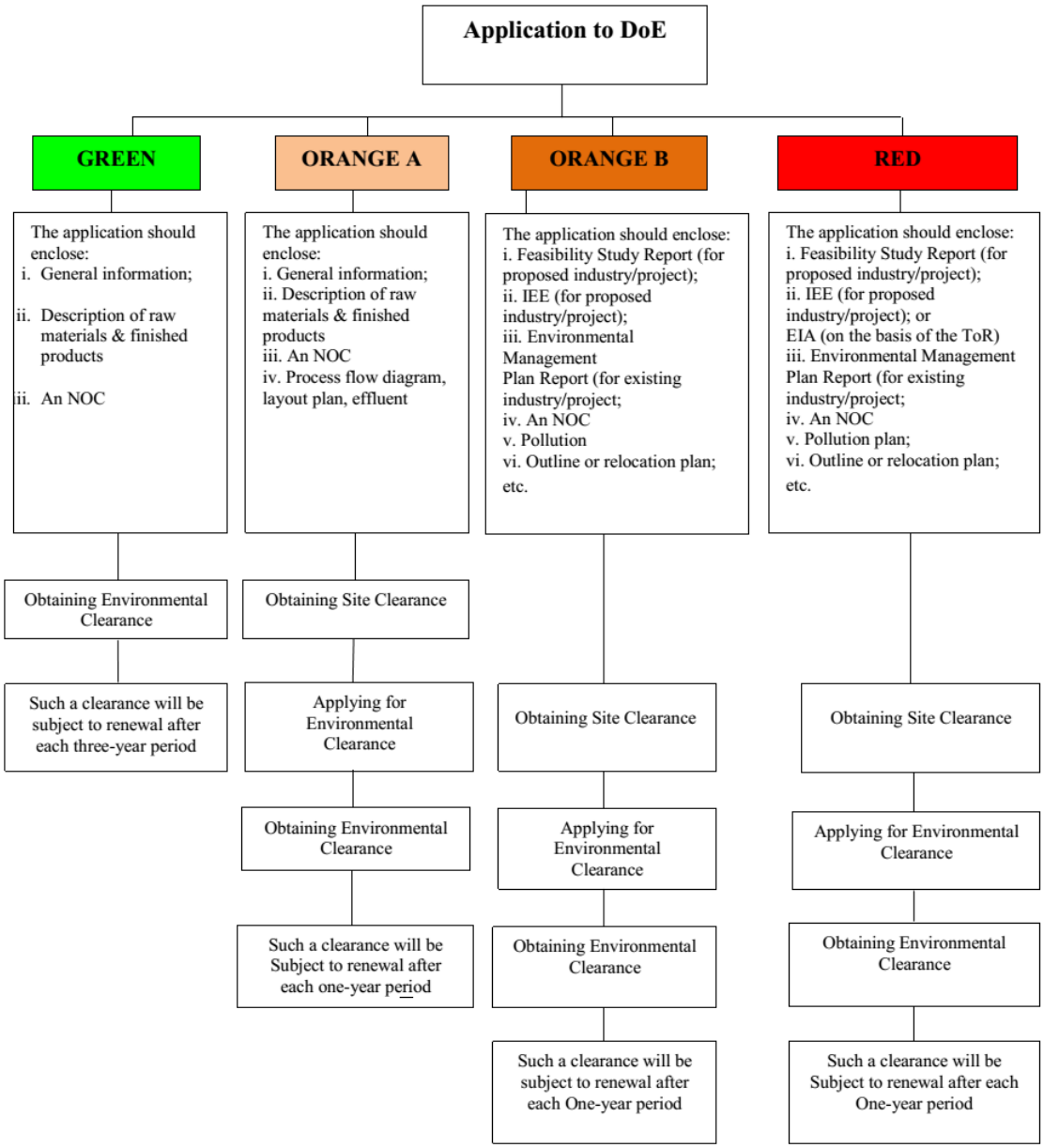
The EIA process consists of three stages, screening, IEE, and detailed EIA:

- Projects categorized as Green and Orange-A does not require IEE or EIA for environmental clearance, however, the proponent must submit an application in a prescribed format along with specified documents;
- Projects categorized as Orange-B require an IEE to be submitted to the DOE along with an application in a prescribed format and other specified documents; and
- Red category projects require both IEE and EIA. An IEE is required for the location clearance, and an EIA is required for the environmental clearance.

As per the ECR 1997, Power Plant project falls under the "RED" category as referred below:

- **Item 6: Power Plant**

The process of obtaining an Environmental Clearance Certificate for the proposed project is outlined in the following **Figure 2-1**.



(Source: EIA Guideline for Industries, Department of Environment, 1997)

Figure 2-1: Process of getting ECC at DoE for Different Categorized Project

2.6 JICA Guidelines

2.6.1 JICA Guidelines for Environmental and Social Considerations

To ensure the environmental and social sustainability of its funded projects, JICA had formulated the Guidelines for Environmental and Social Considerations (hereafter "JICA Guidelines") in April 2010. The objectives of the JICA Guidelines are to 1) encourage the executing agency to have appropriate considerations for environmental and social impacts; and 2) ensure that JICA's support for, and examination of, environmental and social considerations are conducted accordingly. The JICA Guidelines specify requirements that all executing agencies of JICA-funded projects must meet. The key requirements include, but are not limited to, the following:

1. Assessment of potential environmental and social impacts and elaboration of mitigation measures in the earliest possible planning stage, and incorporation of them into the project plan

2. Examination of multiple alternatives to avoid or minimize adverse impacts, and to select better project options
3. Sufficient consultations with local stakeholders with the disclosure of information at the earlier stage
4. Compliance with laws, standards, and plans
5. No significant adverse impacts on ecosystem and biota
6. Avoidance and minimization of involuntary resettlement, where feasible, and preparation and implementation of RAP, where involuntary resettlement is unavoidable
7. Special considerations for indigenous people
8. Sufficient monitoring to check the performance and effectiveness of mitigation measures

Thus, the BEZA, as the executing agency of project, shall satisfy the above requirements as well as the others described in the JICA Guidelines, even if the national laws and policies do not fully prescribe for these issues.

2.6.2 JICA Involuntary Resettlement Policy

The key principle of JICA policies on involuntary resettlement is summarized below.

1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
2. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
3. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
4. Compensation must be based on the full replacement cost as much as possible.
5. Compensation and other kinds of assistance must be provided prior to displacement.
6. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan includes elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
7. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
8. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
9. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Description of "replacement cost" is as follows.

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, the market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.

Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair any partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes;

The above principles are sanctioned by the World Bank's OP 4.12 since it is stated in the JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies." Additional key principles based on World Bank OP 4.12 are as follows:

1) Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits;
2) Eligibility of Benefits include, the PAPs who have formal legal rights to the land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census information collection but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying;
3) Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based;
4) Provide support for the transition period (between displacement and livelihood restoration;
5) Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc.;
6) For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared.

In addition to the above core principles of the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; a time schedule for implementation; and, detailed Financial Plan, etc.

2.6.3 The gap between Bangladeshi Legal Frameworks and JICA Policies

To be competed based on the ongoing process of land acquisition discussion between relevant authorities and BEZA.

Table 2-1: Summary of gaps between the Bangladeshi Legal Framework and the JICA Environmental Guidelines

Sl.	JICA Environmental and Social Considerations Guidelines (JICA Guidelines)	Laws of Bangladesh	Gaps between JICA Guidelines and Laws of Bangladesh
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	Not specified	The 1982 ordinance legislated nothing, while the JICA guidelines require to avoid/ minimize resettlement/ loss of livelihood

Sl.	JICA Environmental and Social Considerations Guidelines (JICA Guidelines)	Laws of Bangladesh	Gaps between JICA Guidelines and Laws of Bangladesh
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	Not specified for non-titled people	There are no provisions for compensation to the non-titled residents in Bangladesh ordinance, while JICA guidelines acknowledge all affected persons whether legally residing or not, eligible for compensation
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	Not specified for keeping the living standard of affected people the same or above pre-project levels.	There are no provisions for maintaining the living standards of affected people at the same or above pre-project levels in Bangladesh ordinance, while JICA guidelines require that no one is worse off as a result of resettlement and would maintain their living level at original levels at least.
4.	Compensation must be based on the full replacement cost as much as possible.	Compensation is made based on the pre-determined government prices as are usually quite cheaper than market prices	Compensation is made based on the pre-determined government prices that are usually lower than replacement cost.
5.	Compensation and other kinds of assistance must be provided prior to displacement.	Payment is made on predetermined time, regardless before or after the construction starts	Compensations and other assistance are made regardless before or after construction, while JICA guidelines require to make it prior to relocation
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	There is no provision for the formulation of RAP and public hearing. Deputy Commissioner contacts to landowner through Land Acquisition Officer (LAO), and if the landowner has no objection, confirmation operation for compensation amount, etc. will be proceeded	There is no provision for preparation of resettlement action plan that describes all features of resettlement requirements and ready to disclose to the public.
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	The 1982 Ordinance have provisions to notify the owners of property to be acquired.	There is no provision in the law for consulting the stakeholders but the land allocation committees at district, division, and central government level.

Sl.	JICA Environmental and Social Considerations Guidelines (JICA Guidelines)	Laws of Bangladesh	Gaps between JICA Guidelines and Laws of Bangladesh
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	No description	Requirements of JICA guidelines are not specifically mentioned in the Bangladesh laws and rules.
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	There is no provision for the monitoring related activities with the participation of affected people.	There is no provision in Bangladesh ordinances, while JICA guidelines recommend participation of affected people in planning, Implementation, and monitoring of RAP.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	In case AP has any objection to the compensation amount; the AP should protest and entrust the matter to the Arbitrator. If AP has any appeal against the Arbitrator's decision, then AP should file a lawsuit to the court and wait for the sentence.	The laws of Bangladesh states appeal to Arbitrator and court case, while JICA guideline recommends establishing an appropriate grievance mechanism for an amicable settlement to minimize legal confrontation.
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including a population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.	No such an activity required	There is no provision in Bangladesh ordinances, while JICA guidelines recommend identification of affected people the earliest possible time preferably at the project identification stage
12.	Eligibility for benefits includes, the Project Affected Persons (PAPs) who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of any census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying		
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.		

Sl.	JICA Environmental and Social Considerations Guidelines (JICA Guidelines)	Laws of Bangladesh	Gaps between JICA Guidelines and Laws of Bangladesh
14.	Provide support for the transition period (between displacement and livelihood restoration).	There is no provision for support for the transition period.	There is no provision in Bangladesh ordinances, while JICA guidelines require providing support for the transition period
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc.	There are no provisions for either acknowledgement of or compensation to vulnerable groups	There is no provision in Bangladesh ordinances, while JICA guidelines require providing special attention to vulnerable people and groups.

2.7 Applicable Standards

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

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

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

CHAPTER 3: PROJECT DESCRIPTION

3 PROJECT DESCRIPTION

3.1 Introduction

Bangladesh Economic Zone Authority (BEZA) is going to establish an economic zone namely Araihazar Economic Zone on 218.84 ha land at Araihazar Upazila under Narayanganj district. Different types of industry will be set up in the economic zone. As per the plan, the economic zone will be started in 2022. The grid frequency fluctuation level is high in Bangladesh and not suitable for most manufacturing processes; therefore, the EZ require an uninterrupted electricity supply. Considering the current grid situation, proposed EZ has a provision to install a power plant. Initially, 5 MW power will be required for the industries operation. The proposed power plant will be installed to serve uninterrupted electricity for operation of different industries within the economic zone. The total capacity of Power plant is approximately 46MW on ISO conditions, i.e., 40MW on Bangladesh site conditions during the full operation of operation phase. Two TITAS gas pipelines are passing through the economic zone area. At the initial stage, the gas requirement of the economic zone has been estimated as 5 mmcfd. The initial gas requirement can be meet up by the Madhobdi TBS by hot tapping from the existing 20"diameter x 1000 psig x Naringdi-Sidhirganj transmission line passing through the economic zone and constructing a CGS/TBS at economic zone site. Gas demand will be increased to 10 mmcfd in 2023, and it will increase periodically. Increased gas demand will not be possible to meet up by TGTDCL from the Madhobdi TBS as many downstream industries are getting gas from Madhobdi TBS. If TGTDCL provides the increased demand gas to economic zone; as a result, downstream users will be experienced a shortage of gas. Now Bangladesh is facing a natural gas shortage. Therefore, Bangladesh has decided to import LNG. To provide the increased gas demand of economic zone, TGTDCL will have to rely on LNG supply into the TGTDCL gas network. Gas Transmission Company Limited (GTCL) has planned to construct a 30" diameter X 1000 psig transmission line from Bakhrabad (Kutumbapur) to Meghnaghat TBS. TGTDCL, BEZA have requested to Petrobangla and GTCL for extending this line up to Horipur TBS. Pertobangla & GTCL have been agreed on this proposal. Noteworthy that for additional quantum of gas supply to economic zone, a 20" diameter x 1000 psig x 5.825 km transmission line from Horipur TBS to Dighibarabo CGS from this 30" transmission line will be constructed.

3.2 Project Components

The project comprises following four components

- Power Plant (46MW power plant on ISO conditions, i.e., 40MW on Bangladesh site conditions)
- Gas transmission line (a 5.825 kilometers pipeline from Horipur TBS to Dighibarabo CGS)
- Substation (230 kV AIS Substation)
- Electricity Transmission Line

3.2.1 Power Plant

3.2.1.1 Location of Proposed Power Plant

The proposed power plant will be established at the southeast corner of the Araihazar Economic zone. Total 22.93 acres land will be required for setup the proposed power plant. The existing land use of the proposed power plant area is agricultural land. The proposed power plant is located at Panchrukhi and Panchgaon mauza of Duptara union of Araihazar upazila under Narayanganj district. The location of the proposed power plant site is presented in Figure 3-1.

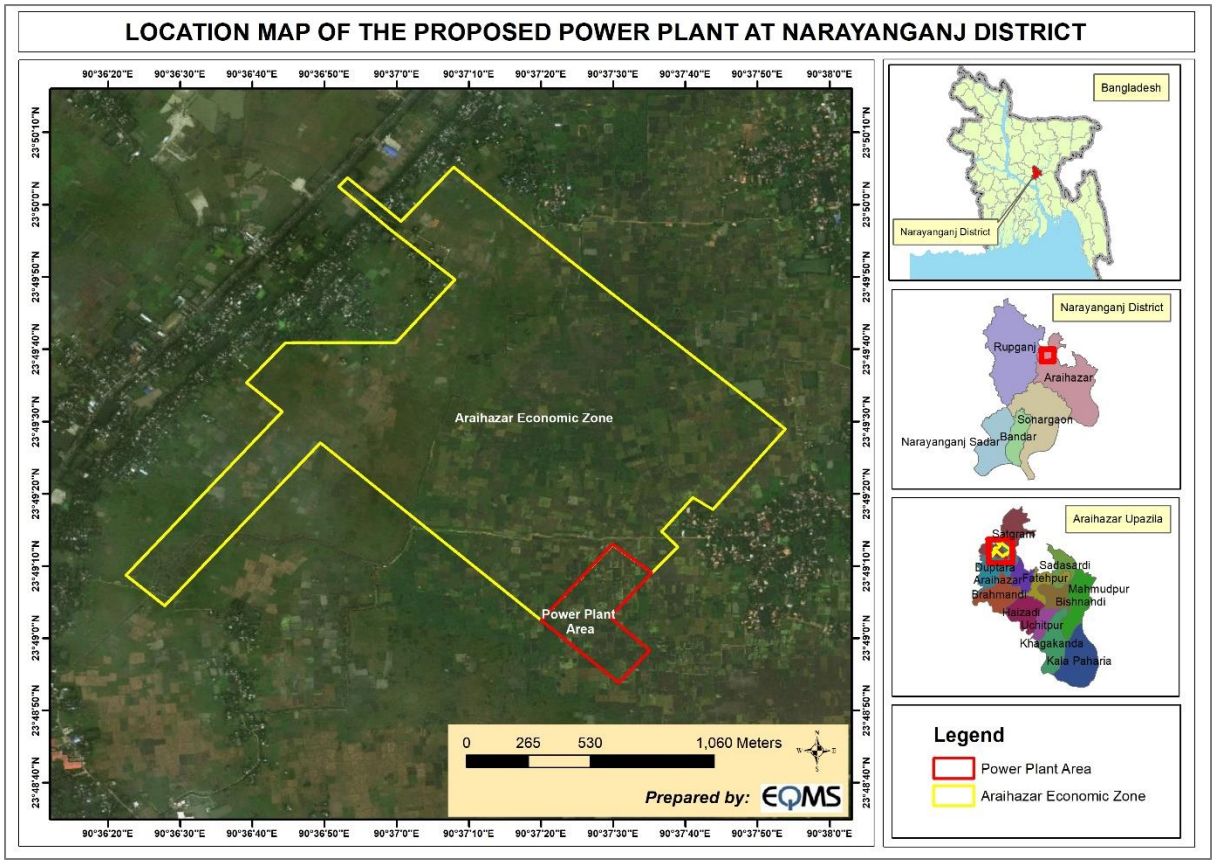


Figure 3-1: Location of the Proposed Power Plant

3.2.1.2 Capacity of the Proposed Power Plant

Since power demand of EZ is small at the beginning of EZ operation, a small capacity DE will supply power to EZ during the period. In accordance with power demand increase, medium capacity GEs, then a large capacity GT will supply power to the EZ accordingly.

For instance, the following generation procedure will be followed in accordance with EZ power-demand increase.

i) 1.5 – 3MW: 1 set of DE generation
ii) 3 – 6MW: 1 set of GE generation
iii) 6 – 9MW: 1 set of DE generation + 1 set of GE generation
iv) 9 –12 MW: 2 sets of GE generation
v) 12 – 15MW: 1 set of DE generation + 2 sets of GE generation
vi) 15MW and above: 1 set of GT generation (+ 1 set of DE generation + 2 sets of GE generation in accordance with power demand)

3.2.1.3 Layout of the Proposed Power Plant

The components of the proposed power plant are as follows. The general layout plan of the proposed power plant is shown in Figure 3-2.

- Gas Turbine Package,
- Gas Turbine Generator,
- GT Inlet Air Filter Unit
- GT Fuel Gas Filter unit
- GT CO_2 Bottle Skid
- Gas Chromatography
- Remote I/O Panel
- Continuous Emission Monitoring System (CEMS)
- 11 kV Switchgear
- Gas Engine

- Diesel Engine
- Electrical Building for the Plant
- Bypass Stack
- Coalescer Filter
- 33/11kV GT Generator Step Up Transformer
- 33/11kV Gas Engine Step Up Transformer
- 33/11kV Diesel Engine Step Up Transformer
- 33/11kV SGT Step Up Transformer
- Station Service Transformer
- Auxiliary Service Transformer
- 33/11kV Switchgear Building
- 33/11kV Transformer
- 230/33 kV Step-Up Transformer
- 230 kV Switchyard
- 230 kV Substation Control Room
- Oil Water Separator
- Cooling Tower
- Cooling Tower Pumps
- Cooling Tower Chemical Feed
- Pre-Treatment Plant
- Raw Water Tank
- Raw Water Pumps
- Fuel Oil Tank
- Fuel Oil Pump
- Holding Pond with Pumps
- Fire Water Pumps
- Fuel Gas Filter Separator
- Gas Compressor
- Air Compressor
- Air Dryer
- Air Receiver
- Warehouse/Workshop

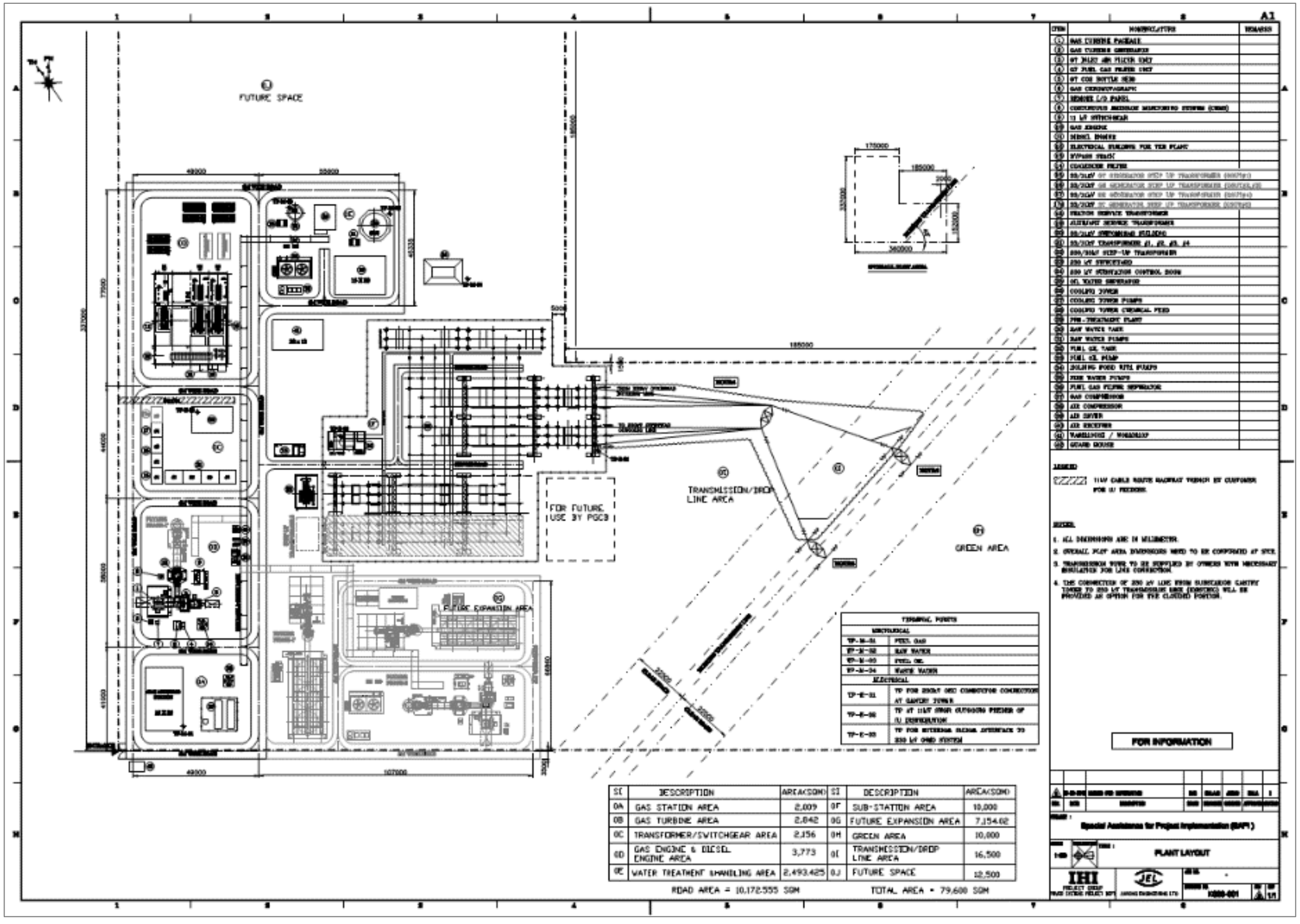


Figure 3-2: Layout of the Proposed Power Plant

3.2.1.4 Components and Power Generation Method

The proposed power plant is based on the diesel engine, gas engine and gas turbine of installed capacity 40MW. The proposed power plant will be a combination of 1 set of 25 MW Gas Turbine, 2 sets of 6 MW Gas Engine and 1 set of 3 MW Diesel Engine. All the system of the plant will be installed as per the design, drawing, and guidelines by the Original Equipment Manufacturer (OEM) and complying the Standards as set by the OEM. The process flowchart of the proposed power plant is given in Figure 3-3.

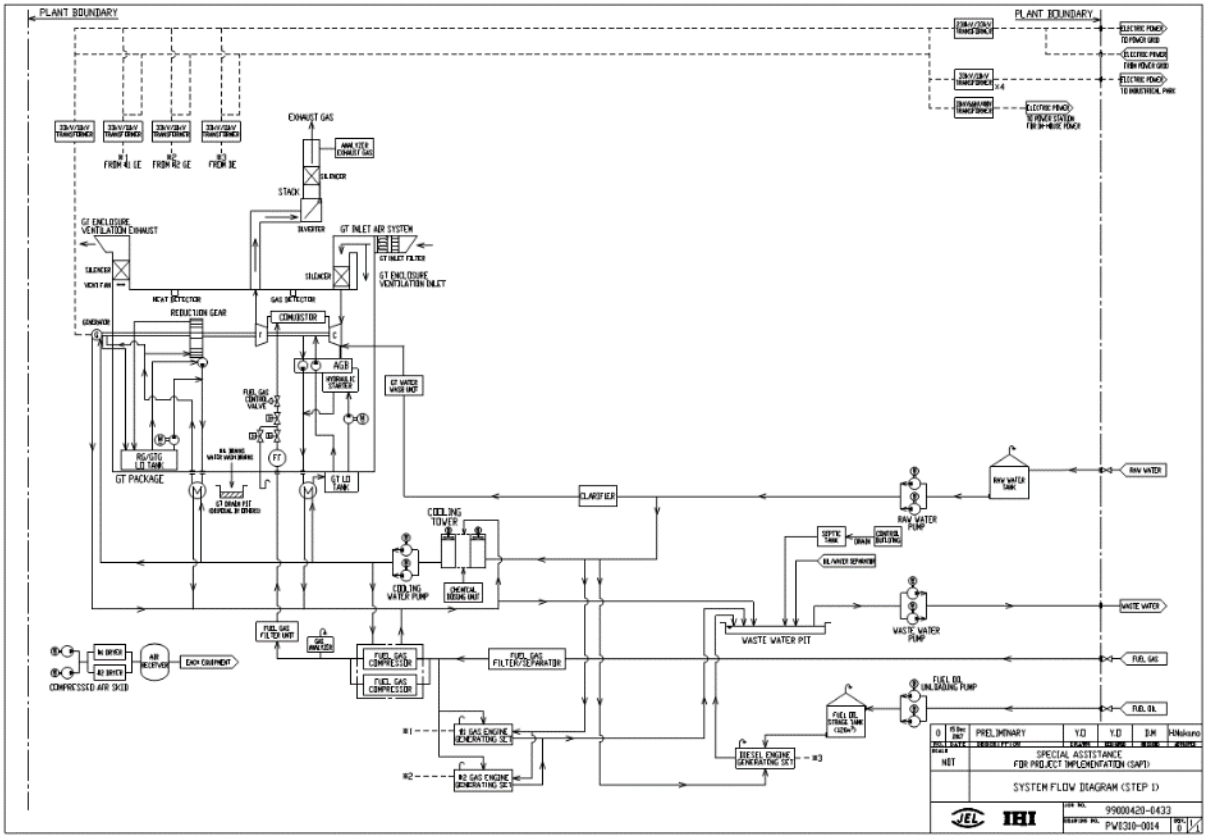


Figure 3-3: Process Flow Diagram of the Proposed Power Plant

<u>Detail Description of Diesel Engine</u>

Only 3 MW diesel engine will be installed at the initial stage of the economic zone operation as the electricity consumption will be less. Nigata 9L28AHX diesel engine will be install for electricity generation. When gas turbine will in operation, electricity generated from diesel engine will not supply to the economic zone. It will sell to the national grid. Description of the major system of the diesel engine as follows.

a. Fuel Supply System

It consists of storage tank, strainers, fuel transfer pump and all day fuel tank. The fuel oil is supplied at the plant site by road. The oil is stored in the storage tank. From the storage tank, oil is pumped to smaller all day tank at daily or short intervals. From this tank, fuel oil is passed through strainers to remove suspended impurities. The clean oil is injected into the engine by fuel injection pump.

b. Air Intake System

This system supplies necessary air to the engine for fuel combustion. It consists of pipes for the supply of fresh air to the engine manifold. Filters are provided to remove dust particles from air which may act as abrasive in the engine cylinder. Diesel engine requires close tolerances to achieve its compression ratio, and because most diesel engines are turbocharged, the air entering the engine

must be clean, free of debris, and as cool as possible. In addition, to improve a turbocharged engine's efficiency, the compressed air must be cooled after being compressed. The air intake system is designed to perform these tasks. Air intake systems are usually one of two types, wet or dry. In this plant system used is, a dry filter system. In dry filter system paper, cloth, or a metal screen material is used to catch and trap dirt before it enters the engine. In addition to cleaning the air, the intake system is usually designed to intake fresh air from as far away from the engine as practicable, usually just outside of the engine's building or enclosure. This provides the engine with a supply of air that has not been heated by the engine's own waste heat. The reason for ensuring that an engine's air supply is as cool as possible is that cool air is denser than hot air. This means that, per unit volume, cool air has more oxygen than hot air. Thus, cool air provides more oxygen per cylinder charge than less dense, hot air. More oxygen means a more efficient fuel burn and more power. After being filtered, the air is routed by the intake system into the engine's intake manifold or air box. The intake system also serves to reduce the airflow noise.

c. Cooling System

The heat released by the burning of fuel in the engine cylinder is partially converted into work. The remainder part of the heat passes through the cylinder wall, piston, rings etc. and may cause damage to system. In order to keep the temperature of the engine parts within the safe operating limits, cooling is provided. The cooling system consists of a water source, pump and cooling towers. The pump circulates water through cylinder and head jacket. The water takes away heat from the engine and it becomes hot. The hot water is cooled by cooling towers and re circulated for cooling.

d. Lubricating System

The system minimizes the wear of rubbing surfaces of the engine. It comprises of lubricating oil tank, pump, filter and oil cooler. The lubrication oil is drawn from the lubricating oil tank by the pump and is passed through filter to remove impurities .The clean lubrication oil is delivered to the points, which require lubrication. The oil coolers incorporated in the system keep the temperature of the oil low.

e. Compressed Air System

The compressed air system is normally in continuous operation. The air is taken from surrounding and compressed into the air receiver. The heat generated is removed in the radiators installed on the compressor unit.

The air compressor unit must be assembled in operating condition. The air receiver must be assembled, tested and ready to receive compressed air. The heat generated must be removed in the radiators installed on the compressed air.

f. Charge Air System

The charge air system is normally in continuous operation when the engine is running. The engine charge air is drawn through the external filtration unit and the silencer by the engine driven turbo charger. The compressed combustion air is then transferred into the engine cylinder after heat generated by the compression removed in the charge air cooler and transferred to the engine jacket water system.

g. Exhaust System

This system leads the engine exhaust gas outside the building and discharges it into atmosphere. A silencer is usually incorporated in the system to reduce the noise level. The exhaust system of a diesel engine performs three functions. First, the exhaust system routes the spent combustion gasses away from the engine, where they are diluted by the atmosphere. This keeps the area around the engine habitable. Second, the exhaust system confines and routes the gases to the turbocharger, if used. Third, the exhaust system allows mufflers to be used to reduce the engine noise.

h. Diesel Engine

Diesel engine is the prime mover, which drives an alternator to produce electrical energy. In the diesel engine, air is drawn into the cylinder and is compressed, during this compression. A metered quantity of diesel fuel is then injected into the cylinder, which ignites spontaneously because of the high temperature.

Detail Description of Gas Engine

a. Power Generation Method

The gas engines drive the electrical generators to produce electricity at 11 KV and 50 Hz. The engines will use natural gas for power generation. Depending upon the ambient air temperature, the air for combustion would be cooled in exchangers prior to compression by the engine. The generated power would be delivered to Economic zone.

b. Generating Set

The Genset Nigata 18V28AGS engine and the generator are mounted on a common base frame. The common base frame is flexibly mounted on a concrete foundation by means of steel springs.

c. General Engine Description

The engine is the four strokes, lean burn, pre chamber, spark ignited, port injected, trunk piston, turbocharged and intercooled design. The engine has a fully microprocessor based Control system, controlling the combustion process individually in each cylinder.

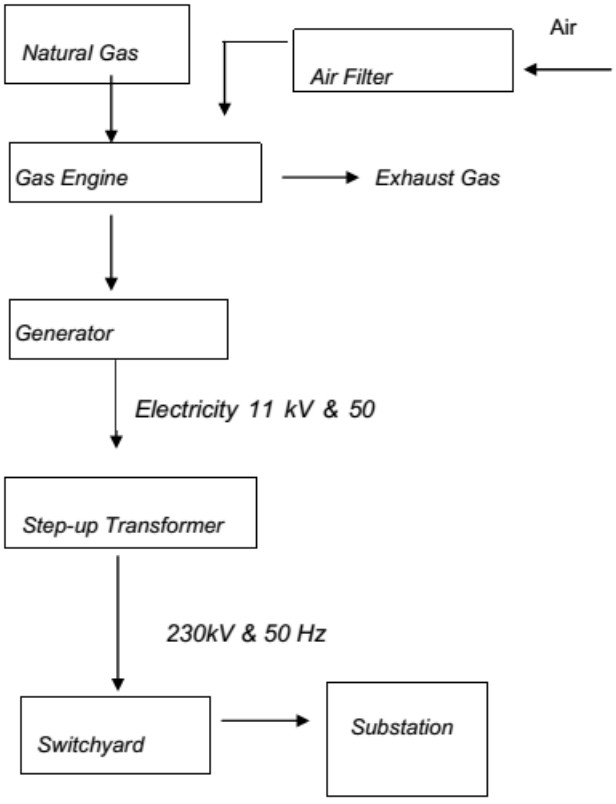


Figure 3-4: Process Diagram of Electricity Generation

d. Cooling Water System

The main task of the cooling system is to provide adequate cooling of critical engine components such as cylinder jackets, cylinder heads and turbochargers as well as to cool the lubrication oil and combustion air entering the cylinders after it has been compressed by the turbocharger. The cooling water system comprises the following equipment:

- Pipes made of MS
- Electric driven pump for jacket cooling circuit
- Electric driven pump for low temperature cooling circuit

A closed circuit cooling water system will be provided to cater for the cooling water requirements for gas engines and the balance of the plant and will comprise of air coolers, cooling water pump, pipe works & valves. The cooling system shall be provided with a 100% duty circulating water pump driven by electric motors fed from separate essential electrical supply sources.

e. Mechanical Auxiliary System

The proper function of the power plant depends on the mechanical auxiliary systems. The proposed systems have been optimized for this particular application. The function of this system is to provide the engine with fuel, lubricating oil, cooling water, and combustion air of the required quantity and quality, as well as to dispose of exhaust gases in a proper manner.

f. Fuel System

The main function of the fuel system is to provide the engine with fuel of correct flow, pressure and degree of purity. The engine shall be designed to operate over their full load range on natural gas only.

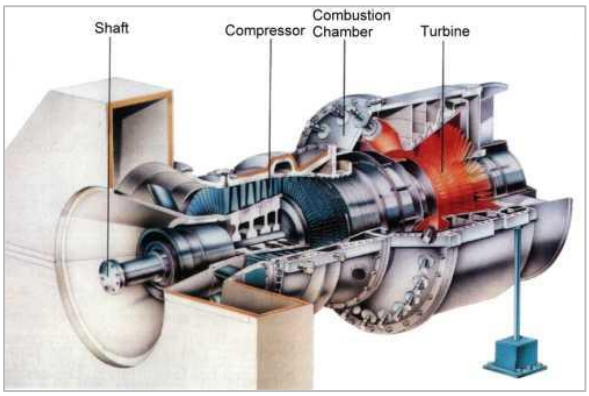
g. Air Intake System

The air intake filter system to the gas generator shall be a proven design. The filter elements shall be suitable for the stated operating regime and environmental conditions existing at site and include provision for removal of the filtered contaminant from the filter housing area ensuring that the possibility of re-entrainment of the contaminant is kept to a minimum. The filter system design shall ensure that the correct air flow rates are used for each stage. The filter system selected shall minimize the cost of replacement filter elements and associated downtime.

h. Exhaust System

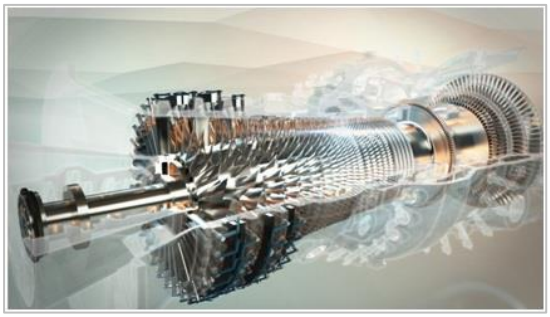
The engine exhaust system shall consist of suitably designed internally insulated exhaust ducting, supports, anchors, bellows units, silencer section and exhaust stack. The height of the stack shall be 12.5 m.

Detail Description of Gas Turbine



Gas turbines are comprised of three primary sections mounted on the same shaft: the compressor, the combustion chamber (or combustor) and the turbine. The compressor can be either axial flow or centrifugal flow. Axial flow compressors are more common in power generation because they have higher flow rates and efficiencies. Axial flow compressors are comprised of multiple stages of rotating and stationary blades (or stators) through which air is drawn in parallel to the axis of rotation and incrementally compressed as it passes through each stage. The acceleration of the air through the

rotating blades and diffusion by the stators increases the pressure and reduces the volume of the air. Although no heat is added, the compression of the air also causes the temperature to increase.



The compressed air is mixed with fuel injected through nozzles. The fuel and compressed air can be pre-mixed or the compressed air can be introduced directly into the combustor. The fuel-air mixture ignites under constant pressure conditions and the hot combustion products (gases) are directed through the turbine where it expands rapidly and imparts rotation to the shaft. The turbine is also comprised of stages, each with a row of stationary blades (or nozzles) to direct the expanding gases followed by a row of moving blades. The rotation of the shaft drives the compressor to draw in and compress more air to sustain continuous combustion. The remaining shaft power is used to drive a generator which produces electricity. Approximately 55 to 65 percent of the power produced by the turbine is used to drive the compressor. To optimize the transfer of kinetic energy from the combustion gases to shaft rotation, gas turbines can have multiple compressor and turbine stages.

Because the compressor must reach a certain speed before the combustion process is continuous – or self-sustaining – initial momentum is imparted to the turbine rotor from an external motor, static frequency converter, or the generator itself. The compressor must be smoothly accelerated and reach firing speed before fuel can be introduced and ignition can occur. Turbine speeds vary widely by manufacturer and design, ranging from 2,000 revolutions per minute (rpm) to 10,000 rpm. Initial ignition occurs from one or more spark plugs (depending on combustor design). Once the turbine reaches self-sustaining speed – above 50% of full speed – the power output is enough to drive the compressor, combustion is continuous, and the starter system can be disengaged.

3.2.1.5 Wastewater Treatment

There will be an oily water separator which will trap waste oil from the oily water. The treated water (with oil and grease concentration <15 ppm) will send to central effluent treatment plant of Araihazar Economic zone for further treatment. The separated oil from the treatment will be given to approved third party who will re-use for other less quality-demanding use. The following line diagram shows the processes involved in the oily water treatment:

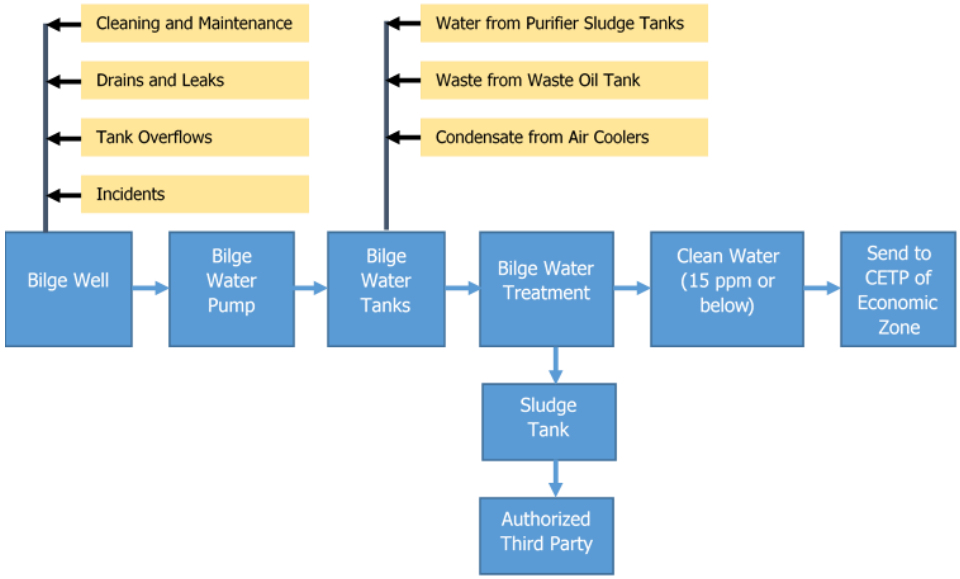


Figure 3-5: Waste/Oily Water Treatment Plant

3.2.1.6 Access to the Project Site

The proposed power plant will be established at the southeast corner of the proposed Araihazar Economic Zone. The proposed AEZ will be connected with Dhaka-Sylhet highway at a length of 400 meters road. The internal roads from the main road to each block will have 2 lanes. All internal roads will be planned to ensure the width of 2.5m as the shoulders on their sidewalk sides so that accidents and trucks etc. parking while waiting will not obstruct traffic. The internal road will be connected with the proposed power plant. The access to the power plant site is presented in the following Figure 3-6.

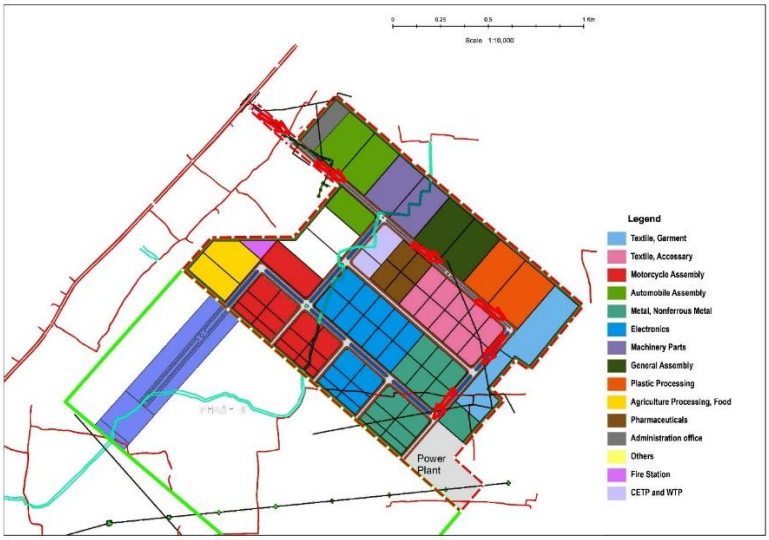


Figure 3-6: Access to the Power Plant Site

3.2.2 Gas Transmission Line

3.2.2.1 Location of Gas Transmission Line

The proposed 5.825 km gas pipeline will be constructed from Horipur TBS to Dighibarabo CGS. The gas pipeline falls under the following administrative area. Figure 3-7 shows the proposed gas pipeline location.

Table 3-1: Administrative Area of Proposed Gas Pipeline Location

District	Upazila	Union/Pauashava	Mauza
Narayanganj	Rupganj	Ward 9 of Tarabo Paurashava	Dighi Borab
	Sonargaon	Kanchpur	Kachpur, Bekhakoir
	Bandar	Madanpur	Bagnoyanogor
		Ward 27 of Kadam Rasul Paurashava	Monoharkharbag

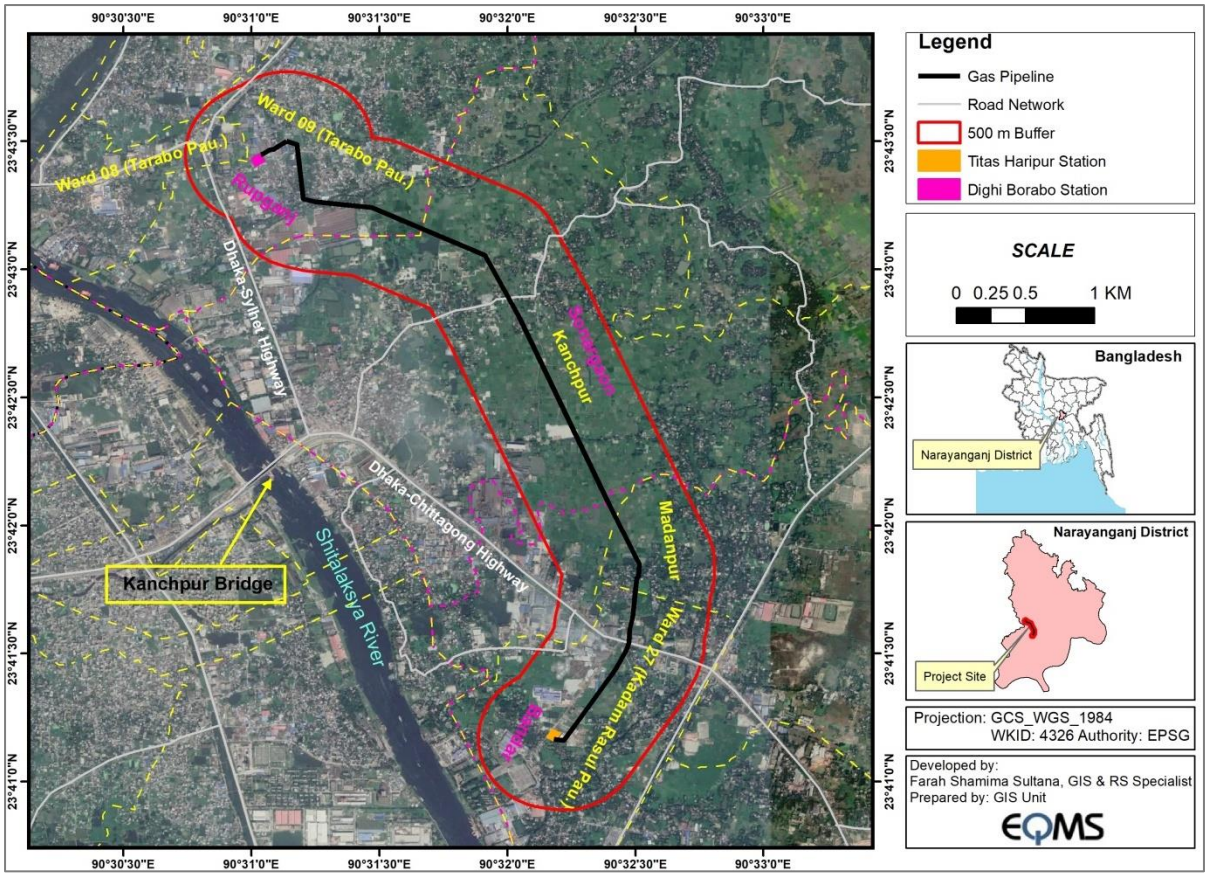
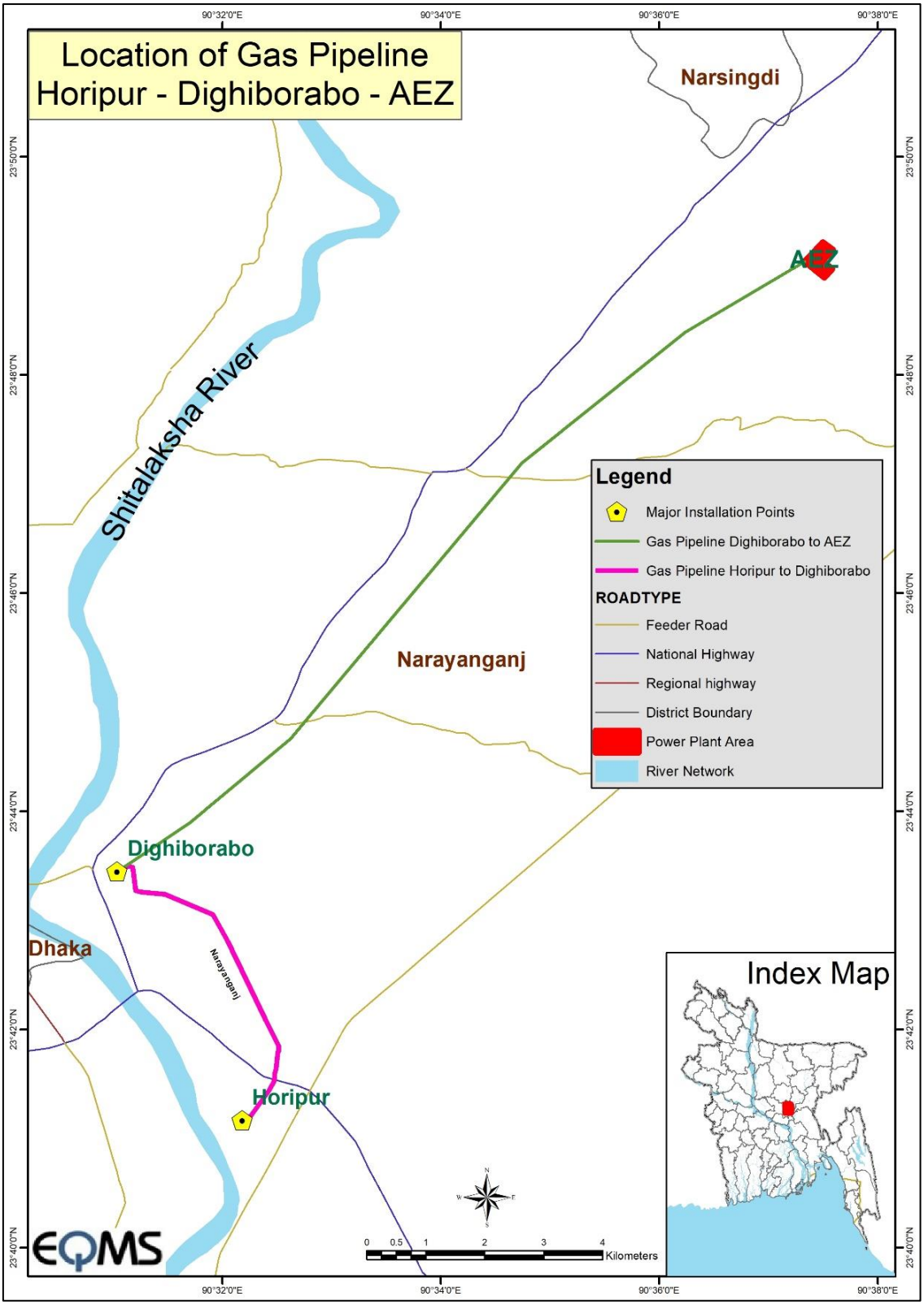


Figure 3-7: Location of the Proposed Gas Pipeline

Geographical relationship and gas transmission connection between the proposed gas transmission line and AEZ is shown in Figure 3-8. The pink line indicates the proposed gas transmission line. The green line indicates the existing pipeline, which will connect Dighiborabo CGS and AEZ.

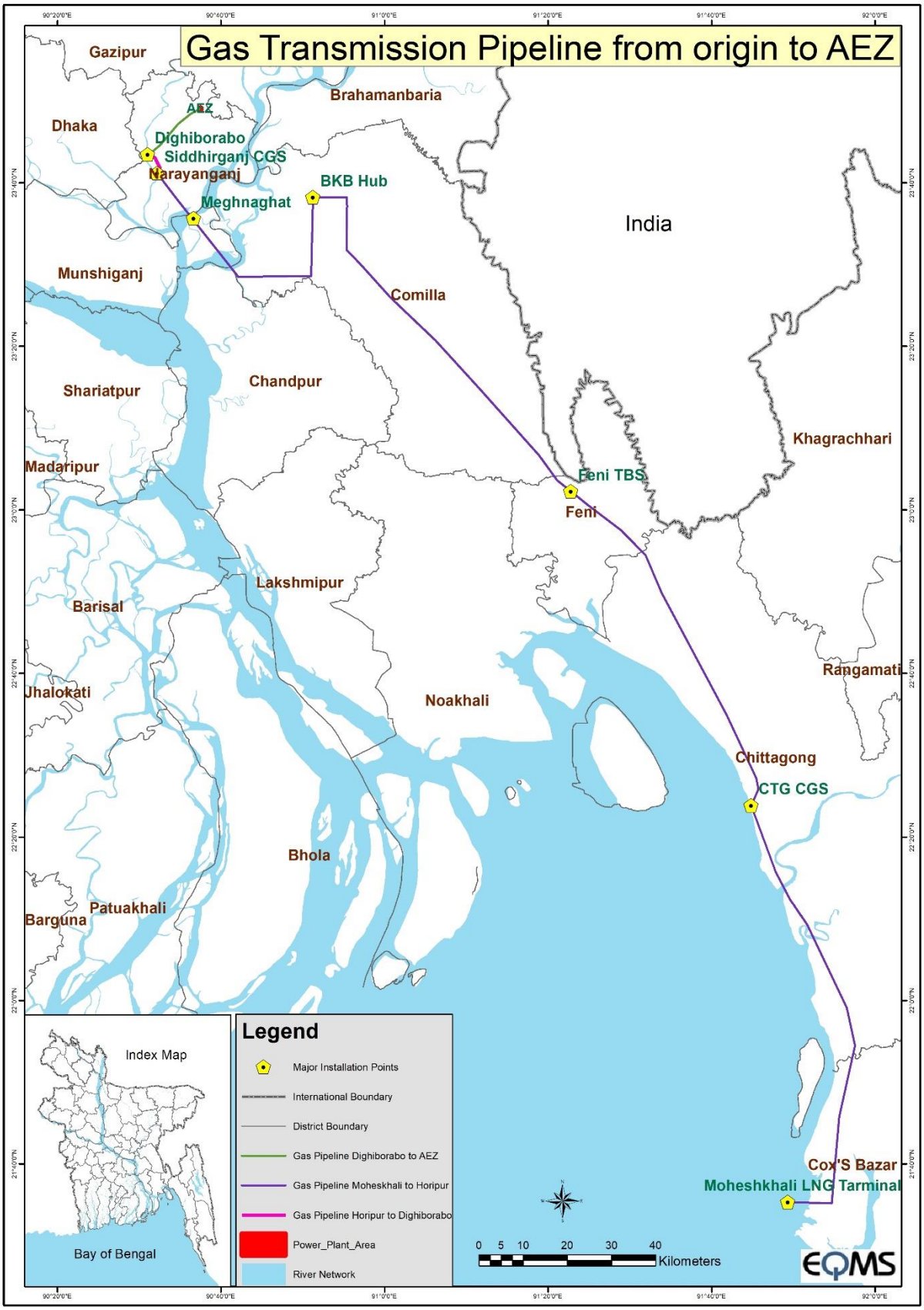
Further, a broader gas transmission line connectivity is illustrated in Figure 3-9 illustrates a broader view of gas transmission connectivity.

Two TITAS gas pipelines are passing through the economic zone area. The power plant will get gas from the exisitng 20-inch exisitng pipeline by hot tapping. Figure 3-10 shows the gas pipeline connection between existing 20-inch gas pipeline and proposed power plant.



Source: EQMS

Figure 3-8: Gas Transmission Connection from the Proposed Gas Transmission Line and AEZ



Source: EQMS

Figure 3-9: Gas Transmission Connectivity from Moheshkhali and the Proposed Gas Transmission Line and AEZ.

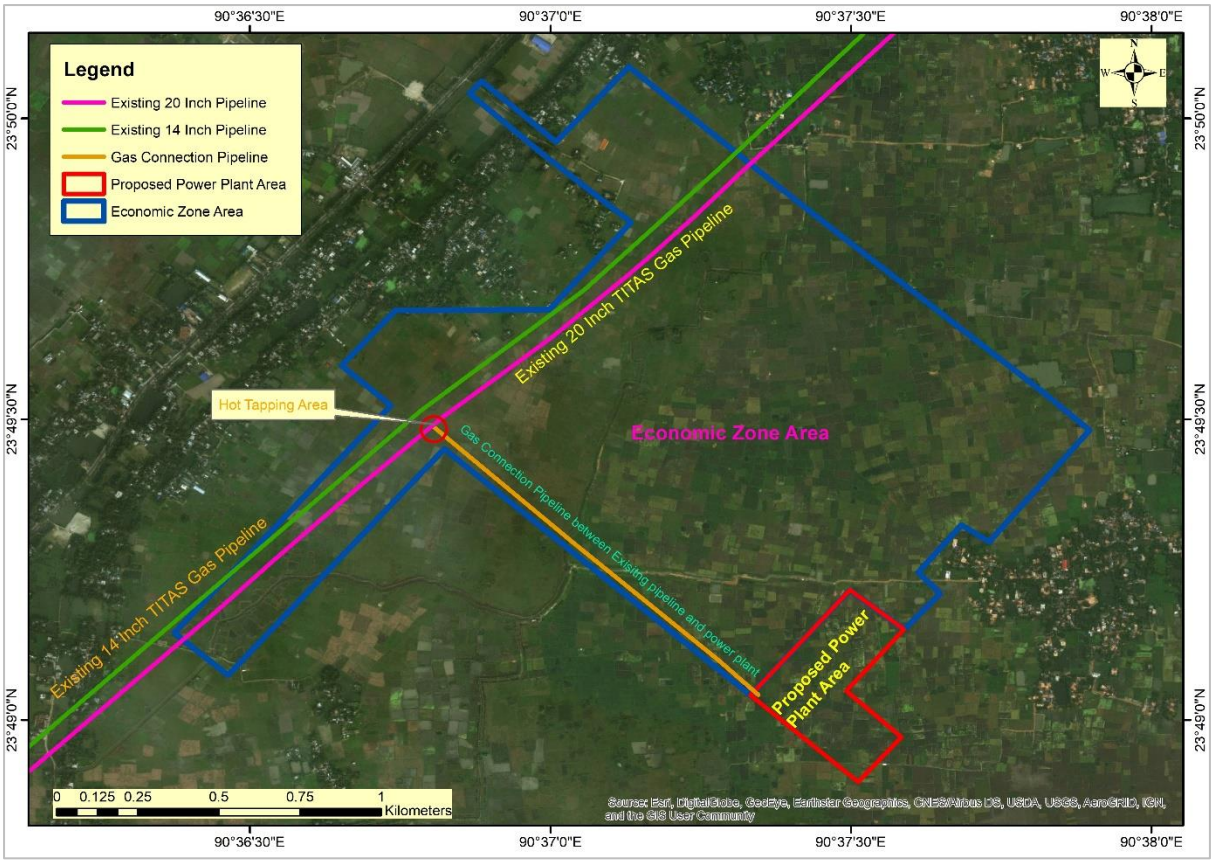


Figure 3-10: Gas Pipeline Connection between Exisitng 20 Inch Pipeline and Power Plant

3.2.2.2 Component of Propsoed Gas Pipeline

- 20" diameter x 1000 psig x 5.825 km transmission line from Horipur TBS to Dighibarabo CGS;
- Width 20 ft. and Depth 3.5ft.
- A new CGS/TBS at Economic Zone Site;
- Off Take modification of Horipur TBS and Dighibarabo CGS;
- The metering arrangement at Dighibarabo CGS
- Cathodic Protection

3.2.2.3 Methods of Gas Pipeline Installation

The proposed gas pipeline will be installed mostly following the open cut method. The gas pipeline needs to cross the Dhaka-Chittagong highway and a canal. The road will be crossed using the thrust boring method whereas the canal will be crossed following the open cut method. These crossing methods have been selected primarily. It will be finalized during the detail design stage. Minimum Trench Dimension of Transmission gas pipeline construction are given below.

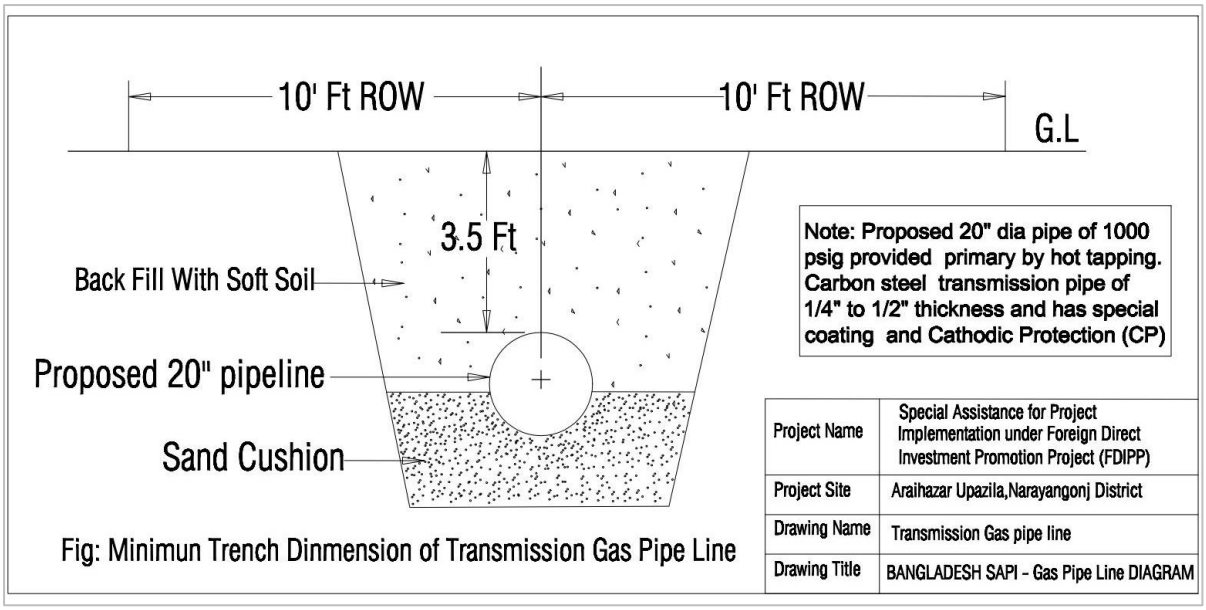


Figure 3-11: Typical Cross-section Drawing of the Gas Transmission Line

3.2.3 Substation

3.2.3.1 Location of Substation

The propsoed substation will be constructed at the north middle of the power plant site. The substation area will cover approximately 2.3 acres land. The following figure shows the substation location.

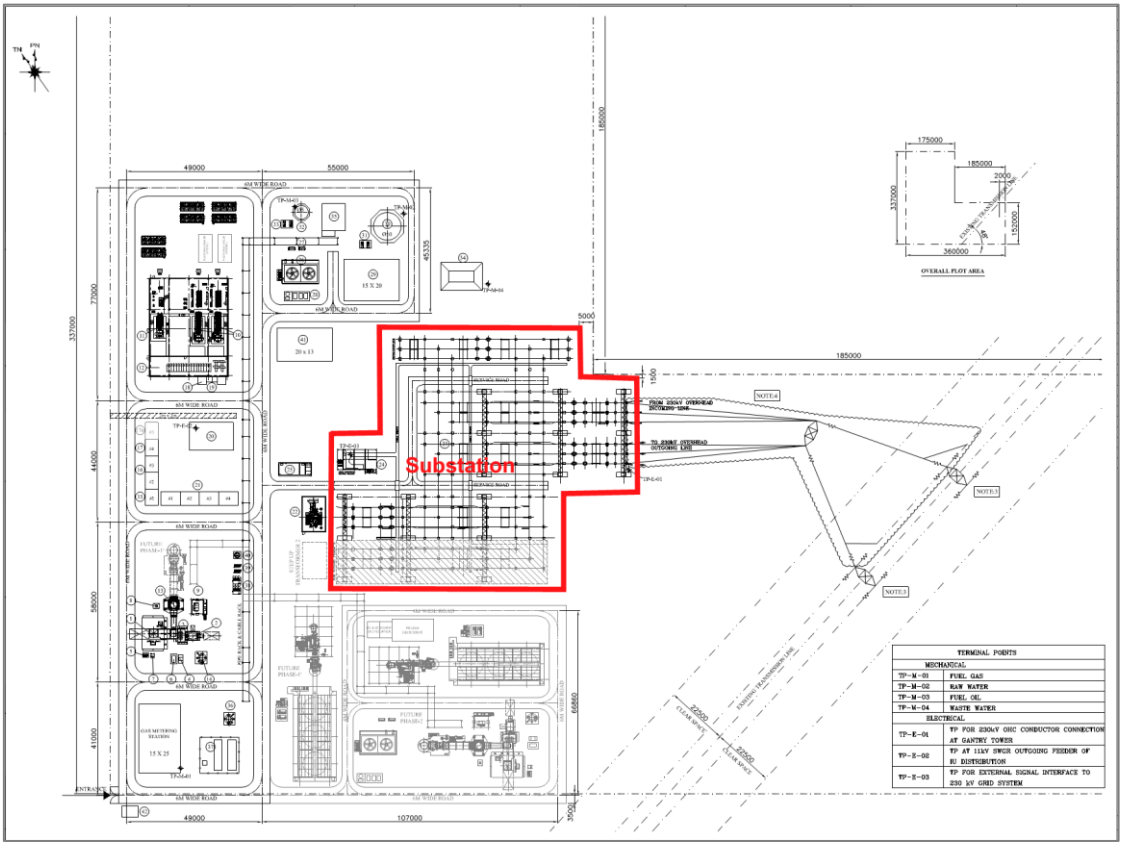


Figure 3-12: Location of Substation in the Power Plant Area

3.2.3.2 Planning for Substation

According to PGCB, 230kV incoming/ outgoing and bus bar circuits are in accordance with PGCB standard circuits since 230kV incoming/outgoing and bus bar circuits will be controlled and operated by PGCB after construction. Characteristics are a loop circuit and double bus bar system. Future expansion of Phase 2 is also considered.

Power factor improvement capacitors are not planned since some of generators run during operation of factories in the EZ and supply reactive power for improving power factor.

3.2.3.3 Major Component

Major equipment is shown in Figure 3-13 and Annex G.

1) 230kV Switchgear: Air Insulated Switchgear (AIS)

Incoming/ outgoing and bus bar circuits are in accordance with PGCB standard circuits including circuit protection, metering, lightning arrestors, signal transmission, etc.

2) One set of main transformer: 230/33kV, 60/75MVA (Self cooling/ Forced fan cooling: ONAN/ONAF) with on-load tap changer.

   In case of Y-Y connection, stabilizing winding will be installed.

   Grounding: Neutral Grounding Resistor (NGR) method

3) 33kV metal-enclosed switchgear

   a) Vacuum Circuit breakers (VCB) will be applied. VCB will be with Disconnecting Switch (DS) or of "Draw-out" type.

   b) Feeders

   - Power supply to the Economic Zone (EZ): 4 feeders and 1 spare feeder which may be used for Phase-1 expansion or Phase-2 supply during initial low power demand.
   - In-house power: 1 feeder, Load Break Switch (LBS) may be used instead of VCB.
   - Generators: 4 feeders (Each generator feeder has changeover circuits of supplying good quality power to the EZ or selling electricity to the grid.) Provision for future installation of Steam Turbine (approximately 12MW) is also considered.

4) Distribution transformer for power supply to the EZ

   33/11kV, 15/20MVA (Self cooling/ Forced fan cooling: ONAN/ONAF): 4sets

5) Transformer for in-house power (substation auxiliaries)

   a) 11kV metal-enclosed switchgear for distribution to the EZ
   b) Vacuum Circuit breakers (VCB) will be applied. VCB will be of "Draw-out" type.
   c) 2 feeders for each distribution transformer, total 8 feeders

The interface between On-site and Off-site is external cable terminals at 11kV Switchgears.

Underground ring-main loop circuit cabling systems are planned for distribution to the EZ by On-site developer.

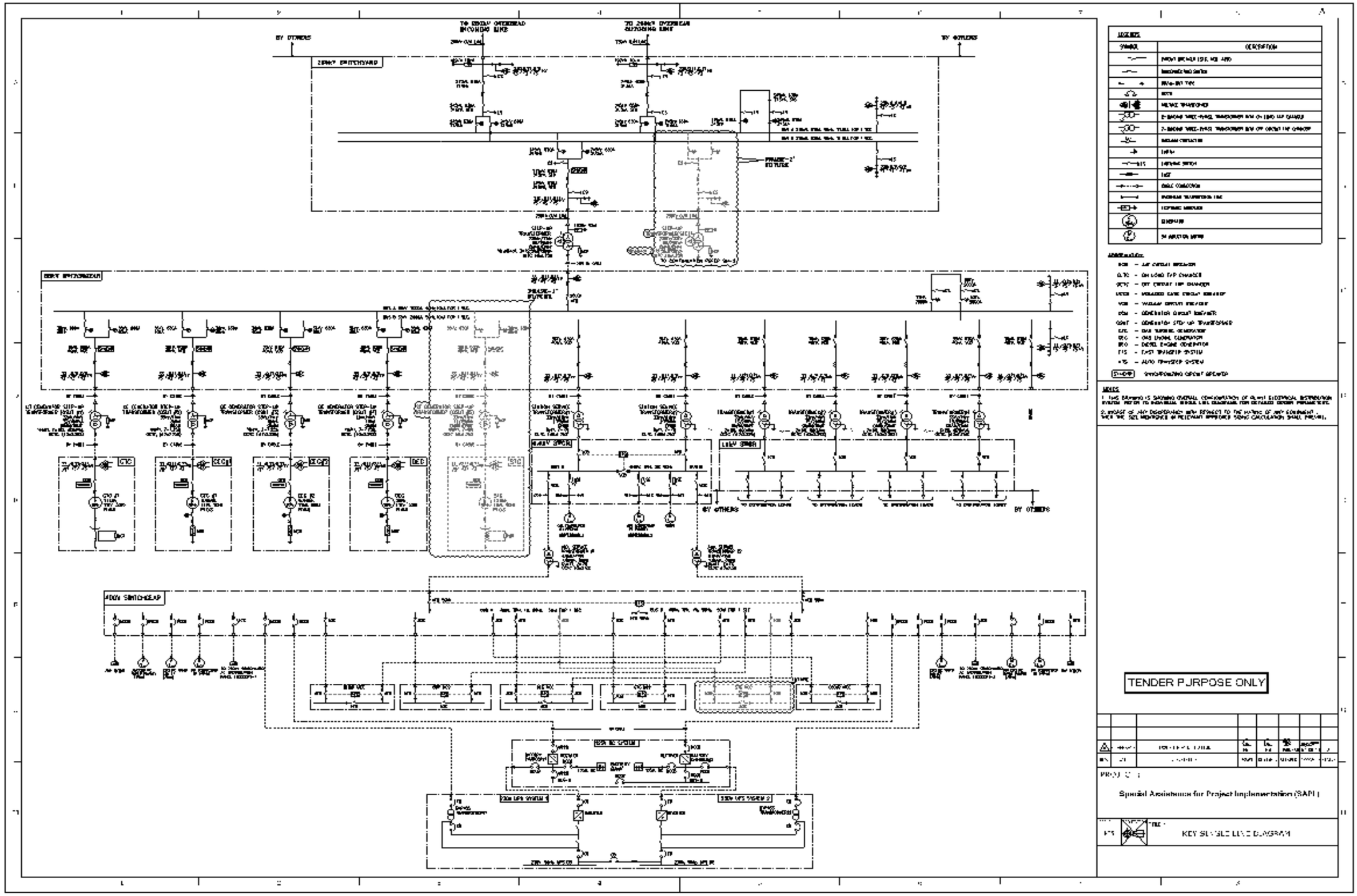


Figure 3-13: Key Single Line Diagram

3.2.4 Transmission Line

Electricity transmission line was included in the application for geeting ToR approval from the Department of Environment (DoE). Initially different studies were conducted to find out the best option for evacuating generated power as well as receiving power for the economic zone. Study team found that a 230 kV transmission line passes over the south corner of the proposed substation and power station location. Distance between substation and transmission line is only 200 meters. For connecting the new Substation with the 230kV Transmission line, only a branch tower and terminal tower will be installed. Following Figure 3-14 shows the connection between substation and exisitng transmission line. The intervention on environment during installation of branch tower and terminal tower is very negligible.

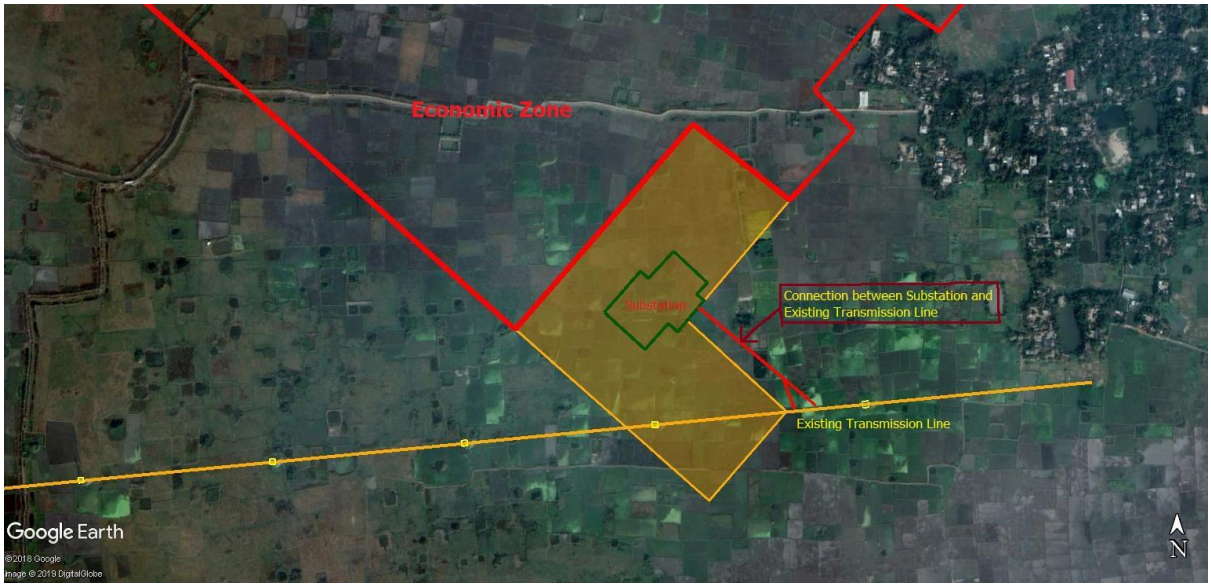


Figure 3-14: Connection between Substation and Existing Transmission Line

3.3 Utility Demand

3.3.1 Land

Total 22.93 acres land will be required for setup the proposed power plant. Approximately 8.65 acres of land need to be acquired, and 8.11 acres land will be leased for construction of the gas pipeline. They are required for land acquisition, and requisition differs because land requisition is not required in some area such as the canal, thrust boring section, and for the avoidance of adjacent existing structures.

Land requisition refers to temporal land use for construction purpose along with RoW. The 20 feet area will be utilized for operation of construction machinery, storing material, equipment, and excavated sand, etc. It will not affect land ownership but leasing fee (compensation) will be paid to landowners. In some area, construction may not require 20 feet.

3.3.2 Fuel

The project at full capacity shall require approximately 10 MMCFD for its Gas Turbine and Gas Generator, etc. The project will have a gas connection from TITAS. For which necessary arrangements for getting the gas connection will be made. Approximately 13.664 t/day diesel will be required for diesel engine operation.

3.3.3 Water

Total water requirement including power plant and domestic use is 163 m^3/day of which 80 m^3/day will be used for gas turbine cooling, and 80 m^3/day will use for gas booster compressor. During

operation of power plant, only 30 persons will be engaged. The domestic water requirement will be 3 m^3/day (100 litre/person). The required water will be collected from underground aquifer.

3.3.4 Manpower Requirement

During Construction Phase

The major construction works include construction of power plant building, office building, water pump house, and construction of wares house, etc. The construction works of the project are expected its completion within 24 month's period. During factory erection and setting up of machinery a good number (about 250) of skilled; semi-skilled and daily wage labors will get job opportunity in the project. In addition to that, this project will create an employment opportunity for a number of persons indirectly by giving business to them.

During Operation Phase

This project will create direct job opportunity for about 30 people in various official capacities.

3.4 Project Schedule

The construction of the proposed power plant will be started in October 2019. The power plant commissioning will start on March 2021. The overall schedule of the proposed power plant is shown in Figure 3-15.

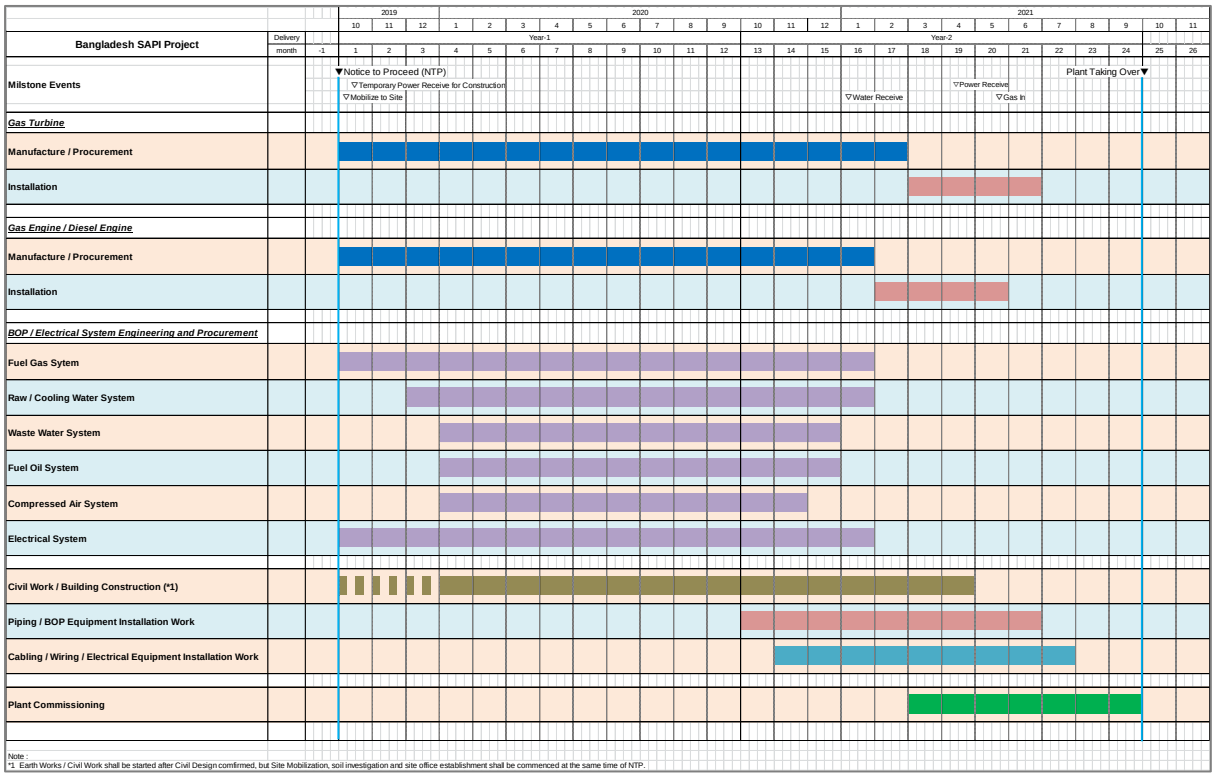


Figure 3-15: Schedule of Proposed Power Plant Project

CHAPTER 4: ALTERNATIVE ANALYSIS

4 ALTERNATIVE ANALYSIS

4.1 Alternatives for Power Plant

4.1.1 Site Selection

Since the proposed power plant is designed to be a captive or a semi-captive power (excess power would be sold to the national grid) plant to Araihazar EZ (AEZ), it is ideal to locate the power plant adjacent to AEZ in order to avoid unnecessary land acquisition and environmental and social impact. Thus, the location of the power plant depends largely on the location of AEZ, and location-wise alternatives can be analyzed collectively for the power plant. The alternative study of power plant is shown in Table 4-1.

Table 4-1: Result of Alternative Location Study for Power Plant

	Option 1	Option 2
Location Map		
Area	22.93 acres	24.3 acres
Location	South east corner of the Araihazar Economic Zone	At Out side North east corner of the Araihazar Economic Zone
Land Acquisition	Not required since land already acruired	Land need to be acquired
Resettlement	No resettlement is needed	Approximately 20 household need to be resettled
Power Evacuation	A 230 kv transmission line is passing over the south east corner of the power plant area. The distance is only 200 meter	Distance between transmission line and substation is about 1.5 km
Land use	Farmland, single cropping	Farmland, single cropping
Environment /Social Consideration	• The distance from the power plant boundary and nearest household is approximately 400 meter • No land acquisition is required • No resettlement is required	• Households are adjacent to the plant boundary therefore dewellers will suffer due to noise pollution • Additional land acquisition is required • Approximately 20 household need to be resettled
Evaluation	Compared with Option 2, Option 1 has advantages from the viewpoint of the environmental/social aspect, easy access to power evacuation and safety aspect. Therefore, Option 1 is chosen as the preferred option.	

4.1.2 Selection of Generation Systems

The following generation systems were considered as options (Table 4-2) for the proposed power plant. Case 2 has been selected based on cost efficiency and also on minimizing the environmental impact of power generation in accordance with the expected increase of power demand within AEZ.

Table 4-2: Alternative Generation Systems

	Case-1 (Initial Plan: 50 MW)	**Case-2 (Selected Plan)**	**Case-3**
Generation System	GT (1) + GE (3) + DE (1)	GT (1) + GE (2) + DE (1)	GE (2)
ISO 15°C, 60%	40 + 3*6 +3= 61 MW	31 + 2*6 +3= 46 MW	2*5 = 10 MW
Under the project site condition 35°C, 60%	30 + 3*6 +3= 51 MW	25 + 2*6 +3= 40 MW	2*5 = 10 MW
Characteristics	All the generation systems will be interchangeable between the EZ and the national grid. As the power demand of the EZ increase, the combination of the systems can be flexible to meet the demand, thus while supplying to power to the EZ, these systems still also allow setting of the excess power generated. DE does not cost efficient but suitable as the starter of the GT, as emergency power, during low demand period.		The national grid would supply power to AEZ. However, frequency and voltage fluctuation would affect the quality of tenant's production. Installing a tap charger to the substation could mitigate the impact. Frequent tap changes would wear it out, and maintenance cost would be high. Tenants who require high-quality power will need to install the inverter. (additional budget required for the tenant)
Construction Period	27 months	27 months	18 months

4.1.3 Alternative Fuels

Natural gas considers as a clean fuel for the generation of electricity. Other sources of energy could be coal, HFO, nuclear power, geothermal, wind power, hydropower and solar power that are used worldwide. Bangladesh has a flat terrain and has only very limited potential for hydroelectricity. Bangladesh does not have any geothermal sites, and the prospects of renewable energy (solar and wind power) are yet to be proven cost-effective and to become attractive for private entrepreneurs. This leaves the two conventional sources of energy, which are coal and fuel. Although Bangladesh has a massive reserve of bituminous coal, the extraction of this coal is not easy and local demand for coal is mostly met from the coal imported from India. Coal-fired plants are also considered less environment-friendly due to its high PM and SOx emission. In this regard, gas-based power plant generates a low environmental burden compared to HFO and coal-fired plants.

4.1.4 Zero Option

The scenario should be based on the expected condition of AEZ "with" and "without" the proposed power plant. BEZA wishes to establish an economic zone that could meet international standards in all aspect. However, as per the study by JICA SAPI team on the frequency and voltage of the 230kV of the existing electricity supply (the national grid) of the country, the power supply from the national grid apparently would fail to provide reliable and stable power to AEZ. Inability to provide reliable and

stable power to the tenants of AEZ would jeopardize the value of AEZ because the fluctuation from the national grid will affect the operation of factory facilities/equipment and their production quality.

If the power plant was not built, the tenant companies who require stable electricity for their products would have to allocate budget to construct their own power generator. In other words, without the power plant, AEZ would fail to meet international standards and would not be able to provide an attractive environment for its tenants.

The power plant would also provide power to the national grid which could have the potential impact on stabilization of the national economy. If the power plant is not constructed, the site will remain as a commercial area since the site is inside AEZ and the land would be sold to a tenant anyway who may produce some environmental impact to some extent.

If the power plant is constructed, the value and economic productivity of AEZ will increase. This could lead to the creation of more job opportunities for AEZ. Several environmental impacts were identified: noise, air pollution, etc. However, these impacts can be mitigated with appropriate measures and monitoring.

4.2 Alternatives for Gas Transmission Line

4.2.1 Location Selection

The preliminary survey was carried out in prior to the topographic survey of the gas transmission line in order to roughly examine the impact of 3 alternative route shown in Table 4-3 and Figure 4-1.

Table 4-3: Comparison of Three Alternative Alignments

Option	Color of the alignment	Characteristics	Impacts
1		Along the National Hwy. Use of the existing RoW	30-50 Shops (tin Shed and Semi Paca), 4 storied building, 1 CNG pump, 6-8 Tin shed Buildings Disturbance to the national Hwy. Land acquisition could be minimized. However, the construction will disturb the traffic of the national Hwy and will cause significant economic loss. Construction would be time-taking and costly due to the traffic. Many shops and small businesses will be disturbed or displaced.
2		Avoid structures but also consider the shortest length	20-25 tin shed houses, 1-2 storied buildings, BARM iron rolling factory, himaloy CNG station, Ekhlas spinning mill 1 multistoried building and another small garment. Land acquisition could be less than alignment 3, but the displacement of houses, industries will be much higher. Negotiation with large factories and workers could take a long time. Cost of removing the large structure would be considerably high.
3		Focused on minimizing structure loss and resettlement.	Tin shed 15-20. 6 small factories. Slightly more land acquisition required than other alignments but the number of resettlement (displacement) and impact to businesses would be minimum. Construction would be faster and less costly.

Source: SAPI team

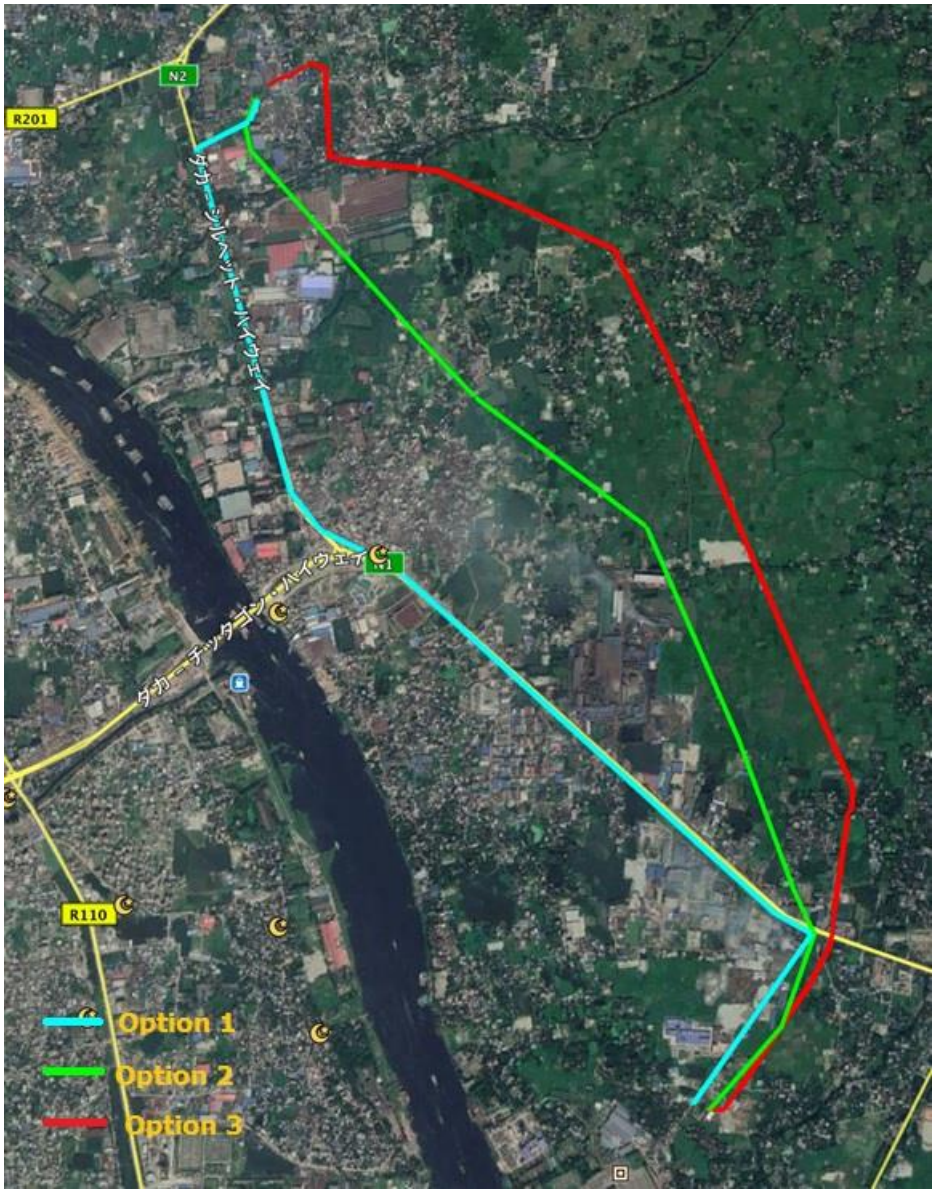


Figure 4-1: Map of 3 alternative Routes of Gas Transmission Line

In accordance with the comparison above and the consultations with the local businesses and landowners, SAPI team presented the comparison and suggested the alignment 3 at the joint meeting at TITAS office on 11 September 2018 with the presence of BEZA's project manager and TITAS's general manager of planning and development, and both parties agreed to proceed with the alignment 3.

4.2.2 Zero option

For the gas transmission line, "Zero option" refers to "no construction of the gas transmission line."

Without the project, the impact described in this report can be avoided. However, the operation of AEZ and the proposed power plant would be hampered due to the shortage of gas supply, and AEZ would lose its value as an economic zone. As a result, new job creation would be limited.

Unlike the land acquisition at AEZ site, the acquired land for the gas transmission line can be restored and used by the previous owners as long as Natural Gas Safety Rules is confirmed.

4.3 Alternative for Substation

Two alternative sites were considered for setting up the substation. Following Table 4-4 shows the alternative for substation.

Table 4-4: Result of Alternative Location Study of Substation

	Option 1	Option 2
Location Map		
Area	2.3 acres	2.25 acres
Location	North middle of the power plant site	Oposite of option 1
Land Acquisition	Not required since land already acruired	Land need to be acquired
Resettlement	No resettlement is needed	Only 1 household need to be resettled
Power Evacuation	The distance between substation and existing transmission line is only 200 meters	Distance between transmission line and substation is about 150 meters
Land use	Farmland, single cropping	Farmland, single cropping
Environment /Social Consideration	• No land acquisition is required • No resettlement is required	• Additional land acquisition is required • Only one household need to be resettled
Evaluation	Compared with Option 2, Option 1 has advantages from the viewpoint of the land acquisition and resettlement aspect. Therefore, Option 1 is chosen as the preferred option.	

4.4 Alternative for Transmission Line

Two alternative options have been studied for selection of power evacuation. These options are described as follows.

a) 11kV and 33kV distribution systems

Initial planning and survey were performed on 11kV and 33kV distribution systems of the Rural Electrification Board (REB) in July 2017 based on "The People's Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority, Final Report (February 2017)".

But it turned out that REB 11kV and 33kV systems don't have enough capacity of 60MVA for increased Economic Zone (EZ) area of 200ha from original 100ha.

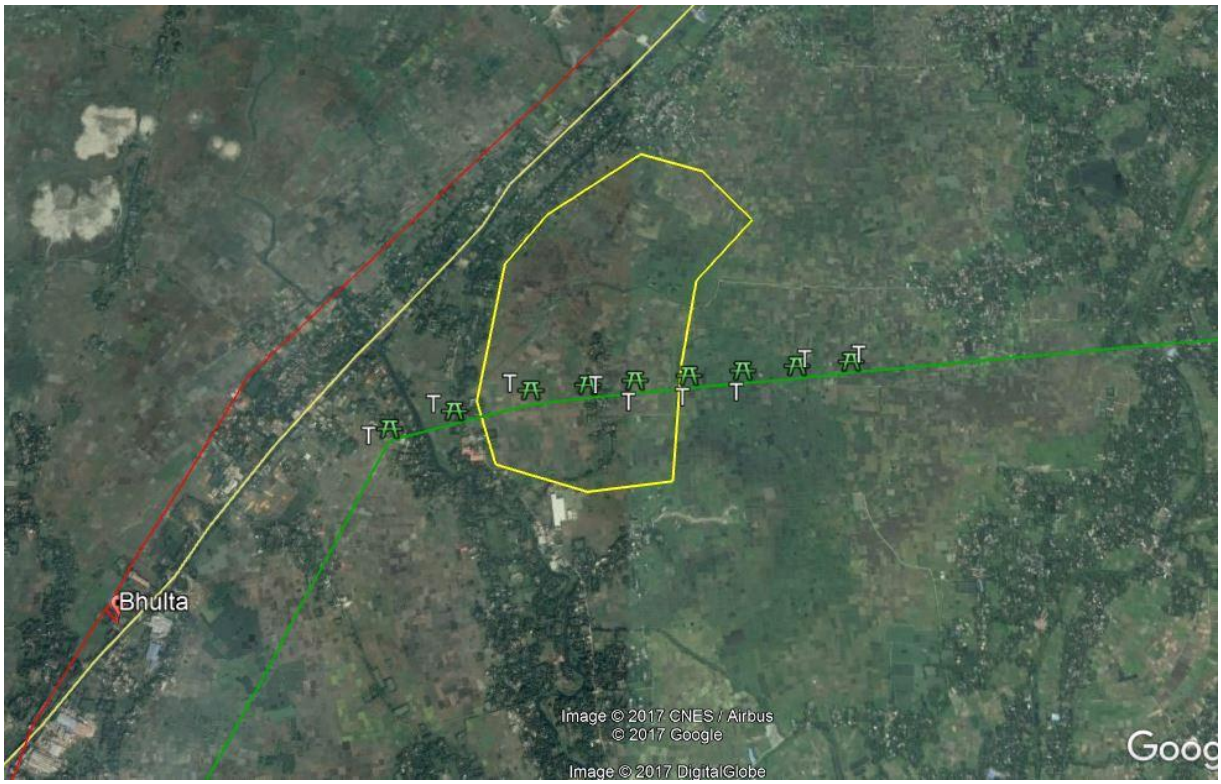
b) 132kV and 230kV transmission systems

For securing enough capacity for the EZ, a meeting was held with PGCB. PGCB agreed that the EZ would receive power from either a 132kV or a 230kV transmission line as an exceptional case

considering it as a government project of EZ by BEZA. As common practice in Bangladesh, consumers receive power from distribution companies such as REB.

A brief survey of 132kV and 230kV transmission lines and towers was conducted at the end of July 2017. On the next visit in September 2017, PGCB System Planning Division advised that the EZ should receive power from the 230kV transmission line having enough capacity since the 132kV transmission line may not have enough capacity considering the Phase 2 expansion.

One major advantage of receiving power from 132kV and 230kV transmission lines is very less frequency of power outage due to planned load shedding. Planned load shedding due to shortage of electricity is conducted by distribution companies such as REB.



Source: PGCB

Figure 4-2: Existing 132kV and 230kV Transmission Lines

Red line: 132kV transmission line, Green line: 230kV transmission line,

Yellow line: Dhaka-Sylhet National Highway N2

Based on further survey on the 230kV transmission line and associated towers, discussion with the PGCB Transmission Line Design Division was conducted in October 2017. Considering transmission line extension to EZ Substation and fuel gas pipeline to Power station adjacent to the Substation, the location of the Substation and the Power station was decided (Figure 4-2).

As shown on Figure 4-2: "The location of the substation and the power plant", 230kV Transmission line passes over south corner of the location of the Substation. For connecting the new Substation with the 230kV Transmission line, branch towers and terminal towers will be newly installed.

CHAPTER 5: BASELINE ENVIRONMENTAL CONDITION

5 EXISTING ENVIRONMENTAL CONDITION

5.1 Introduction

The physical environmental status around the proposed power plant project site and gas transmission pipeline are analyzed for valued environmental components viz., climate, topography, geology, air, water, land, noise and soil around the site. The baseline provides the basis for assessment of impact (likely changes in the baseline conditions) due to the proposed interventions (EZ development project).

5.2 Site Description and its Environment

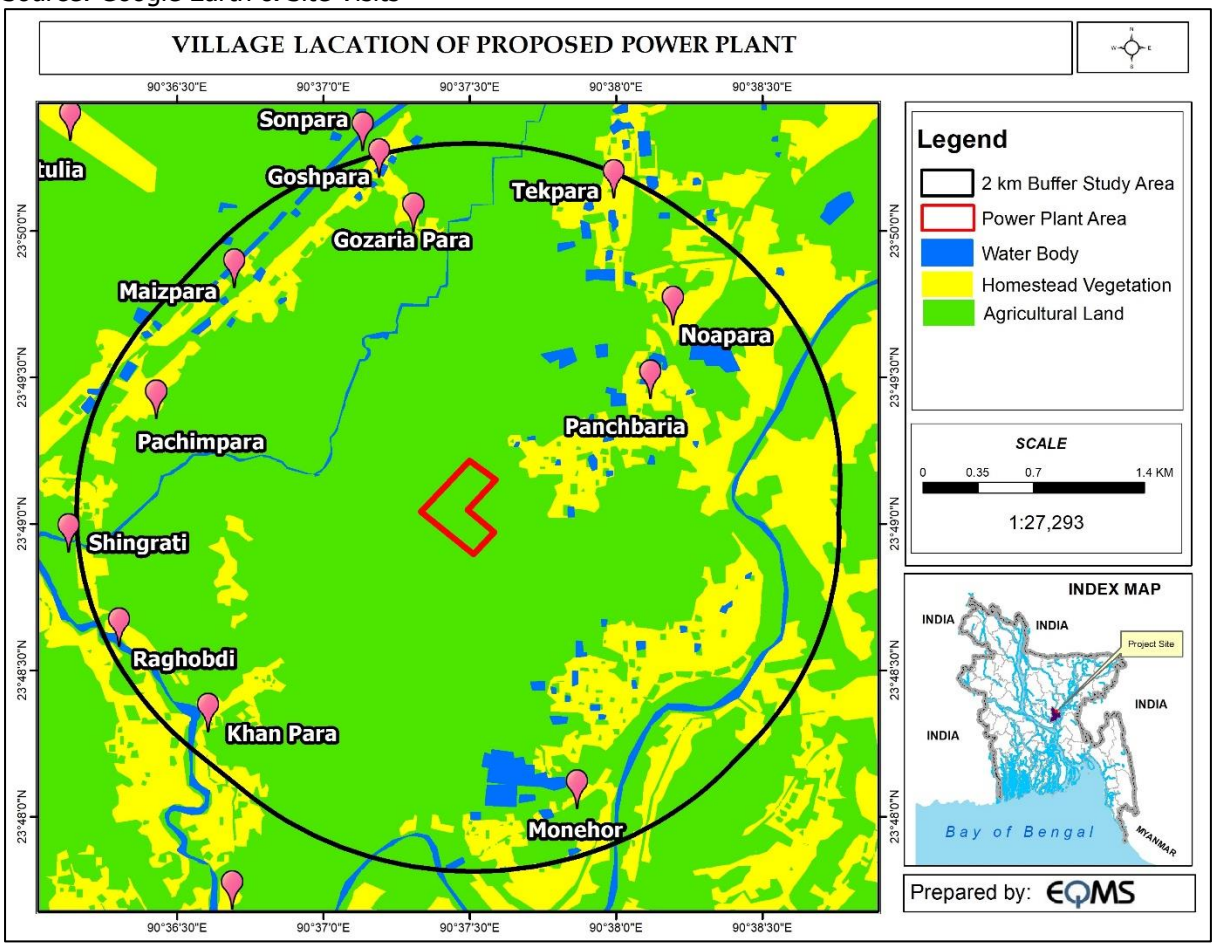
The site and surrounding details have already been presented under ***chapter 3***. The study area considered major settings, villages, roads, river, airport, and railway around the proposed power plant and Gas pipeline route site. The project activity areas are considered as core area and remaining study area as the buffer zone. Environment setting around proposed power plant site and surroundings of access road are given in ***Table 5-1*** below.

Table 5-1: Environmental Setting for Power plant & Gas Transmission Pipeline Project

Particulars	Details
Location	The power plant site is located at Union: Duptara, Upazila: Araihajar, District: Narayanganj Gas transmission pipeline site is located at Union: Word-9 at Tarabo paurashava, Word no-27 at Bandar Paurashava and Kanchpur at Shonargong upazila under District: Narayanganj
Mouza	Power Plant: Panchrukhi & Panchgaon Gas Transmission Pipeline: Dighi Barabo, Jatramura, Behakair, Nagar Kanchpur, Manohar Khanerbagh, Uttar Chandpur, Fular
Project Area	Proposed Power plan area approximately 9.28 ha or 22.93 acres Approximately 8.65 acres of land need to be acquired, and 8.11 acres land will be leased for construction of the gas pipeline.
Road Access	Adjacent Dhaka-Sylhet Highway
River Access	The proposed Power plant is Approx. 1.5 km from Brahmaputra River The proposed Power plant is Approx. 5.5 km from Shitalakhya River Gas transmission pipeline Haripur station is Approx. 740 meters from Shitalakhya River
Nearest Airport	The proposed Power plant is Approx. 30.2 km from Hazrat Shah Jalal International Airport (Dhaka)
Nearest Railway Station	The proposed Power plant is Approx. 30.3 km from Kamalapur Railway Station, Dhaka
Climatic conditions	Avg. Monthly wind speed– 2-5 m/s; Avg. Monthly Min. Temp. – 19.0°C January 1991; Avg. Monthly Max. Temp. – 40.2°C in April 2014; Annual Avg. Rainfall – 1994.6 mm;

Particulars	Details
	Average maximum humidity ranges – 94% to 97%; Average minimum average ranges – 31% to 64%;
Seismic Zone	Zone II
Forests / National Parks	None within 5 km
Archaeologically important places/monuments	No Archaeologically important places/monuments near to the site.

Source: Google Earth & Site Visits



Source: Open Street Map (and) contributors, CC-BY-SA

Figure 5-1: Project site and surrounding within 2 km radius area

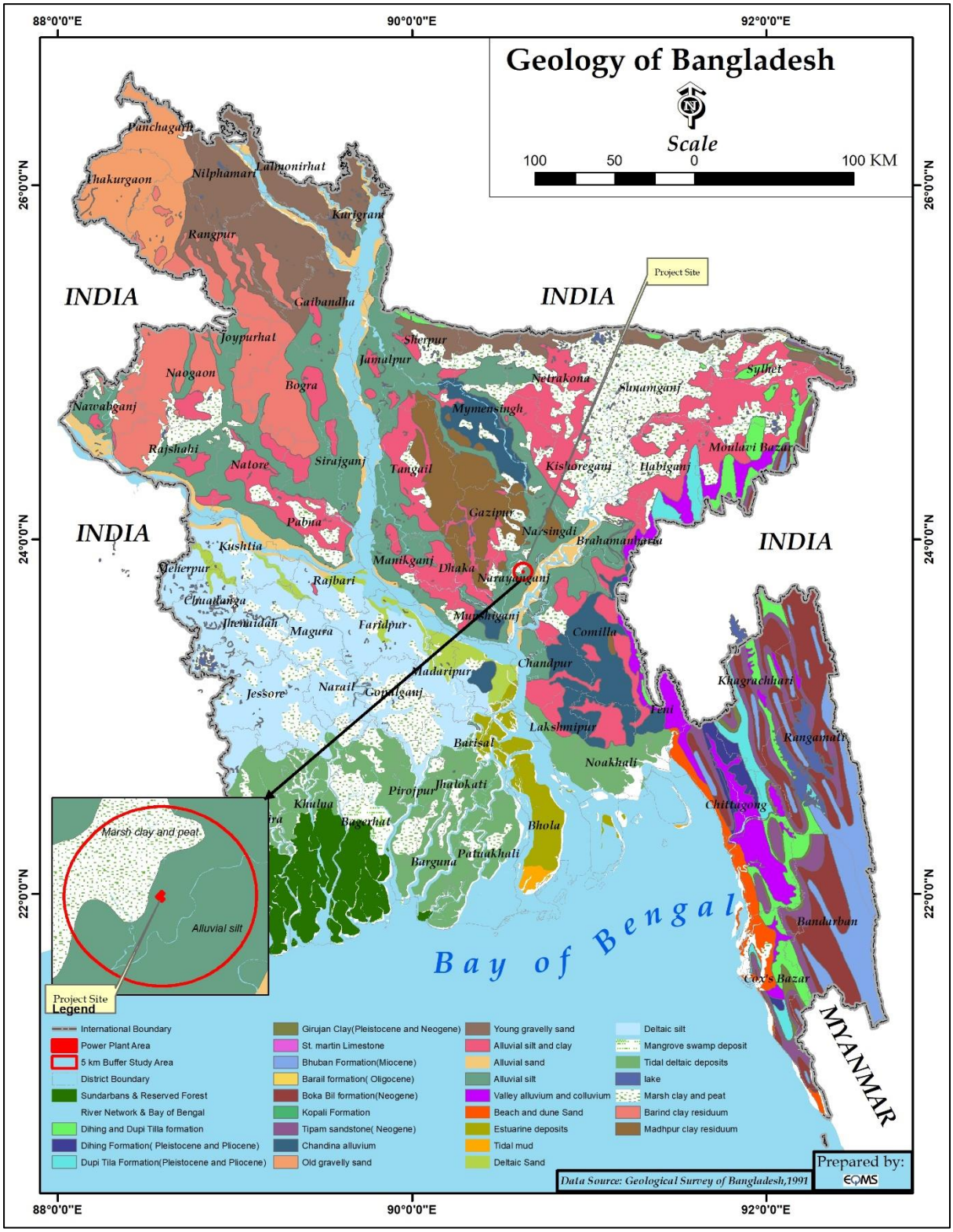
5.3 Physical Environment

5.3.1 Geology

The study area of power plant covers two geology types they are the Marsh clay and peat and Alluvium Silt. The Project area is shown in the geology of Bangladesh Map ***Figure 5-2***.

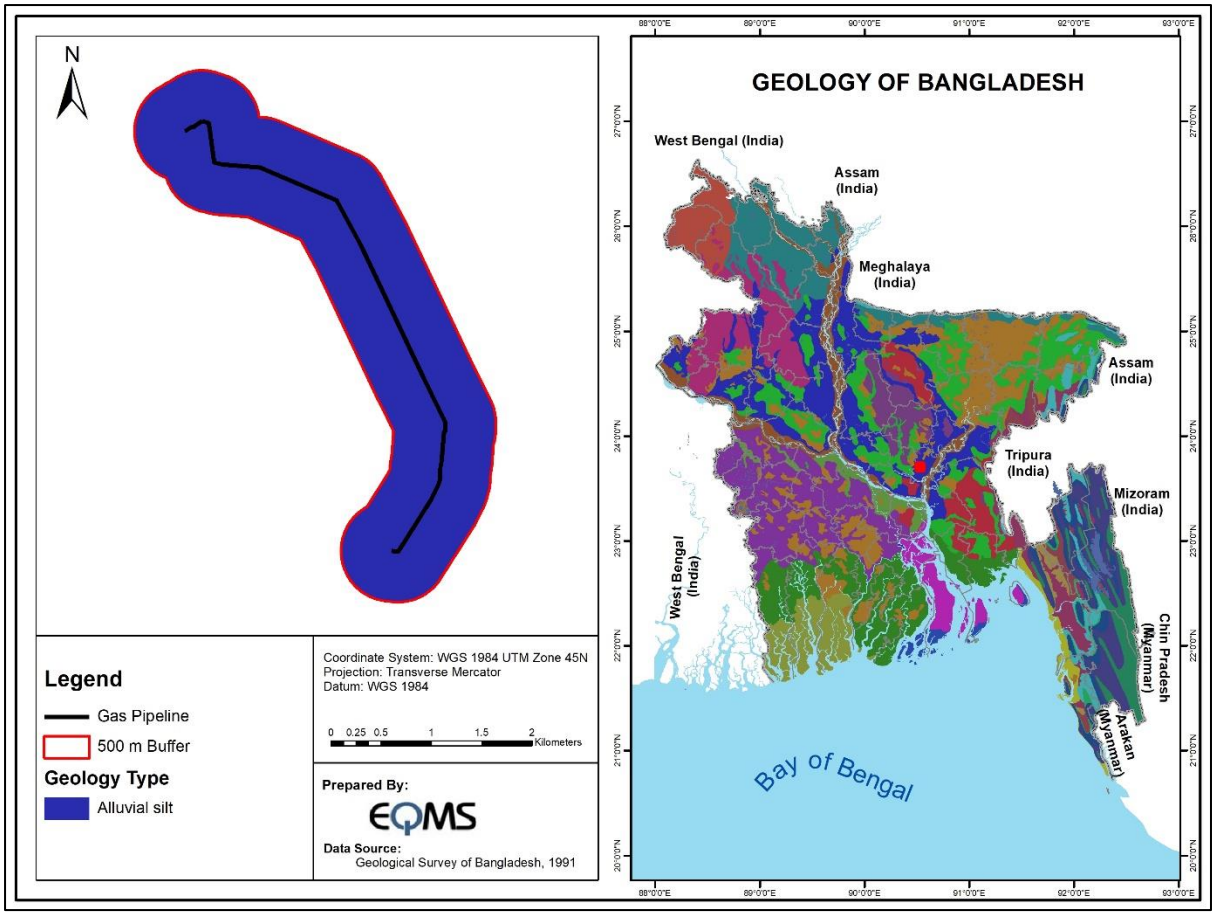
The geology type of the power plant and gas transmission pipeline area is alluvial silt which is light to medium-grey, fine sandy to clay-lade silt. Commonly poorly stratified; the average grain size decreases away from main channels. Chiefly deposited in flood basins and inter-stream areas. The unit includes small back swamp deposits and varying amounts of thin, interstratified sand, deposited during episodic or unusually large floods. Illite is the most abundant clay mineral. Most areas are flooded annually. Included in this unit are thin veneers of sand spread by episodic large floods over

flood-plain silts. Historic pottery, artifacts, and charcoal (radiocarbon dated 500-6,000 years BP) are found in upper 4 m.



Source: Geological Survey of Bangladesh, 1991

Figure 5-2: Geology of 5 km Radius of Study Area

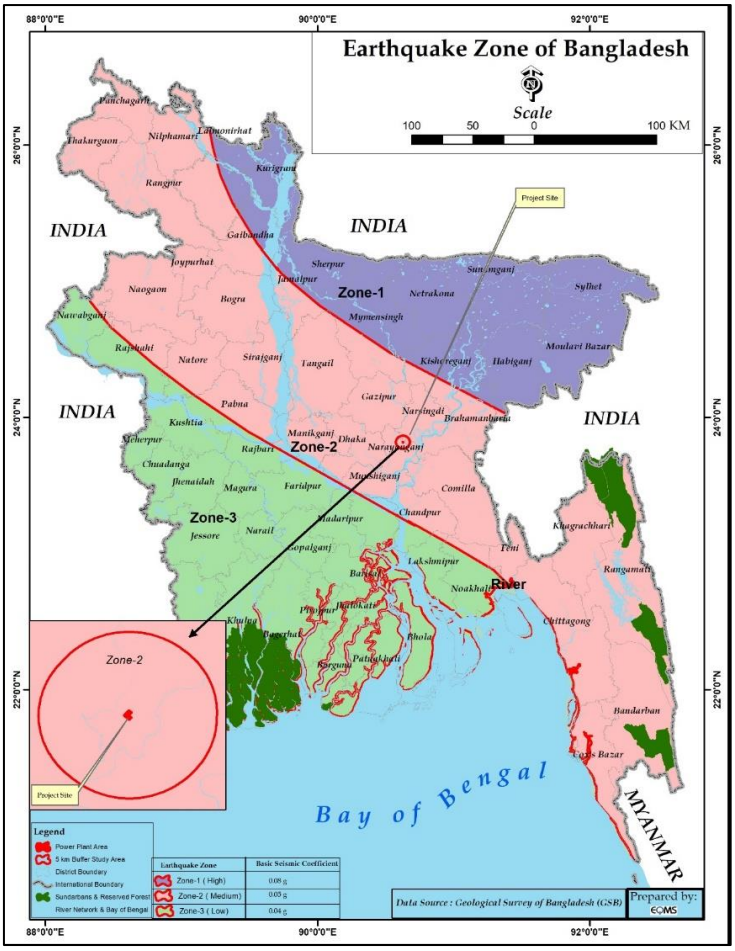


Source: Geological Survey of Bangladesh, 1991

Figure 5-3: Geology of 500 m Buffer Study Area

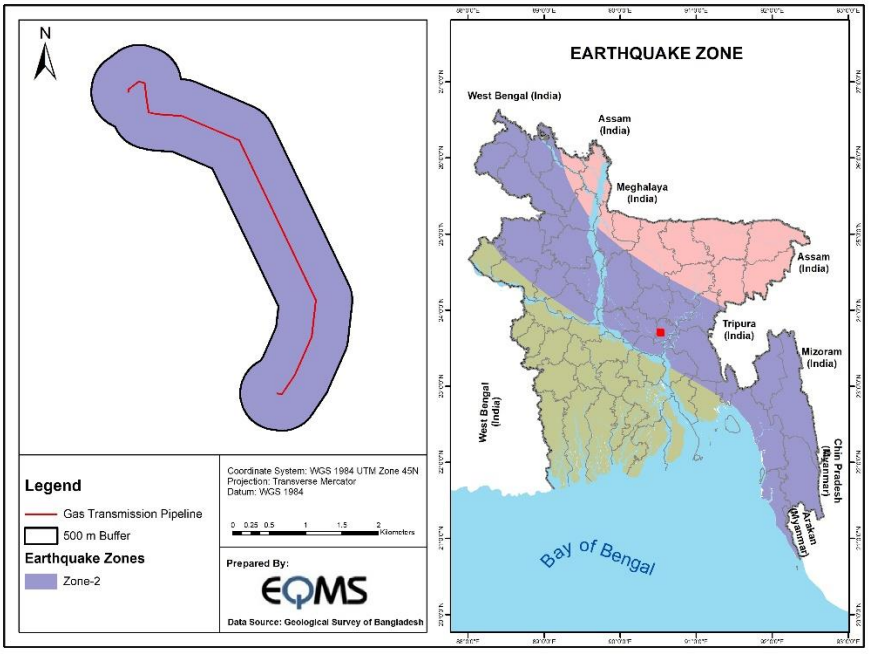
5.3.2 Seismology

Information on earthquakes in and around Bangladesh is available covering the last 250 years. The earthquake record suggests that since 1900 more than 100 moderate to large earthquakes occurred in Bangladesh, out of which more than 65 events occurred after 1960. There is a slight increase in the frequency of earthquakes in the last 30 years. This increase in earthquake activity is an indication of fresh tonic activity or propagation of fractures from the adjacent seismic zone. However, the most serious damage has occurred in the northern part of Bangladesh, and virtually none has been found in the Dhaka region. The proposed power plant and Gas transmission pipeline area is located under Zone 2, and its seismic coefficient is 0.05g.



Source: Geological Survey of Bangladesh (GSB)

Figure 5-4: Earthquake Zones of 5 km Radius of Study Area



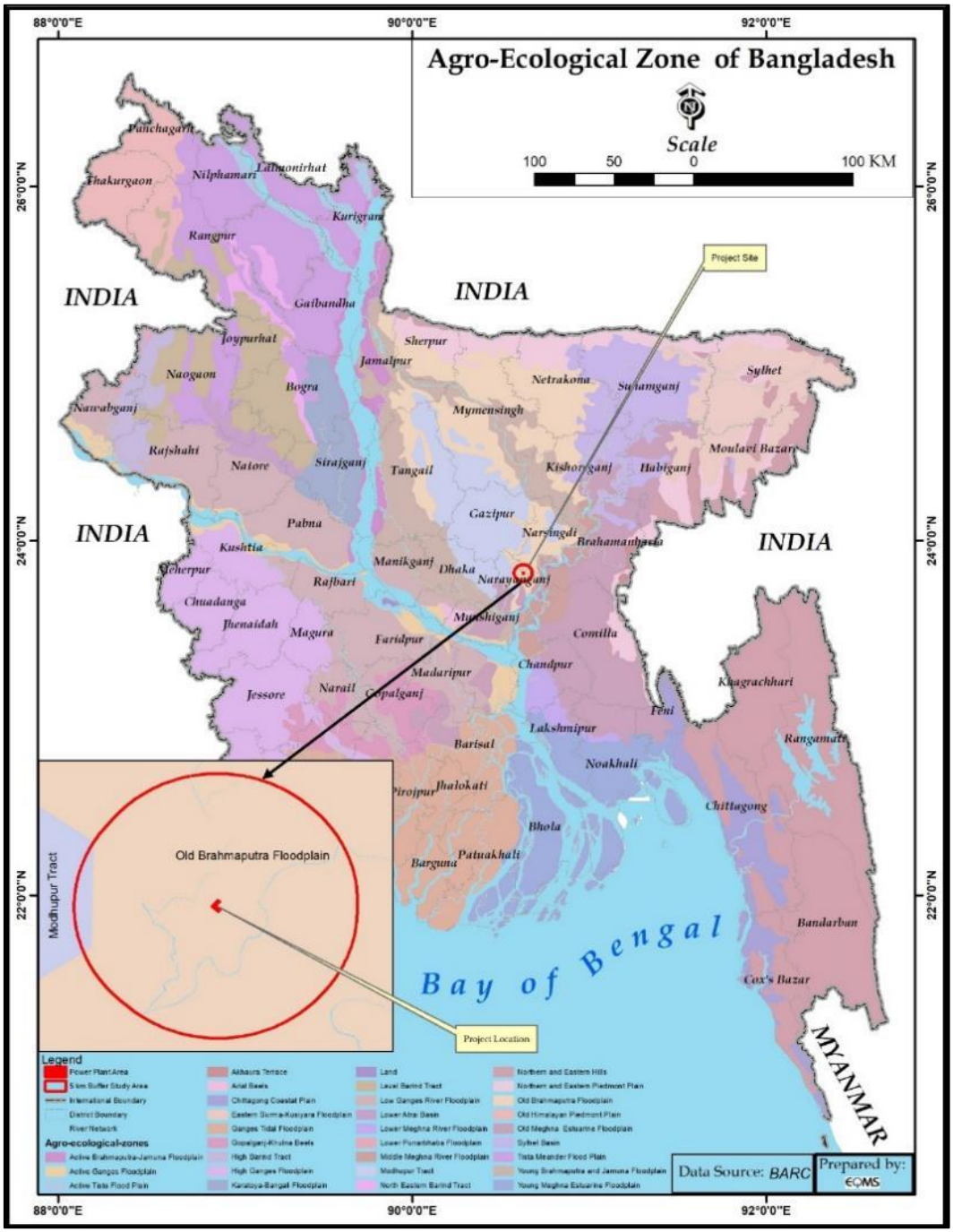
Source: Geological Survey of Bangladesh (GSB)

Figure 5-5: Earthquake Zones of 500 m Buffer Study Area

5.3.3 Soil Characteristics

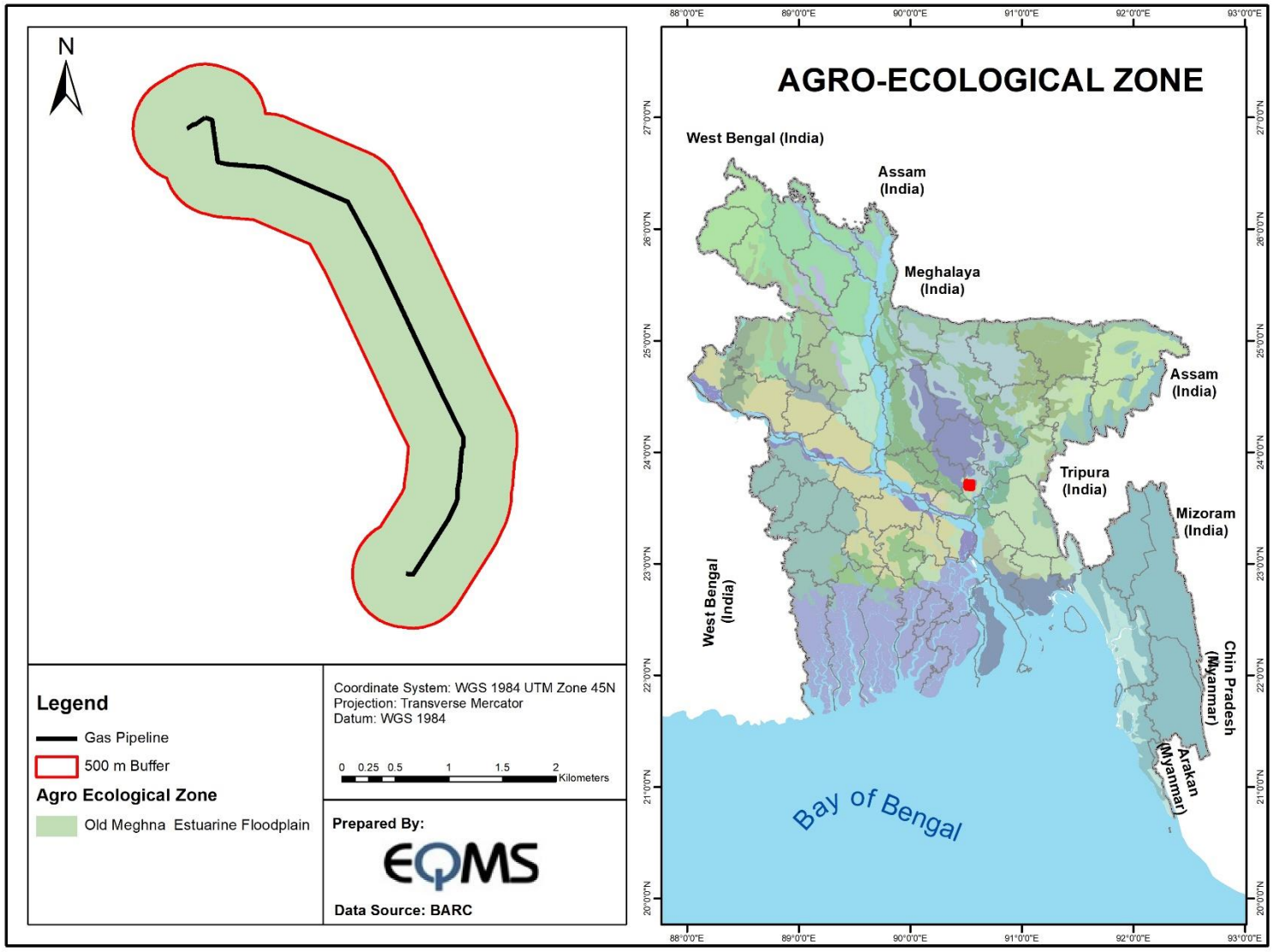
5.3.3.1 Agroecological Regions

The 5 km study area covers four distinct agro-ecological zones; they are the Old Brahmaputra Floodplain and Modhupur Tract. The proposed power plant site falls under the Old Brahmaputra Floodplain zone. In addition, the Gas transmission pipeline area falls under Old Meghna Estuarine Floodplain zone. Agro-ecological zones of Bangladesh have shown in ***Figure 5-6*** & ***Figure 5-7***. Details of these agro-ecological zones has discussed in ***Table 5-2***.



Source: BARC

Figure 5-6: Agro-ecological Zones of 5 km Radius of Study Area



Source: BARC

Figure 5-7: Agro-ecological Zones of 500 m Buffer Study Area

Table 5-2: Details of Agro-ecological zones of Bangladesh within the study area

Characteristics	Old Brahmaputra Floodplain	Modhupur Track	Old Meghna Estuarine floodplain
Physiography	Most areas have broad ridges and basins. The differences in elevation between the ridge top and basin center usually 2-5 meters.	The level upland area with well-drained red-brown soil. Closely dissected upland areas with deep well-drained red soils on level upland soils and deep, broad valleys with grey and dark grey heavy clay. Closely dissected areas with shallow, moderately to poorly drained brown soils. Planed areas with deep and shallow poorly grey silty soils alley with dark grey heavy clays planed areas with shallow poorly drained grey	Smooth, almost level, floodplain ridges and shallow basin
Soil Type	Dark grey floodplain soil generally predominates. The reaction of the cultivated layer is usually medium to very strongly acidic. Organic matter in the cultivated layer range from about 1-1.5 percent in the ridge soil to 2-5 percent in basin soil	Soils are clayey (87%), loamy (13%) and sandy (<1%) organic matter content is low (<1.5%) and pH ranging from 4.5 to 7.8	Silty soils predominate, but silty clay and clay also found. Organic matter contents in the cultivated layer range from 1-2.5 percent in ridges and 2-5% in depression. Moisture holding capacity is high.
Water resources	A limited amount of surface water is available for irrigation mainly in the Old Brahmaputra and Shitalakhya river.	The only limited amount of surface water is available in rivers and bils, and this is almost fully exploited. Groundwater is apparently is generally available, Artesian water occurs in a few valleys near Bhaluka in the north and east	Surface water that could be used for irrigation is widely available from the Meghna, Sitalakhya, Dhaleswari or Ganges distributaries. Groundwater apparently is readily available for use by tubewell.
Present land use	Permeable soils on high ridges: aus, jute, groundnut, sugarcane; with irrigation wheat, potato, tobacco, rabi vegetables, and spices Medium lowland and low land basin: Mainly mixed aus and aman or jute and broadcast aman on lowland. With irrigation, mainly HYV boro	Jackfruits are found on field boundaries, rainfed aus followed by mashkalai or mustard, other crops are sugarcane, Kharif groundnut, with irrigation wheat, potato, rabi vegetables; sal forests are present. HYV boro, HYV aman on irrigated land. Pineapple is also widely grown in Madhupur area.	On highland and medium highlands- aus, T.aman, HYV boro rice, mustard and rabi crops are grown. On medium lowland- mixed aus and aman, jute, wheat, mustard, potato, chilli, kaon, sesame, kheshari, etc. are grown. In the lowland- Local variety of boro are widely grown.

Characteristics	Old Brahmaputra Floodplain	Modhupur Track	Old Meghna Estuarine floodplain
Major Cropping Pattern	Mustard-Aus/Jute-Fallow Vegetable(R) – B.aus – Fallow Sugarcane Boro-Fallow-T.aman and Fallow-Jute-T.aman	Mustard/Vegetable(R)/groundnut Aus/Jute-Fallow Boro-Fallow-T.aman Fallow- B.aus-T.aman Sugarcane Pineapple	in Mustard/wheat/grasspea/potato/ Cucurbits B.aus-T.aman Boro-Fallow-T.amam Sugarcane B.aus-Fallow Mustard-Jute-Fallow

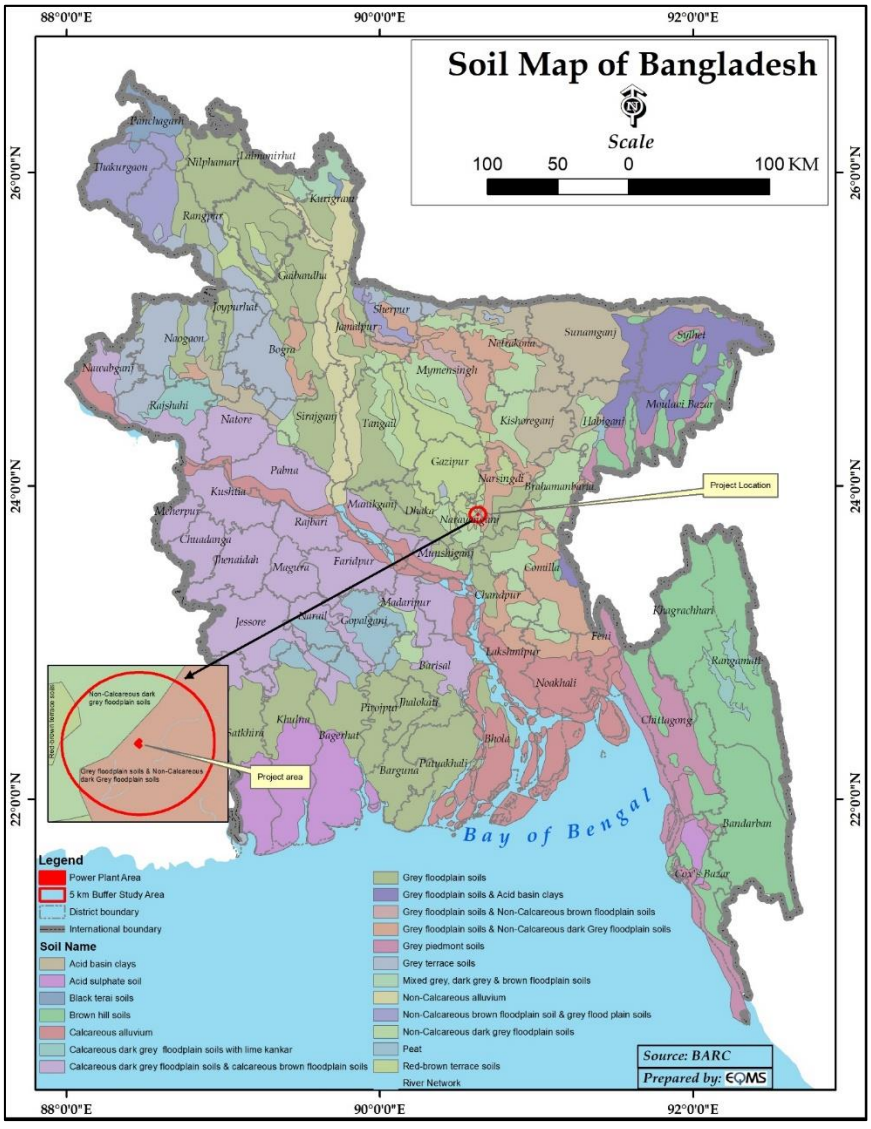
Source: BARC

5.3.3.2 Soil Type

The 5 km study area covers three distinct soil types; they are the Gray Floodplain soil, Non-Calcareous Dark Grey Floodplain soils, and Red Brown terrace soils. Proposed power plant site soil covers Grey Floodplain Soils & Non-Calcareous Dark Grey Floodplain soils. The Gas Transmission pipeline area covers Non-Calcareous Dark Grey Floodplain soils. The soils category of Bangladesh Map is given in ***(Figure 5-8*** & ***Figure 5-9)***.

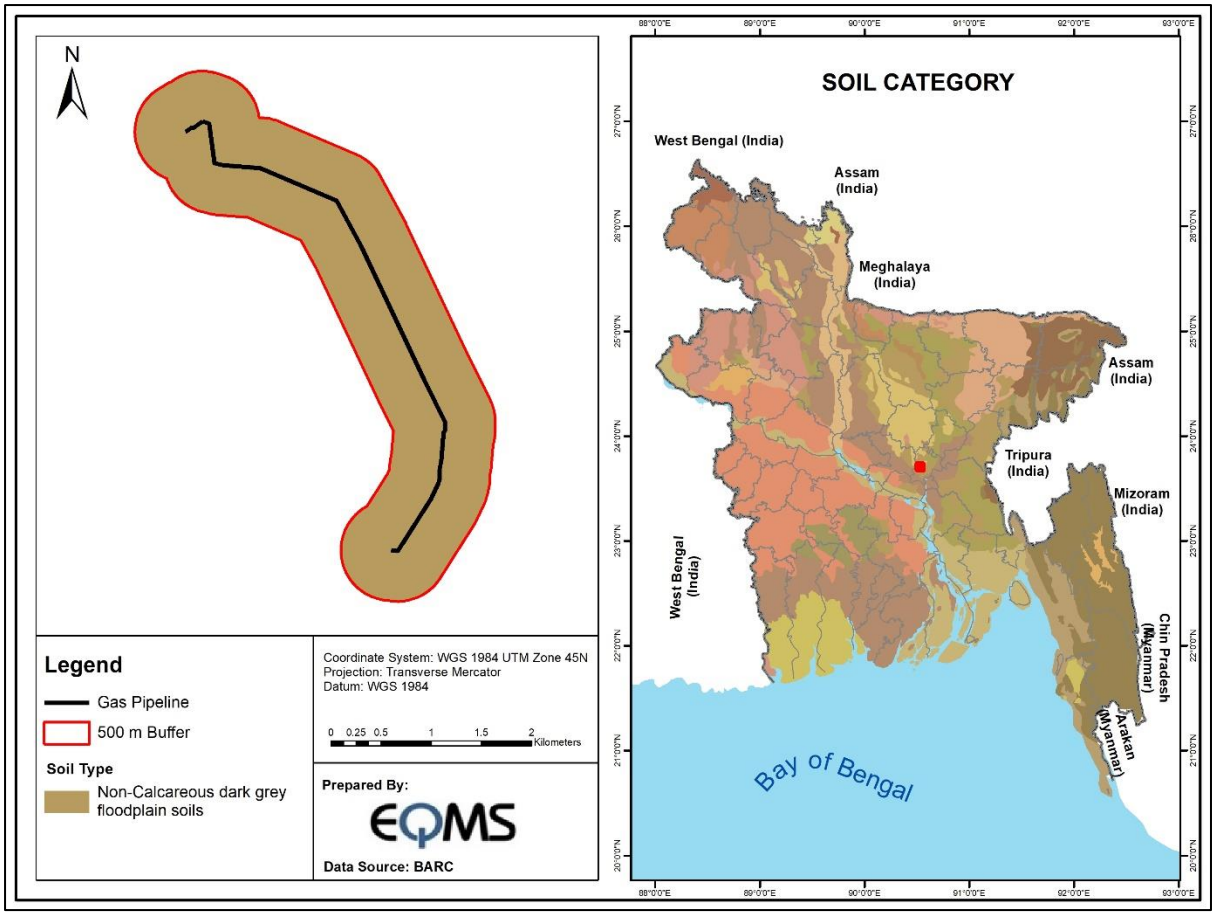
Grey floodplain soil contains lime in part or all of the upper 125 cm of the profile. The topsoil usually is grey or olive-grey when dry, but may be darker and bluish or greenish grey when wet and reduced in the monsoon season. The subsoil usually is grey with yellow-brown or brown mottles and broken or continuous grey coating. The structure usually is prismatic in coarse soils. The soil texture of the project site located union is sandy loam to loam.

Non-calcareous Dark Grey Floodplain soils they have a cambic B-horizon, non-calcareous dark grey topsoil and subsoil. They occur extensively on the Old Brahmaputra and old Meghna estuarine floodplain. Silt loam and silty clay loam are predominant on the Meghna estuarine floodplain and in the Tista meander floodplain, whereas silty clays and heavy clays are extensive on the Old Brahmaputra floodplain. The majority of these soils are Eutric Gleysols.



Source: BARC

Figure 5-8: Soils Category of 5 km Radius of Study Area



Source: BARC

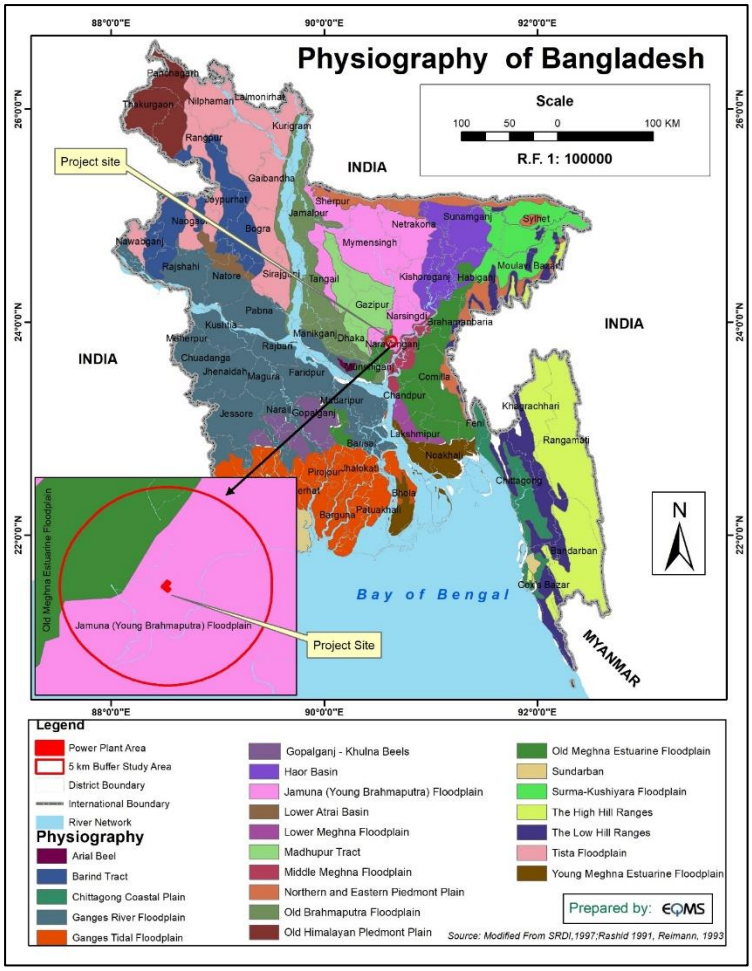
Figure 5-9: Soils Category of 500 m Buffer Study Area

5.3.4 Topography

The proposed power plant site is a naturally depressed area, which remains submerged during monsoon and dry in winter. The land use of the project site is agricultural land. The area is classified as a Jamuna (Young Brahmaputra) Floodplain. A river network is present close to the site that floods during the monsoon season. The physiographic zone of gas transmission pipeline falls under Madhupur tract and Old Meghna Estuarine Floodplain Zone. The RoW of the pipeline is also the depressed area, which remains submerged during monsoon and dry in winter. A physiographic map of Bangladesh is depicted in ***Figure 5-10 & Figure 5-11***.

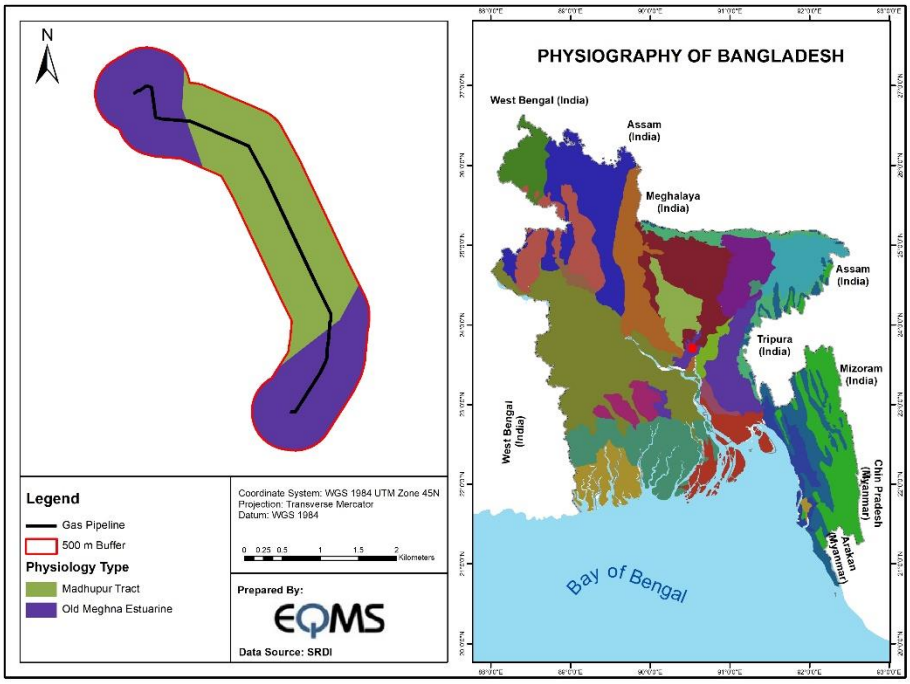
The Powerplant candidate site is flat agricultural land (paddy field) with an elevation of MSL + 2.5 m and is submerged in the rainy season. The Dhawrakhali canal pass adjacent the proposed project boundary. The area on the southeastern side of the candidate site, along with National Road N2 and along the southwestern side of the river are MSL +4 ~ +5.5 m higher than the agricultural land with scattered village roads, houses, and water ponds. The pavement elevation of the National Highway N2 is higher than local land. It has dropped from MSL +10 m at the southwestern side of the bridge to about MSL +7 m at the northeastern side. Rainwater inside the plant candidate site flows from the northeast to the southwest and drains into the southwestern side of the river, connecting to the Meghna River. The elevation of the candidate site is lower than past flood levels of surrounding large rivers such as the Meghna River and the Shitalakshya River. Hence, it is necessary to ensure a surface water diversion around the candidate site after site formation.

A DEM map of the study area is shown in ***Figure 5-12 & Figure 5-13***.



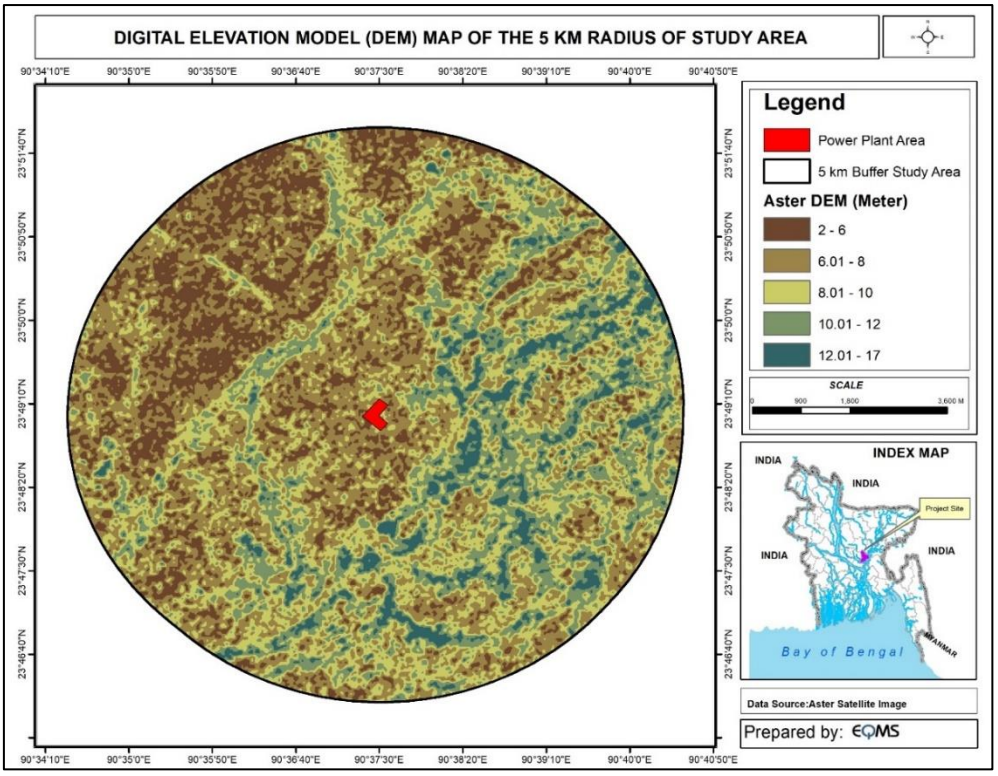
Source: SRDI; Rashid 1991, Reimann, 1993

Figure 5-10: Physiographic Map of 5 km Radius of Study Area



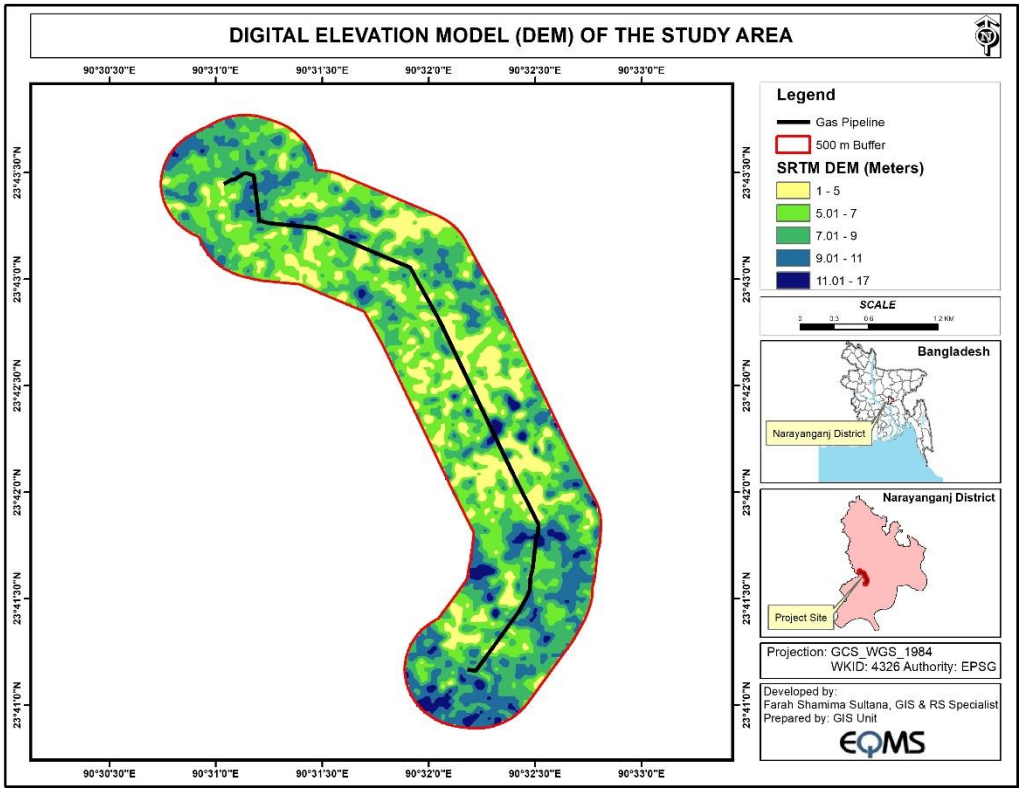
Source: SRDI; Rashid 1991, Reimann, 1993

Figure 5-11: Physiographic Map of 500 m Buffer Study Area



Source: Aster Satellite Image

Figure 5-12: Digital Elevation Model (DEM) Map of 5 km Radius of Study Area



Source: Aster Satellite Image

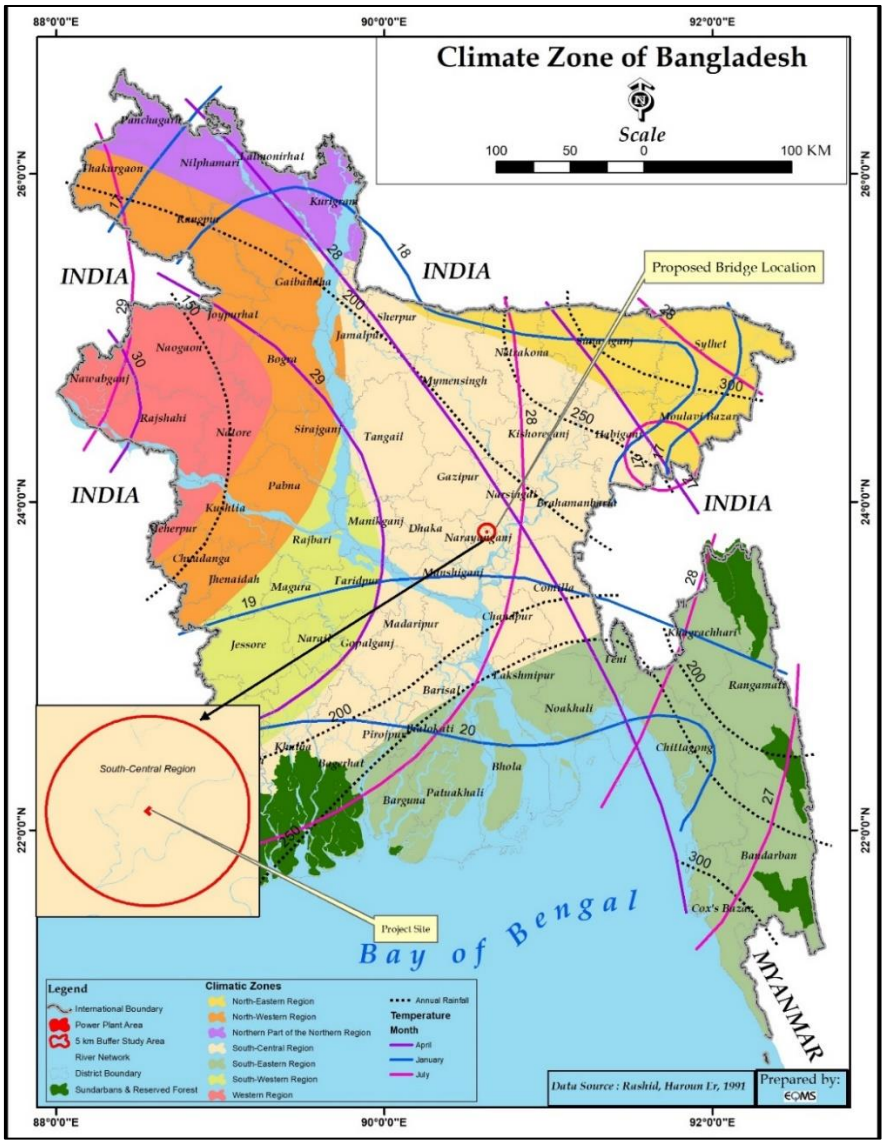
Figure 5-13: Digital Elevation Model (DEM) Map of 500 m Buffer of the Proposed Pipeline

5.3.5 Meteorology

Bangladesh experiences a subtropical monsoon climate, which is characterized by wide seasonal variations of rainfall, high temperatures and humidity throughout the year. There are three distinct seasons in Bangladesh: hot and humid summer stretches from March to June; a wet and cool rainy season from June to October; and a dry and cold winter from October to March. In general, for most parts of the country, summer temperatures range between 30°C to 40°C. April is the warmest month of the calendar. Whereas, January is the coldest month when the average temperature over most parts of the country lies around 10°C.

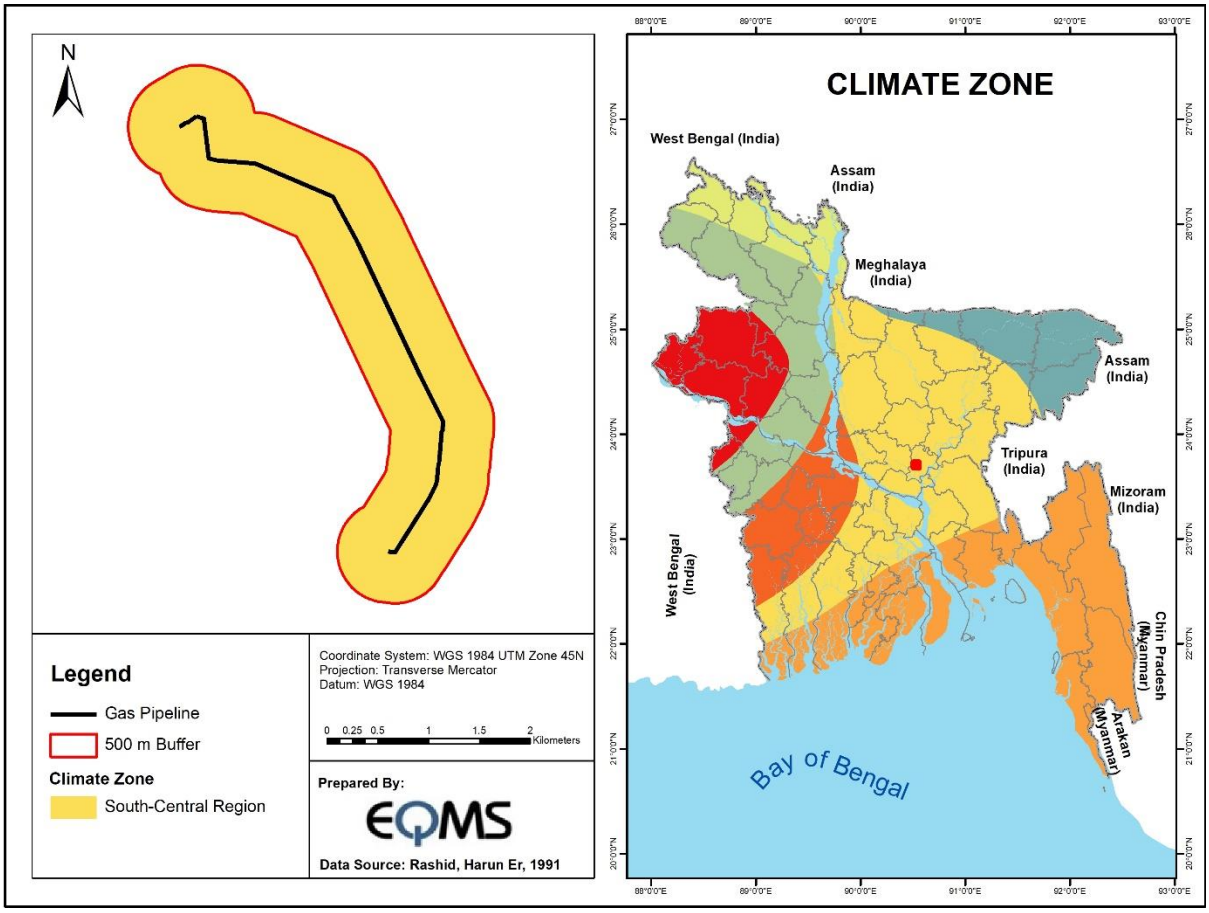
Within the study area, the proposed power plant and Gas transmission pipeline area falls in the south-central climatic subzone of Bangladesh (***Figure 5-14***). This sub climatic zone experiences abundant rainfall (more than 1,900 mm) and moderate temperatures. Eighty percent 80% of the rain falls during the monsoon season. Hail storms and nor-westers are also observed in this area. However, in order to investigate the climatic conditions of the study area, data from different secondary sources have been collected.

Long-term Meteorological data of the last 30 years have been collecting from the nearest BMD stations (Dhaka) and analyzed to get the overall micro-climatic conditions of the study area.



Source: Rashid, Haroun Er, 1991

Figure 5-14: Climate Region Map of 5 km Radius of Study Area



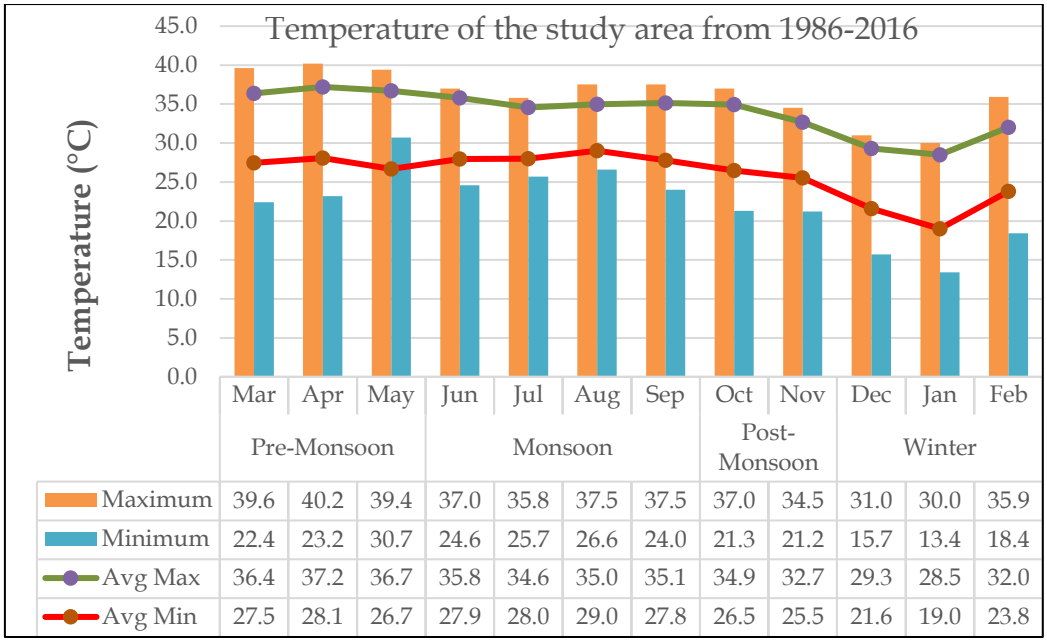
Source: Rashid, Haroun Er, 1991

Figure 5-15: Climate Region Map of 500 m Buffer Study Area

5.3.5.1 Temperature

The maximum, minimum and average temperatures recorded at the Dhaka weather station are presented below in ***Figure 5-16***.

The data analysis of the last 30 years (1986-2016) indicates that monthly maximum temperature varies from 30.0°C to 40.2°C whereas monthly minimum temperature varies from 13.4°C to 26.6°C. The lowest average temperature recorded in the past 30 years was in January 1991 (19.0°C). The highest temperature reached 40.2°C in April 2014. Throughout the year the highest temperatures are generally recorded from March to October and the lowest temperatures from December to January.



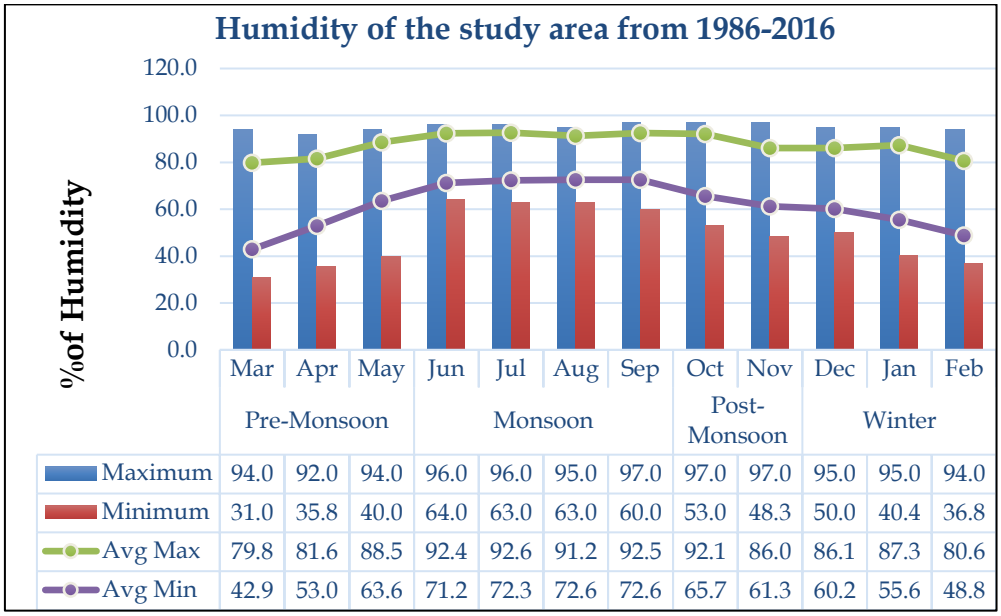
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	39.6	40.2	39.4	37.0	35.8	37.5	37.5	37.0	34.5	31.0	30.0	35.9
Minimum	22.4	23.2	30.7	24.6	25.7	26.6	24.0	21.3	21.2	15.7	13.4	18.4
Avg Max	36.4	37.2	36.7	35.8	34.6	35.0	35.1	34.9	32.7	29.3	28.5	32.0
Avg Min	27.5	28.1	26.7	27.9	28.0	29.0	27.8	26.5	25.5	21.6	19.0	23.8

Source: Bangladesh Meteorological Department, Dhaka

Figure 5-16: Monthly Maximum, Minimum and Average Temperatures (1986-2016) registered at the Dhaka Weather Station

5.3.5.2 Humidity

Due to the heavy rainfall and high air temperature, the humidity levels in Bangladesh remains high. Analyzing the meteorological data, it has been found that during the pre-monsoon period the humidity level remained at its lowest point. Within the study area, February is the driest month with an average minimum of around 49% humidity. However, humidity increases to a maximum in the monsoon period. The average maximum humidity ranges from 94% to 97%, whereas the minimum average ranges from 31% to 64%. The monthly maximum, and maximum averages and minimum, a minimum average of the last 30 years (1986-2016) of registered Dhaka weather station are shown in ***Figure 5-17***.



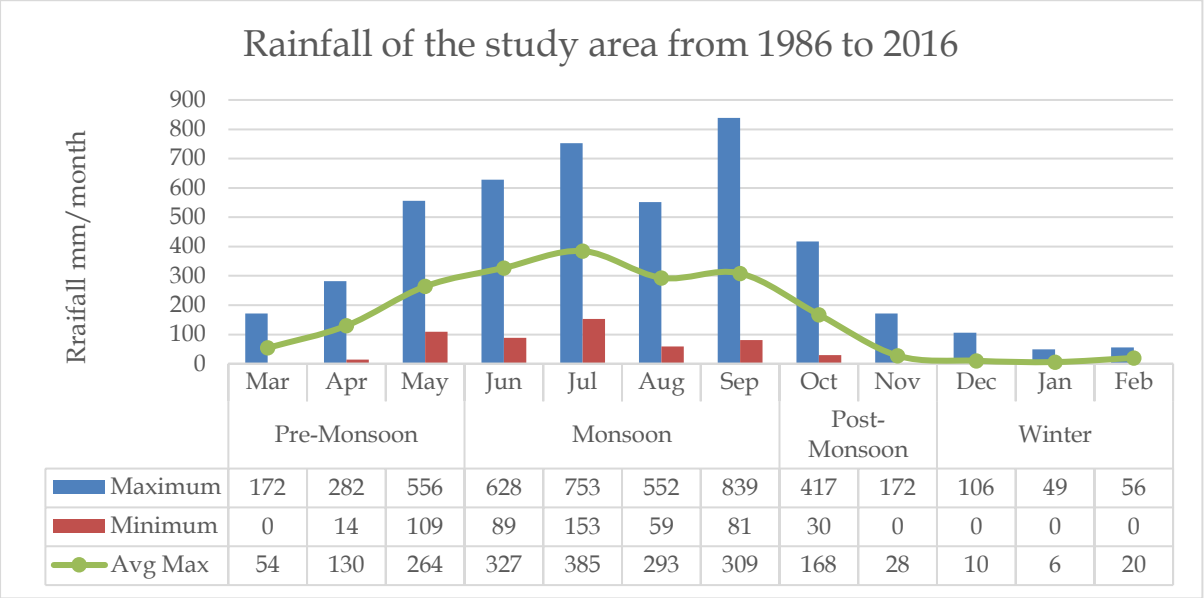
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	94.0	92.0	94.0	96.0	96.0	95.0	97.0	97.0	97.0	95.0	95.0	94.0
Minimum	31.0	35.8	40.0	64.0	63.0	63.0	60.0	53.0	48.3	50.0	40.4	36.8
Avg Max	79.8	81.6	88.5	92.4	92.6	91.2	92.5	92.1	86.0	86.1	87.3	80.6
Avg Min	42.9	53.0	63.6	71.2	72.3	72.6	72.6	65.7	61.3	60.2	55.6	48.8

Source: Bangladesh Meteorological Department, Dhaka

Figure 5-17: Monthly Maximum, Minimum and Average Humidity (1984-2014) registered at the Dhaka Weather Station

5.3.5.3 Rainfall

About 80% of the rainfall occurs during the six monsoon months (May to October) with June and July getting the maximum average rainfall. Minimum rains are reported during the months of November to February whereas the average showering occurs in March, April, and November. The meteorological data of the last 30 years from the Dhaka meteorological station shows that the annual average of total rainfall recorded as 1,994.6 mm/year. According to the analysis of the historical data, the monthly average of total rainfall occurs in July at 1,049 mm whereas monthly minimum rainfall is recorded during the winter season. The monthly maximum, minimum and average rainfall data of the last 30 years (1986-2016) registered at the Dhaka weather station is shown in ***Figure 5-18***.



Source: Bangladesh Meteorological Department, Dhaka

Figure 5-18: Monthly Maximum, Minimum and Average Rainfall (1986-2016) registered at the Dhaka Weather Station

5.3.5.4 Evaporation

Evapotranspiration reaches its maximum level in April when temperature, sunshine and wind are all at, or close to, their maximum levels for the year. Potential evapotranspiration data for Dhaka stations presented in ***Table 5-3***. In Dhaka, evapotranspiration varies from 60 to 147 mm/day, and yearly evapotranspiration in Dhaka is 1245 mm/day.

Table 5-3: Monthly Potential Evapo-Transpiration Data of Dhaka Meteorological Station

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Dhaka	67	83	132	147	138	111	113	115	106	98	75	60	1245

Source: Bangladesh Meteorological Department, Dhaka

5.3.5.5 Wind Speed and Direction

Like the countries wind characteristics, the region characterized by Southerly wind from the Bay of Bengal during monsoon and Northwesterly wind from Himalaya during winter. As per BMD, the windiest month is May with the average wind speed of 2.6 knots and the least windy month is October with the average wind speed of 0.6 knots. Average monthly wind speed data of the Dhaka meteorological station given in ***Table 5-4***.

Table 5-4: Average Monthly Wind Speed Data of Dhaka Meteorological Station

Location	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Yearly
Dhaka	**1.2**	**2**	**1.6**	**2**	**2.6**	**2**	**2**	**1.2**	**2**	**0.6**	**1**	**0.9**	**1.6**

Source: Bangladesh Meteorological Department, Dhaka

5.3.5.6 Sun Shine Hours

The monthly average sunshine hour in Dhaka varies from 3.7 to 8.3 hour/day in a year. Highest average sunshine hours recorded in the month of March. In general, maximum average sunshine hour data of 12 hours in a day found in March, April & May.

5.3.6 Hydrology and Water Resources

5.3.6.1 Surface Water System

The nearby surface water source of the proposed power plant site is Dhawrakhali canal. The closest river is Shitalakhya River, which is 5.5 km far from the proposed power plant area and 740 m from Haripur Station by Titas. Other water bodies fall under the study area are some canals and ponds.

Dhawrakhali canal flows at the middle of the project site which width is approximately 5-7meters. It's downstream connected with Brahmaputra River which width is 24-27 meters. Brahmaputra River is also connected with the Meghna River. After consultation with local fishermen, the survey team try to identify the fishing condition of these khals which were enriching in fish. Now the water becomes polluted for discharging untreated water from various kinds of factories.

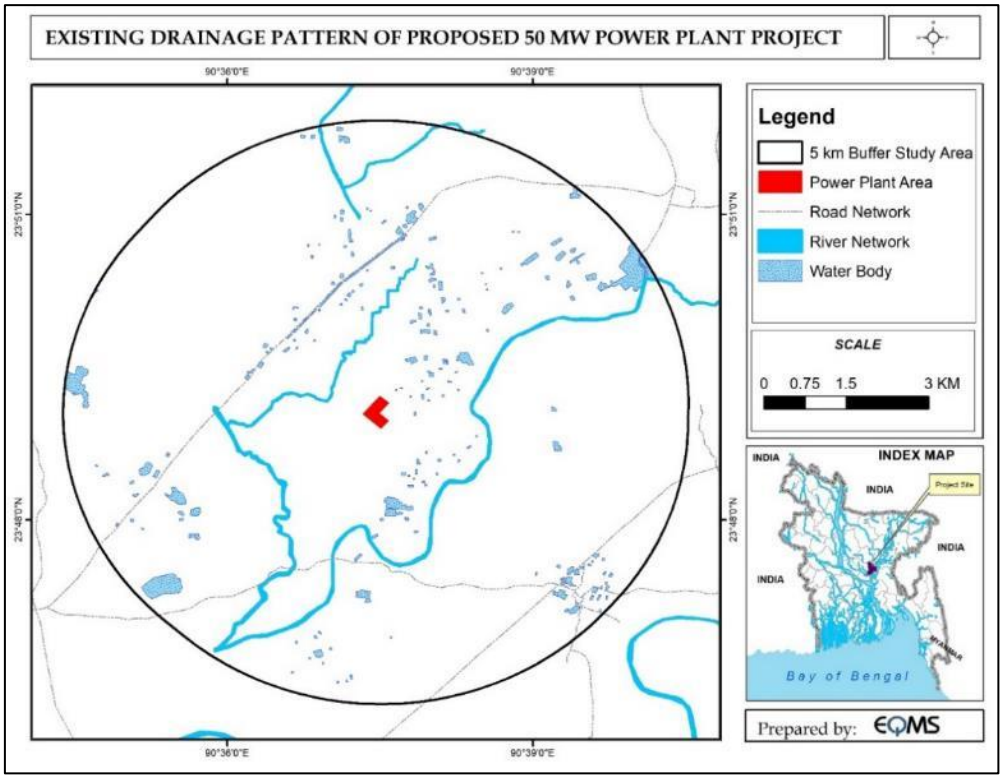
The project site is located on a naturally depressed area, which remains submerged during monsoon and dry in winter. The drainage pattern in 5 km area is given in ***Figure 5-19*** and drainage pattern in 500 m study area is given in ***Figure 5-20***.

The closest river is Shitalakhya River, which is 5.5 km far from the proposed power plant area and Gas transmission pipeline route. The Shitalakhya River originates from the Old Brahmaputra River and is part of the Old Brahmaputra-Lakhya-Meghna river system. The Shitalakhya flows down toward the south and joins the lower Daleswari near Narayanganj, whereupon the combined tributary meets the Meghna River. The Shitalakhya River is a well-defined channel, which traverses the erosion-resistant soils of the Madhupur Tract without meanders and braiding. The length of the river from its offtake to the point of confluence with the Dhaleswari is about 112 km, and its peak discharge during high flood ranges between 1,800 and 2,700 m^3/s. At Narayanganj, the recorded water level peaked at 6.93 mPWD during the 1988 flood which is more than 1.0m higher than the natural ground level. The river was once famous for its clear and cool water. At present Industrial effluent dumped into the river, resulting in high levels of pollution is a cause for concern. Numerous launches move out along the river to different parts of Bangladesh. The government has approved construction of an AK khan container terminal on the river Shitalakhya with foreign investment. The river goes under tidal effect for about five months of the year but never overflows its banks.

5.3.6.2 Drainage Congestion and Water Logging

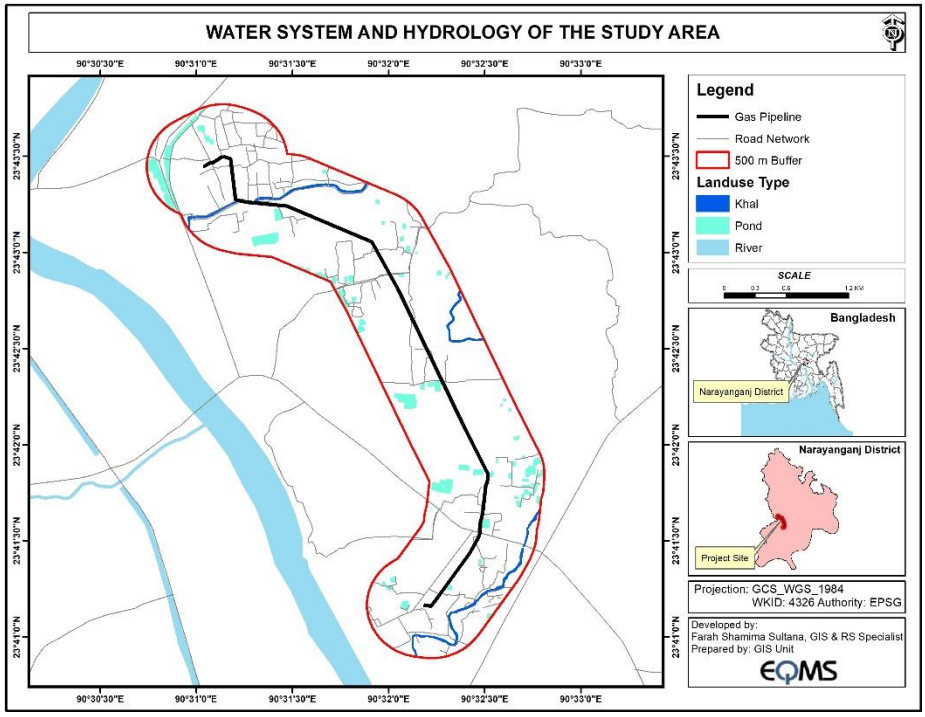
The study area of the proposed site is flat agricultural land (paddy field) with an elevation of MSL + 2.5 m and submerged in the rainy season. Small water channels a few meters lower than the surrounding agricultural ground elevation exist. Waterlogging observed at the site during monsoon season. According to the information collected through focus group discussions (FGD), the area affected in normal floods. However, during heavy rainfall and monsoon season, the river water enters in the low-lying area causes water stagnation in the area for some time. Rainwater inside the power plant site flows from the northeast to the southwest and drains into the southwestern side of the river, which is connecting to the Meghna River. The elevation of the candidate site is lower than past

flood levels of surrounding large rivers such as the Meghna River and the Shitalakshya River. Hence, it is necessary to ensure surface water diversion around the candidate site after site formation.



Source: Google Earth

Figure 5-19: Drainage Pattern of 5 km Radius



Source: Google Earth

Figure 5-20: Drainage Pattern of 500 m buffer area

5.3.6.3 Ground Water System

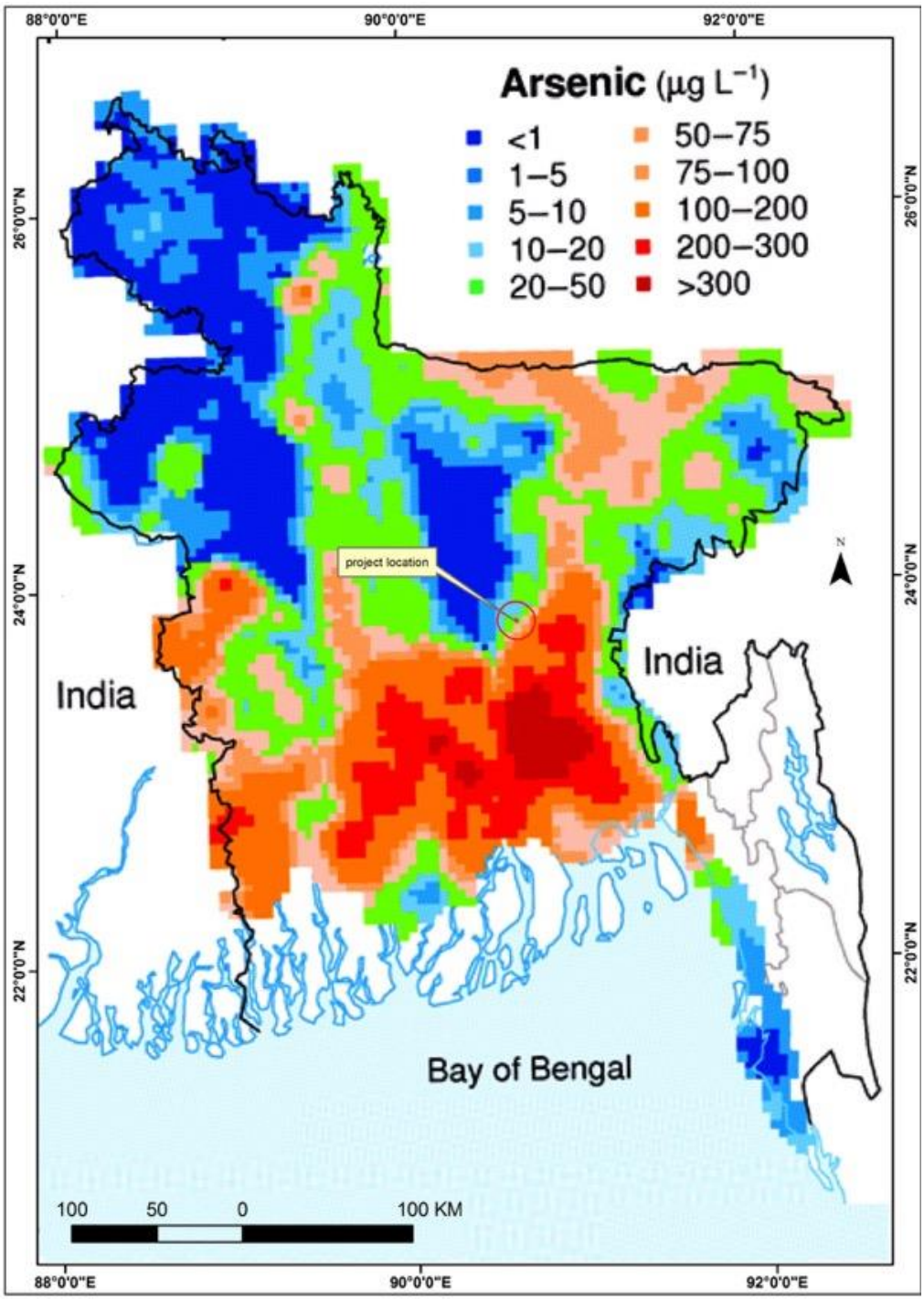
There are three main aquifers in the central region of Bangladesh, where the proposed project is located:

- An upper (composite) aquifer, reaching depths of 50m which is covered with an upper silty clay layer of less than 20m;
- A middle (main) aquifer of fine to heavy sands, which is generally 10-60m deep, and in most areas is hydrologically connected with the composite aquifer above; and
- A deep aquifer of the medium, medium-to-fine or medium-to-coarse sand, which is generally found at depths below 100 m

In the Dhaka region, 80% of the domestic water supply is obtained from the middle aquifer, extracted by tube-wells throughout the city. Groundwater is the main source of water for drinking and irrigation in Bangladesh and most of the cases people rely on groundwater for industrial purposes. Due to the dependency on groundwater and excessive withdrawal, the level of the groundwater table is decreasing day by day in the central region especially in the Dhaka region. On the other hand, the groundwater of the coastal region has seriously affected by salinity. Also, the groundwater is affected by arsenic contamination, and at some places, it found many times higher than the threshold limit (WHO standards).

However, fortunately, Power plant site and gas transmission pipeline not affected by salinity and there is little possibility of salinity intrusion in the near future. Groundwater is the main source of domestic, irrigation and industrial water supply in the project area.

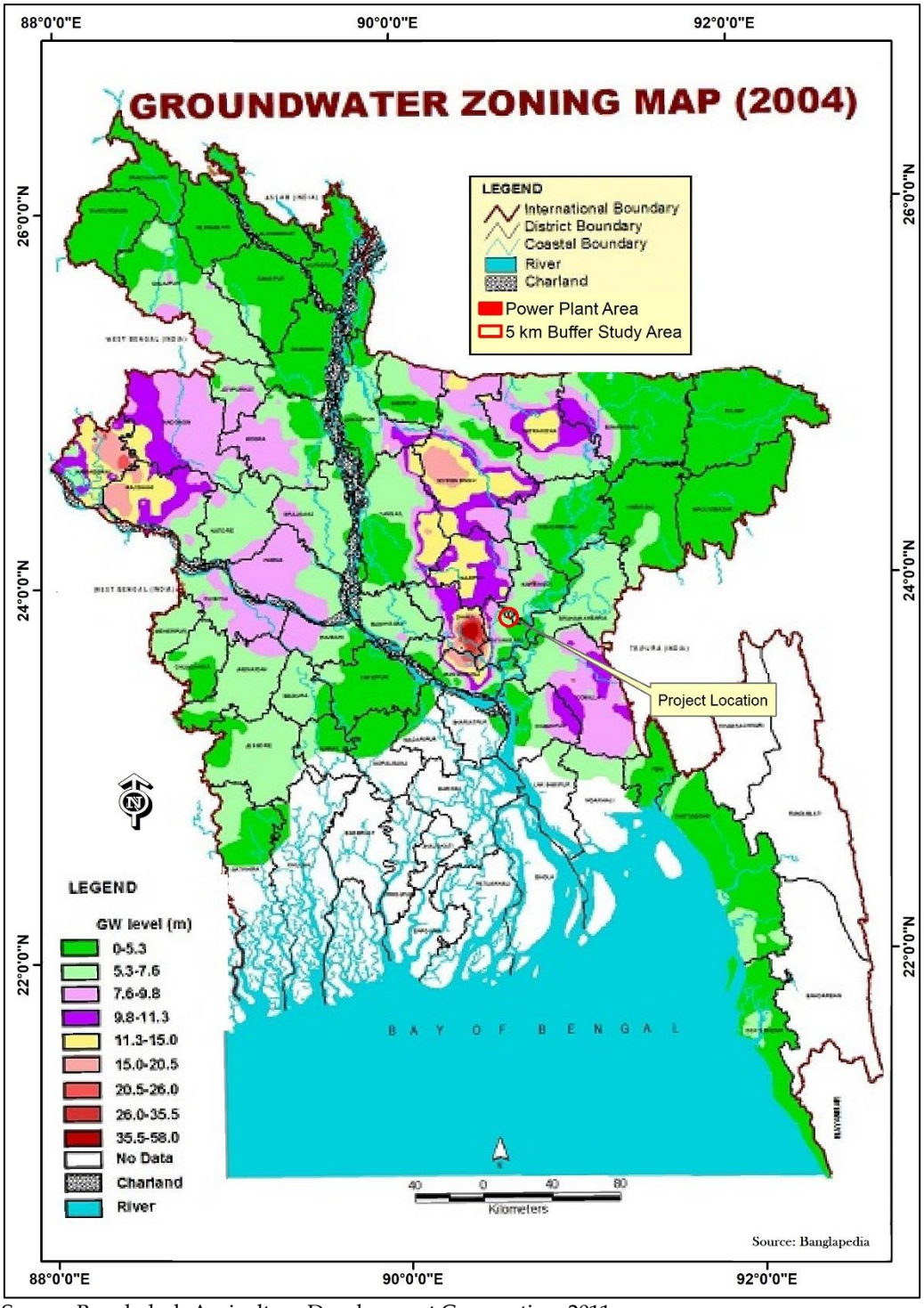
The JICA survey team (Survey 2000) was conducted on 55 TWs altogether, 38 STWs (69.1%) and 17 DTWs (30.9%); 26 (47.3%) in Duptara Union and 29 (52.7%) in Satgram Union. Most of the area is relatively safe with only two TWs in Duptara Union having arsenic exceeding the Bangladeshi standard for drinking water of 50ppb. The water of 23 TWs (79.3%) out of 29 in Satgram Union was within the Bangladeshi standard of 0.3-1 ppm whereas only 14 TWs (53.8%) out of 26 in Duptara Union contained iron within the Bangladeshi standard. In addition, High conductivity value was found in two TWs in Duptara Union at 2005µs/cm (DTW of 645ft) and 3050µs/cm (STW of 170ft), indicating high salinity.



Source: AAN

Figure 5-21: Distribution of Arsenic (As) in Groundwater

Figure 5-22 is showing the Ground Water Zoning Map, which indicated that the project site is located in the area of groundwater level 0-5.3, 5.3- 7.5m. This area also receives a sufficient amount of rainfall, and there is good availability of groundwater that is used by hand pumps for drinking and domestic purposes. The homesteads are using hand deep tube well to meet their domestic demand. Potable ground water is available at an average depth of 110mto 220m. During the site visit, it is observed that a sufficient quantity of water was coming out from the HTW. However, after discussion with the local people, it is learned that there is no specific complaint about non- availability of groundwater.



Source: Bangladesh Agriculture Development Corporation, 2011

Figure 5-22: Ground Water Zoning Map of Bangladesh

5.3.7 Tropical Cyclones

Bangladesh very often becomes the landing ground of cyclones formed in the Bay of Bengal. This is because of the funnel-shaped coast of the Bay of Bengal, most of the damage occurs in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, Kutubdia, Maheshkhali, Nijhum Dwip, Urir Char and other newly formed islands. The coastal zone of Bangladesh is disaster prone.

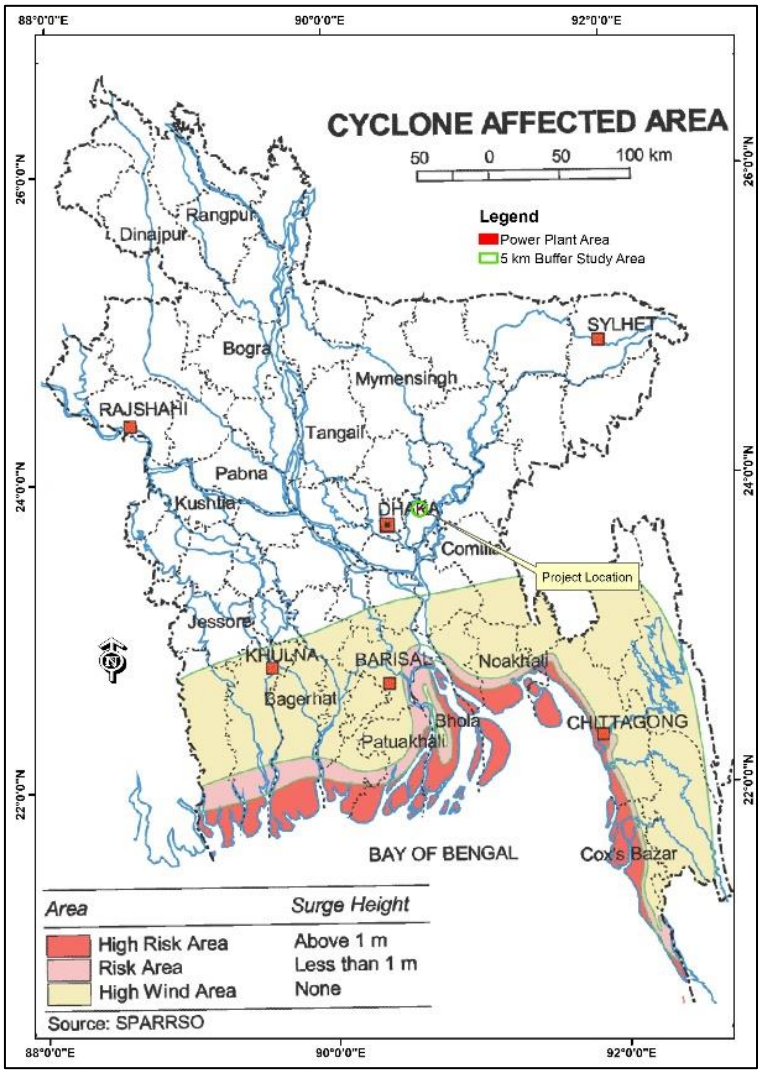
Devastating cyclones hit the coastal areas of Bangladesh almost every year usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and 3-10m high waves, causing extensive damage to life, property, and livestock. Because of the funnel-shaped coast, Bangladesh repeatedly becomes the landing ground of cyclones formed in the Bay of Bengal. These cyclones occur in two seasons, April-May and October-November – i.e., before and after the monsoon.

Cyclones in Bangladesh presently classified according to their intensity, and the following nomenclature is in use:

- Depression (winds up to 62 km/hr);
- Cyclonic storm (winds from 63 to 87 km/hr);
- Severe cyclonic storm (winds from 88 to 118 km/hr); and
- Very severe cyclonic storm of hurricane intensity (winds above 118 km/hr).

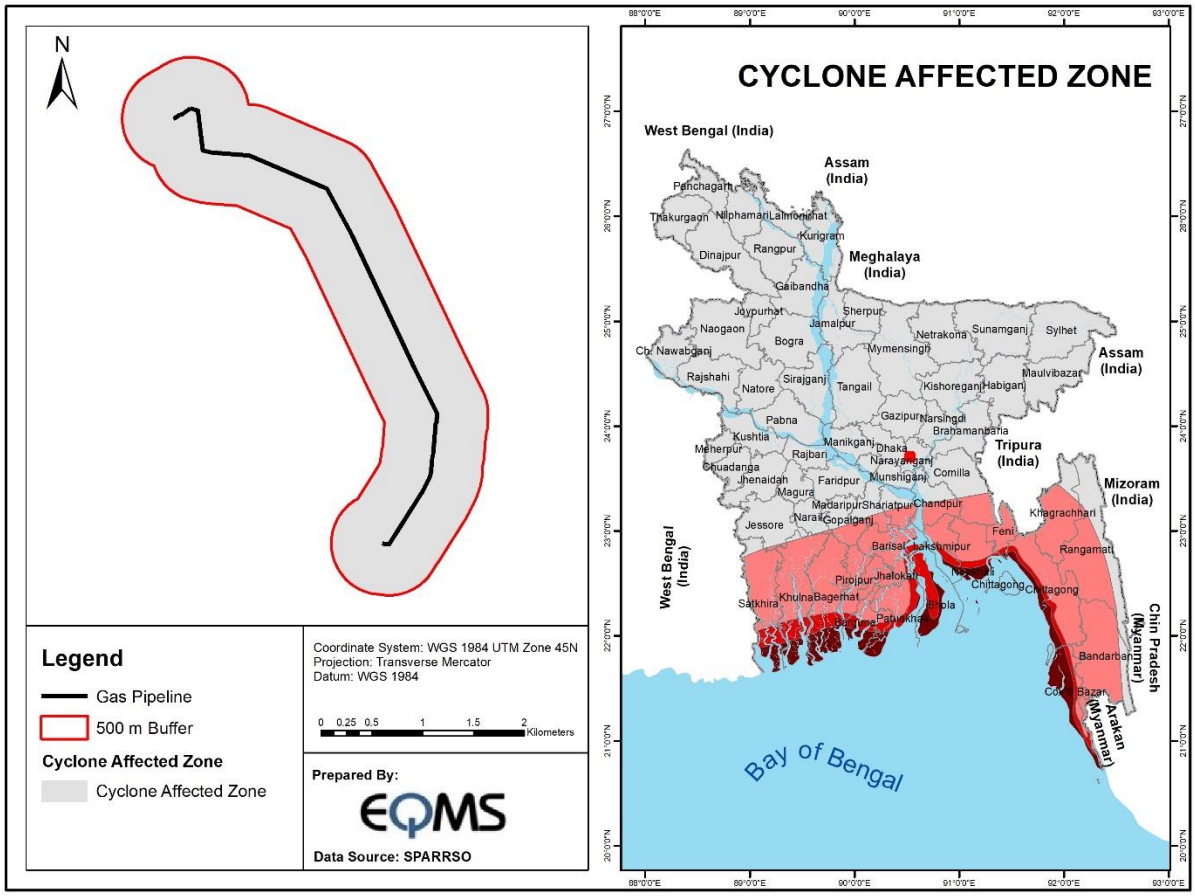
The project site is located in far away from the coastal areas of Bangladesh. Araihazar, Rupganj, Shonargaong & Bandar upazila of Narayanganj district where the project site is located not fall in the cyclone-affected areas of Bangladesh ***(Figure 5-23)*.**

Numbers of cyclones have struck Bangladesh in the past and has caused severe damages at few times. Cyclone-affected area map of Bangladesh is given in ***Figure 5-23* & *Figure 5-24***.



Source: SPARRSO

Figure 5-23: Cyclone Affected Area of 5km Study area

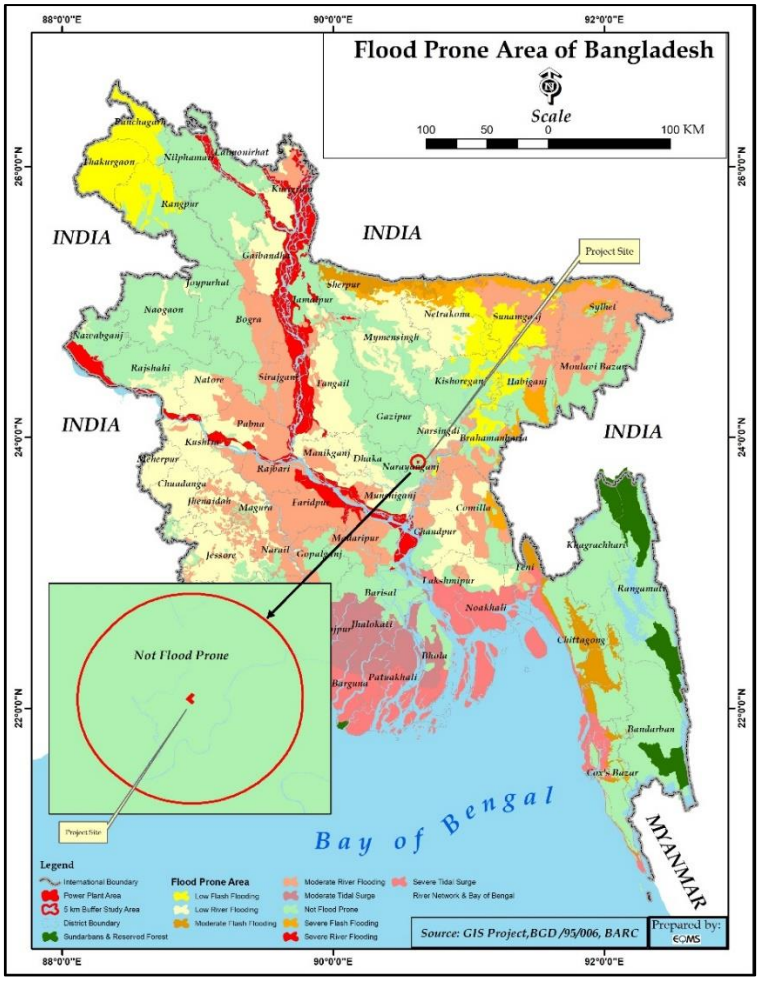


Source: SPARRSO

Figure 5-24: Cyclone Affected Areas of 500 m buffer area

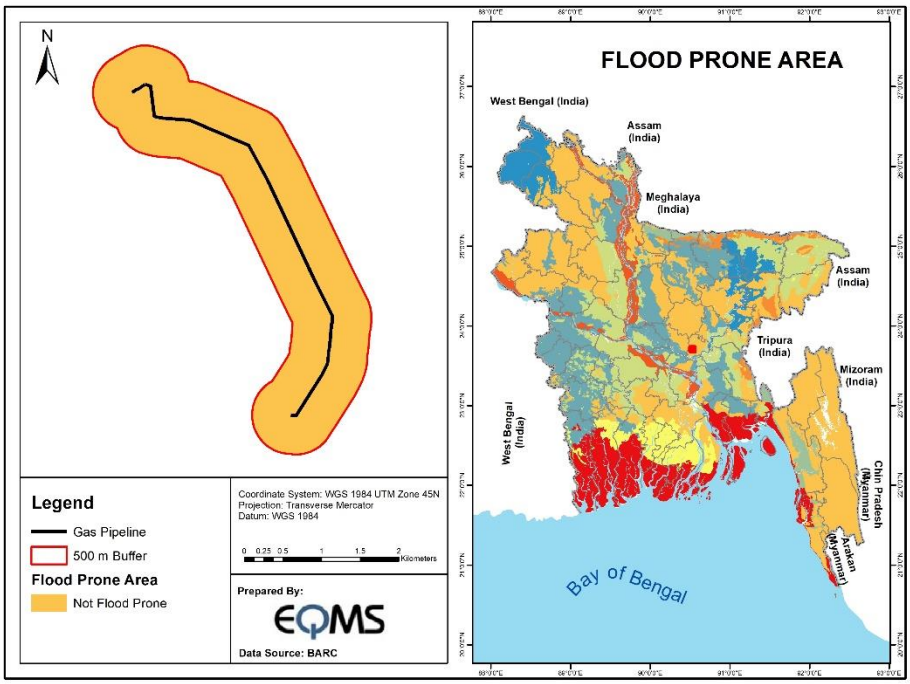
5.3.8 Tidal Flooding

Floods are the most significant natural hazard in the country causing extensive damage to human life and property. The country lies on the downstream part of three major river basins: Brahmaputra, Ganges and Meghna and thus are frequently flooded. There have been many destructive floods in Bangladesh, including very severe floods of 1987, 1988 and 1998. The 1988 flood set a new record for the flooded area, while the 1998 flood was unprecedented with its long duration. The flood damage potential in Bangladesh is increasing due to the possible causes of climate change, urban concentration in the three river basins, encroaching of settlements into flood-prone areas, and overreliance on the safety provided by flood control works such as levees, reservoirs. There are two types of floods which occur in Bangladesh: annual floods (Barsha) that inundate up to 20% of the land area; and low-frequency floods of high magnitude that inundate more than 35% of the area (bonna). The major floods that occurred in 1954, 1955, 1974, 1984, 1987, 1988, 1993, 1998, 1999, 2000, 2007 and 2017 have been very destructive and caused a serious threat to lives and economy. In the context of human exposure in flood hazard zones, nearly 19,279,960 people are present in these zones and Bangladesh ranks 1st among 162 nations. Similarly, the modelled amount of GDP in seismically hazardous zones puts Bangladesh 3rd among 162 countries. The project site falls under not flood prone area. Moreover, within 5 km radius of the power plant and 500 m buffer of Gas transmission line area, major portion is free from river flooding. Flood hazard map of Bangladesh is shown in ***Figure 5-25*** & ***Figure 5-26***.



Source: BARC

Figure 5-25: Flood-Prone Areas of Bangladesh



Source: BARC

Figure 5-26: Flood-Prone Areas of Bangladesh

In order to confirm the real site flood levels of Araihazar, face-to-face surveys have been conducting for residents and Upazilas of Project sites. The main target high water levels are obtained from hearing surveys of local residents (patriarchs) who experienced the 1988 and 1998 floods, then converted to the altitude of digital mapping. According to the results of these surveys, the past average flood water level of Araihazar was + 6.3 m (***Table 5-5***). The past flood water levels of Araihazar was affected by the high-water level of the nearby rivers and can be treated as a static water surface for simplicity's sake.

Table 5-5: Flooding Trace Survey of Power Plant Area

Survey Point No.	Trace water level high (MSL±0.00 m)
Fmh 1	+6.0
Fmh 2	+6.5
Fmh 3	+6.5
Fmh 4	+5.8
Fmh 5	-
Fmh 6	+6.3
Fmh 7	-
Fmh 8	+6.3
Average water level	**+6.3**

Source: JICA Feasibility study

The highest water levels and relevant return periods of the three nearest stations are shown in ***Table 5-6***. The highest water level of Power Plant site was calculated based on an irregular triangular network (TIN) by the weighted average method. The water level of a 100-year return period is 7.21 m.

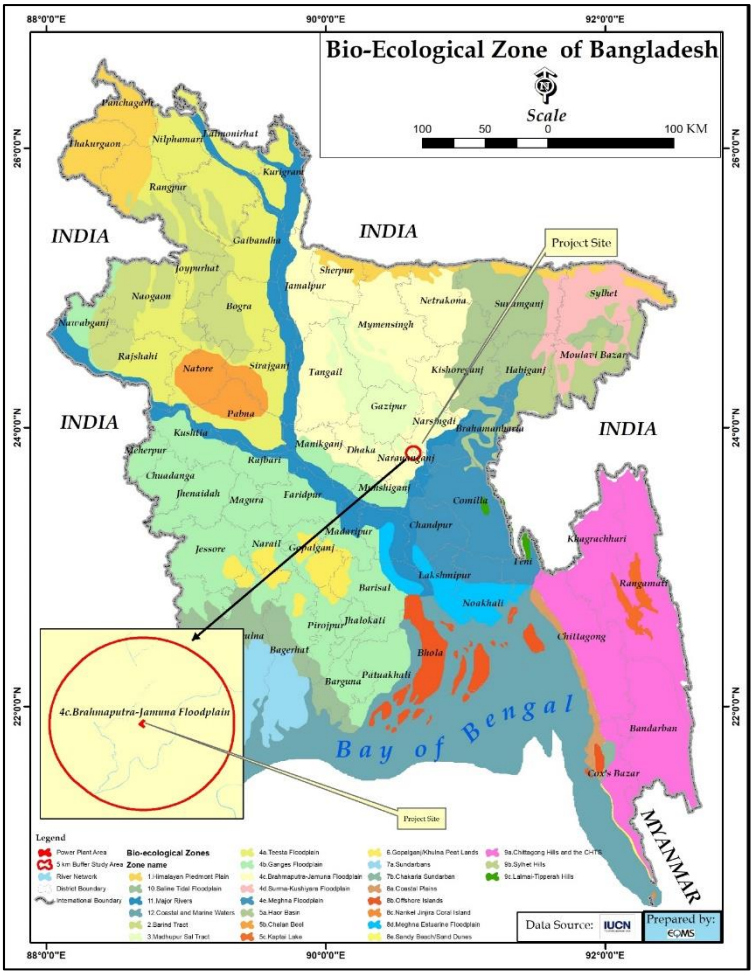
Table 5-6: Maximum Water Level at Nearby Water Level Stations and Estimated Maximum Water Level of Power Plant Site

Vicinity water level station and EZ candidate site	Return period and relevant maximum water level (m)			
	10year	50year	100year	200year
SW 177	6.82	7.57	7.85	8.10
SW 179	6.08	6.60	6.79	6.97
SW 179	5.79	6.31	6.51	6.69
Proposed Power Plant Site	**6.34**	**6.97**	**7.21**	**7.42**

5.4 Biological Environment

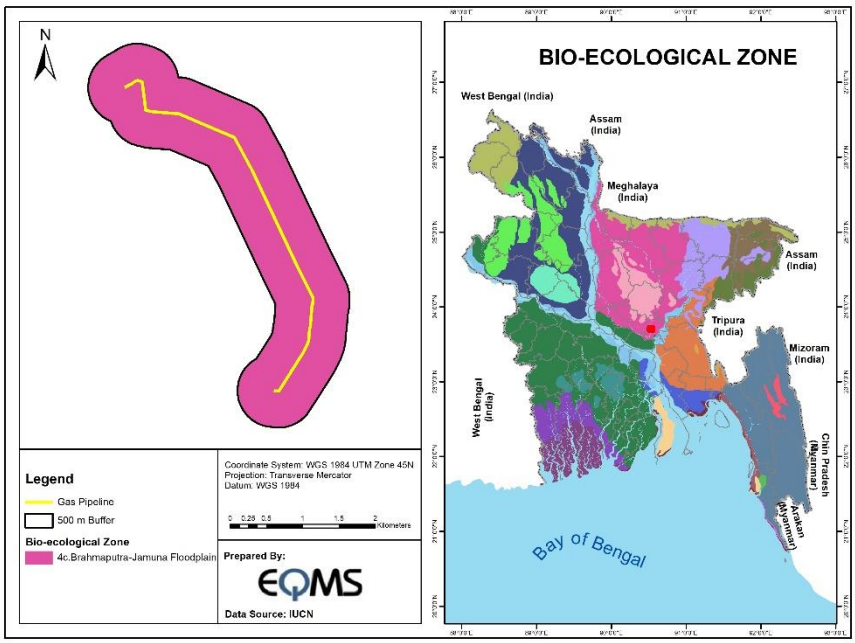
5.4.1 Bio-ecological Zone

IUCN has classified Bangladesh into 25 Bio-ecological Zones in the context of physiographic and biological diversity. The survey area covers single distinct Bio-ecological zones that is Brahmaputra-Jamuna Floodplain (Bio-Ecological Zone 4c). The Project site falls under Brahmaputra-Jamuna Floodplain (Bio-Ecological Zone 4c) Zone. Details of the Bio-ecological zone within the study area are described below. (Source: Bio-ecological zones of Bangladesh, 2002, IUCN).



Source: IUCN

Figure 5-27: Bio-ecological zones of the study area



Source: IUCN

Figure 5-28: Bio-ecological zones near the Proposed Pipeline

5.4.2 Common flora and fauna

5.4.2.1 Introduction

The biodiversity component of the study focused on a few groups of biological components. These were flora, birds, reptiles, amphibians, mammals as well as the surrounding ecosystems. Most of the fieldwork within the project has been addressed with these groups although each group had different approaches and requirements. A multidisciplinary team related to ecology (terrestrial & aquatic) has been engaged in conduct the study. The study area (5 Km buffer area from the project site) occupied various types of ecosystems such as rural settlements, roadside vegetation, croplands, woodland vegetation, and wetlands.

The high-resolution satellite images of the study area were studied to identify ecologically significant areas and different wildlife habitats. Based on the information from the aerial maps and available project site map, a field survey was undertaken to list the available habitat types along with flora and fauna are known to inhabit the area. The surveys included transects within the study area covering all major habitat types. During the transect survey, other members of the team having expertise on respective fields accompanied the ecologist. Secondary ecological data of the study area have been explored from different publications and reports like IUCN, Bangladesh National Herbarium, Birdlife International and Wildlife Trust of Bangladesh (WTB).

5.4.2.2 Aquatic Flora

The plant species usually submerged or partially submerged/floating in the water recorded from the study area are mosquito ferns (*Azollasp*), kachuripana (*Eichornia crassipes)*, tropical white morning-glory (*Ipomea alba)*, esthwaite waterweed (*Hydrilla verticillata)*, taro (*Calocasia esculenta),* globe yellow cress *(Rorippa indica)*, procumbent Yellow-sorrel *(Oxalis corniculata)*, four-leaf clover (*Marselia sp*), lamb's quarters *(Chenopodium album)*, goose weed (*Sphenoclea zeylanica)* and hornworts (*Ceratophyllumsp*), white water-lily (*Nymphaea nouchali),* red water-lily *(Nymphaea rubra).*

None of the species observed is of conservational significance.

5.4.2.3 Terrestrial Flora

A. Grassland

A total 17 species belonging to 14 genera of 10 families were recorded from the study area listed in ***Table 5-7***. Four (4) species of grasses were identified among them Barajavani (*Fimbristylis milliacea),* and Mutha (*Fuirena ciliaris)* were found most commonly occurring. Herbs were represented by 5 species dominated by Kapalphutki (*Cardiospermum halicacabum*), Jhaljamani *(Cocculus hirsutus),* Marmarialata *(Cissus repens)* and Banorkalai (*Atylosia scrabaeoides*) list of grassland flora of the study area.

Table 5-7: A checklist of grassland floral species in the study area

SI	Scientific name	Family	Common Name (Bengali name)	Status of distribution	Type
1	*Coccinia grandis.*	Cucurbitaceae	Telakucha	common	Wild
2	*Ampelocissus latifolia.*	Vitaceae	Angurlata	common	Wild
3	*Atylosia scrabaeoides.*	Fabaceae	Banorkalai	common	Wild
4	*Canavalia gladiate.*	Fabaceae	Mousim, Makhansim	common	Cultivated
5	*Cardiospermum halicacabum*	Sapindaceae	Kapalphutki	common	Wild

SI	Scientific name	Family	Common Name (Bengali name)	Status of distribution	Type
6	*Centrosema pubescens*	Fabaceae	Gandhya Sim	common	Wild
7	*Cissus repens.*	Vitaceae	Marmarialata	common	Wild
8	*Cocculus hirsutus.*	Menispermaceae	Doipata, Jhaljamani	common	Wild
9	*Dioscorea belophylla.*	Fabaceae	Sora Alu	common	Wild
10	*Ichnocarpus frutescens.*	Apocynaceae	Dudhilata	common	Cultivated
11	*Ipomoea aquatica*	Convolvulaceae	Panikalmi	common	Wild
12	*Ricinus communis*	Euphorbiacreae	Venna, Reri	common	Wild
13	*Xanthosoma sagittifolium*	Araceae	Dud Kachu	Common	wild
14	*Senna tora.*	Caesalpiniaceae	Kalkasunda	Common	wild
15	*Fimbristylis dichotoma subsp. podocarpa Koyama*	Cyperaceae	Nirbishi	Common	wild
16	*Fimbristylis milliacea.*	Cyperaceae	Barajavani	Common	wild
17	*Fuirena ciliaris.*	Cyperaceae	Mutha	Common	wild

B. Common plant of the study area

A total of 53 species, 48 genera belongs to 31 families were represented by terrestrial flora. Coconut (*Cocos nucifera),* Eucalyptus *(Eucalyptus citriodora),* Mango *(Mangifera indica),*Guava *(Psidium guajava), Ricinus cummunis,* Litchi (*Lichi chinensis),* Kul-boroi *(Ziziphus mauritiana),* Pepe *(Carica papaya),*Sajna*(Moringa oleifera),* Jambura *(Citrus aurantifolia),* Mahogani *(Sweitenia mahagoni),*Banana (*Musa sapientum),* Kachkola (*Musa paradisiac),* Kathal *(Atrocarpus heterophyllus)* and Acasia *(Acacia nilotica)* were recorded most commonly occurring trees.

Table 5-8: A checklist of common plant species in the study area

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
1.	*Polyalthia longifolia*	Annonaceae	Debdaru	T	sporadic	Cultivated
2.	*Gmelina arborea L.*	Verbenaceae	Gamari	T	sporadic	Cultivated
3.	*Eucalyptus citriodora Hook*	Myrtaceae	Eucalyptus	T	sporadic	Cultivated
4.	*Erythrina ovalifolia Roxb.*	Caesalpiniaceae	Mander, Patiyamander	T	sporadic	Wild
5.	*Dillenia indica L.*	Dilleniaceae	Chalta	T	sporadic	Wild
6.	*Areca catechu L.*	Mimosaceae	Supari, Gua	T	sporadic	Cultivated
7.	*Hibiscus rosa-sinensis*	Malvaceae	Joba	S	sporadic	Cultivated
8.	*Cestrum nocturnum L.*	Solanaceae	Hasnahena	S	sporadic	Cultivated
9.	*Corchorus aestuans L.*	Tiliaceae	Banpat	H	sporadic	Wild
10.	*Mimusops elengi.*	Sapotaceae	Bakul	T	rare	Cultivated

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
11.	*Delonix regia.*	Caesalpiniaceae	Krisnochura	T	rare	Cultivated
12.	*Lawsonia inermis.*	Lythraceae	Mehede	S	rare	Cultivated
13.	*Gardenia coronaria.*	Rubiaceae	Gandhyaraj	S	rare	Cultivated
14.	*Paederia foetida*	Rubiaceae	Gandhyabhaduli	C	rare	Cultivated
15.	*Ziziphus Mauritian*	Rhamnaceae	Kul, Boroi	T	common	Cultivated
16.	*Terminalia arjuna*	Combretaceae	Arjun	T	common	Cultivated
17.	*Tamarindus indica.*	Caesalpiniaceae	Tetul	T	common	Cultivated
18.	*Syzygium cumini (L.) Skeels*	Myrtaceae	Jam	T	common	Cultivated
19.	*Coccinia grandis*	Cucurbitaceae	Telakucha	C	common	Wild
20.	*Lablab purpureus*	Fabaceae	Shim	C	common	Cultivated
21.	*Lageneria siceraria*	Cucurbitaceae	Kadu	C	common	Cultivated
22.	*Alocasia indica*	Araceae	Mankachu	H	common	Wild
23.	*Colocasia esculenta*	Araceae	Bankachu	H	common	Wild
24.	*Cynodon dactylon*	Poaceae	Durba	H	common	Wild
25.	*Musa paradisica*	Mussaceae	Kachkola	H	common	Cultivated
26.	*Carica papaya*	Caricaceae	Pape	S	common	Cultivated
27.	*Sesbania canabina*	Fabaceae	Dhoincha	S	common	Cultivated
28.	*Phyllanthus acidus*	Euphorbiaceae	Arboroi	ST	common	Cultivated
29.	*Psidium guajava*	Myrtaceae	Peyara	ST	common	Cultivated
30.	*Aegle marmelos*	Rutaceae	Bel	T	common	Cultivated
31.	*Albizia procera*	Mimosaceae	Silkoroi	T	common	Cultivated
32.	*Annona squamosa*	Annonaceae	Ata	T	common	Cultivated
33.	*Aphanamixis polystachya*	Meliaceae	Roina	T	common	Wild
34.	*Artocarpus heterophyllus*	Moraceae	Kathal	T	common	Cultivated
35.	*Azadirachta indica*	Meliaceae	Neem	T	common	Cultivated
36.	*Bambusa balcooa*	Poaceae	Barakbans	T	common	Cultivated
37.	*Barringtonia acutangula*	Lecythidaceae	Hijal	T	common	Cultivated
38.	*Bombax ceiba*	Bombaceae	Shimul Tula	T	common	Wild
39.	*Borassus flabellifer*	Palmae	Tal	T	common	Wild
40.	*Citrus grandis*	Rutaceae	Jambura	T	common	Cultivated
41.	*Cocos nucifera*	Arecaceae	Narikel	T	common	Cultivated
42.	*Feronia lemonia*	Rutaceae	Kadbel	T	common	Cultivated
43.	*Litchi chinensis*	Sapindaceae	Lichu	T	common	Cultivated

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
44.	*Litsea monopetala*	Lauraceae	Menda	T	common	Wild
45.	*Moringa oleifera.*	Moringaceae	Sajna	T	common	Wild
46.	*Neolamarckia cadamba.*	Rubiaceae	Kadam	T	common	Wild
47.	*Phoenix sylvestris.*	Arecaceae	Khejur	T	common	Cultivated
48.	*Phyllanthus embelica.*	Euphorbiaceae	Amloki	T	common	Cultivated
49.	*Samanea saman.*	Mimosaceae	Rain Tree, Meghsirish	T	common	Cultivated
50.	*Streblus asper*	Moraceae	Sheora	T	common	Wild
51.	*Switenia mahogani*	Meliaceae	Mahogani	T	Common	cultivated
52.	*Acacia nilotica*	Fabaceae	Acasia	T	Common	Wild
53.	*Casia siamea*	Fabaceae	Cassia tree	T	Common	Wild

C. Agricultural land

Mono-cropping agricultural pattern of paddy is predominant in the area. IRRI and Agrani are cultivated in the agricultural lands. IRRI is cultivated in the late of December whereas Agrani is cultivated in the late of March. Rabi crops cultivated are those: mustard, chilly, onion, vegetables, ladies finger, long yard bean, tomato, etc. In the rainy season, the agricultural lands go under water and generally, it remains in uncultivated for 6-8 months. Therefore, the whole land remains underwater until early winter. It is envisaged that agricultural land would be falling within the power plant area.

5.4.2.4 Aquatic Fauna

A. Macro-invertebrate Fauna

Macro-invertebrate surveys were conducted in September 2018 survey. Macroinvertebrate species such as water spiders (*Argyroneta aquatic*), Common Apple snail (*Pila globosa*), Disk Snail (*Macrochlamys sequax*), River Snail (*Bellamya begalensis*), Brotia Snail (*Brotia costula*), Lymneid Snail (*Lymnaea luteola*), Freshwater Mussels species such as (*Lamellidens corrianus*), (*Lamellidens marginalis*), (*Lamellidens jenkinsianus*) were observed in the study area. None of the species observed is of conservational significance.

B. Fish

In order to get secondary information as well as various literature review found some data / information on the specific floodplain of the project area. The Sonakahli and Dhawrakhali canal interconnected with each other while they are connected to Old-Brahmaputra River. 31 species of 25 genera belonging to 17 families are reported from the canal and river. Among of them 4 species are in endangered, and 2 species are vulnerable, and 3 are near-threatened according to the Red List of IUCN (2015, Vol.3).

Table 5-9: A Checklist of Fish in the Study Area

SL#	Local name	Common name	Scientific name	Family	IUCN Status
1.	Koi	Climbing perch	*Anabus testudines*	Anabantidae	LC
2.	Chela	Large Razorbelly Minnow	*Salmophasia bacaila*	Cyprinidae	LC

SL#	Local name	Common name	Scientific name	Family	IUCN Status
3.	Katol	Catla	*Catla catla*	Cyprinidae	LC
4.	Boal	Freshwater Shark	*Wallago attu*	Siluridae	VU
5.	Rui	Ruhu	*Labeo rohita*	Cyprinidae	LC
6.	Pangash	Yellowtail Catfsh	*Pangasius pangasius*	Pangasiidae	EN
7.	Tengra	Striped Dwarf Catfish	*Mystus vittaus*	Bagridae	LC
8.	Shing	Stinging Catfish	*Heteropneustes fossilis*	Heteropneustidae	LC
9.	Shol	Snakehead Murre	*Channa striatas*	Channidae	LC
10.	Taki	Spotted Snakehead	*Channa punctata*	Channidae	LC
11.	Bele	Bele	*Glossogobius giuris*	Gobiidae	LC
12.	Chital	Humped Featherback	*Chitala chitala*	Notopteridae	EN
13.	Gajar	Giant Snakehead	*Channa marulius*	Channidae	EN
14.	Pabda	Pabda catfish	*Ompok pabda*	Siluridae	EN
15.	Kakila	Silver Needle Fish	*Xenentodon cancila*	Belonidae	LC
16.	Mola	Mola Carplet	*Amblypharyngodon mola*	Cyprinidae	LC
17.	Chela	Large Razorbelly Minnow	*Salmophasia bacaila*	Cyprinidae	LC
18.	Bata	Bata Labeo	*Labeo bata*	Cyprinidae	LC
19.	Jat Punti	Spotfn Swamp Barb	*Puntius sophore*	Cyprinidae	LC
20.	Khailsha	Banded Gouram	*Trichogaster fasciata*	Osphronemidae	LC
21.	Gulsha Tengra	Bleeker's Mystus	*Mystus bleekeri*	Bagridae	LC
22.	Tengra	Striped Dwarf Catfish	*Mystus vittatus*	Bagridae	LC
23.	Magur	Walking Catfish	*Clarias batrachus*	Clariidae	LC
24.	Bacha	Batchwa Vacha	*Eutropiichthys vacha*	Schilbeidae	LC
25.	Potka	Ocellated Pufferfsh	*Tetraodon cutcutia*	Tetraodontidae	LC
26.	Choto Tengra	Tengara Catfsh	*Mystus tengara*	Bagridae	LC
27.	Mrigal	Mrigal Carp	*Cirrhinus cirrhosus*	Cyprinidae	NT
28.	Tatkini	Reba	*Cirrhinus reba*	Cyprinidae	NT
29.	Silver carp	Silver carp	*Hypophthalmichthys molitrix*	Cyprinidae	NT
30.	Grass carp	Grass carp	*Ctenopharyngodon idella*	Cyprinidae	DD
31.	Olive barb	Sar punti	*Systomus sarana*	Cyprinidae	LC

Data source: Study team using IUCN classification system

IUCN Status code: CR - Critically Endangered, EN - Endangered, VU - Vulnerable, LC - Least Concern, DD- Data Deficient, NT-Near Threatened

Fishing at Sonakahali canal

Fishing at Dhawrakhali canal

Small indigenous fish species were also available especially from the monsoon season to post-monsoon season. Such fish are an important protein source for poor people. During the discussion with the local fishermen fishing community, it was revealed that most of the subsistence and part-time fishermen depend on these small fishes not only as a protein source in their diet but also a major part of their income comes is derived from the sale of these fish.

5.4.2.5 Terrestrial Fauna

1. Mammals

Nine species of terrestrial mammals belonging to the 8 genera of 6 families were recorded to occur in the wild in the Project. Golden Jackal (*Canis aureus*), Bengal Fox (*Vulpes bengalensis*) and Indian Gray Mongoose (*Herpestes edwardsii*) were seen visiting canal area, Sonpara during the field survey by the ecology team. Jungle Cat (*Felis chaus*) was reported to be seen by locals during field consultations in agricultural and homestead plantation areas. None of the species is reported to be listed in RED category of IUCN 2015 v2.However, Indian Gray Mongoose (*Herpestes edwardsii*), Jungle Cat (*Felis chaus*) and Asian House Shrew (*Suncus murinus*) are reported to be listed in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capturing.

Table 5-10: A checklist of mammals found in the study area

SL#	Local Name	Common Name	Scientific Name	Family	IUCN Status*
1.	Khet-indur	Lesser Bandicoot Rat	*Bandicota bengalensis*	Muridae	LC
2.	Dhari Indur	Large Bandicoot Rat	*Bandicota indica*	Muridae	LC
3.	Nengti Indur	House Mouse	*Mus musculus*	Muridae	LC
4.	Chucho	House Shrew	*Suncus murinus*	Soricidae	LC
5.	Chamchika	Indian Pipistrelle	*Pipistrellus coromandra*	Vespertilionidae	LC
6.	Boro Beji	Common Mongoose	*Herpestes edwardsii*	Herpestidae	LC
7.	Khek Shial	Bengal Fox	*Vulpes bengalensis*	Canidae	VU
8.	Ban Biral	Jungle Cat	*Felis chaus*	Felidae	NT
9.	Pati Shial	Golden Jackal	*Canis aureus*	Canidae	LC

Data source: Study team using IUCN classification system

IUCN Status code: CR - Critically Endangered, EN - Endangered, VU - Vulnerable, LC - Least Concern, NT-Near Threatened

2. Avifauna

A total of 43 species belonging to 37 genera of 27 families were observed to be in the study area during field survey by ecology team in September 2018. These species are present in the variety of habitats from Grassland, homestead plantation, agriculture plantation, and aquatic habitat. The list of species is included in ***Table 5-11***. Out of these 45 species, Red Vented Bulbul (*Pycnonotus cafer*), Black Drongo (*Dicrurus macrocercus*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Black Kite (*Milvus migrans*), Large Billed Crow (*Corvus macrorhynchos*), Rufous Treepie (*Dendrocitta vagabunda*), Indian Roller (*Coracias benghalensis*), Common Hoopee (*Upupa epops*), Black Rumped Flameback (*Dinopium benghalense*), White Throated Kingfisher (*Halcyon smyrnensis*), Pied Kingfisher (*Ceryle rudis*), Fulvus breasted Woodpecker (*Dendrocopos macei*), Shikra (*Accipiter badius*), White Wagtail *(Motacilla flava*), Red Wattled Lapwing (*Vanellus indicus*), Asian Koel (*Eudynamys scolopacea*), Rock Pigeon (*Columbam livia*), Common Myna (*Acridotheres tristis*), Jungle Myna (*Acridotheres grandis*) and Green Bee-eater (*Merops orientalis*) are reported to be listed in Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capture.

The proposed project site has many harbours species such as Red-vented Bulbul, Red Watted Lapwing, Black Kite, Black Drongo, Rock Pigeon, Long-tailed Shrike and Common Myna. These species are common in the area, and sufficient habitats are available within area once the construction and operation activities are commenced. None of the species was listed as threatened as per IUCN classification.

Table 5-11: A checklist of birds in the study area

SL	Local name	Common name	Scientific name	Family	IUCN status*
1.	Bangla Kaththokra	Lesser Goldenback	*Dinopium benghalense*	Alcedinidae	LC
2.	Shobuj Tia	Rose-ringed Parakeet	*Psittacula krameri*	Psittacidae	LC
3.	Halde Pakhi	Black-hooded Oriole	*Oriolus xanthornus*	Oriolidae	LC
4.	Kala Fingey	Black Drongo	*Dicrurus macrocercus*	Dicruridae	LC
5.	Pati Kak	House Crow	*Corvus splendens*	Corvidae	LC
6.	Dar Kak	Jungle Crow	*Corvus levaillanti*	Corvidae	LC
7.	Bangla Bulbul	Red-vented Bulbul	*Pycnonotus cafe*	Pycnonotidae	LC
8.	Pati Tuntuni	Common Tailorbird	*Orthotomus sutorius*	Sylviidae	LC
9.	Dhani Futki	Paddy field Warbler	*Acrocephalus agricola*	Sylviidae	LC
10.	Gobrey Shalik	Pied Myna	*Sturnus contra*	Sturnidae	LC
11.	Jhuti Shalik	Jungle Myna	*Acridotheres fuscus*	Sturnidae	LC
12.	Bhat Shalik	Common Myna	*Acridotheres tristis*	Sturnidae	LC
13.	Doel	Oriental Magpie Robin	*Copsychus saularis*	Muscicapidae	LC
14.	Chorui	House Sparrow	*Passer domesticus*	Passeridae	LC
15.	Gecho Chorui	Tree Sparrow	*Passer montanus*	Passeridae	LC
16.	Dhani Tulika	Paddy field Pipit	*Anthus rufulus*	Motacillidae	LC
17.	Tila Ghughu	Eastern Spotted Dove	*Spilopelia chinensis*	Columbidae	LC

SL	Local name	Common name	Scientific name	Family	IUCN status*
18.	Nilmatha Hash	Mallard	*Anas platyrhynchos*	Anatidae	LC
19.	Metey Rajesh,	Greylag goose	*Anser anser*	Anatidae	NT
20.	Himaloee Kaththokra	Himalayan Flameback	*Dinopium shorii*	Picidae	DD
21.	Bada Satarey	Marsh Babble	*Pellorneum palustre*	Timaliidae	DD
22.	Holdebook Chotok	Yellow-breasted Bunting	*Emberiza aureola*	Emberizidae	VU
23.	Dhub Boga	Little Egret	*Egretta garzetta*	Ardeidae	LC
24.	Boro Pankouri	Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	LC
25.	Desi Pankouri	Indian Cormoran	*Phalacrocorax fuscicollis*	Ardeidae	LC
26.	Chhoto pankouri	Little Cormorant	*Microcarbo niger*	Phalacrocoracidae	LC
27.	Lal pa Dhenga	Black-winged Stilt	*Himantopus himantopus*	Recurvirostridae	LC
28.	Proshanto Sonajiria	Pacifc Golden Plover	*Pluvialis fulva*	Charadriidae	LC
29.	Utturey Titi	Northern Lapwing	*Vanellus vanellus*	Charadriidae	LC
30.	Pati Batan	Common Sandpiper	*Actitis hypoleucos*	Scolopacidae	LC
31.	Bon Batan	Wood Sandpiper	*Tringa glareola*	Scolopacidae	LC
32.	Khoiramatha Gangchil	Brown-headed Gull	*Larus brunnicephalus*	Laridae	LC
33.	Choto Panchi	Little Tern	*Sterna albifrons*	Laridae	LC
34.	Katua Chil	Black-winged Kite	*Elanus caeruleus*	Accipitridae	LC
35.	Teela Eagle	Crested Serpent Eagle	*Spilornis cheela*	Accipitridae	LC
36.	Pati Shikre	Shikra	*Accipiter badius*	Accipitridae	LC
37.	Bhubon Chil	Black Kite	*Milvus migrans*	Accipitridae	LC
38.	Shobuj Shuichora	Green Bee-eater	*Merops orientalis*	Meropidae	LC
39.	Nilkan Machranga	Blue-eared Kingfisher	*Alcedo meninting*	Alcedinidae	LC
40.	Chhoto Maachranga	Common Kingfisher	*Alcedo atthis*	Alcedinidae	LC
41.	Lal Machranga	Ruddy Kingfisher	*Halcyon coromanda*	Alcedinidae	LC
42.	Meghou Machranga	Stork-billed Kingfisher	*Pelargopsis capensis*	Halcyonida	LC
43.	Dholagola Maachranga	White-throated Kingfisher	*Halcyon smyrnensis*	Halcyonidae	LC

Data source: Study team using IUCN classification system

IUCN Status code: CR - Critically Endangered, EN - Endangered, VU - Vulnerable, LC - Least Concern, DD- Data Deficient, NT-Near Threatened

Lesser Goldenback

Black Drongo

Red-vented Bulbul

Spotted Dove

Pied Myna

Yellow-breasted Bunting

3. Herpeto-fauna

Nineteen (19) species belonging to 17 genera of 14 families are reported from the area. Out of these House Lizard (*Hemidactylus flaviviridis),* Indian Rat Snake (*Ptyas mucosa*) and Checkered Keelback (*Xenochropis piscator*) were observed by ecology team during a field survey in October 2017. Rests of the reptilian fauna were reported to be observed by locals during field consultations in the villages of the project area. Among the 9, Bengal Monitor (*Varanus benghalensis*) and Spotted Flapshell Turtle (*Lissemys punctata*) are reported to be listed in Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capturing.

Table 5-12: A checklist of herpetofauna in the study area

SL#	Local name	Common name	Scientific name	Family	IUCN Status
1	Dhora Shap	Checkered Keelback	*Xenochrophis piscator*	Natricidae	LC
2	Shangkhini	Banded Krait	*Bungarus fasciatus*	Elapidae	LC
3	Paina Shap	Common Smooth-scaled Water Snake	*Enhydris enhydris*	Homalopsidae	LC
4	Baro Dumukha Shap	Diard's Blindsnake	*Argyrophis diardii*	Typhlopidae	LC
5	Laodoga Shap	Vine Snake	*Ahaetulla nasuta*	Colubridae	LC
6	Darash Shap	Indian Rat Snake	*Ptyas mucosa*	Colubridae	LC
7	Gui shap	Bengal Monitor	*Varanusbengalensis*	Varanidae	NT
8	Sona gui	Yellow Monitor	*Varanusflavescens*	Varanidae	NT
9	Roktochosa	Common Garden Lizard	*Calotes versicolor*	Agamidae	LC
10	Tiktiki	House Lizard	*Hemidactylus flaviviridis*	Gekkonidae	LC
11		Roofed Turtle	*Pangshuratecta*	Geoemydida	LC
12	Shundhi Kasim	Spotted Flapshell Turtle	*Lissemyspunctata*	Trionychidae	LC
13	Tokkhak	Tokay Gecko	*Gekko gecko*	Gekkonidae	LC
14	Dhum Kachchim	Brown Softshell Turtle	*Nilssoniahurum*	Trionychidae	LC
15	Sona Bang	Indian Bullfrog	*Hoplobatrachus tigerinus*	Dicroglossidae	LC
16	Sobuj Dhani Bang	Two-striped Grass Frog	*Hylarana taipehensis*	Ranidae	LC
17	Shobuj Bang	Green Frog	*Euphlyctishexadactylus*	Dicroglossidae	LC
18	Kuno Bang	Asian Common Toad	*Duttaphrynus melanostictus*	Bufonidae	LC
19	Kotkoti Bang	Skipper Frog	*Euphlyctis cyanophlyctis*	Dicroglossidae	LC

Data source: Study team using IUCN classification system
IUCN Status code: CR - Critically Endangered, EN - Endangered, VU - Vulnerable, LC - Least Concern, NT-Near Threatened

5.4.3 Ecosystem Services and Function

The ecosystem of the study area is mainly terrestrial and aquatic. Ecosystem services and function help local people and vice versa. Major benefits of the ecosystem services of the study area are given below

- The photosynthetic processes remove carbon dioxide in the air and supply oxygen to the environment.
- Trees serve as sources of timber for housing construction, among others
- Animals supply the protein needs of humans, serve as pets or animal skin for making shoes, bags, and other derivatives
- The watershed provides fresh, clean water for human consumption
- Trees serve as a buffer against storms preventing the destruction of houses by strong winds

- Some species of plants can cure human ailments
- Humus from the decomposition of organic matter serves as a natural fertilizer in areas cleared for agriculture

Major role of the ecosystem function is as follows

Gas Regulation

Relates to the influence of natural and managed systems in relation to biogeochemical processes including greenhouse gases, photochemical smog and volatile organic compounds (VOCs)

Climate Regulation

Influence of land cover and biological mediated processes that regulate atmospheric processes and weather patterns that in turn create the microclimate in which different plants and animals (including humans) live and function.

Water Regulation

The influence of land cover, topography, soils, hydrological conditions in the spatial and temporal distribution of water through the atmosphere, soils, aquifers, rivers, lakes and wetlands.

Soil Retention

Minimizing soil loss by having adequate vegetation cover, root biomass, retaining rocks and soil biota.

Nutrient Retention

The role of ecosystems in the transport, storage and recycling of nutrients.

Waste treatment and Assimilation

The extent to which ecosystems are able to transport, store and recycle certain excesses of organic and inorganic wastes through distribution, assimilation, transport and chemical decomposition.

Biological Control

The interactions within biotic communities that act restrain forces to control populations of potential pests and disease vectors. This function consists of natural and biological control mechanisms.

Barrier Effect of Vegetation

Vegetation impedes the movement of airborne substances such as dust and aerosols (including agricultural chemicals and industrial and transport emissions), enhances air mixing and mitigates noise.

5.4.4 Protected Areas, Wildlife Sanctuaries, Game Reserves

5.4.4.1 Protected area (PA)

A Protected Area (PA) refers to an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means, i.e. PA is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources (IUCN, 1990). No PA exists at or near the project site ***(Figure 5-29*** & ***Figure 5-30)***.

The project area of power plant does not hold any Important Plant Areas (IPAs) as identified as Plantlife International, Key Biodiversity Areas as identified by IUCN and Alliance for Zero Extinction Sites (AZE).

5.4.4.2 National Park (NP)

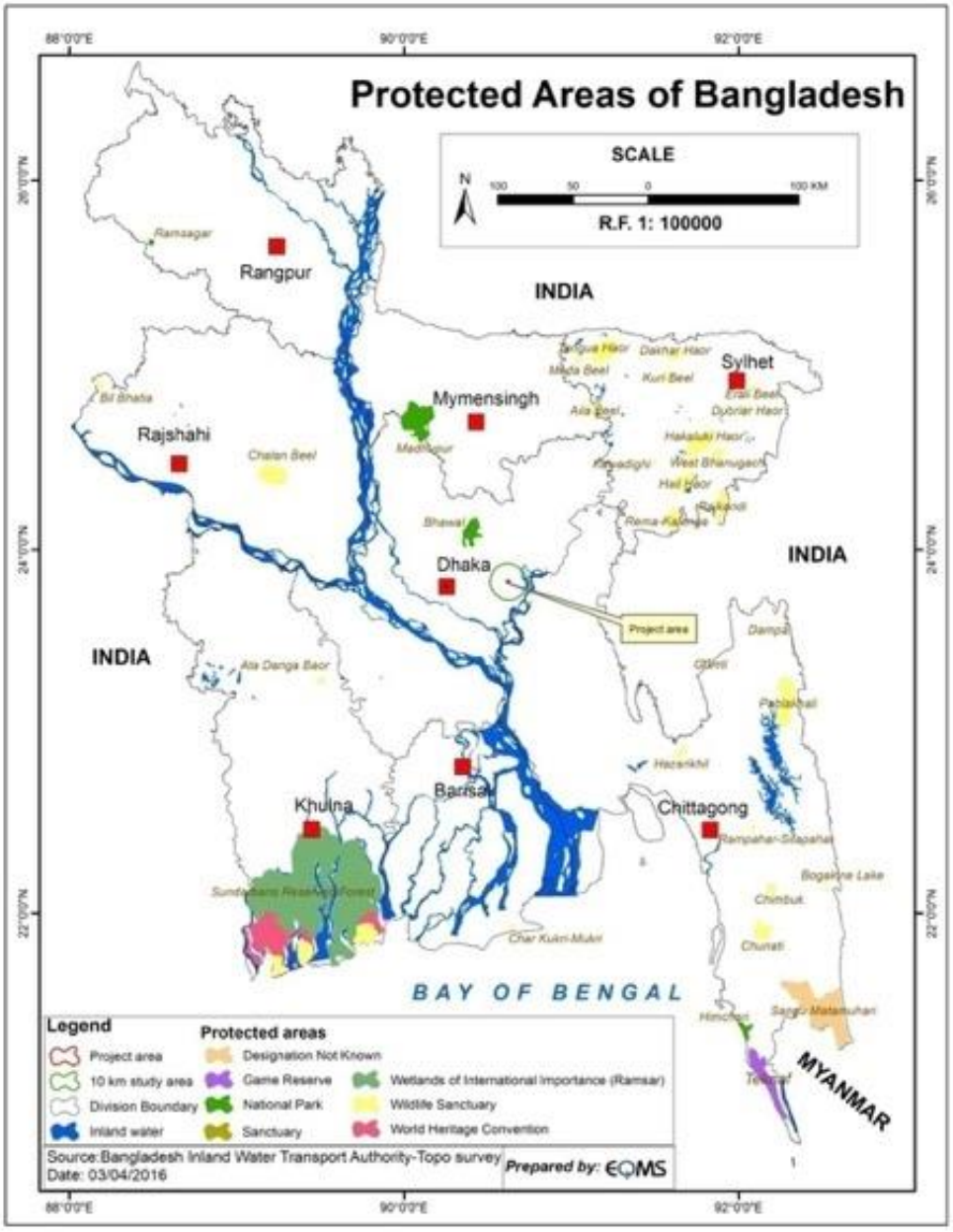
It is a reserved land, usually declared and owned by a national government, protected from most human development and pollution. No NP exists at or near the proposed project site ***(Figure 5-29*** & ***Figure 5-30).***

5.4.4.3 Game reserve (GR)

It is an area of land set aside for the maintenance of wildlife for tourism or hunting purposes. No GR exists at or near the study areas.

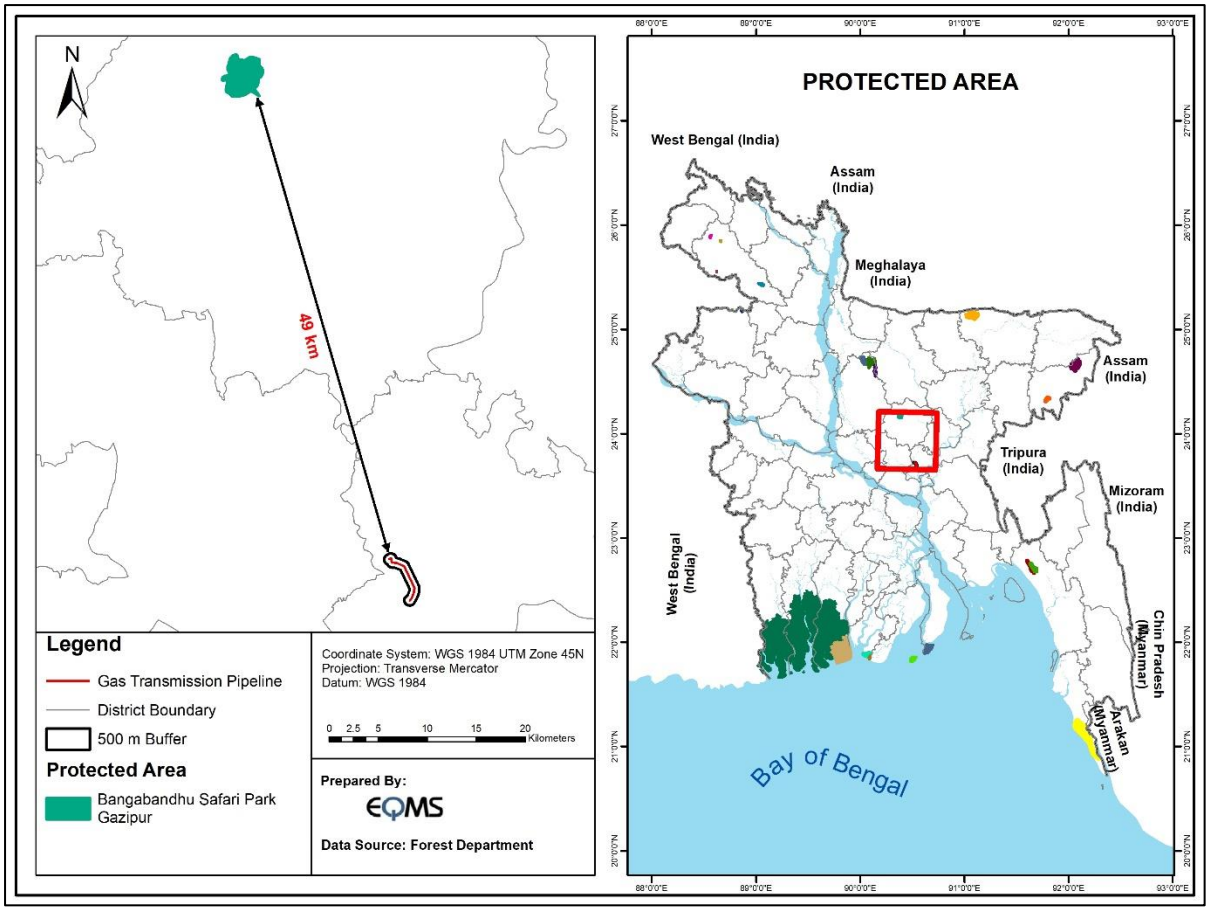
5.4.4.4 Wildlife Sanctuary (WS)

An area assures that the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment, where these require specific human manipulation for their perpetuation. No WS exists at or near the study areas.



Source: Forest Department

Figure 5-29: Protected Areas of 5 km Study area of Power Plant



Source: Forest Department

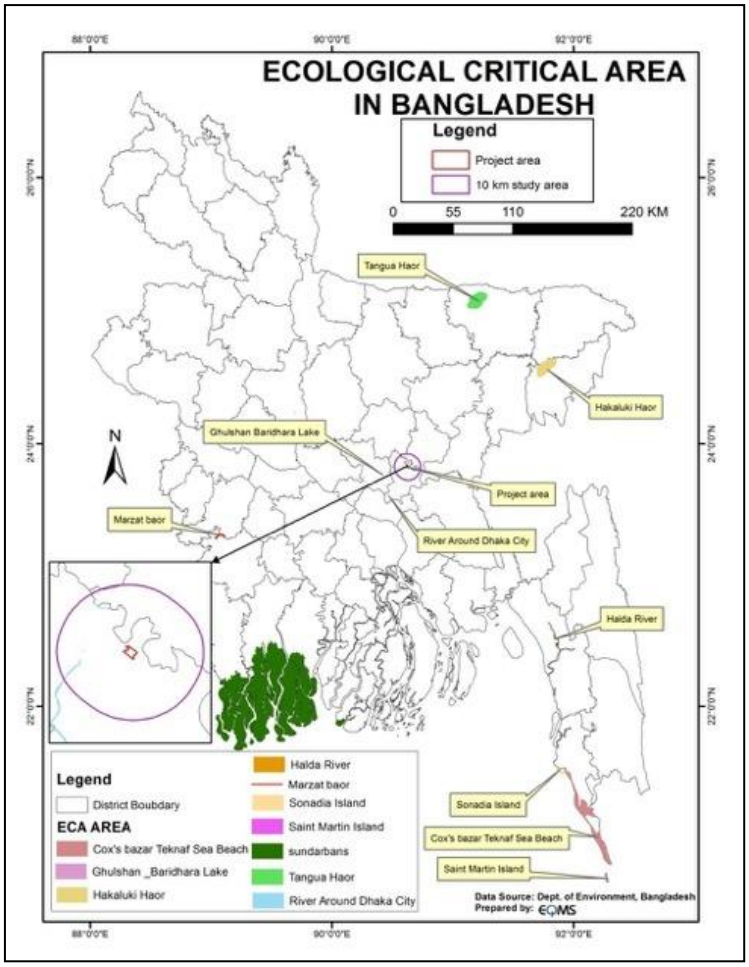
Figure 5-30: Protected Areas of 500 m buffer of Gas Transmission Pipeline

5.4.4.5 Ecologically Critical Area (ECA)

Bangladesh Environment Conservation Act, 1995, defines a Critical Area (ECA) where an ecosystem has been considered to be threatened and reaching a critical state (***Figure 5-31***) endangerment. In 2009, the Bangladesh Government declared the four rivers, such as Buriganga, Sitalakhaya, Turag and Balu around Dhaka city as ECAs. The Gazette notification to this effect imposes restrictions on a number of activities in these rivers and their associated riparian environs. These include all types of hunting, collection of all types of aquatic species living in the rivers, all activities that could result in the destruction of floral or faunal habitats, all activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste.

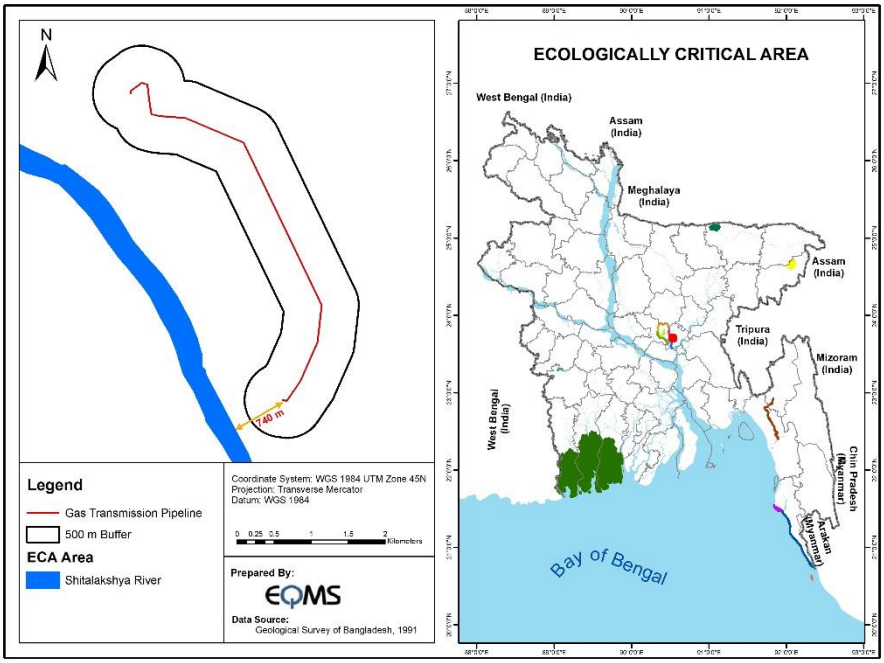
5.4.4.6 Cultural Heritage

Nothing found in the development area would be affected by the development.



Source: Department of Environment (DoE)

Figure 5-31: Ecological Critical Area in Bangladesh



Source: Department of Environment (DoE)

Figure 5-32: Ecological Critical Area in Bangladesh

5.5 Environmental Quality

5.5.1 Air Quality

The objective of the ambient air quality-monitoring program was to establish the baseline ambient air quality in the study area. The profile of the study area is mainly semi-urban, which has a mix of scattered settlements, industries and agriculture areas. Major possible source of air pollution in this area is industrial activities. Other activities, which add to air pollution, are vehicular movement, agricultural activities, and domestic emissions.

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

The methodology of Air Quality Monitoring

The ambient air quality of the study area monitored at Five (5) locations for the power plant and Three (3) locations for gas transmission pipeline during the monitoring period (September 2018). The monitoring parameters included Particulate Matter (SPM, PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours with the remaining parameters monitored on a 24-hourly basis during the study period.

Selection of sampling locations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations ***(Figure 5-33)*** are based on the following aspects covered in the field survey plan developed prior to the fieldwork:

- Meteorological conditions of the area are based on information provided by the BMD observatory at Dhaka;
- The topography of the study area; and
- Location of sensitive receptors such as major settlements;

The particulate and gaseous samples collected during the monitoring have been analyzed as per the procedures specified in **Table 5-13**. The geographical locations and setting of the ambient air quality monitoring locations have been presenting in **Table 5-14** & **Table 5-15**.

Table 5-13: Methodology for Analysis of Ambient Air Quality

Sl.	Parameter	Analysis procedure
1.	SPM	Gravimetric method
2.	PM_{10}	Gravimetric method
3.	$PM_{2.5}$	Gravimetric method
4.	SO_2	The colorimetric method at 560nm using spectrophotometer readings (West-Gaeke method)
5.	NOx	The colorimetric method at 540 nm using spectrophotometer readings (Jacob and Hochheiser method)
6.	CO	Digital CO meter

Table 5-14: Ambient Air Quality Sampling Locations for Power Plant

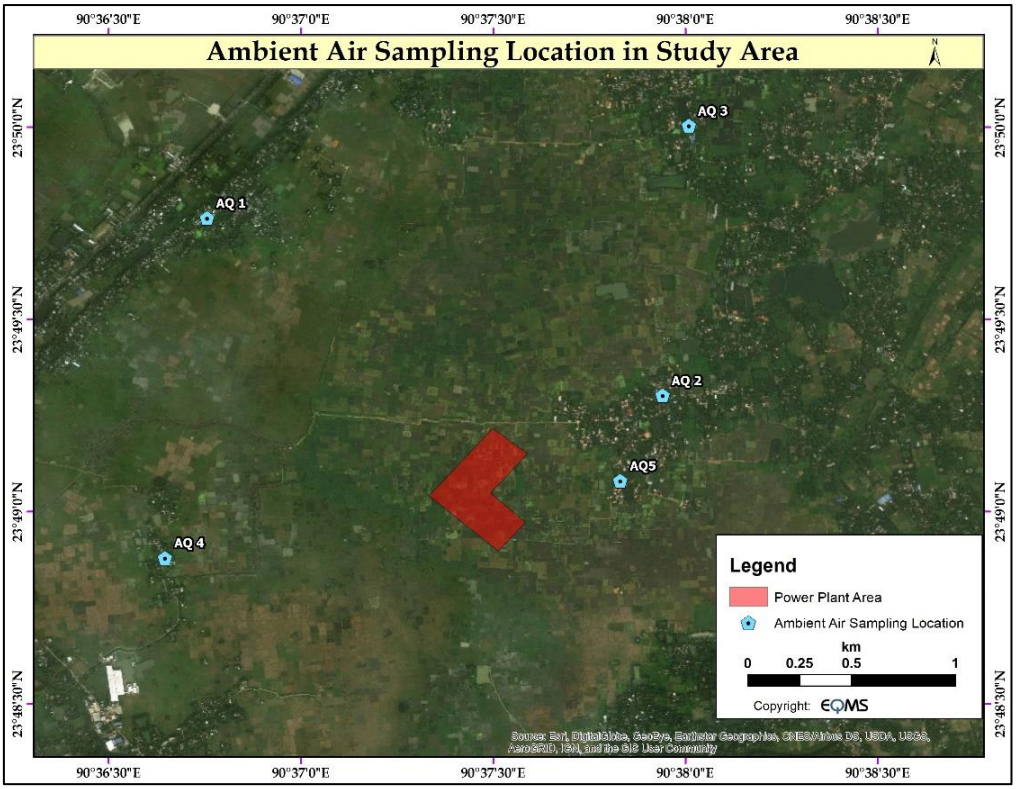
Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1.	In front of Nurul Haque House; Vill: Maizpara, Union: Satgram, Upazila: Araihazar	AQ1	23°49'45.8"N 90°36'45.3"E	Rural
2.	In front of Panchbaria Boro bari; Vill: Panchbaria,	AQ2	23°49'18.1"N	Rural

	Union: Duptara,Upazila: Araihazar		90°37'56.4"E	
3.	In front of Tekpara govt. primary school; Vill: Tekpara, Union: Satgram, Upazila: Araihazar	AQ3	23°50'00.4"N 90°38'00.5"E	Rural
4.	In front of Rahim sekh house; Vill: Shingrati, Union: Duptara,Upazila: Araihazar	AQ4	23°48'52.59"N 90°36'38.57"E	Rural
5.	Infront of Nasir Pradhan House; Vill: Dakhinpara, Union: Duptara,Upazila: Araihazar	AQ5	23°49'4.00"N 90°37'49.83"E	Rural

Table 5-15: Ambient Air Quality Sampling Locations for Gas Transmission Pipeline

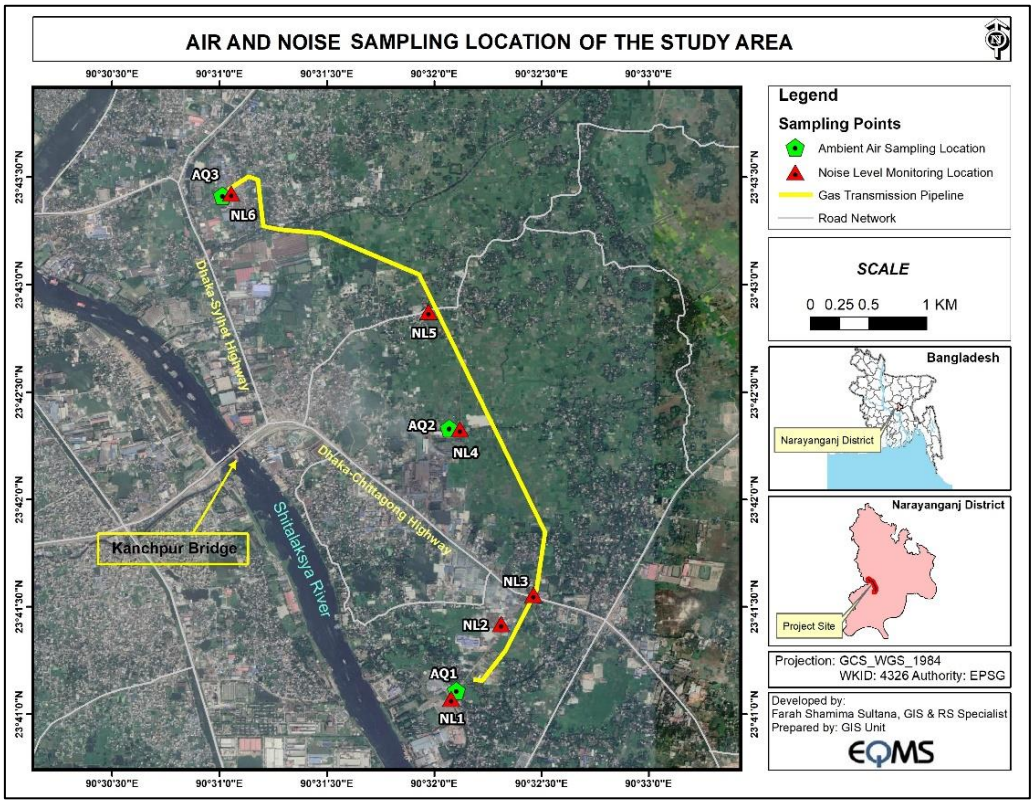
Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1.	In front of Saiful Islam House; Vill: Ward-27, Kadam Rasul Paurashava, Upazila: Bandar	AQ1	23°41'6.64"N 90°32'6.24"E	Rural
2.	In front of Zahir Master House; Vill: Kanchpur, Union: Kanchpur, Upazila: Sonargong	AQ2	23°42'19.87"N 90°32'4.28"E	Rural
3.	Dighi Barabo, Chairman Bari Road, Vill: Digi Barabo, Tarabo Paurashava, Upazila: Rupganj	AQ3	23°43'24.89"N 90°31'3.52"E	Rural

Air Quality Monitoring Pictures



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-33: Air Quality Monitoring Locations for Powerplant



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-34: Air & Noise Quality Monitoring Locations for Gas Transmission Pipeline

Ambient Air Quality in the Study Area

The monitored ambient air qualities are summarized in ***Table 5-16***.

Table 5-16: Ambient Air Quality in the Study Area

SL.	Sampling Station Code	Ambient air pollution concentration					
		$PM_{2.5}$	PM_{10}	SPM	SO_2	NOx	CO
	Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ppm
Power Plant							
1.	AQ1	52.1	116.6	167.4	10.1	30.2	2.5
2.	AQ2	34.5	87.6	134.7	6.3	19.4	0.50
3.	AQ3	41.7	98.5	150.2	7.2	22.4	1
4.	AQ4	31.6	84.2	123.8	5.7	16.6	0.50
5.	AQ5	35.7	89.1	125.4	6.6	12.4	0.50
Gas Transmission pipeline							
1.	AQ1	37.1	97.2	138.2	5.2	15.5	1
2.	AQ2	40.5	85.9	141.5	6.3	14.9	0.50
3.	AQ3	50.1	110.9	165.3	9.5	25.4	1
Duration (hours)		24	24	8	24	24	8
Weather Condition		Sunny					
Bangladesh Standard (*according to Environmental Conservation Rules' 1997 and subsequent amendment in 2005*)		65	150	200	365	65	9
IFC EHS Guideline (2007)		75 (24 hr) 35 (year)	150 (24 hr) 70 (year)	-	500(10 min)125 (24 hr)	200 (1 hr) 40 (year)	-
Method of analysis		Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	Indicator tube

Note:

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

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

**** WHO Ambient Air Quality Guideline Values (2005 and 2000), which are also being referred to the World Bank and IFC's General EHS Guidelines (2007)*

Analysis and Discussion of Result

$PM_{2.5}$

Particulate matter is the dust found in the air. Particulate matter is the term for tiny particles found in the air. These particles can include dust, dirt, smoke, and liquid droplets. The 24-hourly average $PM_{2.5}$ concentration in ambient air in the study area was recorded in the range of 31.6µg/m³ – 52.1µg/m³. In addition, for gas pipeline average $PM_{2.5}$ concentration was recorded in the range of 37.1µg/m3 – 50.1µg/m3. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in Bangladesh as well as IFC EHS Guidelines (2007).

PM_{10}

The 24-hourly dry season average PM_{10} concentration in ambient air in the study area was recorded in the range of 84.2µg/m^3–116.6µg/m^3. In addition, for gas pipeline average PM_{10} concentration was recorded in the range of 85.9µg/m3 – 110.9µg/m^3. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{10} in Bangladesh.

SPM

The 24-hourly average SPM concentration in ambient air in the study area was recorded in the range of 123.8µg/m^3–167.4µg/m^3. In addition, for gas pipeline average SPM concentration was recorded in the range of 138.2µg/m^3 – 165.3µg/m^3. The monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for SPM in Bangladesh as well as IFC EHS Guidelines (2007).

SO_2

The 24-hourly average SO_2 concentration was recorded in the range of 5.7µg/m^3– 10.1µg/m^3. In addition, for gas pipeline average SO_2 concentration was recorded in the range of 5.2µg/m^3 – 9.5 µg/m^3. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for SO_2 in Bangladesh as well as IFC EHS Guidelines (2007).

NOx

The 24-hourly average NOx concentration was recorded in the range of 12.4µg/m^3– 30.2µg/m^3. In addition, for gas pipeline average SO_2 concentration was recorded in the range of 14.9µg/m^3 – 25.4µg/m^3. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for NOx in Bangladesh as well as IFC EHS Guidelines (2007).

CO

The 8-hourly CO concentration was recorded at AQ2, AQ3, AQ4 and AQ5 below 2ppm excluding AQ1. In addition, gas pipeline air monitoring also showed lower CO concentration. CO concentrations were reported low at all the monitoring locations while comparing with the Bangladesh Standards (9ppm).

5.5.2 Noise Level

Noise levels were recorded at seven (7) locations for the power plant and six (6) locations for Gas pipeline during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are shown in ***Table 5-17***. The Noise monitoring Location map is given in ***Figure 5-34*** & ***Figure 5-35.*** The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations were chosen in such a way that a representative data could record all over the block. The sound level recorded in the form of A-weighted equivalent continuous sound pressure level (Leq) values with the use of A-weighting filters in the noise-measuring instrument.

Table 5-17: Details of Ambient Noise Monitoring Locations for Powerplant

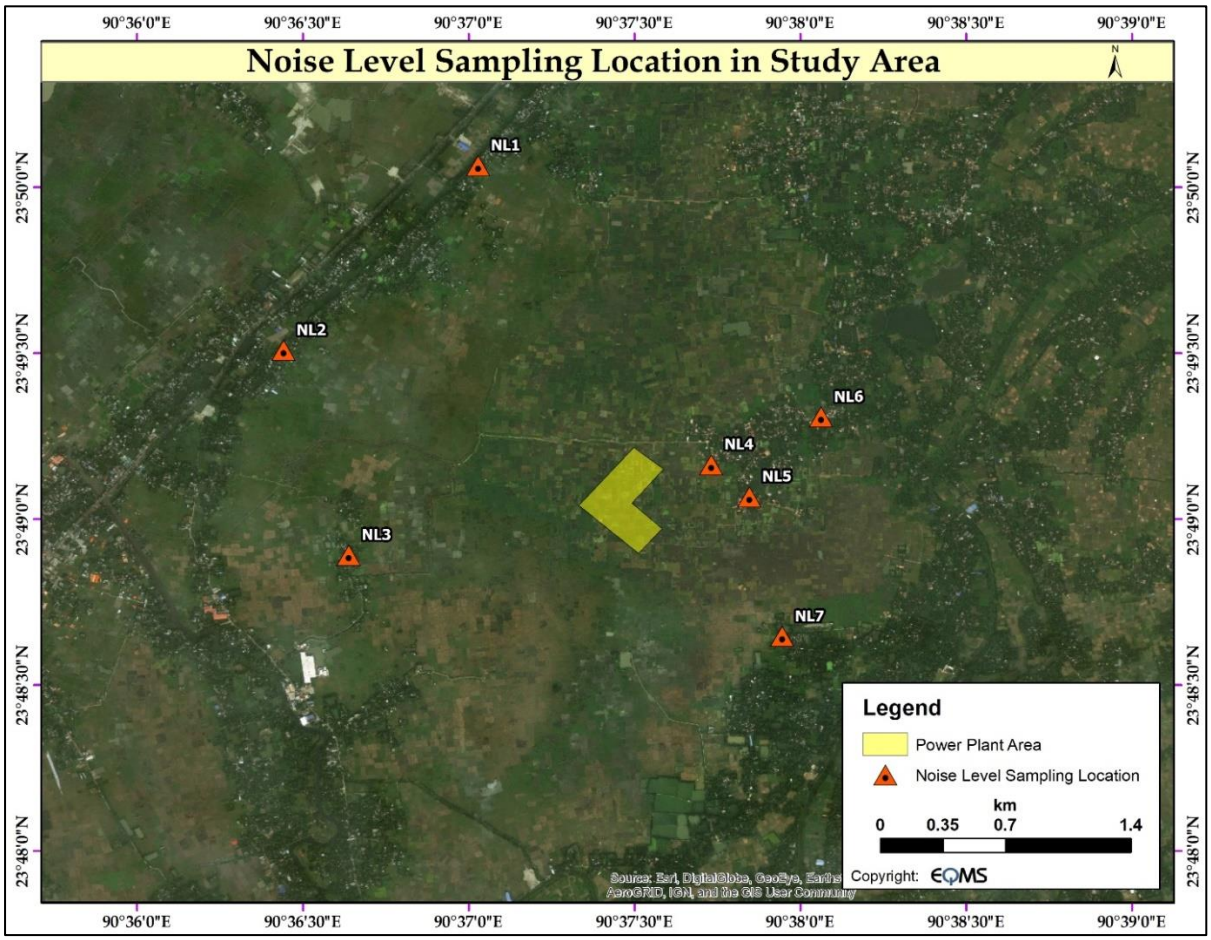
Sl.	Location	Location Code	Geographic location	Location setting
1.	In front of Sonpara govt. primary school; Vill: Sonpara, Union: Satgram	NL1	23°50'04.1"N 90°37'01.4"E	Silent
2.	In front of Naziruddin community clinic; Vill: Panchrukhi, Union: Satgram	NL2	23°49'26.8"N 90°36'26.6"E	Silent
3.	In front of Arju mia house; Vill: Shingrati, Union: Duptara	NL3	23°48'47.6"N 90°36'40.0"E	Residential

Sl.	Location	Location Code	Geographic location	Location setting
4.	In front of Hekim Prodhan House, Vill: Panchbaria Gram, Union: Duptara	NL4	23°49'10.54"N 90°37'43.47"E	Residential
5.	Dakkhin Para Jame Mosque, Vill: Panchbaria Gram, Union: Duptara	NL5	23°49'1.56"N 90°37'48.85"E	Silent
6.	In front of Danis Market; Vill: Panchbaria, Union: Duptara	NL6	23°49'18.2"N 90°38'04.5"E	Commercial
7.	In front of Uttar Dewan Para Mosque, Vill: Panchbaria Gram, Union: Duptara	NL7	23°48'37.45"N 90°37'59.23"E	Silent

Table 5-18: Details of Ambient Noise Monitoring Locations for Gas Transmission Pipeline

Sl.	Location	Location Code	Geographic location	Location setting
1.	In front of Kawsar mia House, Vill: Ward-27, Kadam Rasul Paurashava, Upazila: Bandar	NL1	23°41'4.31"N 90°32'4.77"E	Residential
2.	In front of Bandar Steel, Vill: Ward-27, Kadam Rasul Paurashava, Upazila: Bandar	NL2	23°41'25.25"N 90°32'18.76"E	Industrial
3.	In front of Al Fahad Trade Lines, Vill: Ward-3, Madanpur, Upazila: Bandar	NL3	23°41'33.38"N 90°32'27.79"E	Commercial
4.	In front of Jamia Siddikia Madrasa, Vill: Kanchpur, Upazila: Sonargong	NL4	23°42'19.63"N 90°32'7.19"E	Silent
5.	In front of AB foods & Beverage Limited, Vill: Kanchpur, Upazila: Sonargong	NL5	23°42'52.42"N 90°31'58.50"E	Industrial
6.	In front of Uttar Harun or Rashid House, Vill: Dighi Borabo, Upazila: Rupganj	NL6	23°43'25.50"N 90°31'3.27"E	Residential

Noise Level Monitoring Pictures



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-35: Noise Monitoring Locations for Power Plant

The recorded noise level has been in Table 5-19.

Table 5-19: Noise Level Parameter around the Project Site

Location	Noise level (dB(A)) Dry Season				Applicable standard (dB(A))*		IFC EHS Guideline (2007)		Location setting
	L_{eq} (day)	L_{eq} (night)	L_{max}	L_{min}	Day	Night	Day	Night	
Power Plant									
NL1	53.2	41.2	70.3	48.2	50	40	55	45	Silent
NL2	61.5	55.3	68.9	52.3	55	45	55	45	Silent
NL3	49.4	44.2	61	43.5	55	45	55	45	Residential
NL4	52.3	44.6	70.4	42.1	55	45	55	45	Residential
NL5	50.6	43.1	68.2	38.5	50	40	55	45	Silent
NL6	61.3	56.9	72	53.4	70	60	70	70	Commercial
NL7	49.4	42.8	67.1	37.5	50	40	55	45	Silent
Gas Transmission pipeline									
NL1	54.5	42.9	73.7	42.5	55	45	55	45	Residential
NL2	68.4	65.3	73.5	45.1	75	70	70	70	Industrial
NL3	67.8	55.6	70.2	46.2	70	60	70	70	Commercial
NL4	48.5	38.7	65.6	43.1	50	40	55	45	Silent
NL5	65.9	61.2	72.9	44.6	75	70	70	70	Industrial
NL6	53.4	42.5	69.2	41.5	55	45	55	45	Residential

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

The noise level at some locations within the study area of the power plant was well within the standard limit of ECR'97 (subsequent amendment in 2006) except NL1 & NL2. The noise monitoring location NL1 falls into the silent zone but it is too close to Dhaka-Sylhet highway and 95 m far from Kazi Kabir textile limited and NL2 also falls under the silent zone, but its noise level found also high because of a textile mill called Shuchona Textile. The project area falls into the residential area according to the Bangladesh Environmental Quality Standard ECR'97 categorization.

The noise level at some locations within the study area of Gas Transmission Line was well within the standard limit of ECR'97 (subsequent amendment in 2006).

The Project will comply with the noise emission criteria as per the standards stipulated in the reference framework, i.e. Schedule 4 of Environmental Conservation Rules (ECR), 1997 of Bangladesh as well as Noise Level Guidelines as prescribed in the IFC EHS Guideline (2007).

5.5.3 Water Quality

5.5.3.1 Surface Water Quality

Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Surface water samples were taken from representative selected surface water body's sources representing different parts of the study area.

The surface water sampling collected from the Dhawrakhali canal to the project area. Surface water sampling locations were selected to obtain a representative water sample from various zones within the study area. Three (3) samples of surface water (SW1, SW2 & SW3) were collected from the canal near power plant site, and another three (3) samples of surface water (SW1, SW2 & SW3) were collected from the pond near Gas pipeline alignment. Detail of the sampling location provided in ***Table 5-20*** & ***Table 5-21***.

Table 5-20: Details of Surface Water Sampling Locations for Power Plant

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
1.	Dhawrakhali Khal (Up-stream) Village: Tekpara	SW1	23°49'57.01"N 90°37'25.47"E	Canal
2.	Dhawrakhali Khal (Down-stream); Village: Panchrukhi	SW2	23°42'38.83"N 90°31'48.67"E	Canal
3.	Dhawrakhali Khal, Village: Panchrukhi	SW3	23°43'4.29"N 90°31'42.21"E	Canal

Table 5-21: Details of Surface Water Sampling Locations for Gas Transmission Pipeline

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
4.	Pond near Horipur TBS station, Ward:27, Bandar	SW1	23°41'6.93"N 90°32'8.28"E	Pond
5.	Pond near Kanchpur, Sonargong	SW2	23°48'56.8"N 90°36'09.5"E	Pond
6.	Pond near Ekhlas spinning mill, Tarabo Paurashava, Rupganj	SW3	23°49'38.29"N 90°37'8.79"E	Pond

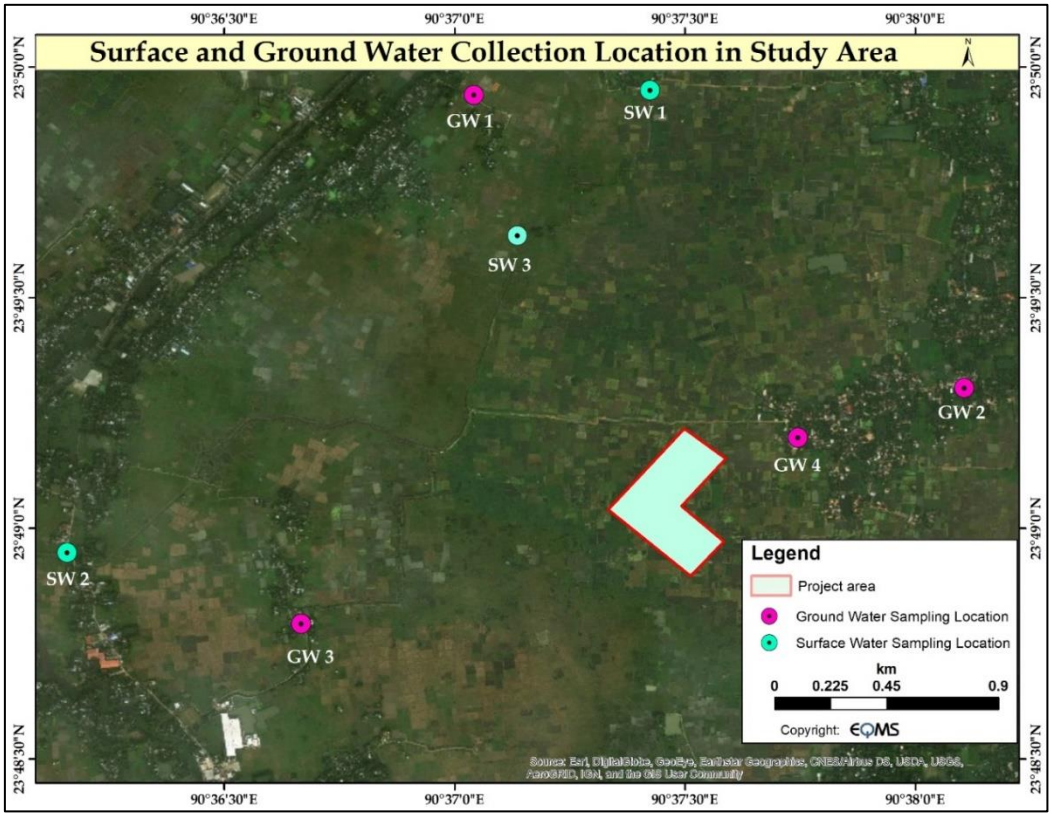
Surface & Ground Water Collection Pictures

Surface water collection from near to the Power Plant site

Surface water collection from the pond located near to the proposed Gas Pipeline

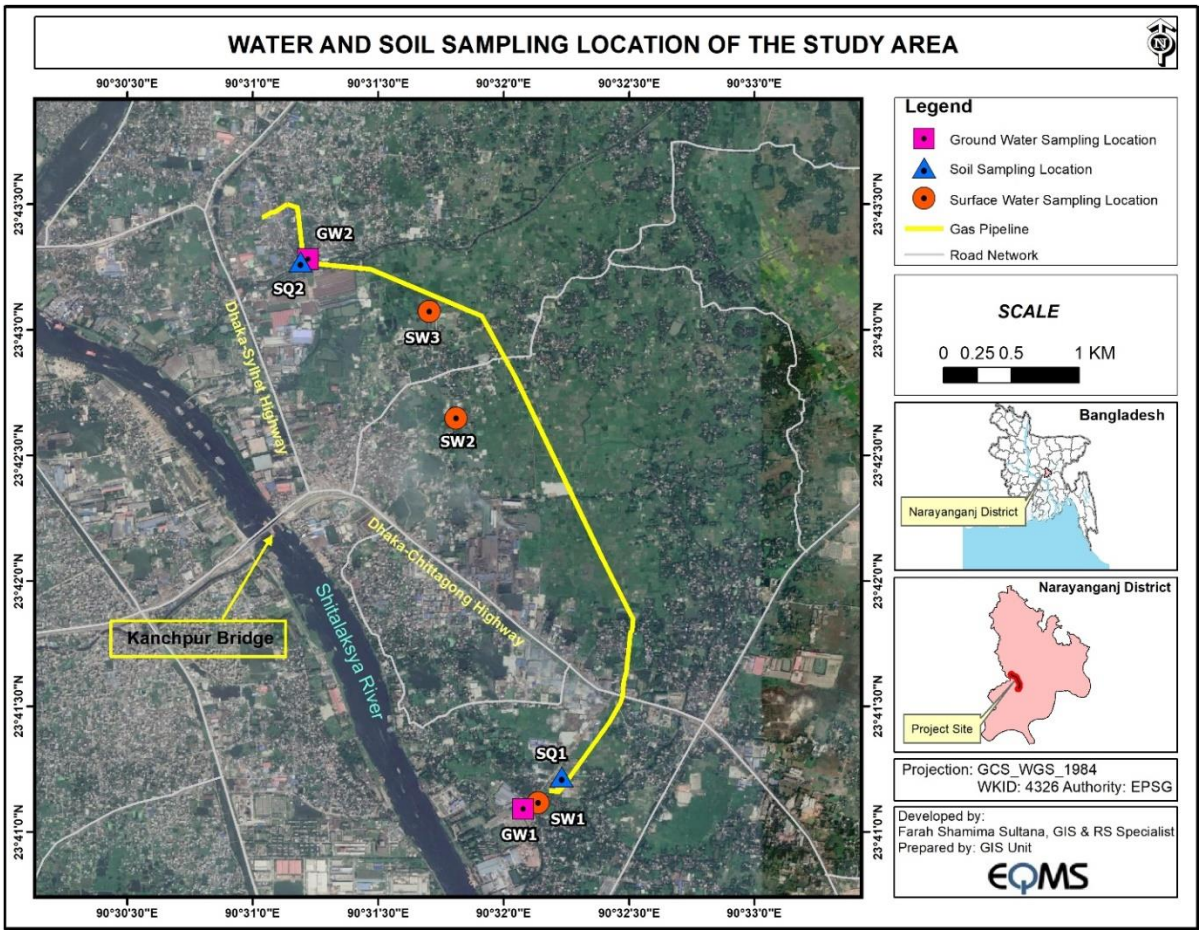
Surface water collection from near to the Power Plant site

Groundwater collection from resident located near to the proposed Gas Pipeline



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-36: Surface Water & Ground Water Sample Collection Locations at Power Plant Site



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-37: Surface Water & Ground Water Sample Collection Locations at Gas Transmission Site

The samples were analyzed for parameters covering Bacteriological and physicochemical characteristics that include certain heavy metals and trace elements.

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

The samples were analyzed as per standard procedures/methods given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in ***Table 5-22***.

Table 5-22: Methods for Water Analysis

Sl.	Parameter	Test method (APHA)
1.	Temperature (˚C)	Digital thermometer
2.	TDS (mg/l)	Digital TDS meter
3.	EC (µmhos/***cm***)	Digital EC meter
4.	DO (mg/l)	Digital DO meter
5.	pH	Digital pH meter
6.	Biochemical Oxygen Demand (BOD)	5 days incubation
7.	Chemical Oxygen Demand (COD)	CRM
8.	Chloride	Titrimetric

Sl.	Parameter	Test method (APHA)
9.	Hardness	Titrimetric
10.	Iron (Fe)	AAS
11.	Manganese (Mn)	AAS
12.	Sulphate	UVS
13.	Total Suspended Solid (TSS)	Gravity Multimeter
14.	Turbidity	Turbidity Meter
15.	Alkalinity	Titrimetric
16.	Calcium	CRM
17.	Coliform (Faecal)	MFM
18.	Coliform (Total)	MFM

N.B: AAS-Atomic Absorption Spectrophotometer, UVS-UV-Visible Spectrophotometer, CRM-Closed Reflex Methods, MFM-Membrane Filtration Method

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

The surface water quality compared with the Bangladesh ECR standard for best practice-based classification criteria. ***Table 5-23*** shows the analysis results. Some of the water analysis parameters discussed below in detail:

A certain quantity of surface water was collected from upstream and downstream areas of the Dhawrakhali Canal. The surface water quality of Dhawrakhali canal near to power plant become polluted because of untreated water discharge from dying industries. The concentration level of BOD is above the Bangladesh Standard for both SW2 & SW3. DO found low at SW3 for power plant site as per Bangladesh Standard.

The quality of surface water near gas pipeline site is within standard compared with the standards for Inland Surface Water, Environment Conservation Rules (ECR), and 1997-Schedule 3) except pH. pH found above standard because of industrial waste near Gas pipeline alignment.

Table 5-23: Surface Water Quality Analysis

Characteristics	Unit	Concentration Present						Bangladesh Standard*					
		SW1	SW2	SW3	SW1	SW2	SW3	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by the various process and cooling industries	Water usable for irrigation
		Power Plant			Gas Transmission Pipeline								
Temperature	ºC	27.2	28.2	27.0	28.2	27.3	27.5	-	-	-	-	-	-
BOD	mg/l	9	17	23	2.0	1.1	3.1	2 or less	3 or less	3 or less	6 of less	10 or less	10 or less
COD	mg/l	32	56	88	72	40	80			-			
EC	µS/cm	630	650	560	0.78	0.68	0.72	-	-	-	-	-	-
DO	mg/l	6.28	6.04	2.26	7.6	6.0	7.8	6 or above	5 of more	6 or more	5 or more	5 or more	5 or more
pH	-	7.70	7.8	7.52	8.69	8.70	8.76	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
TDS	ppt	0.32	0.33	0.35	0.39	0.34	0.36	-	-	-	-	-	-
Chloride	mg/l	73	76	81	19.7	16.2	18.9			-			
Hardness	mg/l	265	275	270	178	183	202			-			
Iron (Fe)	mg/l	0.12	0.05	0.30	0.03	0.08	0.06			-			
Manganese (Mn)	mg/l	0.03	0.04	0.03	0.3	0.2	0.2			-			
Sulphate	mg/l	5	4	1	18	21	20			-			
Total Suspended Solid (TSS)	mg/l	22	14	20	13	16	15			-			
Turbidity	NTU	21.2	2.2	6	4.4	10.5	8.9			-			

Characteristics	Unit	Concentration Present						Bangladesh Standard*					
		SW1	SW2	SW3	SW1	SW2	SW3	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by the various process and cooling industries	Water usable for irrigation
		Power Plant			Gas Transmission Pipeline								
Alkalinity	mg/l	185	183	243	130	132	128			-			
Calcium	mg/l	298	268	256	18	22	21			-			
Coliform (Faecal)	mg/l	25	34	16	10	6	2			-			
Coliform (Total)/100	mg/l	53	55	23	24	14	6	50 or less	200 or less	5000 or less	-	5000 or less	1000 or less

(Source: Laboratory Analysis, DPHE and EQMS laboratory)

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

5.5.3.2 Ground Water Quality

The water sampling and analysis were undertaken to understand the overall baseline water quality of the groundwater in the study area. Groundwater samples were taken from representatively selected groundwater sources representing different parts of the study area.

The groundwater sampling locations were selected to obtain a representative water sample from various zones within the study area. The samples were collected from existing tube wells (hand-tube wells being used by the villagers). A total Four (4) groundwater samples were collected from different locations of the power plant area. In addition, total Two (2) groundwater samples were collected from different locations of Gas Pipeline area. Details of the sampling locations provided in ***Table 5-24*** and ***Table 5-25*** depicted in ***Figure 5-36*** and ***Figure 5-37***.

Table 5-24: Details of Ground Water Sampling Locations for Power Plant

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
1.	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram,Upazila: Araihajar	GW1	23°49'56.5"N 90°37'02.6"E	Tubewell
2.	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram, Upazila: Araihajar	GW2	23°49'18.2"N 90°38'06.5"E	Tubewell
3.	In front of Arju mia Sentu House, Vill: Shingrati, Union: Duptara,Upazila: Araihajar	GW3	23°48'47.6"N 90°36'40.0"E	Tubewell
4.	In front of Ali Ahmed House, Vill: Panchbaria, Union: Duptara,Upazila: Araihajar	GW4	23°49'11.8"N 90°37'44.7"E	Tubewell

Table 5-25: Details of Ground Water Sampling Locations for Gas Pipeline Site

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
1.	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram,Upazila: Araihajar	GW1	23°49'56.5"N 90°37'02.6"E	Tubewell
2.	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram, Upazila: Araihajar	GW2	23°49'18.2"N 90°38'06.5"E	Tubewell

The samples analyzed for parameters covering Bacteriological and physicochemical characteristics, which included certain heavy metals and trace elements.

Water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can and 250 ml sterilized clean PET bottle and transported to the lab by using cool box at 4^0C. After that, physio-chemical and bacteriological tests have performed.

The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in Table 5-26.

Table 5-26: Methods for Water Analysis

Sl.	Parameter	Test method (APHA)
1.	Temperature (˚C)	Digital thermometer
2.	TDS (mg/l)	Digital TDS meter
3.	EC (µmhos/cm)	Digital EC meter
4.	DO (mg/l)	Digital DO meter
5.	pH	Digital pH meter

Sl.	Parameter	Test method (APHA)
6.	Arsenic (As)	AAS
7.	Calcium (Ca)	AAS
8.	Chemical Oxygen Demand (COD)	CRM
9.	Chloride	Titrimetric
10.	Coliform (Faecal)	MFM
11.	Coliform (Total)	MFM
12.	Fluoride	UVS
13.	Iron (Fe)	AAS
14.	Lead (Pb)	AAS
15.	Manganese (Mn)	AAS
16.	Phosphate	UVS
17.	Sulphate	UVS
18.	Total Suspended Solid (TSS)	Gravity Multimeter
19.	Turbidity	Turbidity Meter

N.B: AAS-Atomic Absorption Spectrophotometer, UVS-UV-Visible Spectrophotometer, CRM-Closed Reflex Methods, MFM-Membrane Filtration Method

The quality of groundwater was compared with the Drinking Water Standard E.C.R.-Schedule-3, 1997. The standards have been presenting along with the monitoring of the results of groundwater for comparison. The assessment of potential impacts to groundwater has considered Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines.

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

In September 2017, the survey team collected groundwater samples from tube wells in and around the power plant area. The result of the groundwater field samples and the GoB standards for potable water (ECR, 1997) is shown below in Table 5-27. The concentration levels of Manganese (Mn) & BOD of tube well found above the standard set by the DOE, GoB for drinking water. But the levels of pH, TDS, As, Ca, COD, Chloride, Fluoride, Fe, Pb, Phosphate, Sulphate, TSS and turbidity were found to be within the limit set by the DOE, GoB for drinking water. The average depths of deep tube wells for drinking water are at least 600-700 feet. After consultation with the DPHE officer of Araihazar, According to the overall water quality data, practically good quality and quantity of groundwater are available in and around the project site.

In September 2018, the survey team collected groundwater samples from tube wells in and around the Gas Pipeline area. The concentration levels of Manganese (Mn) & BOD of tube well found above the standard set by the DOE, GoB for drinking water. But the levels of pH, TDS, As, Ca, COD, Chloride, Fluoride, Fe, Pb, Phosphate, Sulphate, TSS and turbidity were found to be within the limit set by the DOE, GoB for drinking water.

Table 5-27: Ground Water Quality Analysis Result

Sl.	Parameters	Unit	Sampling code						Bangladesh Standard	WHO
			Power Plant				Gas Transmission Pipeline			
			GW1	GW2	GW3	GW4	GW1	GW2		
1.	Temperature	^{0}C	27.3	26.0	27.4	27.3	27.3	27.2	20-30 ˚C	-
2.	EC	µS/cm	540	1130	510	0.78	0.44	0.80	-	(2,000 by EPA)
3.	pH	-	7.80	7.42	7.25	8.63	8.40	8.26	6.5-8.5	9.2
4.	DO	mg/L	7.80	7.01	7.61	8.0	4.9	6.9	6	-
5.	TDS	ppt	0.28	0.57	0.26	0.39	0.44	0.80	-	1500
6.	Arsenic (As)	mg/L	0.001	0.001	0.001	<0.010	<0.010	<0.010	0.05 mg/l	0.05
7.	Calcium (Ca)	mg/L	303	268	287	19	20	23	75	200.0
8.	COD	mg/L	4	4	4	4	4	4	4.0	-
9.	Chloride	mg/L	45	150	52	20+	19.8	19.5	150-600	250.0
10.	Coliform (Faecal)	N/100ml	2	0	0	0	0	0	0	0
11.	Coliform (Total)	N/100ml	6	3	0	5	0	8	0	0
12.	Fluoride	mg/L	0.67	1.72	0.44	0.13	0.21	0.10	1.0	1.5
13.	Iron (Fe)	mg/L	0.42	0.19	0.36	0.01	0.01	0.02	0.3-1	0.3
14.	Lead (Pb)	mg/L	0.021	0.001	0.001	0.002	0.003	0.001	0.05	0.01
15.	Manganese (Mn)	mg/L	0.10	0.46	0.11	0.3	0.5	0.3	0.1	0.1
16.	Phosphate	mg/L	0.32	0.43	0.37	0	0	0	6.0	-
17.	Sulphate	mg/L	4	5	6	3.0	3.0	5.0	400	400
18.	Total Suspended Solid (TSS)	mg/L	15	12	13	4	1	1	10	-
19.	Turbidity	NTU	3.9	3.1	4.2	6.2	0.6	0.5	10	5>
20.	BOD	mg/L	1	1	1	3.3	1.2	3.2	0.2	-

Source: Laboratory Analysis, DPHE and EQMS laboratory

5.5.4 Soil Quality

Sampling Methodology and Locations

The soil sampling strategy was designed to assess the existing soil quality over the study area. Two soil samples were collected from the study area at the wet season. The details of the soil sampling locations at the power plant site are presented in ***Figure 5-37*** & ***Figure 5-38***. A composite sampling technique has used for soil sampling from each location.

Soil samples were collected using hand held augur from a depth of 45 cm from the topsoil surface. At each location, soil samples were collected from two spots and homogenized. The homogenized samples were collected following a quartering technique and then packed in polyethene plastic jars and sealed. The sealed samples were sent to the laboratory for analysis.

The soil samples were analyzed for physical and chemical characteristics including minerals, heavy metals and trace elements.

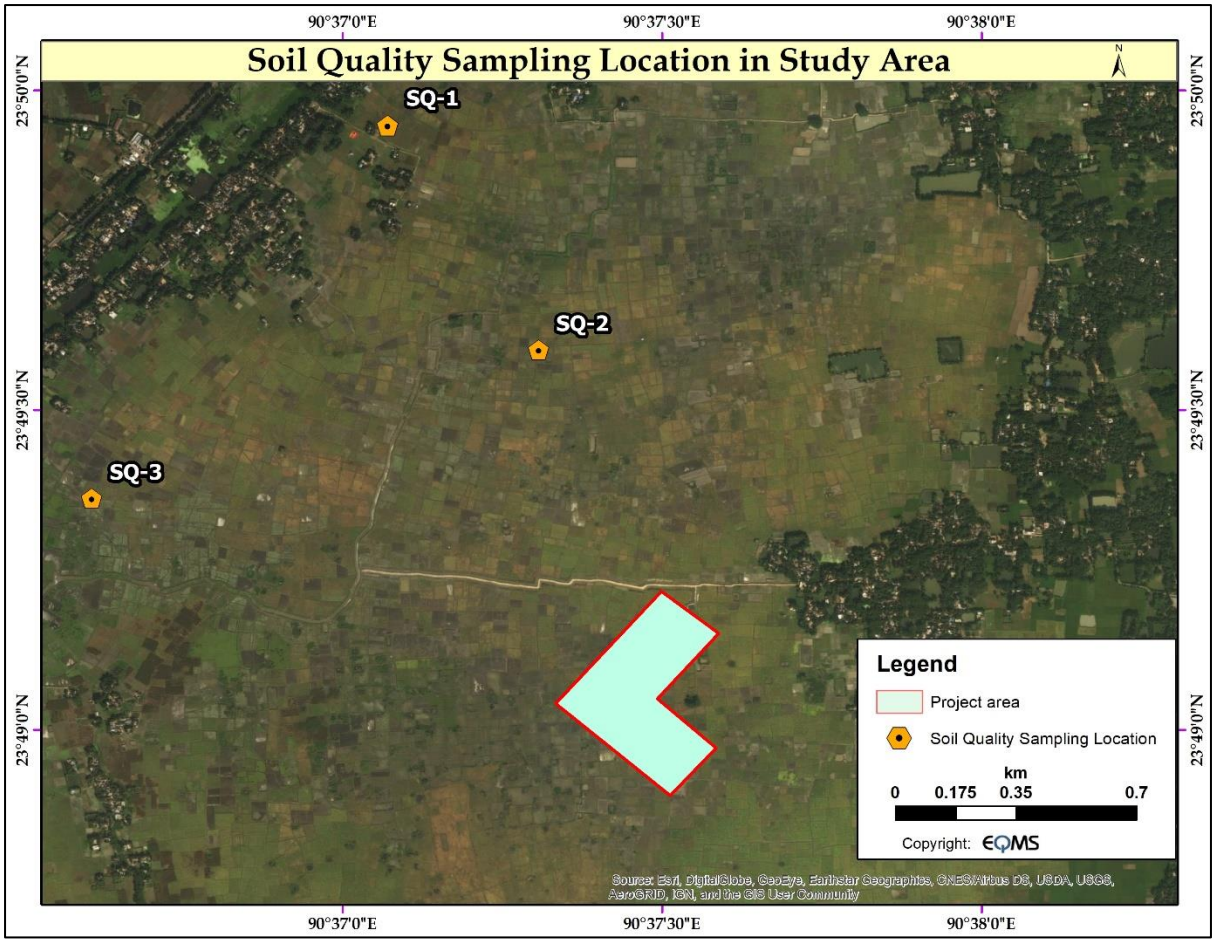
Soil Sample Collection Pictures

Table 5-28: Location of Soil Samples at Power Plant Site

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1.	Project Site; Vill: Sonpara, Union: Satgram, Upazila: Araihazar	SQ1	23°49'56.7"N 90°37'04.2"E	Project area
2.	Vill: Tekpara, Union: Satgram, Upazila: Araihazar	SQ2	23°49'37.3"N 90°37'06.8"E	Land
3.	Retention Pond area	SQ3	23°49'18.8"N 90°36'43.6"E	Land

Table 5-29: Location of Soil Samples at gas Transmission Pipeline Site

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1.	Near to Haripur TBS, Ward: 27, Kadam Rasul paurashava, Upazila: Bandar, Narayanganj	SQ1	23°41'13.17"N 90°32'13.91"E	Land
2.	Vill: Dighi barabo, Ward: 9, Upazila: Rupganj, Narayanganj	SQ2	23°49'37.3"N 90°37'06.8"E	Land



Source: Esri, Digital Globe, Geo Eye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero GRID, IGN, and the GIS User Community

Figure 5-38: Soil Sampling Location Map at Power Plant site

Table 5-30: Soil Quality Results at Power Plant Site

Location			Soil Quality					USEPA Guideline*
			Power Plant			Gas Transmission Pipeline		
Sample Code		**-**	**SQ1**	**SQ2**	**SQ3**	**SQ1**	**SQ2**	**-**
Parameter		Unit	Result	Result	Result	Result	Result	-
Grain Size Distribution	Sand	%	14	15	13	85	8	-
	Silt		66	58	51	10	47	-
	Clay		20	27	36	5	45	-
Textural Class		-	Silt Loam	Silty clay loam	Silty clay loam	Loamy Sand	Silty Clay	-
pH		-	6.9	6.9	6.9	5.6	5.2	-
Organic Content		%	2.89	1.83	2.35	0.54	1.01	-
Potassium		meq/100g soil	0.09	0.12	0.14	0.20	0.15	-
Calcium		meq/100g soil	11.42	12.83	13.16	7.85	11.0	-

Location		Soil Quality					USEPA Guideline*
		Power Plant			Gas Transmission Pipeline		
Sodium	meq/100g soil	0.38	0.50	0.44	0.39	0.19	-
Phosphorous	µg/g	0.85	1.01	1.30	37.37	1.48	-
Copper	mg/kg	1.79	7.46	5.21	0.37	0.99	149
Iron	µg/g	32.31	70.80	8.80	14.65	58.03	-
Manganese	µg/g	4.12	6.48	10.14	5.59	39.32	-
Zinc	mg/kg	0.84	1.34	1.24	5.63	4.98	459
Lead	mg/kg	0.02	0.143	0.06	3.50	11.75	128
Cadmium	mg/kg	11.31	25.00	27.62	0.10	0.025	4.98
Chromium	mg/kg	23.82	30.35	29.50	31.75	45.50	111
Chloride	ppm	35.50	35.50	35.50	106.5	35.5	-
Arsenic	ppm	0.52	1.30	1.57	1.78	1.86	

*Consensus-based freshwater sediment quality guidelines, USEPA, 2000

International guidelines are taken since there is no standard for soil pollution in Bangladesh. As shown in ***Table 5-30***, contamination by heavy metals, copper, Zinc, Lead and Chromium are within guidelines and considered as no polluted. However, Cadmium limit is 11.31 mg/kg- 27.62mg/kg that cross the limit at power plant area.

** As we know, in power plant sector two specific parameter for soil named oil and grease considered important. During construction and operation phase, it harms the soil as well as its adjacent surface water resources. As per fuel consumption information (discussed Ch.3) about 13.664 t/day diesel will be utilize, some of them will spill out and seepage so far baseline condition and management plan is required.

CHAPTER 6: SOCIO-ECONOMIC ENVIRONMENT

6 SOCIO-ECONOMIC CONDITION

6.1 Population

6.1.1 Demography

In the 5-kilometer study area power plant, there are 159,785 households (HHs) including squatters with a total population of 534,281 that will be somehow affected (directly or indirectly) by the implementation of the Project. Population density per square km of the study area is 2,973, which is very much higher than the national figure of 976 per square km. The average sex ratio is 107 against the national figure of 100, which depicts a higher male population than the female population. Moreover, where national household size is 4.44, the average household size of the study area is slightly higher (4.7). ***Table 6-1*** shows the Demography profile of the project study area.

Table 6-1: Demography of the Proposed Power plant area

Upazila	Union	Total population	Total HHs	Average HH size	Sex Ratio	Population density (Sq. Km)
Narsingdi Sadar	Amdia	42,118	8,637	4.9	102	2,078
	Meher Para	43,700	9,434	4.6	110	4,685
	Madhabdi Paurashava	49,583	11,323	4.3	139	3,315
	Kanthalia	38,390	7,986	4.8	100	3,204
Araihazar	Sadasardi	39,615	7,956	4.9	106	3,460
	Duptara	37,495	7,911	4.7	107	2,242
	Araihazar	25,593	25,593	4.4	102	3,215
	Fatehpur	20,834	4,354	4.8	103	2,938
	Brahmandi	48,999	10,561	4.6	101	3,002
	Satgram	41,731	8,366	5.0	103	2,126
Rupganj	Kanchan Paurashava	49,468	10,912	4.5	103	3031
	Golakandail	62,747	12,744	4.9	114	3,380
	Bholaba	34,008	34,008	4.9	96	1,973
Project Study Area		**534,281**	**159,785**	**4.7**	**107**	**2,973.0**

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

100% census and the socio-economic survey were carried out in the project surroundings area. A total of 253 households with a Project Affected Persons (PAPs) of 1092 were identified and surveyed in Gas Pipeline Project area. The average household size is 4.3 which is more or less similar to the national average. The national average household size is 4.4.

Table 6-2: General/Demographic Profile of Affected Population

Profile	Number
Number of total affected Households	253
Number of total Population	1092
Average AHs Size	4.3

Source: EQMS survey, November 2018

In the 500 meters study area of Gas transmission pipeline, there are about 39622 households (HHs) including squatters with a total population of 115099 that will be influenced by the implementation of the proposed bridge. The average sex ratio is 111, and the average household size is 4.0. The demography of the study area is shown in the following Table 6-3.

Table 6-3: Demography of the Gas Transmission Pipeline Area

Upazila	Union	Total Pop	Total HHs	Avg. HH size	Pop Density (sq. Km)	Sex Ratio
Tarabo Paurashava	Word-8	20065	5081	3.9		118
Tarabo Paurashava	Word-9	41390	10977	3.8		114
Sonargaon	Kanchpur	60734	15331	3.9	4838	106
Bandar	Madanpur	21273	4842	4.4	3418	110
Kadam Rasul Paurashave	Word-9	13543	3391	4.0		108
Study Area		**115099**	**39622**	**4.0**	**4128**	**111**

Source: Population and Housing Census, BBS, 2011

6.1.2 Ethnic Composition

According to population and housing census (2011), only 10 ethnic households consisting 31 populations are found in the Union lied within the 2 km radius boundary from the power plant site. These ethnic groups are Marma, Chakma and Others.

According to the population and housing census (2011), total household of the gas transmission pipeline study area in Tarabo Paurashava, Sonargaon and Kadam Rasul Upazilla total 139 ethnic community household has been found. Only Chakma and Rakhain ethnic community have been found. The major ethnic community like Garo, Barmon and Coach has not found in the proposed study area.

6.1.3 Religion

As per BBS, Population and Census (2011), the population of the project study area primarily consists of Muslims constituting almost 94.4% of the total population. The remaining 5.6% is primarily comprised of Hindus with Christians, Buddhists, and others comprising far lesser percentages. The following ***Table 6-4*** indicates the various religious profiles of the project study area.

Table 6-4: Religion Profile of Proposed Power Plant Area

Upazila	Union	Total pop.	Muslim		Hindu		Christian		Buddhist		Others	
			Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Narsingdi Sadar	Amdia	42118	40855	97.0	1262	3.0	0	0	0	0	1	0.002
	Meher Para	43700	40923	93.6	2774	6.3	2	0.005	0	0	1	0.002
	Madhabdi	49583	44377	89.5	5194	10.5	4	0.01	7	0.01	1	0.002
	Kanthalia	38390	37891	98.7	499	1.3	0	0	0	0	0	0.000
Araihazar	Sadasardi	39615	34786	87.8	4822	12.2	7	0.02	0	0	0	0.000
	Duptara	37495	35181	93.8	2313	6.2	0	0	0	0	1	0.003
	Araihazar	25593	23603	92.2	1984	7.8	6	0.02	0	0	0	0.000
	Fatehpur	20834	20273	97.3	559	2.7	0	0	0	0	2	0.010
	Brahmandi	48999	48276	98.5	723	1.5	0	0	0	0	0	0.000
	Satgram	41731	41519	99.5	212	0.5	0	0	0	0	0	0.000
Rupganj	Kanchan	49468	46504	94.0	2914	5.9	35	0.07	8	0.02	7	0.014
	Golakandail	62747	57669	91.9	5035	8.0	19	0.03	3	0.00	21	0.033
	Bholaba	34008	32416	95.3	1592	4.7	0	0	0	0	0	0.000
Project Study Area		**534281**	**504273**	94.4	**29883**	5.6	**73**	0.01	**18**	0.003	**34**	**0.006**

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

According to the population and housing census (2011), the Muslim community constituting almost 97.2% of the total population dominates the population of the study areas. The remaining 4.3% is Hindu. The following indicates the various religious profile of the project study area.

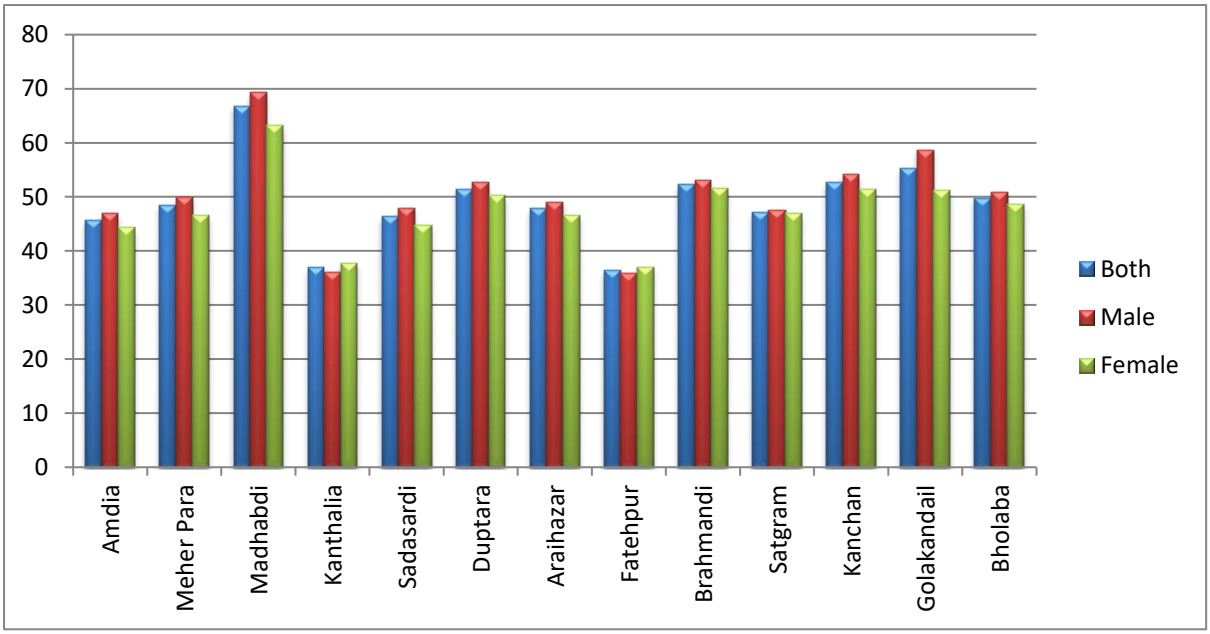
Table 6-5: Religious Profile of the Gas Transmission Pipeline Area

Upazila	Union	Total population	Muslim		Hindu		Christian		Buddhist		Others	
			Pop	%	Pop	%	Pop	%	Pop	%	Pop	%
Tarabo Paurashava	Word-8	20065	19644	97.9	409	2.0	2		10		0	0
Tarabo Paurashava	Word-9	41390	39457	95.3	1901	4.5	1		1		30	
Sonargaon	Kanchpur	60734	58303	95.9	2211		148	.2	45		27	
Bandar	Madanpur	21273	21059	98.9	207	0.9	7		0		0	0
Kadam Rasul Paurashave	Word-9	13543	13256	97.8	238	1.7	46		3		0	0
Study Area		**115099**	**151719**	**97.2**	**4966**	**4.3**	**204**		**59**		**57**	**0**

Source: Population and Housing Census, BBS, 2011

6.2 Education

The population and housing census (2011) shows that the concentration of literate people in underlying unions of selected Upazilas is 49% which is lower than the national average of 51.8%. Like the national figure similar scenario is found in the case of female literacy which is lower than the male counterpart and it's 47.7% where male literacy is 50.1%. ***Figure 6-1*** shows the Literacy rate of the project area.



Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

Figure 6-1: Literacy Rate by Sex

Based on census and socioeconomic data, it was revealed that majority (63.8%) of affected persons have completed primary level education. About 175 (16%) and 78 (7.1%) have passed secondary and higher secondary level education respectively while only 50 (4.5%) identified as privileged of

having tertiary level education. Fifty-seven affected people were found illiterate. Survey result also revealed that illiteracy rate is comparatively similar between male and female population.

Table 6-6: Level of Education of Affected Household Head

EDUCATION	MALE		FEMALE		TOTAL	
	Nos.	%	Nos.	%	Nos.	%
Primary	372	34.1	325	29.8	697	63.8
S.S.C	92	8.4	83	7.6	175	16.0
H.S.C	56	5.1	22	2.0	78	7.1
B.A or Equivalent	24	2.2	8	0.7	32	2.9
M.A or Equivalent	15	1.4	3	0.3	18	1.6
Literate	20	1.8	15	1.4	35	3.2
Illiterate	30	2.7	27	2.5	57	5.2
Total	**609**	**55.8**	**483**	**44.2**	**1092**	**100.0**

Source: EQMS survey, November 2018

According to the population and housing census (2011), it shows that the concentration of literate people in two unions and 3 words of selected upazila. The literacy rate in the study area is 60.2% which is average rate than the national average of 47.68%. The following Table 6-7 shows the literacy rate of the project study area.

Table 6-7: Literacy of the Gas Transmission Pipeline Area

Upazila	Union	Literacy (%)
Tarabo Paurashava	Word-8	54.9
Tarabo Paurashava	Word-9	60.4
Sonargaon	Kanchpur	62.9
Bandar	Madanpur	56.5
Kadam Rasul Paurashave	Word-9	66.3
Study Area		**60.2**

Source: Population and Housing Census, BBS, 2011

6.3 Settlement and Housing

According to population and housing census (2011), total households of the project power plant study area is 111077. Predominant structure of this study area is kutcha (71.7%) followed by Semi-pucka (21.1%), Pucka (6.7%) and Jhupri (0.5%). Housing tenancy of the study area is owned by (49.6%), rented (46.6 %) and Rent free (3.8%). ***Table 6-8*** and ***Table 6-10*** show the type of structure and Housing tenancy in the project study area.

Table 6-8: Type of Structure in the Proposed Power Plant Area

Upazila	Union	Number of Households	Type of Structure (%)			
			Pucka	Semi-pucka	Kutcha	Jhupri
Narsingdi Sadar	Amdia	8608	1.8	11.0	86.9	0.3
	Meher Para	9300	6.2	25.8	67.3	0.6

Upazila	Union	Number of Households	Type of Structure (%)			
			Pucka	Semi-pucka	Kutcha	Jhupri
	Madhabdi	10467	20.7	51.4	27.5	0.4
	Kanthalia	7979	1.6	8.9	88.8	0.6
Araihazar	Sadasardi	7916	6.2	15.7	77.9	0.2
	Duptara	7848	7.6	23.9	68.3	0.3
	Araihazar	5759	6.6	19.0	73.8	0.6
	Fatehpur	4333	4.5	17.7	77.7	0.1
	Brahmandi	10514	5.1	15.4	79.0	0.5
	Satgram	8342	3.8	15.5	79.9	0.8
Rupganj	Kanchan	10647	5.7	19.6	74.4	0.3
	Golakandail	12370	12.2	34.8	52.3	0.6
	Bholaba	6994	5.3	15.6	78.2	0.9
Project Study Area		**111077**	**6.7**	**21.1**	**71.7**	**0.5**

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

According to the population and housing census (2011), total household of the project study area is **39622**.

The Gas Pipeline project has very limited impact on structures. A total of 15251 sft of residential and commercial structures will be affected by the project of which 4711 sft is pucca, 10082 sft semi-pucca and 458 sft is tin-made and need to be relocated. One weaving factory and one closed textile mills were identified in the project alignment. The weaving factory will be affected partially and needs to be relocated temporarily. The gas pipelines cross the textile mill through its open space, so relocation is not required. Category of structures by construction materials in gas pipeline project is given ***Table 6-9***.

Table 6-9: Amount of Structures by Construction Materials

SL No.	Name of Mouza	Type of Structures			Total
		Pucca	Semi-Pucca	Tin-made	
1	DighiBorabo	916	8427	248	9591
2	Behakair	3795	---	210	4005
3	Monoharkharbag	---	1655	---	1655
		4711	**10082**	**458**	**15251**

Source: EQMS survey, November 2018

The predominant structure of this study area is Kutcha (40.5%) followed by Pucka (12.2%), Semi-pucka and jhupri (46.8% and 0.5%). Housing tenancy of the study area is owned by (40.1%), rented (56.7%) and rent free 3.2%). The following ***Table 6-10*** shows the type of structure and housing tenancy in the project study area.

Table 6-10: Types of Structure and Housing Tenancy in the Gas Transmission Pipeline Area

Upazila	Union	Type of Structure (%)				Housing Tenancy (%)		
		Pucka	Semi-pucka	Kutcha	Jhupri	Owned	Rented	Rent free
Tarabo	Word-8	10.3	68.2	21.3	0.2	20.1	75.9	4

Upazila	Union	Type of Structure (%)				Housing Tenancy (%)		
		Pucka	Semi-pucka	Kutcha	Jhupri	Owned	Rented	Rent free
Paurashava								
Tarabo Paurashava	Word-9	8.4	63.8	27.6	0.2	20.2	75.6	4.1
Sonargaon	Kanchpur	19.2	43.9	36.5	0.3	37.4	59.5	3.2
Bandar	Madanpur	12.4	22.6	63.2	1.7	62	35.1	2.9
Kadam Rasul Paurashave	Word-9	10.6	35.4	54	0	60.7	37.5	1.8
Study Area		**12.2**	**46.8**	**40.5**	**0.5**	**40.1**	**56.7**	**3.2**

Source: Population and Housing Census, BBS, 2011

6.4 Traffic and Transport

In the project area constituted by 5 km radius, total Metalled (581.3 km), Semi metalled (194.9 km), Unmetalled (963.72km) road is 1739.92 Kilometer. In the study area, Unmetalled road is 55.4% followed by 33.4% Metalled and 11.2% Semi Metalled. Additionally, most (41%) roads lie under Rupganj upazila compared to Narshingdhi Sadar (37.5%) and Araihazar Upazila (21.5%).Moreover, there are 34 bus stands underlie within the study area.

Table 6-11: Roads Communication in the Proposed Power Plant Area

Upazila	Metalled Road	%	Semi Metalled Road	%	Unmetalled Road	%	Total	%	Bus Stand
Narshingdhi Sadar	245.72	14.1	21.16	1.2	385.1	22.1	651.9	37.5	7
Araihazar	159	9.1	25	1.4	190.0	10.9	374.0	21.5	18
Rupganj	176.58	10.1	148.74	8.5	388.7	22.3	714.0	41.0	9
Total	**581.3**	**33.4**	**194.9**	**11.2**	**963.7**	**55.4**	**1739.9**	**100.0**	**34**

Source: District Statistics 2011, Bangladesh Bureau of Statistics (BBS)

According to the District Statistics (2011), in the Sonargoan and Bandar Upazila total metalled, Semi-metalled, unmetalled (kaccha) road is respectively 215 km, 49km, and 387 km which is total 654 km. No railway (all broad gauge, meter gauge and duel gage) in the study area. Only in Bandar Upazilla the total 0.72 km waterway in monsoon (river + canal).

6.5 Public Utilities

6.5.1 Water supply and Electricity

At the project study area, the major source of drinking water is tube-well where about 93.8% population use tube-wells water. About 3.2% people have access to tap water. Other 3.0% people have access neither tube-well nor tap water. An overview is depicted in below ***Table 6-12***.

Electricity is an important indicator for measuring the quality of life in the study area. In the project study area, 91.8% of the households have grid electricity connection. However, households mostly use the electricity for lighting and fanning purposes. Electricity connection of the study area shows ***Table 6-12***.

Table 6-12: Sources of Drinking Water and Electricity Facility of the Proposed Power Plant Area

Upazila	Union	Number of Households	Source of Drinking Water (%)			Electricity Connection (%)
			Tap	Tube-well	Other	
Narsingdi Sadar	Amdia	8608	0.1	99.1	0.9	90.4
	Meher Para	9300	0.5	97.6	1.9	95.6
	Madhabdi	10467	26.4	73.4	0.2	98.9
	Kanthalia	7979	0.5	87.7	11.8	84.7
Araihazar	Sadasardi	7916	0.6	97.8	1.6	92.4
	Duptara	7848	7.0	88.3	4.7	92.1
	Araihazar	5759	0.5	98.4	1.1	91.9
	Fatehpur	4333	0.4	97.7	1.9	91.7
	Brahmandi	10514	0.4	97.1	2.5	93.0
	Satgram	8342	0.2	95.4	4.4	90.0
Rupganj	Kanchan	10647	3.0	91.8	5.3	92.2
	Golakandail	12370	2.1	96.5	1.3	94.9
	Bholaba	6994	0.4	98.2	1.3	86.1
Project Study Area		**111077**	**3.2**	**93.8**	**3.0**	**91.8**

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

According to census and SES findings, it was learned that 100% affected households have access to safe water for drinking, cooking and other regular household's uses. **Table 6-13** shows the status of AH's access to safe water.

Table 6-13: Access to Water

SL No.	Sources of Water	No. of HH by use pattern		
		Drinking	Cooking	Bath/Washing and other
1	Tube-well	56	56	56
2	Motor/deep tube-well	119	119	119
3	Supply	78	78	78
4	River/canal	0	0	0
5	Pond	0	0	0
Total		**253**	**253**	**253**

Source: EQMS survey, November 2018

At the project study area, the major source of drinking water is tube-well where about 92.9% population use tube-wells water. 2.9 % population use tap water. Other 4.3% people have access neither tube-well nor tap water. An overview is depicted in Table 6-14**.**

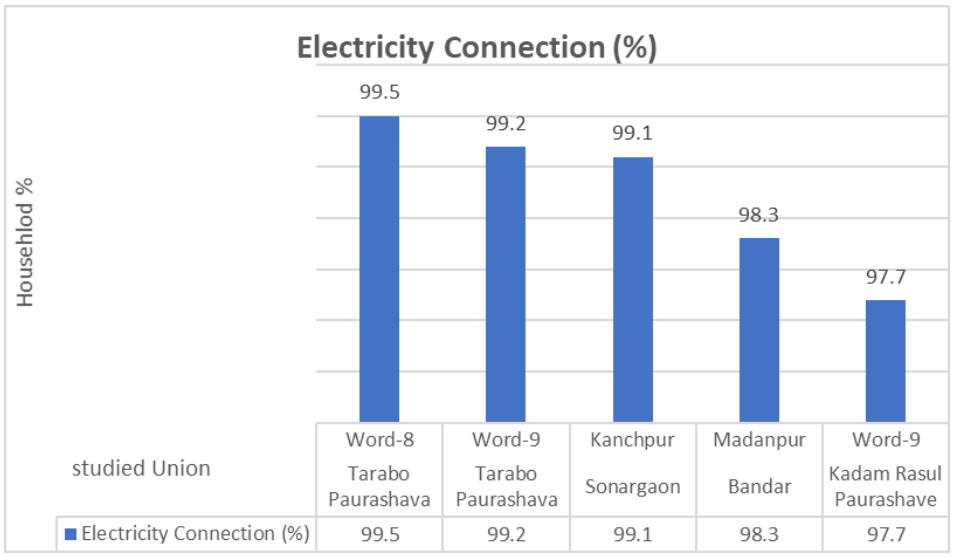
Table 6-14: Sources of Drinking Water in the Gas Transmission pipeline area

Upazila	Union	Tap (%)	Tube-well (%)	Other (%)
Tarabo Paurashava	Word-8	2.7	96.8	0.6
Tarabo Paurashava	Word-9	3	95.6	1.3

Sonargaon	Kanchpur	6	93.6	0.4
Bandar	Madanpur	2.7	96	1.4
Kadam Rasul Paurashave	Word-9	0.1	82.3	17.6
Study Area		**2.9**	**92.9**	**4.3**

Source: Population and Housing Census, BBS, 2011

Electricity is an important indicator for measuring the quality of life in the Study area. In the study area, almost 98.8% of the households have grid electricity connection. The following Figure 6-2 shows the detail electricity connection situation by union or paurashava. However, households, mostly use electricity for lighting and farming purposes.



Source: Population and Housing Census, BBS, 2011

Figure 6-2: Electricity Connection of the Gas Transmission Pipeline Area

6.5.2 Sanitation

In the Project area, only about 11.1% and 44.7% of households use respectively water sealed and non-water-sealed sanitary latrine facility, which represents the 55.8% of households in the study area. 36.7% of households use non-sanitary facilities. On the contrary, 5.2% households defecate in open places with no access to hygienic latrine facilities. ***Table 6-15*** shows sanitation facility of the project area.

Table 6-15: Sanitation Facility of the Project Area

Upazila	Union	Number of Households	Type of Toilet Facility (%)			
			Sanitary (water-sealed)	Sanitary (non-water-sealed)	Non-sanitary	None
Narsingdi Sadar	Amdia	8608	16.7	50.2	28.8	4.4
	Meher Para	9300	22.7	50.8	22.0	4.5
	Madhabdi	10467	30.1	32.7	6.2	0.1
	Kanthalia	7979	6.4	18.4	61.3	13.9
Araihazar	Sadasardi	7916	11.4	43.0	38.4	7.3
	Duptara	7848	7.1	53.2	35.7	4.0
	Araihazar	5759	8.1	34.5	54.0	3.5

Upazila	Union	Number of Households	Type of Toilet Facility (%)			
			Sanitary (water-sealed)	Sanitary (non-water-sealed)	Non-sanitary	None
	Fatehpur	4333	5.9	49.7	37.9	6.6
	Brahmandi	10514	6.2	44.3	44.5	5.1
	Satgram	8342	2.0	49.0	43.7	5.3
Rupganj	Kanchan	10647	8.7	54.6	32.1	4.6
	Golakandail	12370	13.3	48.7	36.4	1.6
	Bholaba	6994	6.3	51.4	36.0	6.2
Project Study Area		**111077**	11.1	44.7	36.7	5.2

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

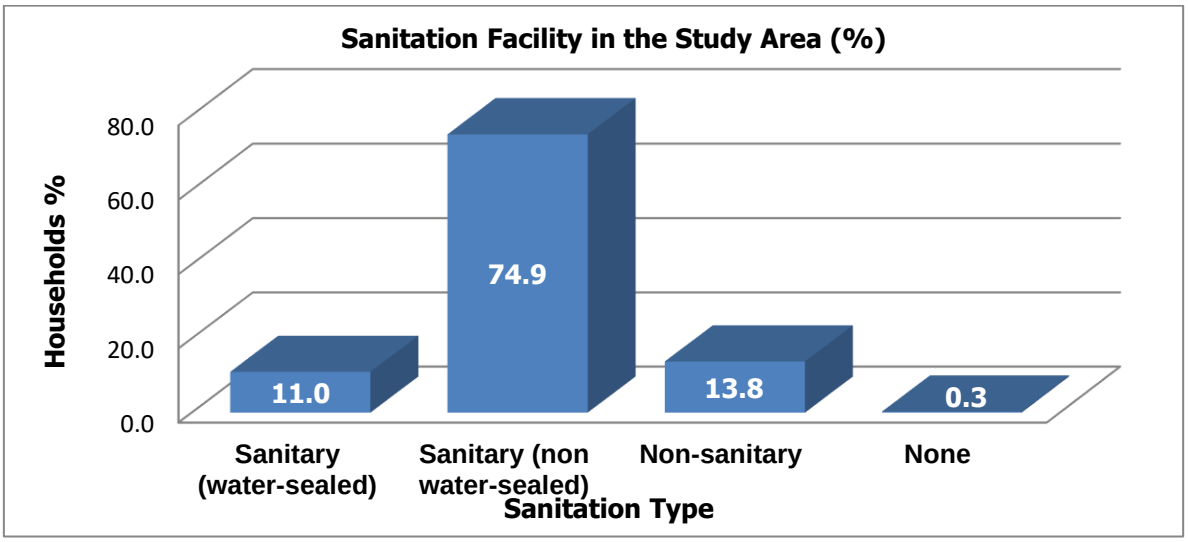
Survey results show that 100% affected households are using the sanitary, i.e. hygienic latrine. All affected households have a sanitary latrine, i.e. hygienic sanitation facilities. Available sanitation facilities using by project-affected households is presented in ***Table 6-16***.

Table 6-16: Access to Sanitation

SL No.	Type of Latrine	No. of HH.	%
1	Sanitary Latrine	226	89.3
2	Pit Latrine	27	10.7
3	Kutcha	0	0.0
	Total	**253**	**100.0**

Source: EQMS survey, November 2018

In the study area, about 11.0% and 74.9% of households use water sealed and non-water-sealed sanitary latrine facility, respectively, whereas about 13.8% of households use non-sanitary facilities. 0.3% of households defecate in open places with no access to hygienic latrine facilities. The following ***Figure 6-3*** shows sanitation facility of the project area.



Source: Population and Housing Census, BBS, 2011

Figure 6-3: Sanitation Facility in the Study Area

6.5.3 Healthcare Facility

Three Upazilas; Narshingdhi Sadar, Araihazar, Rupganj, lie under the 5km project area. Within these Upazilas there 791 numbers of Beds, 376 numbers of Doctors and 369 numbers of Nurses are available including both Govt. and Private clinic facilities *(District Statistical 2011, BBS).* Ratios of patients per bed, doctor, are slightly high compared to these of national figure. For 10000 patients 5.7 beds are available where the national figure is 4.00 beds. The patient-doctor ratio is same compared to national figure (10000:3). On the other hand, 2.7 nurses for 10000 patients that are lower than the national figure 2.8. (*Source: WHO: Global Atlas of the Health Workforce)*

The project is located in the central zone of Bangladesh and very close to the capital city of Dhaka. The project area also regarded as the business hub of the country. As a result, the project location has comparatively improved connectivity networks and has adequate opportunity to get services from various Government Department. All of AHs have easy access to health services. **Table 6-17** shows the distance of health services available to the project affected persons.

Table 6-17: Accessibility to Other Social Services

SL No	Name of Services	Distance			Total
		< 1 km	>1 < 3km	>3km	
1	Access to Health Services	130	69	54	**253**

Tarabo Paurashava, Sonargaon Upazilla, Bandar Upazilla and Kadam Rasul Pausashava of Narayangonj Districts in Sonargoan Upazilla there is 35 MBBS and FCPS, in Bandar there is 18 MBBS, and FCPS has been found in the proposed area. In the study area of Sonargoan there are 12 and Bandar there is 3 private hospital/clinic and Sonargoan Upazilla 1 and Bandar Upazilla 3 diagnostic centers have been found.

6.5.4 Solid waste

Uncontrolled waste generation coupled with inadequate collection and disposal systems have the potentiality to give rise to pollution and environmental degradation as well as diseases. While no specific data on local waste management was collected from the study area, it is likely that – as with many other parts of rural Bangladesh – the villages within the study area have no formal waste management facilities, and that in general people dispose of their waste in landfills or in fallow land.

Uncontrolled waste generation coupled with inadequate collection and disposal systems have the potentiality to give rise to pollution and environmental degradation as well as disease. While no specific data on local waste management was collected from the study area, it is likely that – as with many other parts of rural Bangladesh – the villages within the study area have no formal waste management facilities, and that in general people dispose of their waste in landfills or in fallow land.

6.6 Economy and Employment

According to the District Statistics 2011, (BBS), Narshingdi Sadar, Araihazar and Rupganj have 6975, 5764 and 150 enlisted fishermen. The number of fishermen depicts the fishing practices of the respective Upazila.

6.6.1 Field of Economic Activities

In accordance with the Population Census of Bangladesh (2011), Service is the dominant source of employment in the project study area. Approximately, 43.5% and 51.3% male and female involved in Service activities. Moreover, significant numbers of the population; 28.7% male and 42.1% female, of the project area are employed in Industries. Unlike other parts of Bangladesh, only 17.2% of the economically active population is engaged in agricultural sectors. ***Table 6-18*** shows the employment status of the project area.

Table 6-18: Employment Status of the Proposed Power Plant Area

Upazila	Union	Population Aged 7+, not attending school and employed		Field of Activity											
				Agriculture				Industry				Service			
		Male	Female	Male		Female		Male		Female		Male		Female	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Narsingdi Sadar	Amdia	4659	297	2253	48.4	22	7.4	803	17.2	143	48.1	1603	34.4	132	44.4
	Meher Para	4921	734	567	11.5	28	3.8	1281	26.0	275	37.5	3073	62.4	431	58.7
	Madhabdi	4595	903	103	2.2	4	0.4	2160	47.0	458	50.7	2332	50.8	441	48.8
	Kanthalia	5570	858	1043	18.7	25	2.9	3628	65.1	469	54.7	899	16.1	364	42.4
Araihazar	Sadasardi	4228	551	670	15.8	40	7.3	1331	31.5	214	38.8	2227	52.7	297	53.9
	Duptara	3116	420	1012	32.5	55	13.1	506	16.2	44	10.5	1598	51.3	321	76.4
	Araihazar	3020	504	869	28.8	47	9.3	1023	33.9	284	56.3	1128	37.4	173	34.3
	Fatehpur	2853	283	910	31.9	31	11.0	961	33.7	138	48.8	982	34.4	114	40.3
	Brahmandi	4764	658	1166	24.5	34	5.2	889	18.7	354	53.8	2709	56.9	270	41.0
	Satgram	4490	365	1504	33.5	14	3.8	238	5.3	26	7.1	2748	61.2	325	89.0
Rupganj	Kanchan	4465	533	1759	39.4	31	5.8	1213	27.2	270	50.7	1493	33.4	232	43.5
	Golakandail	4636	1370	781	16.8	49	3.6	1836	39.6	945	69.0	2019	43.6	376	27.4
	Bholaba	3058	153	1751	57.3	19	12.4	345	11.3	33	21.6	962	31.5	101	66.0
Project Study Area		54375	7629	14388	27.8	399	6.6	16214	28.7	3653	42.1	23773	43.5	3577	51.3

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

According to the census and SES findings, most of the affected household head (49.8%) are engaged with commercial/business activities as the project location considered one of the major business and industrial hub. A detail of occupation distribution of affected household head is presented in **Table 6-19.**

Table 6-19: Distribution of Occupation of Affected Household Head

Name of Occupation	Male		Female		Total	
	N	%	N	%	N	%
Agriculture	16	6.3	0	0	16	6.3
Teacher	0	0.0	0	0	0	0.0
Abroad worker	3	1.2	0	0	3	1.2
Private Job	55	21.7	3	1.2	58	22.9
Household work	3	1.2	19	7.5	22	8.7
Fishing	1	0.4	0	0.0	1	0.4
Business	123	48.6	3	1.2	126	49.8
Day Labor	5	2.0	0	0.0	5	2.0
Rickshaw/Van Driver	0	0.0	0	0.0	0	0.0
Unemployed	0	0.0	1	0.4	1	0.4
Driver	2	0.8		0.0	2	0.8
Traditional Healer	2	0.8	0	0.0	2	0.8
Others	4	1.6		0.0	4	1.6
Elder Person	13	5.1	0	0.0	13	5.1
Total	**227**	**89.7**	**26**	**10.3**	**253**	**100.0**

Source: EQMS survey, November 2018

According to the Population and Housing Census (2011), agriculture including crops cultivation, fishing, direct farming, sharecropping, agricultural laborers etc. is the dominant source of employment in the study area. Approximately, 18804 and 744 male and 45 females involved in agricultural activities. Moreover, significant numbers of the population 7306 male and 2740 females of the study area are employed in services. Agriculture (crops cultivation and agricultural labor) is the primary income source in the study area. The following ***Table 6-20*** shows the employment status of the project area.

Table 6-20: Employment Status of the Gas Transmission Pipeline Area

Upazila	Union	Population Aged 7+, not attending school but employed			Field of Activity					
					Agriculture		Industry		Service	
		Total	Male	Female	Male	Female	Male	Female	Male	Female
Tarabo Paurashava	Word-8	2906	1877	1029	21	2	965	815	891	212
Tarabo Paurashava	Word-9	6299	3925	2374	141	16	2448	1936	1336	422
Sonargaon	Kanchpur	6348	4390	1958	328	14	146	50	3916	1894
Bandar	Madanpur	2118	1661	457	225	8	687	313	749	136
Kadam Rasul Paurashave	Word-9	1133	843	290	51	5	378	209	414	76
	Study Area	**18804**	**12696**	**6108**	**766**	**45**	**4624**	**3323**	**7306**	**2740**

Source: Population and Housing Census, BBS, 2011

CHAPTER 7: SCOPING AND TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT

7 SCOPING AND TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Screening

Screening is the step to categorize projects/activities based on the degree of environmental impacts caused by the project.

The Project was classified as "Red" under the regulation of Bangladesh and "A" according to the JICA Environmental Guidelines, and thus EIA is necessary to be conducted.

7.2 Scoping

In order to assess the likely significant environmental and social impacts, potential environmental and social impacts of the Project were preliminarily identified based on the project description and overall environmental and social conditions in and around power plant and Gas transmission pipeline Project. The impacts of pollution, natural and social environments, health and safety, emergency risk, and others were classified as A to D in accordance with the following criteria, assuming no specific measures toward the impacts are taken:

1) A-/A+: Significant/ant negative/positive impact
2) B-/B+: Some negative/positive impact
3) C-/C+: Degree and scope of impact are not clear thus more investigation required
4) D: Impacts are negligible, no further study required

7.3 Results of Scoping for Environmental and Social Impact Assessment

Results of the scoping for environmental and social impact assessment are shown in ***Table 7-1*** & ***Table 7-2***. Scoping was conducted toward the development project of the power plant and gas transmission pipeline project. These impacts were evaluated in each of the three phases separately, namely: pre-construction, construction phase and operation phase.

Table 7-1: Scoping Matrix of the power plant Project

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	C	**CO:** Construction machinery and transportation vehicles will be generated SOx, NOx, smoke, soot and earth, sand and dust particles will be scattered. This may cause air pollution. **OP:** Primarily natural gas will be used as the fuel for GT and GE for the primary operation, and diesel fuel will be used as the fuel for subsidiary operation. The exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution SOx or NOx without proper technologies and maintenance.
	2	Water pollution	B-	B-	**CO**: Effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from the washing of aggregate and sand. If these are inadequately handled, surface water and underground water will be contaminated. **OP:** Groundwater will be used in the cooling system and therefore, the thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, river water and underground water will be contaminated.
	3	Waste	B-	B-	**CO:** Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected. **OP:** The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated
	4	Soil pollution	B-	B-	**CO:** With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built, and earth and sand may flow out at the time of rainfall.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
					Storage of raw material, fuel and construction debris may contaminate the soil.
					OP: Improper storage, handling, disposal of diesel fuel, lubricants, solid, and hazardous waste may lead to contamination of the soil.
	5	Noise	A-	A-	**CO:** Noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact
					OP: Without serious attention and countermeasures, the noise generation source during the operation includes the power plant operation, worker's commutation, traffic of vehicles for carrying the periodic inspection materials.
	6	Ground subsidence	D	C	**CO/OP:** There is no evidence or trace of ground surface subsidence around all the project sites. Degree and scope of impact are not clear thus more investigation required.
	7	Offensive Odours	D	D	**CO:** Odor may produce by domestic waste from the campsite. However, the impact will be very negligible.
					OP: No impacts are expected
	8	Sediment quality	B-	D	**CO:** Inadequate handling of domestic solid waste, hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds.
					OP: No impact is expected
Natural environment	9	Protected areas	D	D	**CO/OP:** Since no natural preservation area and national parks exist in and around the power plant area, an impact on protected areas is not expected.
	10	Ecosystems	B-	B-	**CO:** Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies.
					OP: The power plant site and its surrounding areas will have already been converted into commercial purposes. There is no natural forest in these areas. Plant's gaseous emission and excessive noise may disturb to the

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
					surrounding inhabiting floral and faunal species. Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.
	11	Hydrology	B-	B-	**CO**: During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds. **OP**: Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.
	12	Topography and geology	D	D	**CO/OP:** No impacts are expected
Social environment	13	Involuntary Resettlement	D	D	**CO:** The power plant will be established under the designated site of AEZ. No additional land will be acquired. **OP:** No impacts are expected
	14	Vulnerable group	B-/B+	B+	**CO:** Very minimum vulnerable people will be affected as per census survey. On the other hand, job opportunity and commercial opportunity would increase. **OP:** Non-technical skill job opportunities as workers of the power plant and commercial opportunity would improve.
	15	Indigenous and ethnic people	D	D	**CO:** No indigenous and ethnic persons were identified as per the census survey, and no such communities exist around the project site. **OP:** No impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B+	B+	**CO:** Increase of job opportunity as construction workers. **OP:** Increase of job opportunity as workers of the power plant or commercial opportunity targeted to these workers is expected.
	17	Land use and utilization of local resources	D	D	**CO:** There will be no significant change in land use. **OP:** During operation of the power plant, no further changes are expected.
	18	Water usage	B-	B-	**CO:** The surrounding wells may be affected by the reduction of underground water level resulting from underground water intake during the construction work and labor camps. **OP:** Groundwater abstraction at the Plant will be undertaken for plant

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
					cooling and domestic purposes. Excessive withdrawal of groundwater may lead to depletion of aquifers without proper assessment of the depth of the existing wells and installed groundwater wells with supply capacities.
	19	Existing social infrastructures and services	D	D	**CO:** Constructional activities of the power plant will not affect the access of the inhabitants to the social infrastructure and service facilities of the community. **OP:** no impacts are expected due to development of the power plant.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	**CO:** No impacts are expected. **OP:** No impacts are expected.
	21	Misdistribution of benefits and damages	D	D	**CO**: Employment opportunity will be increasing. Candidates of construction workers may experience some misdistribution between communities. However, the impacts will be very minimum. **OP:** No activity will cause misdistribution of benefits and damages
	22	Local conflicts of interest	D	D	**CO:** Due to an increase in employment opportunity will be increasing. Candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum. **OP:** There are people who would get job opportunity as workers of the power plant.
	23	Cultural heritage	D	D	**CO/OP:** Nothing found in the development area would be affected by the development.
	24	Landscape	D	D	**CO/OP:** There is no picturesque scenery in or around the site.
	25	Gender	B-	D	**CO:** Female laborers may be discriminated in wage at the construction site. **OP:** Project activities do not attract gender issues.
	26	Children rights	B-	D	**CO:** Underage employment may occur at the construction stage. **OP:** No impacts are expected.
	27	Infectious	B-	B-	**CO:** Workers and Engineers coming from the outside area may carry an

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
		diseases			infectious disease, which may spread among other workers. **OP:** There is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.
	28	Working conditions, including occupational safety	B-	B-	**CO:** Accidents and incidents during construction may occur. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapors, liquids are the major hazards which are harmful to workers health. **OP:** Accidents or incidents are expected to occur due to electrical work, fire accident, gas leakage etc.
Others	29	Accidents	B-	B-	**CO:** Accidents may occur due to the operation and movement of heavy equipment, vehicle and machinery. **OP:** Road accidents may occur due to plant vehicles and motorbikes. Gas distribution line has risk due to the bursting of pipes or leakage.
	30	Transboundary impact and climate change	D	B-	**CO:** Emission from construction work is expected, but impacts are negligible. **OP:** Emissions of GHGs are generated from vehicle traffic and power plant operations.

Evaluation: A-: Significant Negative Impact A+: Significant Positive Impact

B-: Some Negative Impact B+: Some Positive Impact

C: Degree and scope of impact are not clear thus more investigation required

D: No impacts or impacts are negligible; no further study is required;

Table 7-2: Scoping Matrix of the Gas Transmission Pipeline Project

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	D	**PC/CO:** During the clearing of RoW excavation and backfilling of pipelines, some dust distribution is expected. Also, the movement of vehicles and heavy equipment may emit a small amount of SOx, NOx and CO2.
					OP: No impacts are expected.
	2	Water pollution	B-	D	**CO**: For installation of gas pipeline, land acquisition (20-feet strip) for the RoW is required and some water bodies will be affected. Additionally, for smooth implementation of the work, temporary roads would be constructed on one side of the RoW within the 20-Feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction stage as excavated soil from trench will be dumped beside RoW.
					OP: No impacts are expected
	3	Waste	B-	D	**CO:** Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected and typically managed by the appointed contractors;
					OP: No impacts are expected
	4	Soil pollution	B-	B-	**PC:** It is likely that the soils of the project sites will not be polluted
					CO: The soils of the canal crossing sites may be polluted with the liquid wastes (mud) generated from the canal crossing activities. Vehicular oil and lubricants also pollute the soil quality. The waste lubricants will not only pollute the soils but also contaminate the groundwater in the long run.
					OP: Pigging of the pipe for cleaning purposes may generate hazardous pollutants from TBS/CGS etc., which are likely to be spread over the soils. If these pollutants are not safely disposed of, then the soils of the project areas will be polluted.
	5	Noise	B-	D	**PC/CO:** With the progress of construction work, the noise will be

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
					generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact
					OP: No impacts are expected
	6	Ground subsidence	D	D	**CO/OP:** There is no evidence or trace of ground surface subsidence around all the project sites. No impacts or impacts are negligible, no further study is required;
	7	Offensive odours	B-	D	**CO:** The amount of domestic solid waste will increase due to the inflow of a great number of workers. If such waste is inadequately handled, the odour may be produced by putrefaction;
					OP: No impacts are expected
	8	Sediment quality	B-	D	**CO:** The bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the crossing activities. The waste lubricants will not only pollute the sediments of water bodies but also contaminate the groundwater in the long run.
					OP: No physical activities are expected during operation, and no impacts are expected.
Natural environment	9	Protected areas	D	D	**PC/CO/OP:** No direct connection with protected area involves the project despite the Sitalakhya River which is considered as ECA under the government notification. No surface water will be disturbed with underground pipelining technologies utilized by the authorized agencies as per the applicable laws and regulation of natural gas utilization and safety.
	10	Ecosystems	B-	D	**PC:** The habitat types and ecosystem found in the non-forested agricultural and homestead areas are not considered to be significant from a biodiversity perspective. Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. Similar to terrestrial ecosystems, aquatic ecosystems are also not likely to be affected.
					CO: Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Many species of flora and fauna would frighten easily by vehicle horns and civil works that may become distressed. With the progress of construction work, canal water pollution will occur

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
					due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies. Contamination will occur due to civil construction work.
					OP: No impacts are expected
	11	Hydrology	B-	D	**CO**: For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW.
					OP: After the backfilling, no impacts are expected.
	12	Topography and geology	D	D	**CO/OP:** No impacts are expected
Social environment	13	Involuntary Resettlement	A-	D	**PC/CO:** Acquisition of land for the project will affect them significantly. Because, (i) the land price of the land situated beside the acquired land will be decreased as construction of structures is prohibited within certain distance from the RoW, (ii) a remaining small piece of land has no use after acquiring larger portion of a plot but the project does not compensate for that small piece of land, (iii) some have no other properties than the affected one; Requisition of land for the project will also affect people of the project area. The soil becomes compacted, and this type of land is not good for cultivation, it takes time to make the land useful for cultivation.
					OP: No impacts are expected
	14	Vulnerable group	B-	D	**CO:** Very minimum vulnerable people will be affected. On the other hand, job opportunity as construction worker would increase.
					OP: The landowners can use the land for agricultural purpose after the pipeline installation.
	15	Indigenous and ethnic people	D	D	**CO:** no indigenous/ethnic people live in the project affected area.
					OP: no impacts are expected
	16	Local economies,	B-/B+	B-	**CO:** PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. Some industries' operation will be

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
		such as employment, livelihood, etc.			temporarily closed for the pipeline installation. Workers of the factories will lose their job temporary. On the other hand, an increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. **OP:** Productivity of the agricultural land will remain low for a certain period of time due to land work.
	17	Land use and utilization of local resources	B-	C	**CO:** Along the RoW, approximately 8.86 acres of agricultural land will be acquired for the construction. Therefore, agricultural productivity will be affected during and after the construction. The site is single cropped land, and the condition of land will be restored, so the impact is anticipated to be low. Several factories will need to suspend operation, and their factory will be partially demolished due to the construction. **OP:** No impact on agriculture resources is anticipated. In the RoW areas, agricultural land use practices will be restored.
	18	Water usage	D	D	**CO:** The water will be used only for drinking, so the impact is very negligible. No impacts are expected. **OP:** No impacts are expected.
	19	Existing social infrastructures and services	D	D	**CO:** An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community. However, the construction period is short so that impacts is very minimum. **OP:** No impacts are expected.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	**CO:** Construction may disturb access to social or public institutions and services temporarily but the construction period is short, and impact will be minimum. **OP:** No impacts are expected.
	21	Misdistribution of benefits and damages	B-	D	**PC**: Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation. **OP:** No impact is expected.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
	22	Local conflicts of interest	D	D	**CO:** Due to an increase in employment opportunity, workers may experience some conflicts between communities. However, the impacts will be very minimum. **OP:** No impact is expected.
	23	Cultural heritage	D	D	**PC/CO/OP:** No cultural heritage is found
	24	Landscape	D	D	**PC/CO/OP:** There is no picturesque scenery in or around the site.
	25	Gender	B-	D	**PC/CO:** Female laborers may be discriminated in wage at the construction site. **OP:** Project activities do not attract gender issues.
	26	Children rights	B-	D	**CO:** Access to school may be disturbed, and underage employment may occur at the construction stage. **OP:** No impact is expected.
	27	Infectious diseases	B-	D	**CO:** Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers. **OP:** No impact is expected.
	28	Working conditions, including occupational safety	B-	B-	**CO:** Noise and vibration due to the movement of vehicles, heavy equipment and Lorries will have an impact on workers health as well as surrounding people. The produced welding sparks and radiation from radioisotopes, which are harmful to the human body, will impact on the health of the workers. It is anticipated that there are possibilities of fire due to the negligence of the responsible personnel for handling, storing and using of primer and condensate. **OP:** During operation and maintenance period, the leakage of gas from the high-pressure pipeline may occur. Further, various forms of operation or manoeuvring errors may occur during the operation. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
Others	29	Accidents	B-	B-	**CO:** It is anticipated that the risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machinery. All these would have a potential impact on the health of the working personnel and the people living in the neighbouring areas. **OP:** During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated which may cause fire and another disaster to the life, property and environment. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project.
	30	Transboundary impact and climate change	D	D	**CO:** Emission from construction work is expected, but Impacts are negligible. **OP:** No impacts are expected from the operational activities.

Evaluation: A-: Significant Negative Impact A+: Significant Positive Impact
B-: Some Negative Impact B+: Some Positive Impact
C: Degree and scope of impact are not clear thus more investigation required
D: No impacts or impacts are negligible, no further study is required

7.4 The term of References for EIA

In order to fulfil the requirements of the JICA Environmental Guidelines and advisory instructions given by JICA Environmental and Social Consideration Advisory Committee, the JICA Survey Team prepared a term of reference (TOR) for identified uncertain impacts summarized for the JICA EIA study and RAP study. A summary of the additional survey items and their survey methodologies is presented in below.

Table 7-3: Methods of Survey and Impact Assessment (TOR) for Power Plant

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
Environmental pollution	1.	Air pollution	The existing ambient air quality of the study area monitored at Five (5) locations during the monitoring period. The monitoring parameters included Particulate Matter (SPM, PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours, and the rest of the parameters monitored on 24-hourly basis during the duration of the study.	Industrial emissions and movement of vehicular access
	2.	Water pollution	Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Samples were taken from a selected surface water body's source representing different parts of the study area. Three surface water and Four groundwater sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area.	Estimated power plant's surface & groundwater quality
	3.	Waste	Review and summary of the previous survey	Study Estimated of power plant
	4.	Soil pollution	The soil sampling strategy was designed to assess the existing soil quality over the study area. The analysis results of physio-chemical parameters (metal content), pH level of samples is studied.	Estimated power plant's soil quality
	5.	Noise	Noise levels recorded at seven (7) locations in the study area during the monitoring period. Noise levels recorded in the form of sound pressure levels with the help of a digital sound level meter.	Increased traffic movement and power plant operations
	6.	Ground subsidence	Deep well boring survey and pump up test from Araihazar EZ site secondary documents	Secondary data/studies from AEZ
	7.	Sediment quality	Review and summary of the previous survey	Estimated power plant and treated

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
				wastewater from ETP
Natural environment	8.	Ecosystems	Field survey	Secondary data/studies for the sensitivity of the observed species
	9.	Hydrology	Review and summary of the JICA previous study on AEZ	Previous study
Social environment	10.	Vulnerable group	Focus group discussion	Comparison of the survey results and proposed entitlement matrix and stakeholder meetings, Estimated Power plant and their expected jobs
	11.	Water usage	Field survey, inventory of loss, census and socioeconomic survey	
	12.	Gender	Focus group discussion	
	13.	Children's rights	Census and socioeconomic survey	
	14.	Infectious diseases	Census survey of the project site and Secondary data	Secondary data
	15.	Working conditions including occupational safety	Focus group discussion	Secondary data
Others	16.	Accidents	Secondary data from LGED, RHD	Secondary data
	17.	Transboundary impact and climate change	Secondary data and air dispersion modelling	Secondary data

Table 7-4: Methods of Survey and Impact Assessment (TOR) for Gas Transmission pipeline

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
Environmental pollution	1.	Air pollution	The existing ambient air quality of the study area monitored at Three (3) locations during the monitoring period. The monitoring parameters included Particulate Matter (SPM, PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours, and the rest of the parameters monitored on 24-hourly basis during the duration of the study.	Emissions from equipment and movement of vehicular access

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
	2.	Water pollution	Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Samples were taken from a selected surface water body's source representing different parts of the study area. Three surface water and two groundwater sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area.	Estimated project area's surface & groundwater quality
	3.	Waste	Review and summary of the previous survey	Study Estimated the project area
	4.	Soil pollution	The soil sampling strategy will design to assess the existing soil quality over the study area. The analysis results of physio-chemical parameters (metal content), pH level of samples is studied.	Estimated project area's soil quality
	5.	Noise	Noise levels baseline study at Six (6) locations in the study area. Noise levels will be recorded in the form of sound pressure levels with the help of a digital sound level meter.	Increased traffic movement and operation of constructional equipment and machinery
	6.	Offensive Odor	Review and summary of the previous survey near the project site	Study Estimated the project area
	7.	Sediment quality	Review and summary of the previous survey near the project site	Study Estimated the project area
Natural environment	8.	Ecosystems	Field survey	Secondary data/studies for the sensitivity of the observed species
	9.	Hydrology	Review and summary of the previous survey near the project site	Study Estimated the project area
Social environment	10.	Involuntary Resettlement	RAP study	RAP survey results and proposed entitlement matrix and stakeholder meetings, Estimated Gas transmission
	11.	Vulnerable group	RAP study and Focus group discussion	
	12.	Local economies, such as employment, livelihood, etc.	Socio-economic census surveys for affected people will be conducted to identify income and livelihood of PAPs.	

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
	13.	Land use and utilization of local resources	Field survey, inventory of loss, census survey	project and their expected jobs
	14.	Misdistribution of benefits and damages	Field survey, inventory of loss, census and socioeconomic survey	
	15.	Gender	RAP Study	
	16.	Children's rights	Census and socioeconomic survey	
	17.	Infectious diseases	Census survey of the project site and Secondary data	Primary data
	18.	Working conditions including occupational safety	Focus group discussion	Primary data
Others	19.	Accidents	Secondary data from LGED, RHD	Secondary data

CHAPTER 8: IDENTIFICATION, PREDICTION AND EVALUATION OF POTENTIAL IMPACTS

8 SCOPING AND TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Impact Identification

An environmental impact is defined as any change to an existing condition of the environment. Findings of the assessment are presented according to site preparation, construction and operation phases. The impacts will be determined as significant, positive or negative, direct or indirect, long term or short term.

The EIA study, based on the screening and scoping study, review of proposed civil works, review of similar environmental assessment reports, baseline monitoring and stakeholder consultations, has identified major environmental and social concerns that are expected from the project (***Table 7-1***). The impacts are broadly classified into following 4 rating during preconstruction, construction and operation stage:

- Environmental Pollution
- Natural Environment
- Social Environment
- Others

This chapter describes the rating and environmental impacts caused by the project both tentatively during construction and permanently during operation.

8.2 Project Impacts to key Items

Pre-construction phase will involve site clearance, levelling & filling activities for development of EZ. Upon land acquisition, BEZA plans land grading of the EZ in order for the land to be flooding resilient. The power plant will construct under the EZ developed the land. Related to land development impacts would be mitigated by EZ Authority.

Project impacts to key items caused by the project both tentatively during construction and permanently during operation phase is given below.

8.3 Environmental Pollution

8.3.1 Air Pollution

8.3.1.1 Preconstruction Phase

Gas Pipeline

During the clearing of RoW, some earth activities are performed for this project. This is essential for the movement of vehicles and heavy equipment that create a small amount of dust and SOx, NOx and CO_2. However, this small amount of pollution has no significant impact on the overall pollution of the ambient air quality.

8.3.1.2 Construction Phase

Power Plant

All earthworks construction, site clearing, small structures demolition, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, hauling of

materials, construction of access road will generate dust and affect the local airshed. Construction of access roads and its dust is likely to be the most significant direct potential impact on the local community. With the progress of construction work, SOx, NOx, smoke and soot will be generated from the construction machinery and transportation vehicles and earth, sand and dust particles will be scattered. This may cause air pollution.

Gas Pipeline

During Construction stage transportation of the pipeline, construction of earth road, digging of the earth for the trench, pressure regulating and metering stations, welding, cleaning and coating/ wrapping of the pipeline etc. could cause low atmospheric pollution in the air which may create health problem on workers and surroundings inhabitants. In addition, movement of vehicles and heavy equipment emit a small amount of SOx, NOx and CO_2. The emission of dust, gaseous pollutants (SOx, NOx and CO_2) and suspended particulates will be moderate.

8.3.1.3 Operation Phase

Power plant

The power plant will operate both diesel and natural gas. The 3 MW diesel engine will operate at the initial commencement of economic zone as the initial stage the economic zone will require less power. During the full-scale operation of the economic zone, the diesel engine will use as the backup power supply for starting GT during the blackout, the emergency power supply including the shortage of gas fuel supply and continuous power supply during low power demand of EZ. During the operation stage, the main source of air pollution is engine exhaust gas. Different gaseous emission, e.g. NOx and CO will generate from the gas-based engine and gas turbine whereas SO_2, NOx and CO will generate from diesel engine stack.

To know the intensity of impact is essential to predict air quality at receptor locations during operation of the proposed power plant. Modelling exercise has been performed to estimate the ground level concentration of SO_2, NOx and CO around the project site. USEPA approved dispersion modelling software AERMOD has been used to view the dispersion of the pollutants from the proposed power plant. Resultant results also calculated by adding emission of the proposed power plant. AERMOD is a modelling system consisting of three separate modules: AERMET, AERMAP, and AERMOD. AERMET is a meteorological pre-processor and uses hourly surface observations, cloud cover, and upper air parameters from a twice-daily vertical sampling of the atmosphere to create two output files consisting of surface and vertical profile data, respectively. The terrain pre-processor AERMAP uses Digital Elevation Model (DEM) maps as well as user-generated receptor grids. AERMAP's output file consists of the x, y locations of each receptor, mean sea level (MSL) elevation and hill profile parameters.

Model Options: The following regulatory default options were run in AERMOD in this assessment:

- Stack-tip downwash;
- Elevated terrain effects;
- Use of calms processing routine;
- Use of missing data processing routine; and
- No exponential decay

According to the baseline survey, households are present at 200 m distance from the Northeast side of the power plant boundary. The Project site and its surroundings have been considered as a rural area, and therefore, the rural dispersion coefficient was used in the Model.

Meteorological Data: The input meteorological data for the AERMOD was generated using the MM5 model, which was downscaled to fine grid data suitable for modelling. The data used in the study was site-specific and was collected over a one-year period (2016). In all, there were 8760 hours of meteorological data used in the model. This quantity of data allows an adequate assessment of hourly, 24-hourly and annual average pollutant concentrations around the Project site.

Terrain Data: Terrain data for the AERMAP model were taken from the 30 m SRTM database, while land cover data was sourced from satellite imagery of the Project site and its surroundings.

Receptors locations are shown in Table 8-1.

Table 8-1: Receptors Locations

Sl.	Sampling Station	Station Code	Geographic Location	Elevation (m)	Direction and Distance
1.	In front of Nurul Haque House;Vill: Maizpara, Union: Satgram, Upazila: Araihazar	AQ1	23°49'45.80"N 90°36'45.30"E	11.0	NW Direction (1.6 kms)
2.	In front of Panchbaria Boro bari;Vill: Panchbaria, Union: Duptara,Upazila: Araihazar	AQ2	23°49'18.10"N 90°37'56.40"E	11.74	ENE Direction (665 meters)
3.	In front of Tekpara govt. primary school; Vill: Tekpara, Union: Satgram, Upazila: Araihazar	AQ3	23°50'0.20"N 90°38'0.48"E	11.04	East Direction (512 Meters)
4.	In front of Rahim Sekh house;Vill: Shingrati, Union: Duptara,Upazila: Araihazar	AQ4	23°48'52.75"N 90°36'38.76"E	10.40	NNE Direction (1.71 km)
5.	Infront of Nasir Pradhan House; Vill: Dakhinpara, Union: Duptara,Upazila: Araihazar	AQ5	23°49'4.00"N 90°37'49.83"E	9.43	NNE Direction (1.71 kms)

An assessment of the potential impacts has been undertaken through an air quality modelling exercise. This assessment is based on a power plant configuration consisting of one 25 MW capacity gas turbine, two sets of 6 MW gas engine and 1 set of 3 MW diesel engine. Discharge to the atmosphere from the plant occurs via four stacks, one stack for each engine. The diesel engine will use only emergency period during the economic zone will run in full scale. The model has been undertaken considering the worst-case scenario. The location of the power plant stacks is in Table 8-2.

Table 8-2: List of Stack Locations

Stack Number	X Coordinate	Y Coordinate
1	257878.00	2636086.00
2	258011.00	2636210.00
3	258006.00	2636215.00
4	257996.00	2636224.00

The input parameters considered for the air dispersion modelling have been summarized in Table 8-3.

Table 8-3: Data Inputs Required for Modeling

No.	Scenario	Value
1	**Control Pathway**	
	Dispersion option	Non-Default Option
	Terrain	Flat
	Dispersion Coefficient	Rural
	Flagpole Receptor	No
2	**Meteorological Input**	
	Met Input Data	Meteorological data from 1 January 2016 to 31 December (Pre-processed Meteorological Data)
	Wind Speed Categories	A: 1.54 m/s B: 3.09 m/s C: 5.14 m/s D: 8.23 m/s E: 10.8 m/s F: No upper bound
	Latitude	23°49'4.00"N
	Longitude	90°37'27.43"E
	Anemometer Height	14 m
	Base Elevation	9 m
3	**Receptor Pathway**	
	No. of X-axis Receptors	51
	No. of Y-axis Receptors	51
	Spacing for the X-axis	200
	Spacing for the Y-axis	200
	Sensitive Receptor	5
4	**Source Pathway**	Point Source
5	**Output Pathway**	Pollutants Ground Level Concentration
	SO_2	1 Hourly, 24 Hourly and Annual
	NOx	1 Hourly, 24 Hourly and Annual
	CO	1 Hourly, 8 Hourly, 24 Hourly and Annual

The incremental pollutant concentrations due to the project operations have been provided below. The resultant ground level concentration values have been calculated by adding the incremental values to the baseline concentrations. The resultant concentrations have been compared with the more stringent guidelines out of the ambient air quality standards prescribed by Department of Environment, Bangladesh and the IFC/WB interim guidelines to assess the impact of the proposed project on the ambient air quality.

Incremental ground level concentrations obtained from modelling for air quality due to emissions of $S0_2$, NOx, and CO are detailed below. SO_2 emission has been estimated only for the diesel engine as natural gas of Bangladesh contain a negligible amount of sulfur. The emission rate of SO_2 has been calculated based on the diesel requirement as 13.66 t/d and 2.5% sulfur content.

Nitrogen Oxide (NOx)

The predicted 24-hour incremental ground level concentration of NOx at all the monitored locations for ambient air quality is presented in Table 8-4 below.

Table 8-4: Predicted 24-hr Maximum Ground Level Concentration of NOx

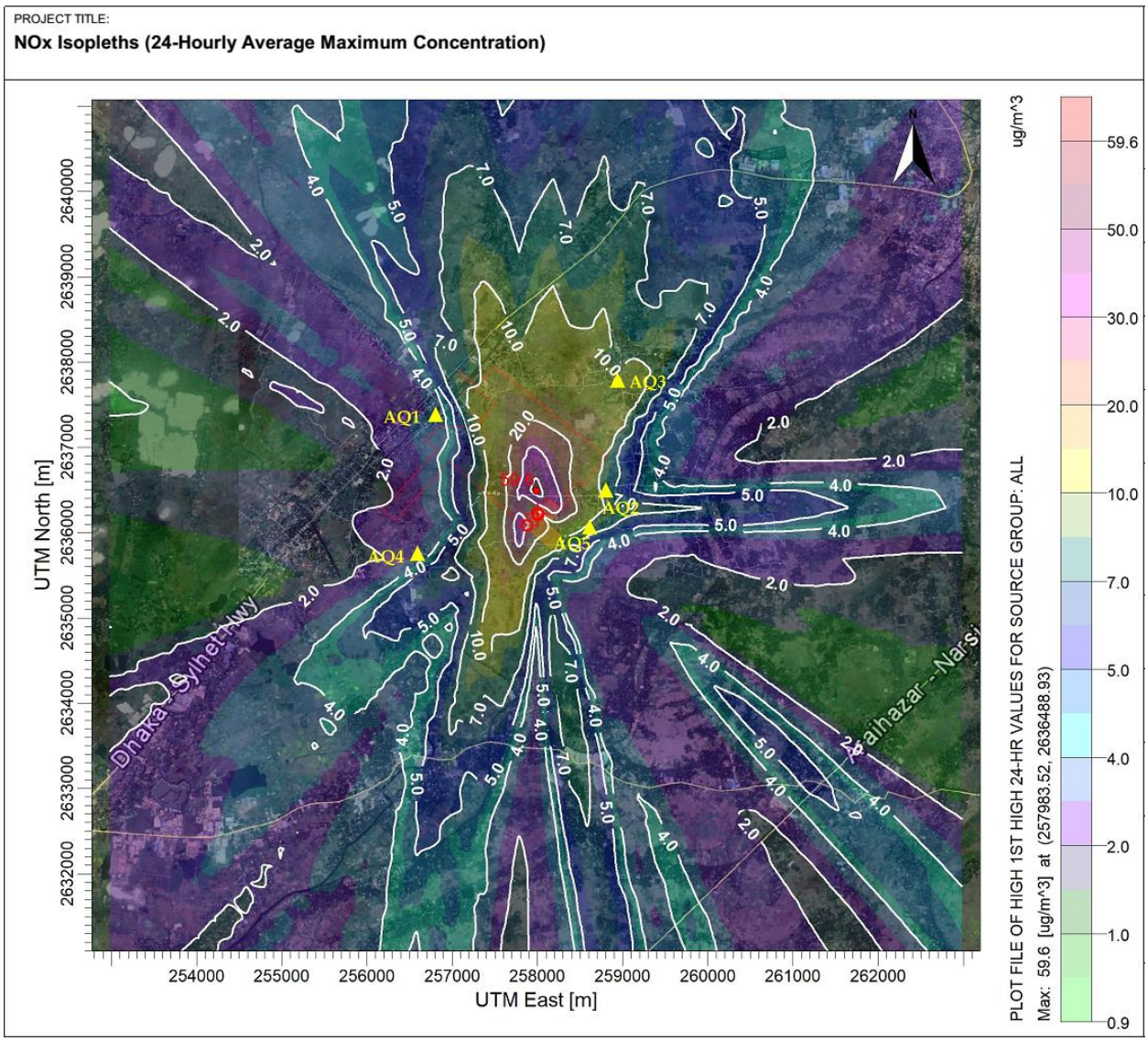
Receptor	Baseline NOx level (24 hours) (µg/m³)	Predicted NOx level (24 hr Average) (µg/m³)	Total Concentration (Predicted+ Background) (µg/m³)	Bangladesh Standard (24 Hours) (µg/m³)		IFC, 2008 Limit (24 Hours) (µg/m³)
				ECR 97*	Draft ECR, 2017	
AQ1	30.2	3.1	33.3	-	200	-
AQ2	19.4	8.4	27.8			
AQ3	22.4	10.5	32.9			
AQ4	16.6	3.1	19.7			
AQ5	12.4	8.9	21.3			

Source: EQMS

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

The maximum concentration of NOx was observed to 59.6 µg /m3 at coordinates of (257983.52m E 2636488.93m N) to the North of the stacks. The corresponding isopleth for NOx emissions from the power plant operations is as given in Figure 8-1.

There is no stipulated 24-hourly standard for NOx in ECR 97 (amendment in 2005). Ministry of Environment and Forest (MoEF) has prepared draft ECR 2017 including 24 hourly NOx standards. It has been concluded that the ground level incremental concentration of NOx in the ambient air quality monitored locations will be within the acceptable limit (Table 8-4).



Source: EQMS

Figure 8-1: 24 Hourly Ground Level Incremental Concentration of NOx

Carbon Monoxide

The predicted 8-hour incremental ground level concentration of CO due to the proposed power plant operations at all the monitored locations for ambient air quality is presented in Table 8-5.

Table 8-5: Predicted 8-hr Maximum Ground Level Concentration of CO

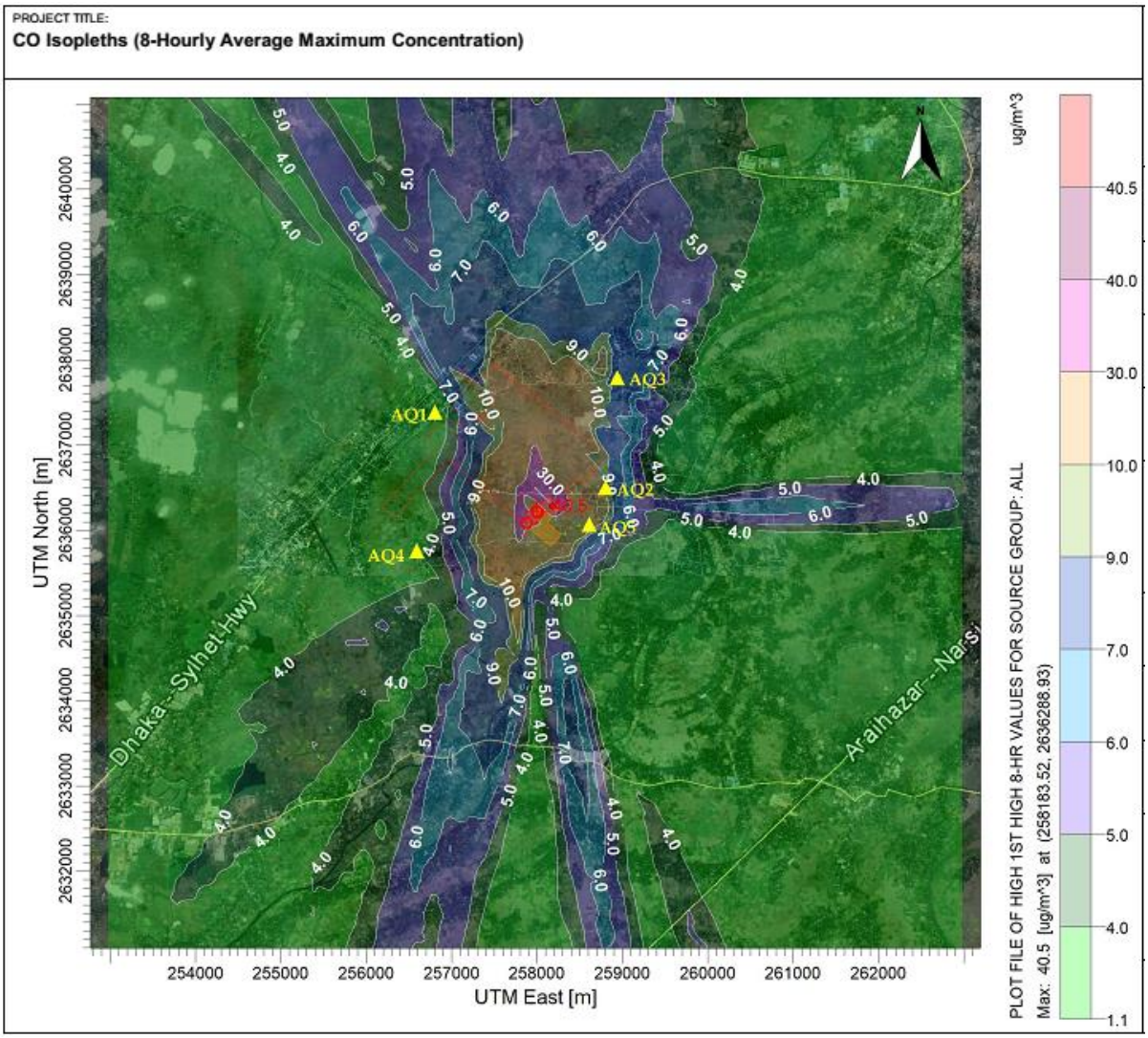
Receptor	Baseline CO level (8 hours) (ppm)	Predicted CO level (8 hr. Average) (ppm)	Total Concentration (Predicted+ Background) (µg/m³)	Bangladesh Standard (8 Hours) (ppm)		IFC, 2008 Limit (24 Hours) (ppm)
				ECR 97*	Draft ECR, 2017	
AQ1	2.5	0.003	2.503	9	9	-
AQ2	0.50	0.009	0.509			

Receptor	Baseline CO level (8 hours) (ppm)	Predicted CO level (8 hr. Average) (ppm)	Total Concentration (Predicted+ Background) (µg/m³)	Bangladesh Standard (8 Hours) (ppm)		IFC, 2008 Limit (24 Hours) (ppm)
				ECR 97*	Draft ECR, 2017	
AQ3	1	0.007	1.007			
AQ4	0.50	0.003	0.503			
AQ5	0.50	0.010	0.510			

Source: EQMS

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

The maximum concentration of CO was observed to 40.5 µg /m³ (0.035 ppm) at coordinates of (258183.52m E 2636288.93m N) to the Northeast of the stack which will be within plant boundary. The corresponding isopleth for CO emissions from the power plant operations is as given in Figure 8-2.



Source: EQMS

Figure 8-2: 8 Hourly Ground Level Incremental Concentration of CO

It has been concluded that the total incremental ground level concentration of CO due to the proposed power plant operations is well within the national standard.

Sulphur Dioxide (SO_2)

Sulphur dioxide has been estimated only for diesel engine generator as natural has insignificant sulphur content. The predicted 24-hour incremental ground level concentration of $S0_2$ at all the monitored locations for ambient air quality is presented in Table 8-6 below.

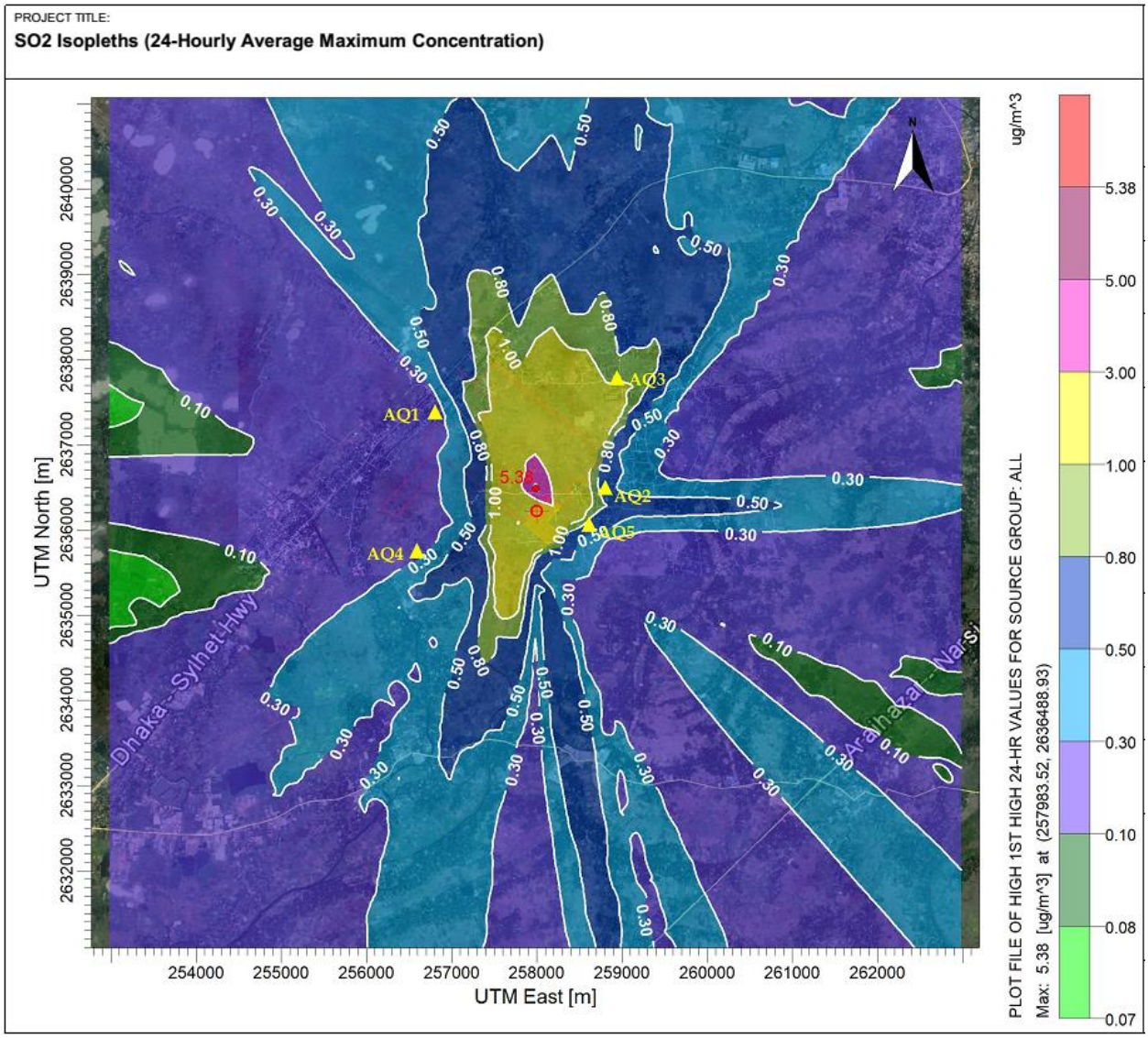
Table 8-6: Predicted 24-hr Maximum Ground Level Concentration of SO_2

Receptor	Baseline SO_2 level (24 hours) (µg/m³)	Predicted SO_2 level (24 hr. Average)	Total Concentration (Predicted+ Background) (µg/m³)	Bangladesh Standard (24 Hours) (µg/m³)		IFC, 2008 Limit (24 Hours) (µg/m³)
				ECR 97*	Draft ECR, 2017	
AQ1	10.1	0.23	10.3	365	85	125 (Interim Target-1)
AQ2	6.3	0.64	6.9			
AQ3	7.2	0.90	8.1			
AQ4	5.7	0.23	5.9			
AQ5	6.6	0.70	7.3			

Source: EQMS

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

The maximum concentration of $S0_2$ was observed to 5.38 µg /m³ at coordinates of (257983.52 mE 2636488.93 mN) to the North of the stack, and the location is in the economic zone boundary. The corresponding isopleth for S02 emissions from the power plant operations is as given in Figure 8-3.



Source: EQMS

Figure 8-3: 24 Hourly Ground Level Incremental Concentration of SO_2

Table 8-6 shows the total incremental ground level concentration of SO_2 due to the proposed power plant operations is well within the national standard as well as the IFC standard.

Gas Pipeline

There are no such significant impacts on air quality will be observed in the Operation period as no other development work will be done except small maintenance works.

8.3.2 Water Pollution

8.3.2.1 Construction Phase

A. Impact on Surface Water Quality

Power Plant

Waste and wastewater generated during the construction phase of the project include construction debris and wastes, and some other solid wastes (e.g., from labor sheds), human wastes from people working at the project site (e.g., from labor sheds), and some liquid waste from construction processes. These waste/ wastewaters could lead to pollution of adjacent water bodies and general environment, if not properly disposed of Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality.

Gas Pipeline

For installation of gas pipeline, land acquisition (20-feet strip) for the RoW is required and some water bodies will be affected. Additionally, for smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-Feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction stage as excavated soil from trench will be dumped beside RoW. Waste will also be produced from the washing of aggregate and sand. If these are inadequately handled, surface water and underground water may be contaminated. Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality.

B. Impact on Ground Water Quality

Power Plant

Groundwater is fresh shallow aquifers of the study area. No significant impacts are anticipated on the groundwater quality due to development and construction of power plant facilities.

Gas Pipeline

Water provided at the site for workers installing the pipeline and for the engineers and administrative support must meet the drinking water standards established by DoE. If local groundwater is the source of drinking water, it shall have to be chlorinated. Otherwise, it will affect workers health.

8.3.2.2 Operation Phase

A. Impact on Surface Water Quality

Power plant

Total water consumption is 160 m^3/day of which 80 m^3/day will be used for gas turbine cooling, and rest 80 m3/day will use for gas booster compressor. Groundwater will be used in the cooling system and therefore, the thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, nearest surface water will be contaminated.

B. Impact on Ground Water Quality

Power plant

There will be very minimal chance of contaminating groundwater from wastewater and sewage during the operation phase. Pre-treated wastewater will be collected from the power plant through anti-corrosive

pipes to the treatment plant and only be discharged to nature after meeting the national discharge standards. Following measures should be taken to minimize the groundwater pollution.

8.3.3 Waste

8.3.3.1 Construction Phase

Power plant/Gas transmission pipeline

Solid Waste resulting from the construction work of power plant, substations and transmission pipeline include metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected and typically managed by the appointed contractors.

8.3.3.2 Operation Phase

Power plant

The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment plant. Further, the household solid waste such as cans, bottles and food remnants discarded by employees is also generated. If such waste is inadequately handled, river/canal water and underground water will be contaminated, and sanitation problems will arise. Appropriate waste management by law and regulation is the responsibility of the power plant facilities, which shall be approved by DoE for their own EIAs.

Gas pipeline

No impact is expected for operating gas transmission pipeline.

8.3.4 Soil Pollution

8.3.4.1 Construction Phase

Power Plant

With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built, and earth and sand may flow out at the time of rainfall. Storage of raw material, vehicles & equipment fuel and construction debris may contaminate the soil. Soil may be contaminated through spills and leaks of Fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.

Contractors are required to take all the proposed mitigation measures. Plant authority will ensure that all the proposed mitigation measures are being incorporated in the bid document issued to the contractor and the implementation during construction.

Gas Pipeline

During the construction period, the soils of the river crossing sites may be polluted with the liquid wastes (mud) generated from the river crossing activities. Similarly, the operation of the thrust Boring machines and movement of heavy vehicular traffic and Construction equipment & machinery during road crossings and pipeline construction activities will generate discharges of obnoxious wastes like diesel & lubricants etc. Vehicular oil and lubricants also polluted the soil quality. The waste lubricants will not only pollute the soils but also contaminate the groundwater in the long run.

8.3.4.2 Operation Phase

Power Plant

After the development of the power plant, disposal of domestic and process waste may contaminate land and soil quality of the area. The impact can be significant and long-term in case of uncontrolled discharges. Improper storage, handling, disposal of diesel fuel, lubricants, solid and hazardous waste may lead to contaminate the soil.

Gas Pipeline

During the operation and maintenance, pigging of the pipe for cleaning purposes will generate significant liquid hazardous pollutants from TBS, valve station etc., which are likely to be spread over the soils. If these pollutants are not safely disposed of, then the soils of the project areas will be polluted.

The vehicles and machinery stationed in the TBS, valve stations sites may be responsible for polluting the soils when the lubricants of these vehicles and machineries will be spilt over the soils.

8.3.5 Noise

8.3.5.1 Construction Phase

Power Plant/Gas Pipeline

Operation of different types of machinery and equipment for construction activities, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise during the construction period of the power plant and Gas transmission pipeline project. The produced noise may have the impact on the existing acoustic environment of the rural category defined in ECR, 1997. Local inhabitants may feel disturbed due to noise from line sources (traffic movement). Impacts of noise will potentially affect the following:-

a. Impacts of Noise to Immediate Neighbors
   - Continuous exposure of neighbours to noise nuisance may result in a noise-induced hearing loss;
   - Noise nuisance may reduce the concentration of neighbors

b. Noise Impacts on Employees
   - The high noise level will force employees to shout loud when communicating with one another;
   - Exposure of employees to high noise level (above 85dB) continuous for 8 hours per day may result in noise-induced hearing loss;
   - Exposure of ear to peak sound level instantaneously may result in deafness

8.3.5.2 Operation Phase

Power Plant/Gas Pipeline

In the operation phase of the power plant will increase significantly which will increase the noise level of the area. The noise generation source during the operation includes workers' commutation, traffic of vehicles for carrying the periodic inspection materials and operation of the power generation facilities. The inhabitants of the surrounding area have taken up noise problem. The noise of the power generation facilities is produced even during the nighttime, so sufficient consideration must be given to the impact of noise.

No impacts are expected for Gas transmission pipeline project at operation stage.

8.3.6 Ground Subsidence

8.3.6.1 Construction Phase

Power Plant/Gas Pipeline

There is no evidence or trace of ground surface subsidence around the project sites. Impacts are negligible, no further study is required.

8.3.6.2 Operation Phase

Power Plant

There is no evidence or trace of ground surface subsidence around the project sites. Impacts are negligible, no further study is required.

Gas Pipeline

No impact is expected for operating gas transmission pipeline.

8.3.7 Offensive odours

8.3.7.1 Construction Phase

Power plant/Gas Pipeline

No impacts are expected at the construction of power plant.

The amount of household solid waste will increase due to the inflow of a great number of workers at the campsite of the Gas pipeline project. Compost and organic waste, rubbish waste and burning of bitumen may generate very low odour from the constriction campsite. If such waste is inadequately handled, the odour may be produced by putrefaction.

8.3.7.2 Operation Phase

Power plant/Gas Pipeline

Compost and organic waste, rubbish waste, odour from domestic sources and some smaller commercial premises such as shops and restaurants may generate odour. However, the impacts are very negligible, so no further study is required.

8.3.8 Sediment Quality

8.3.8.1 Construction Phase

Power plant

Development of the structures, administrative buildings and construction of the internal road may disturb the bottom sediment profile of the water bodies. Storage of raw material, fuel, solid waste, hazardous chemical and construction debris may contaminate the bottom sediment. These measures should be taken to prevent the sediment pollution. Mitigation measures to be adopted are mentioned below.

Gas Pipeline

During the construction period, the bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the crossing activities. The waste lubricants will not only pollute the sediments of water bodies but also contaminate the groundwater in the long run.

8.3.8.2 Operation Phase

Power plant

Improper storage, handling and disposal of solid and hazardous waste may lead to contamination of the bottom sediment of nearest water bodies. All waste including solid and liquid wastes will be treated properly before being disposed of into nature.

Gas Pipeline

During operation and maintenance, pigging of pipe for cleaning purposes will generate significant liquid hazardous pollutants from TBS, Valve Station etc., which are likely to be spread over the sediments of the waterbody. If these pollutants are not safely disposed of, then the sediments of the project areas will be polluted.

8.4 Natural Environment

8.4.1 Protected areas/Ecologically Critical Area

8.4.1.1 Pre-construction, Construction & Operation Phase

Power Plant

Since no national protected area, natural packs, Game reserve and wildlife sanctuary exist within 5 km radius of power plant area. So on impact is expected.

Gas pipeline

In 2009, the Bangladesh Government declared the four rivers, such as Buriganga, Sitalakhaya, Turag and Balu around Dhaka city as ECAs.

The Haripur station by titas is very close to Sitalakhaya River which is 740m south-west direction from the station. The Gazette notification to this effect imposes restrictions on a number of activities in these rivers and their associated riparian environs. These include all types of hunting, collection of all types of aquatic species living in the rivers, all activities that could result in the destruction of floral or faunal habitats, all activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste.

8.4.2 Ecosystems

8.4.2.1 Pre-construction Phase

Terrestrial Ecosystems

Gas pipeline

The habitat types and ecosystem found in the non-forested agricultural and homestead areas are not considered to be significant from a biodiversity perspective. Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. Many species of wildlife would be frightened easily by vehicle horns and may become distressed.

An increased risk of weed dispersal and invasion will be there through the increase in human and vehicular traffic movement across the project area. The seeds of weeds are often easily transferred to areas where they do not currently exist, via the wheels of vehicles or on the soles of shoes. The presence and/or invasion of weed species to an area is generally to the detriment of habitats and species present.

Aquatic Ecosystems

Gas pipeline

Similar to terrestrial ecosystems, aquatic ecosystems are also not likely to be impacted badly by the activities carried out during the pre-construction phase. Aquatic flora and most of the fauna species will not be disturbed by the survey activities of this phase. The use of vehicles may inadvertently scare nearby water birds or other species by moving too close to them and disrupting feeding or nesting behaviour. Once disrupted, some bird species may not return to that particular area.

8.4.2.2 Construction Phase

Power Plant/Gas Pipeline

Terrestrial Ecosystems

The power plant site and its surrounding areas have already been converting into the agricultural land and are used for artificial purposes. With the progress of excavation work for structures and gas pipeline, the habitat of the plants and animals may disappear. The area to be modified by installation of gas pipelines, and there will be the moderate impact on plants and animals. There is no natural forest in these areas.

Terrestrial Flora

Removal of vegetation from the project site as well as the surrounding area is the single most important negative impact on terrestrial flora. The severity of impact depends largely on the type and species composition, which will be removed during construction. Accordingly, it is important to know the exact location of the project site and its direct and indirect impact area to pinpoint the vegetation types and species composition growing in those particular areas. Impacts will be temporary in most of the cases, and a high-quality management plan will minimize the impacts further.

i. Agricultural Land Flora

The project will have a very similar impact on agricultural vegetation. Clearing of these crop cover from the construction area will create some negative impact on food security for the community as a whole. At present, the project site is mainly used for agricultural crops. It is likely that the project work will be started immediately after the monsoon season. This coincides with the transplanting of crops and others in the fields. The crop production will be affected during construction periods.

ii. Homestead Plantation Flora

The project activities have high potential to impact on homestead vegetation and agro-forestry by offering increased disturbance and clearing. However, almost exclusively this vegetation is very close to the homestead buildings. The project authorities try to avoid acquiring existing homestead buildings. However, all vegetation will be cleared from the homesteads that are within the project area.

iii. Roadside Vegetation

There will be little or no impact on roadside plantations, as these strip plantations will certainly be replanted after the completion of the construction work.

Terrestrial Fauna

Relative impact on terrestrial fauna will be determined by their habitat preference, food source and sensitivity to human activities. Moreover, the species both vertebrates and invertebrates species found in the project sites, are highly adaptive to regular anthropogenic disturbance and so the impact from project

activities will be short and non-severe. But, any overlap between the project activity and their breeding period will produce much greater impact.

i. Agricultural Land Fauna

The main impact will come from the displacement and disturbance due to the increased noise level and human activities. Most of the fauna species inhabiting this habitat are highly adaptive to periodical human interference, and so the project activities will create no real negative impact on their regular lifecycle.

ii. Homestead Plantation Fauna

As discussed in the floral impact chapter, vegetation around the homestead will be disturbed and cleared and so the faunal species inhabiting within the project area. All Medium and small mammals will avoid the locations due to increased human presence. However, these displacements and avoidance will be temporary, and within a short period after construction, these species may come back to their old habitat.

Resident birds in the homestead vegetation will be disturbed. As a temporary refuge, the affected faunal population will migrate to the nearby available and undisturbed habitat.

iii. Roadside Vegetation Fauna

Disturbance and impact on roadside vegetation would be very small and should not cause any long-term negative consequences on the local faunal species.

Aquatic ecosystem

With the progress of construction work, water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the water bodies. Contamination will occur due to civil construction work. This may have an adverse effect on many forms of life in the river, canal and ponds. Many seasonal and perennial water bodies will lose their characteristics. Run-off from a construction site may contain sediments or contaminant that may pollute water quality of canals, ponds and adjacent river that will affect the aquatic life. Impact on the habitat of aquatic and reverence fauna due to accidental spillage. The economic productivity of the wetlands will also decrease with the reduction of seasonally flooded areas and subsequent loss of wetland-dependent species. The seasonal wetlands provide the basis for many fisheries production of the area. Wetland vegetation provides important shelter for many fish species.

i. Aquatic Flora

Impact on aquatic flora would be short term during the construction phase. Removal of vegetation cannot be envisaged, as seasonal wetlands of the project area will be dry at that time of the year. Therefore, the severity of the impact will not be great. However, disturbance in the seedbeds will reduce the species density and diversity temporarily along the study area.

ii. Aquatic Fauna

Similar to that of terrestrial fauna, impact on aquatic fauna will determine by their habitat preference, food source and sensitivity. Both vertebrate and invertebrate species found in the project sites are already adapted to regular anthropogenic disturbance, and so the impact from project activities will be short and non-severe. Moreover, as most of the activities of the construction would take place during the dry period, hence the major part of the wetlands would be dry. Therefore, the impact will be minimal.

iii. Fish Habitat Loss

Gas pipeline

The construction phase activities will destroy the respective rivers, canals and ponds habitats temporarily. The parental stocks around the construction area of the affected riverine habitats will be lost completely for this season. But it will revive at the post-project situation in the consecutive year. Fish habitat condition of affected ponds will be lost and subject to restore with developmental interventions.

In addition to the impact on land and structures, the Gas Pipeline project has very limited impact on trees. A total of 225 fruits trees were identified of which 147 were large, 37 were medium, and 2 were and saplings. There were 29 large size timber trees and only 10 banana trees to be cut down due to the project. Impact on trees is presented in Table 8-7.

Table 8-7: Number of Affected Trees (by Type and Size)

Categories of trees	Number of Trees by size (Nos)				Total
	Large	Medium	Small	Sapling	
Fruits	147	37	0	2	186
Timber	29	0	0	0	29
Banana Plant	0	0	0	0	10
Total	**176**	**37**	**0**	**2**	**225**

Source: EQMS survey, November 2018

8.4.2.3 Operation Phase

Power Plant

The power plant site and its surrounding areas have already been converted into the agricultural land and are used for artificial purposes. There is no natural forest in these areas. The area to be used in the power plant is comparatively small and will have some impact on plants and animals. Plant development will involve generation of emissions, effluents and increased vehicular movements may have the overall negative impact on the eco-system. Air pollutant will impact the existing vegetation and avifauna in the area. Likely impact on flora and fauna during the operation phase of the project will be mostly from Noise generation due to the operation of the power plant. The impact will be mainly on the terrestrial flora and fauna within the project site and its surrounding.

Gas Pipeline

Further, after the gas pipeline has been laid, the site will be backfilled, and the transmission line except for the scaffolding will be put back to the current state. There will be almost no impact on the terrestrial ecosystem.

8.4.3 Hydrology

8.4.3.1 Pre-construction Phase

Gas Pipeline

Most of the RoW of the gas pipeline would pass over agricultural lands and seasonal wetlands, which are important for the natural drainage of the surrounding areas. There is no river falls under the right of way of the Gas pipeline. No such significant impact may be observed during mobilization of the equipment and material during pre-construction.

8.4.3.2 Construction Phase

Power Plant

Water consumed for the construction work and related activities during the construction phase would include water for washing vehicles and equipment, sprinkling water, and domestic water. The source of water during construction will be groundwater. The amount of water consumption is limited and short-term. It can be concluded that water uptake from the groundwater during the construction phase would be very limited and would not cause any significant impact on Ground aquifer as well as adjacent waterbodies. Without drainage retaining systems, excess drainage water from the power plant could flood the surrounding lower area.

Gas Pipeline

For installation of gas pipeline, land acquisition (20-feet strip) for the RoW is required. For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW.

8.4.3.3 Operation Phase

Power Plant

The site has been raised with the sand dredged soil from Meghna River. The proposed power plant site will be required to be levelled at 6 to 7m height from MSL. Without drainage retaining systems, excess drainage water from the power plant could flood the surrounding lower area.

Gas Pipeline

After completion of the gas pipeline works, if the excavated trench is not back-filled by compact sand properly and make it levelled with the existing ground level, it may cause long-term drainage congestion in and around the RoW. Moreover, this will be dangerous for the gas pipeline itself.

8.4.4 Topography and Geology

8.4.4.1 Construction Phase

Power Plant/Gas Pipeline

The proposed power plant will be constructed at developed AEZ area. No activities are planned for the power plant as well as gas transmission pipeline that will cause the impact on topography and geology at the construction phase.

8.4.4.2 Operation Phase

Power Plant/Gas Pipeline

No activities are planned that will cause the impact on topography and geology at operation phase. The surface features of land will be the same at operation period. Therefore, impacts are negligible, so no further study is required.

8.5 Social Environment

8.5.1 Involuntary Resettlement

8.5.1.1 Pre-construction Phase

Power plant

The proposed power plant site will be established under the Araihazar Economic Zone area. Therefore, no additional land will be acquired for the power plant.

Gas Pipeline

About 6 km length RoW of the pipeline requires both acquisition (20 feet wide) and requisition (20 feet wide) of land. An almost approx. 8.86 Acres area of land would be needed for acquisition. Acquisition of land for the project will affect them significantly. Because, (i) the land price of the land situated beside the acquired land will be decreased as construction of structures is prohibited within certain distance from the RoW, (ii) a remaining small piece of land has no use after acquiring larger portion of a plot, but the project does not compensate for that small piece of land, (iii) some have no other properties than the affected one. Detailed data is indicated in the resettlement action plan report.

The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. The entire land is privately owned and needs to be acquired. The land acquisition process is yet to start, and it will take a few months. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition. Impact on land and populations by the gas transmission line is presented in Table 8-8

Table 8-8: Number of Land Losing Affected Households and Populations

SL No.	Name of Mouza	Quantum of Land	No. of Households Losing land	No. of Populations
1	Bagnoyanogor	0.07	10	62
2	Behakoir	3.11	102	414
3	DighiBorabo	1.90	67	320
4	Kachpur	1.22	32	116
5	Monoharkharbag	2.55	42	180
	Total	**8.85**	**253**	**1092**

Source: EQMS survey, November 2018

Requisition of land for the project will also affect people of the project area. Movement of the heavy vehicle, use of chemical for cleaning aid joining the pipes, the heap of pipes, and disposal of waste materials here and there decrease the quality of land. The soil becomes compacted, and this type of land is not good for cultivation, it takes time to make the land useful for cultivation.

8.5.1.2 Construction & Operation Phase

Power plant/ Gas pipeline

The entire land was lower agricultural land in the project site. There was no cultural, historical and aesthetic interesting the project land and no loss of sensible place. There is no need to acquire any land at construction & operation stage. Therefore, No impacts are expected because of involuntary resettlement, so no further study is required.

8.5.2 Vulnerable Group

8.5.2.1 Pre-construction/Construction Phase

Power Plant

The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affectedly the project activities. Vulnerable people would be affected both for the power plant. On the other hand, job opportunity and commercial activities would increase during construction activities.

Gas Pipeline

In the Gas Pipeline project, out 253 households a total of 58 (22.92%) households were identified as vulnerable. Among them 20 are female-headed having no male income earner, 13 are elderly headed, and 25 were identified as extremely poor. Vulnerable households in the project area are presented in below Table categorically. A list of vulnerable household is annexed with this RAP.

Table 8-9: Affected Vulnerable AHs

Vulnerable Category	Total	%
Female-Headed AH without male income earner	20	34.5
Elderly Headed Households (70+)	13	22.4
Households belonging below poverty line (103500 BDT yearly income)	25	43.1
Total	**58**	**100.0**

Source: EQMS survey, November 2018

8.5.2.2 Operation Phase

Power Plant

The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affectedly the project activities. Job opportunity as workers of the power plant and commercial opportunity would increase. Although women are also considered as a vulnerable and marginalized group, the impacts on the same have been identified and assessed separately. These groups of people are at a greater disadvantage or susceptible to more risk due to the sudden change in their socio-economic environment. The primary reasons for their vulnerability are:

- Limited control over family resources;
- Limited say in the utilization of compensation money;
- Lack of capacity to adapt to changes in their socio-economic scenario; and
- Limited skill base to support alternative occupations or earning mechanisms.

Gas Pipeline

The affected persons will lose their land for a temporary basis. After the installation of pipeline, they can use this land for agriculture purpose or others. In addition, they also can build small structures but will not allow for multi-structures. No impacts are expected.

8.5.3 Indigenous and ethnic people

8.5.3.1 Construction/Operation Phase

Power plant/Gas Pipeline

No indigenous/ethnic people live in the project affected area. No impacts or impacts are negligible, so no further study is required.

8.5.4 Local Economics, Such as Employment, Livelihood

8.5.4.1 Pre-construction/Construction Phase

Power plant

Agricultural income will be impacted for implementation of the proposed power plant project. The households (owners, sharecroppers) depended mainly on agriculture may be impacted significantly, and their livelihood status may be changed.

Gas pipeline

Agricultural income will be impacted in two ways for implementation of the proposed project viz. (1) acquisition of land and (ii) requisition of land. Acquisition of land for construction of structures like TBS and CGS etc. will impact permanently on agricultural income and requisition of land will impact temporarily (but relatively for a longer period). Hence, the households (owners, sharecroppers) depended mainly on agriculture may be impacted significantly and their livelihood status may be changed.

In Bangladesh landowners leased out their land to intending farmers on a temporary basis and for a certain period of time on verbal and mutual understanding. Through this informal arrangement, the sharecropper sometimes has to pay money to owners and sometimes share the harvested crops. In most cases, there is no written agreement between the landowners and sharecroppers. To identify the sharecroppers, the landowners are the main source as there is no written agreement or contract between them. Impact on indirectly affected person was assessed through census and SES. Only one (1) persons were identified as sharecroppers in the project area. A list of sharecroppers is annexed with this document. Mouza-wise sharecroppers are presented in Table 8-10:

Table 8-10: Mouza-wise Sharecroppers

SL No.	Name of Mouza	No. of Sharecroppers
1	Bagnoyanogor	0
2	Behakoir	1
3	DighiBorabo	0
4	Kachpur	0
5	Monoharkharbag	0
Total		**1**

Source: EQMS survey, November 2018

In the process of census and impact assessment in the project alignment, three small industrial units and one restaurant were identified. The Sayeed Textile Mills at Dighiborabo is found closed since long ago. No persons or worker except one security personnel involved with this industry. The employed security guard will not lose his job. Other two small industries are operating with its full capacity. Sayeed Textile mills don't require relocation as the pipeline goes through its open space. But other two factories need to be relocated temporarily. Workers involved with these factories will lose their job due to the construction

of the gas transmission line. A total of 52 workers will lose their livelihood earning source. The number of wage loser person is presented in Table 8-11.

Table 8-11: Number of Wage Loser in the Gas Pipeline Project

SL No.	Name of Mouza	Type of Enterprise	No. of Worker
1	Dighiborabo	Sayeed Textile	0
2	Do	Khan Garments	25
3	Do	Restaurant	7
4	Monohorkharbag	Wood Processing Plant	20
Total			**52**

Source: EQMS survey, November 2018

On the other hand, The construction work requires a great number of workers. Employment opportunities for both skilled and unskilled labor in the construction sector, service sector and business sector would increase. Limited employment opportunity is prevailing in most of the areas under the project, and a good number of people are unemployed. Some people seasonally migrate-out from their villages for earning their livelihoods. Local potential laborer households as well as small contractor households, if any, may get the chance of working with the proposed project as the proposed project would require workers for construction, management, accessories supplies, etc. Both skilled and unskilled laborer would be required for quite a long period. People also expressed their interest to be employed in those activities.

8.5.4.2 Operation Phase

Power plant/Gas Pipeline

Long-term livelihoods will be impacted by the project. As Power plant site and Gas transmission pipeline sites, a good percentage of the population is dependent on agriculture as an income resource. Families are taking paddy crops from their fields on an annual basis.

On the other hand, the increase of job opportunity as workers of the power plants or commercial opportunity targeted to these workers is expected. There is a high percentage of day workers around the project site. They want to be hired not only during the period of construction work but also during the operation of the power plant. When large-sized heavy equipment is transported for maintenance and management by ship may be interfered. Materials may be unloaded at the time of maintenance and management.

In the RoW areas, agricultural land use practices will be suspended for a temporary basis. After installation of pipeline, Farmers can use this land again for agricultural activities.

8.5.5 Land Use and Utilization of local resources

8.5.5.1 Pre-construction/ Construction Phase

Power Plant

The 9.28 ha or 22.93 acres of agricultural land will be altered by the industrial purpose. Therefore, the annual agricultural production rate of that upazila will be decreased. In the project site, the land is single cropped agricultural land, so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development.

Gas pipeline

If the TBS and CGS are installed on the agricultural lands, then the land use practice will be changed partially from the agricultural to non-agricultural use for those areas. The Gas Pipeline requires approximately 8.86 acres of land. The entire land for the project identified as privately owned land and need to be acquired. A large portion (8.17 acres) of land selected for gas pipeline project is found as the agricultural category, though at many places the owners of land developed the land for homestead purposes. But the classification of land is not recorded in the respective land office. The gas pipeline project covers five mouzas in three Upazila in Narayanganj districts. Category-wise quantum of acquired land is presented in Table 8-12.

Table 8-12: Quantum of Acquired Land

SL No.	Name of Mouza	Number of Plots	Amount of Acquired Land (in acres)					Total
			Doba (Waterbody)	Agri land	Pond	Viti	Fallow	
1	Bagnoyanogor	1	0	0.07	0.00	0.00	0.00	0.07
2	Behakoir	74	0	3.11	0.00	0.00	0.00	3.11
3	DighiBorabo	40	0	1.31	0.36	0.07	0.16	1.90
4	Kachpur	21	0	1.22	0.00	0.00	0.00	1.22
5	Monoharkharbag	**67**	0.0468	2.45	0.01	0.04	0.01	2.55
	Total	**203**	**0.0468**	**8.17**	**0.36**	**0.11**	**0.17**	**8.86**

Source: EQMS survey, November 2018

Therefore, the annual agricultural production rate of that upazila will diminish. In the project site, the land is single cropped agricultural land, so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development.

8.5.5.2 Operation Phase

Power Plant/Gas Pipeline

No impact on agriculture resources is anticipated from power plant development during the operation phase. In the RoW areas of gas transmission pipeline, land use practices will be restored.

8.5.6 Water Usage

8.5.6.1 Construction Phase

Power Plant

Groundwater will be used in the during the construction phase of the power plant. Therefore, Excessive withdrawal of groundwater may lead to depletion of aquifers. Source of water of these activities will be the groundwater from own borehole. The water source will be approximate 260-300m deep wells. A past survey estimated the arsenic contamination concentration to be low enough to not be a problem. Measures should be taken to minimize water extraction by reducing water consumption and wastage. Adoption of the advanced technologies and machinery which helps in minimizing water requirement for construction;

8.5.6.2 Operation Phase

Power Plant

Total water consumption is 160 m3/day of which 80 m3/day will be used for gas turbine cooling, and rest 80 m3/day will use for gas booster compressor. However, the groundwater will be taken from deep wells (260m to 300m) so that it will a considerable reduction of the underground water level. Excessive withdrawal of groundwater may lead to depletion of aquifers.

Moreover, it is necessary to prevent excessive depletion of wells due to excess water usage and the subsidence of surrounding ground.

8.5.7 Existing Social Infrastructures and Services

8.5.7.1 Construction Phase

Power plant/Gas Pipeline

An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community. However, the impact is very negligible. So, No impacts are expected.

8.5.7.2 Operation Phase

Power plant/Gas pipeline

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area. No impact is expected.

8.5.8 Social Institutions Such as Social Infrastructure and Local Decision-making institutions

8.5.8.1 Construction Phase

Power plant/Gas Pipeline

Regulations of Bangladesh stipulate that public consultation must be held in the land acquisition process. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office.

8.5.8.2 Operation Phase

Power plant/Gas Pipeline

No impact on social institutions such as social infrastructure and the local decision is anticipated from the power plant and Gas pipeline development during the operation phase.

8.5.9 Misdistribution of Benefits and Damages

8.5.9.1 Pre-construction Phase

Gas Pipeline

Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation. Equality of compensation shall be assured as there is a possibility of unequal compensation between local residents.

8.5.9.2 Construction Phase

Power plant/Gas Pipeline

Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors.

8.5.9.3 Operation Phase

Power plant/Gas Pipeline

Misdistribution of benefits and damages would occur since there are PAHs who lose their income source for power plant and gas pipeline development, while there are people who would get job opportunity as workers of the power plant. Therefore, in the operation phase, the impact will be negligible. Therefore, no further study is required.

8.5.10 Local Conflict of Interest

8.5.10.1 Pre-construction/ Construction Phase

Power plant/Gas Pipeline

Due to an increase in employment opportunity will be increasing during preconstruction and construction; candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum.

8.5.10.2 Operation Phase

Power plant/Gas Pipeline

PAHs who lose their income source, while there are people who would get job opportunity as workers of the power plant. Therefore, in the operation phase, the impact will be negligible.

8.5.11 Cultural Heritage/Asset

8.5.11.1 Pre-construction, Construction & Operation Phase

Power plant/Gas Pipeline

No cultural Heritage exists around the proposed power plant site and Gas pipeline alignment. Nothing found in the development area would be affected by the development. Therefore, no impact is expected on cultural heritage due to proposed project implementation.

8.5.12 Landscape

8.5.12.1 Construction Phase

Power plant/Gas Pipeline

There is no picturesque scenery in or around the site. All construction activities for the administration building, boundary wall will be carried out within the power plant site, and gas transmission line installation will not cause any impact on the landscape and scenic beauty. A green buffer of 3.5 m only one row of trees will be developed all around the project site which will enhance the scenic beauty of the area.

8.5.12.2 Operation Phase

Power plant/Gas pipeline

The landscape of power plant site is the naturally depressed area which will be changed to industrial land use after the development of power plant site. No major change in landscape is associated with the development of the power plant.

Plantation area which will be tentatively occupied during pre-construction/construction phase will be restored to the original state and returned to the landowner after construction.

8.5.13 Gender

8.5.13.1 Pre-construction & Construction Phase

Power plant/Gas pipeline

There are women among those to be resettled and/or lose their livelihood means. They currently have low living standards and lack proper facilities; they will have better access to social services throughout the year. However, wives of those men who lose their land or jobs may suffer from adverse effects on their household economy. Female laborers may be discriminated in wage at the construction site.

8.5.13.2 Operation Phase

Power plant/Gas pipeline

Project activities do not attract gender issues. Job opportunities will be open to women according to their qualification.

8.5.14 Children's Right

8.5.14.1 Pre-construction & Construction Phase

Power plant/Gas pipeline

The following item was examined to forecast the impact:

- May impact on educational opportunity of school going children in PAHs of the Project;
- May impact on educational opportunity of school going children in the local community;
- Impact of the project on the increase of child labor;

8.5.14.2 Operation Phase

Power plan/Gas pipeline

There are many affected households who have school going children's. They must be relocating to other places, and these children's educational opportunity will be temporarily disrupted due to the relocation. Currently, the majority of the children of PAHs in the project area go to school in and around power plant area and gas pipeline alignment.

8.5.15 Infectious Diseases

8.5.15.1 Construction Phase

Power plan/Gas pipeline

The entire construction phase is expected to continue for about 3 years. This will require the labor of unskilled, semi-skilled, skilled and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly of skilled laborers and workers. During Construction, in general, a lot of

migrant workers flow into the sites, who may have the possibility with HIV/AID and infectious diseases can spread among other workers and local peoples.

8.5.15.2 Operation Phase

Power plan

This is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.

8.5.16 Working Conditions, Including Occupational Safety

Working conditions are at the core of paid work and employment relationships. Working conditions cover a broad range of topics and issues, from working time (hours of work, rest periods, and work schedules) to remuneration, as well as the physical conditions and mental demands that exist in the workplace. Occupational safety and health (OSH), also commonly referred to as occupational health and safety (OHS), occupational health, or workplace health and safety (WHS), Community Health & Safety is a multidisciplinary field concerned with the safety, health, and welfare of people at work. The details of Occupational Health & Safety, Community Health & Safety & Risk of fire are given in Section 7.5.17 to Section 7.5.19.

8.5.17 Occupational Health and Safety

8.5.17.1 Construction Phase

Power Plant

There would be a possibility to occur accidents and incident during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health. In order to prevent accidents and incidents, the project proponent regulates to install security and maintain safety prevention measures and devices suitable for use in each plot for construction in the internal regulation. Therefore, the construction contractor based on the international guidelines should manage the working condition during the construction.

Gas pipeline

During the construction period producing so much noise and vibration cause of the movement of vehicles, heavy equipment and Lorries will impact on workers health as well as surrounding people. The produced welding sparks and radiation from radioisotopes, which are harmful to the human body, will impact on the health of the workers; local people and wildlife.

It is anticipated that there are high possibilities of fire due to the negligence of the responsible personnel for handling, storing and using of primer and condensate.

8.5.17.2 Operation Phase

Power Plant

During the operation phase power plant will start their operation, accidents or incidents are expected to occur more or less during the operation phase. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health. Based on the rules, the power plant should prepare and implement appropriate mitigation measure under the respective impact

assessment based on the international guidelines. The accommodation for workers will be arranged according to the project proponent of logistics, residential and commercial area in order to provide a dwelling place for them. The mitigation measure should be prepared for the respective occupational risk based on the operation plan and working condition of the power plant.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment. Further, various forms of operation or manoeuvring errors may occur during the operation. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project. The Disaster Emergency Response Plan is to be prepared and actions to be taken by the implementing agency to cope with any of the emergency periods.

8.5.18 Community Health and Safety

8.5.18.1 Construction Phase

Power Plant/Gas Pipeline

It is envisaged that during the construction phase activities, a lot of the material and heavy equipment is scheduled to be brought to the site in vehicles via the inner access roads. Some of these impacts associated specifically with roadways are:

- Traffic congestions on roads and possible disruption to the community usage during peak movement hours;
- Increased risks with respect to safety associated with traffic movement;
- Inconvenience to the community in terms of air and noise pollution caused by the movement of vehicles;
- Structural and surface damage to the road due to movement of heavy vehicles and equipment; and
- The proposed gas transmission pipeline would cross Highway road, many other rural roads. Only feeder and village roads will face temporary communication disruption as major roads will be constructed through the underpass. Smooth transportation of passengers and goods using the village roads will be impacted negatively in this regard;

Apart from the traffic, other community health and safety impacts resulting from the construction phase of activities would typically include (but not be limited to):

- Generation of dust, noise and odour from the construction site which may have health-related impacts on the local community;
- Fire Safety from the ongoing construction activities which may include handling and storage of flammable chemicals and materials;
- Improper disposal and migration of sewage into the surroundings;
- Improper disposal of sewage and waste may lead to contamination of groundwater, as the water table in the project area is very high.
- Any waste disposal in the canal from the project would affect the population in downstream of water flow
- It is also anticipated that the construction of the gas pipeline has risk due to the bursting of pipes or leakage and conflagration. All these significantly impact the health of the working personnel and the people living in the neighbouring.

Potential impacts during the construction period on existing infrastructure and community health and safety are expected to be moderate.

8.5.18.2 Operation Phase

Power Plant

The health and safety risks in the plant during operations include the potential for respiratory diseases, burns, allergies and operational accidents among the employees and immediate neighbouring communities if adequate mitigation measures to prevent the above are not implemented. In addition, local public health centres may report an increase in cases involving respiratory ailments like coughing, phlegm; eye irritation etc. due to the dust and particulate matter from operations.

Traffic: The impacts envisaged from the project activities on with respect to community usage of access roads are mostly confined to the operation phase when the resource movement in and out of the site is higher. In addition, the local people would be benefitted from the strengthening of the road connecting the access road to the Project site.

Influx: Apart from the operation phase, skilled technicians and operators are also likely to be sourced for operating the plants once it goes into operation. It is envisaged that during that phase these technicians would be housed in rented accommodation in and around Araihazar.

Health and Safety: The key health & safety impacts on the local community during operation phase include:

- Emission & Noise generated from the operation of the power plant. These emissions may include compounds of Nitrogen and Carbon which may be harmful to the surrounding community;
- Fire & Explosion Hazards;
- Improper sewage and waste disposal;

8.5.19 Risk of Fire

8.5.19.1 Construction Phase

Power plant/Gas Pipeline

Risk of fire might increase due to the implementation of the construction work for the project. Labor's camp will face the high risk of fire at construction period. Faulty electrics are the biggest cause of workplace fires, loose wires, plugs that are overloaded and old equipment can all make for a potential death trap. Discarded cigarettes can cause fires if not put out and disposed of properly in the project area. Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present. It has to be said that one of the most common causes of fires in the workplace is human error. Fires can occur as a result of negligence in a variety of different ways including improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended.

8.5.19.2 Operation Phase

Power plant

Risk of fire would increase due to the operational activities of the power plant and population growth in and around the project area. Electrical systems that are overloaded, resulting in hotwiring or connections or failed components might occur at operation phase.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment.

8.6 Others

8.6.1 Accidents

8.6.1.1 Construction Phase

Power Plant/Gas Pipeline

It is anticipated that the risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machinery. It is also anticipated that the construction of the gas pipeline has risk due to the bursting of pipes or leakage. All these would have a potential impact upon the health of the working personnel and the people living in the neighbouring areas.

8.6.1.2 Operation Phase

Power Plant

Road accidents would be increased due to industrial vehicles, commuter buses, and motor lines.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project.

8.6.2 Transboundary impact and climate change

Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming.

8.6.2.1 Construction Phase

Power Plant

Although construction machines and vehicles generate greenhouse gases, quantities of generated gases do not give serious impact and negligible on this item. To minimize GHG emission during the construction phase, mitigation measures shall be taken by the contractor, such as management of operation time of construction machinery, avoidance of excessive loading operation, and education of construction workers/drivers about the idling stop practice for construction machinery and vehicles.

8.6.2.2 Operation Phase

Power Plant

Amount of emission of Carbon Dioxides (CO_2) based on the increase of vehicles. However, Emission from construction vehicles/equipment is negligible compared to the number of passing vehicles daily. In addition, energy-saving equipment and fuels that emit less GHG will be recommended to be installed to the power plant for their operations as much as possible. Besides, the power plant authority will initiate the utilization of commuter bus for workers to reduce traffic GHG emission.

8.7 Environmental Impact Assessment

In connection with the scoping matrix described in Table 7-1 & Table 7-2, the rating was reevaluated based on the survey and findings. Revised evaluation (rating) is presented in the table below.

Table 8-13: Environmental Impact Assessment for Proposed Power Plant Based on Survey

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	C	B-	B-	**CO:** All earthworks construction, site clearing, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, hauling of materials, construction of the internal road will generate dust and affect the local airshed. Construction machinery and transportation vehicles will be generated SOx, NOx, smoke, soot and earth, sand and dust particles will be scattered. This may cause air pollution. **OP:** Primarily natural gas will be used as the fuel for GT and GE for the primary operation, and diesel fuel will be used as the fuel for subsidiary operation. It has been confirmed through air dispersion modelling that the exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution such as SOx or NOx without proper technologies and maintenance.
	2	Water pollution	B-	B-	B-	B-	**CO**: Effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from the washing of aggregate and sand. If these are inadequately handled, surface water and underground water may be contaminated. Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality. **OP:** Groundwater will be used in the cooling system and therefore, the thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							generated, and waste will also be produced. If they are inadequately handled, surface water and underground water will be contaminated.
	3	Waste	B-	B-	B-	B-	**CO:** Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected.
							OP: The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated.
	4	Soil pollution	B-	B-	B-	B-	**CO:** With the progress of excavation work for structures, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built, and earth and sand may flow out at the time of rainfall. Storage of raw material, fuel and construction debris may contaminate the soil. Soil may also contaminate through spills and leaks of fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.
							OP: Improper storage, handling, disposal of diesel fuel, lubricants, solid and hazardous waste may lead to contamination of the soil.
	5	Noise	A-	A-	B-	A-	**CO:** Noise will be generated from the construction machinery, equipment and transportation vehicles. However, the construction site is far from the residential area. Therefore, the impacts are moderate.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							OP: Without serious attention and countermeasures, the noise generation source during the operation includes the power plant operation, worker's commutation and traffic of vehicles for carrying the periodic inspection materials. The inhabitants of the surrounding area may have the noise problem.
	6	Ground subsidence	D	C	N/A	D	**CO/OP:** There is no evidence or trace of ground surface subsidence around all the project sites.
	7	Offensive odours	D	D	N/A	N/A	**CO:** Odor may produce by domestic waste from the campsite. However, the impact will be very negligible. **OP:** No impacts are expected.
	8	Sediment quality	B-	D	B-	N/A	**CO:** Inadequate handling of domestic solid waste, raw material, hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds. **OP:** No impact is expected
Natural environment	9	Protected areas	D	D	N/A	N/A	**CO/OP:** Since no natural preservation area and national parks exist in and around the power plant area, an impact on protected areas is not expected.
	10	Ecosystems	B-	B-	B-	B-	**CO:** Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies. **OP:** The power plant site and its surrounding areas will have already been converted into commercial purposes. There is no natural forest in these areas. Plant's gaseous emission and excessive noise may disturb the surrounding inhabiting floral and faunal species. Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
	11	Hydrology	B-	B-	B-	B-	**CO**: During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds. **OP**: Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.
	12	Topography and geology	D	D	N/A	N/A	**CO/OP:** No impacts are expected
Social environment	13	Involuntary Resettlement	D	D	N/A	N/A	**CO:** The power plant will be established under the designated site of AEZ. No additional land will be acquired. **OP:** No impacts are expected.
	14	Vulnerable group	B-/B+	B+	B-/B+	B+	**CO:** The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities. Very minimum vulnerable people will be affected as per census survey. On the other hand, job opportunity and commercial opportunity would increase. **OP:** Non-technical skill job opportunities as workers of the power plant and commercial opportunity would improve.
	15	Indigenous and ethnic people	D	D	N/A	N/A	**CO:** No indigenous and ethnic persons were identified as per the census survey, and no such communities exist around the project site. **OP:** No impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B+	B+	B+	B+	**CO:** Increase of job opportunity as construction workers. **OP:** Increase of job opportunity as workers of the power plant or commercial opportunity targeted to these workers is expected.
	17	Land use and utilization of	D	D	N/A	N/A	**CO:** There will be no significant change in land use. **OP:** During operation of the power plant, no further

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
		local resources					changes are expected.
	18	Water usage	B-	B-	B-	B-	**CO:** The surrounding wells may be affected by the reduction of underground water level resulting from underground water intake during the construction work and labor camps. **OP:** Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes. Excessive withdrawal of groundwater may lead to depletion of aquifers without proper monitoring/ assessment of the depth of the existing wells and installed deep groundwater wells with supply capacities. The deep-well water within the AEZ will utilize different water layer so that significant impact is not expected to the surrounding wells near the project site.
	19	Existing social infrastructures and services	D	D	N/A	N/A	**CO:** Constructional activities of the power plant will not affect the access of the inhabitants to the social infrastructure and service facilities of the community. **OP:** No impacts are expected due to the development of the power plant.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	**CO:** No impacts are expected. **OP:** No impacts are expected.
	21	Misdistribution of benefits and damages	D	D	N/A	N/A	**CO**: Employment opportunity will be increasing. Those who are not hired as construction workers may experience some misdistribution between communities. However, the impacts will be very minimum. **OP:** No activity will cause misdistribution of benefits and

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							damages.
	22	Local conflicts of interest	D	D	N/A	N/A	**CO:** Due to an increase in employment opportunity will be increasing. Those who are not hired as construction workers may experience some conflicts between communities. However, the impacts will be very minimum.
							OP: There are people who would get job opportunity as workers of the power plant.
	23	Cultural heritage	D	D	N/A	N/A	**CO/OP:** Nothing found in the development area would be affected by the development.
	24	Landscape	D	D	N/A	N/A	**CO/OP:** There is no picturesque scenery in or around the site.
	25	Gender	B-	D	B-	N/A	**CO:** Female laborers may be discriminated in wage at the construction site.
							OP: Project activities do not attract gender issues.
	26	Children rights	B-	D	B-	N/A	**CO:** Underage employment may occur at the construction stage.
							OP: No impacts are expected.
	27	Infectious diseases	B-	B-	B-	B-	**CO:** Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers.
							OP: There is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.
	28	Working conditions, including occupational safety	B-	B-	B-	B-	**CO:** Accidents and incidents during construction may occur. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health.
							OP: Accidents or incidents are expected to occur due to electrical work, fire accident, gas leakage etc.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
Others	29	Accidents	B-	B-	B-	B-	**CO:** Accidents may occur due to the operation and movement of heavy equipment, vehicle and machinery. **OP:** Road accidents may occur due to plant vehicles and motorbikes. Gas distribution line has risk due to the bursting of pipes or leakage.
	30	Transboundary impact and climate change	D	B-	N/A	B-	**CO:** Emission from construction work is expected, but impacts are negligible. **OP:** Emissions of GHGs are generated from vehicle traffic and power plant operations.

Evaluation: A-: Significant Negative Impact A+: Significant Positive Impact
B-: Some Negative Impact B+: Some Positive Impact
C: Degree and scope of impact are not clear thus more investigation required
D: No impacts or impacts are negligible; no further study is required;

Table 8-14: Environmental Impact Assessment for Gas Transmission Pipeline Based on Survey

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	D	B-	N/A	**PC/CO:** During the clearing of RoW excavation and backfilling of pipelines, some dust distribution is expected. Also, movement of vehicles and heavy equipment emit a small amount of SOx, NOx and CO2.
							OP: No impacts are expected
	2	Water pollution	B-	D	B-	N/A	**CO**: For installation of gas pipeline, land acquisition (20-feet strip) for the RoW is required and some water bodies will be affected. Additionally, for smooth implementation of the work, temporary roads would be constructed on one side of the RoW within the 20-Feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction stage as excavated soil from trench will be dumped beside RoW. Waste will also be produced from the washing of aggregate and sand. If these are inadequately handled, surface water and underground water may be contaminated. Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality.
							OP: No impacts are expected
	3	Waste	B-	D	B-	N/A	**CO:** Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the domestic solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected and typically managed by the appointed contractors.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							OP: No impacts are expected
	4	Soil pollution	B-	B-	B-	B-	**PC:** It is likely that the soils of the project sites will not be polluted.
							CO: The soils of the canal crossing sites may be polluted with the liquid wastes (mud) generated from the canal crossing activities. Vehicular oil and lubricants also pollute the soil quality. The waste lubricants will not only pollute the soils but also contaminate the groundwater in the long run.
							OP: Pigging of the pipe for cleaning purposes may generate hazardous pollutants from TBS/CGS etc., which are likely to be spread over the soils. If these pollutants are not safety disposed of, then the soils of the project areas will be polluted.
	5	Noise	B-	D	B-	N/A	**PC/CO**: With the progress of construction work, the noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact
							OP: No impacts are expected
	6	Ground subsidence	D	D	N/A	N/A	**CO/OP:** There is no evidence or trace of ground surface subsidence around all the project sites. No impacts or impacts are negligible, no further study is required.
	7	Offensive odours	B-	D	B-	N/A	**CO**: The amount of domestic solid waste will increase due to the inflow of a great number of workers. If such waste is inadequately handled, the odour may be produced by putrefaction;
							OP: No impacts are expected
	8	Sediment quality	B-	D	B-	N/A	**CO:** The bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the crossing activities. The waste lubricants will not only pollute the sediments of waterbodies but also

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							contaminate the groundwater in the long run. **OP:** No physical activities are expected during operation, and no impacts are expected.
Natural environment	9	Protected areas	D	D	N/A	N/A	**PC/CO/OP:** No direct connection with protected area involves the project despite the Sitalakhya River which is considered as ECA under the government notification. No surface water will be disturbed with underground pipelining technologies utilized by the authorized agencies as per the applicable laws and regulation of natural gas utilization and safety.
	10	Ecosystems	B-	D	B-	N/A	**PC:** The habitat types and ecosystem found in the non-forested agricultural and homestead areas are not considered to be significant from a biodiversity perspective. Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. Similar to terrestrial ecosystems, aquatic ecosystems are also not likely to be affected. The gas Pipeline project has very limited impact on trees. A total of 225 fruits trees were identified of which 147 were large, 37 were medium, and 2 were and saplings. There were 29 large size timber trees and only 10 banana trees to be cut down due to the project. **CO:** Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Many species of flora and fauna would frighten easily by vehicle horns and civil works that may become distressed. With the progress of construction work, canal water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies. Contamination will occur due to civil construction

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							work.
							OP: No impacts are expected
	11	Hydrology	B-	D	B-	N/A	**CO**: For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW.
							OP: After the backfilling, no impacts are expected.
	12	Topography and geology	D	D	N/A	N/A	**CO/OP:** No impacts are expected
Social environment	13	Involuntary Resettlement	A-	D	A-	N/A	**PC/CO:** The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. The entire land is privately owned and needs to be acquired. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition. Additionally, the value of surrounding land that is not acquired will decrease as the construction of structures is prohibited within a certain distance from the RoW. The project does not compensate for the small piece of land which can only be used as agricultural land. Some PAPs have no other properties than the affected properties. Requisition of land for the project will also affect people of the project area. The soil becomes compacted and will not be suitable for cultivation at least for one crop season.
							OP: No impacts are expected
	14	Vulnerable	B-	D	B-	N/A	**CO:** Gas Pipeline project, out 253 households a total

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
		group					of 58 (22.92%) households were identified as vulnerable. Among them 20 are female-headed having no male income earner, 13 are elderly headed, and 25 were identified as extremely poor. Very minimum vulnerable people will be affected. On the other hand, job opportunity and commercial opportunity would increase. **OP:** The landowners can use the land for agricultural purpose after the pipeline installation.
	15	Indigenous and ethnic people	D	D	N/A	N/A	**CO:** no indigenous/ethnic people live in the project affected area. **OP:** no impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B-/B+	B-	B-/A+	D	**CO:** Only one (1) persons were identified as sharecroppers in the project area. Two factories need to be relocated temporarily. Workers involved with these factories will lose their job due to the construction of the gas transmission line. A total of 52 workers will lose their livelihood earning source. PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. Some industries' operation will be temporarily closed for the pipeline installation. Workers of the factories will lose their job temporary. On the other hand, an increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. **OP:** In the RoW areas, agricultural land use practices will be suspended for a temporary basis. After installation of pipeline, Farmers can use this land again for agricultural activities.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
	17	Land use and utilization of local resources	B-	C	B-	D	**CO:** The Gas Pipeline requires approximately 8.86 acres of land. The entire land for the project identified as privately owned land and need to be acquired. Large portion (8.17 acres) of land selected for gas pipeline project is found as an agricultural category, though at many places the owners of land developed the land for homestead purposes. The 8.86 acres of agricultural land will be altered by the construction activities. Therefore, the annual agricultural production rate of that upazila will diminish. In the project site, the land is single cropped agricultural land, so the impact on agriculture activities/ resources is anticipated to have a low impact from the project development. **OP:** No impact on agriculture resources is anticipated. In the RoW areas, agricultural land use practices will be restored.
	18	Water usage	D	D	N/A	N/A	**CO:** The water will be used only for drinking, so the impact is very negligible. No impacts are expected. **OP:** No impacts are expected.
	19	Existing social infrastructures and services	D	D	N/A	N/A	**CO:** An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community. However, the construction period is short so that impacts is very minimum. **OP:** No impacts are expected.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	**CO:** Construction may disturb access to social or public institutions and services temporarily but the construction period is short, and impact will be minimum. **OP:** No impacts are expected.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
	21	Misdistribution of benefits and damages	B-	D	B-	N/A	**PC:** Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation. **CO:** Affected Landowners, factory workers, may not find the same income source. **OP:** No impact is expected.
	22	Local conflicts of interest	D	D	N/A	N/A	**CO:** Due to an increase in employment opportunity will be increasing during construction; candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum. **OP:** No impact is expected.
	23	Cultural heritage	D	D	N/A	N/A	**PC/CO/OP:** No cultural heritage is found
	24	Landscape	D	D	N/A	N/A	**PC/CO/OP:** There is no picturesque scenery in or around the site.
	25	Gender	B-	D	B-	N/A	**CO:** Wives of those men who lose their land or jobs may suffer from adverse effects on their household economy. Female laborers may be discriminated in wage at the construction site. **OP:** Project activities do not attract gender issues.
	26	Children rights	B-	D	B-	N/A	**CO:** Access to school may be disturbed, and underage employment may occur at the construction stage. **OP:** No impact is expected.
	27	Infectious diseases	B-	D	B-	N/A	**CO:** It is envisaged that outsourced personnel will comprise mostly of skilled laborers and workers. During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility with HIV/AID and infectious diseases can spread among other workers and local peoples. **OP:** No impact is expected.
	28	Working conditions,	B-	B-	B-	B-	**CO:** Noise and vibration due to the movement of vehicles, heavy equipment and Lorries will have

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
		including occupational safety					impact workers health as well as surrounding people. The produced welding sparks and radiation from radioisotopes, which are harmful to the human body will impact the health of the workers; local people and wildlife. It is anticipated that there are high possibilities of fire due to the negligence of the responsible personnel for handling, storing and using of primer and condensate.
							OP: During operation and maintenance period, the leakage of gas from the high-pressure pipeline may occur. Further, various forms of operation or manoeuvring errors may occur during the operation. Severe flood and earthquake may damage the gas pipeline period, as a result, it may cause severe injury of the workers.
Others	29	Accidents	B-	B-	B-	B-	**CO:** It is anticipated that the risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machinery. **OP:** During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated which may cause fire and other disasters to the life, property and environment. Severe flood and earthquake may damage the gas pipeline period, as a result, it may cause severe injury of the workers.
	30	Transboundary impact and climate change	D	D	N/A	N/A	**CO/OP:** Impacts are negligible.

Evaluation: A-: Significant Negative Impact A+: Significant Positive Impact
B-: Some Negative Impact B+: Some Positive Impact
C: Impacts are not clear, need more investigation
D: No impacts or impacts are negligible, no further study is required

CHAPTER 9: ENVIRONMENTAL MANAGEMENT PLAN

9 ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING INDICATORS

9.1 Introduction

The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time frame with specific responsibility assigned and follow-up actions defined. EMP is a plan of actions for avoidance, mitigation and management of the negative impacts of the project. Environmental & Social enhancement is also an important component of EMP. A detailed set of mitigation measures have been compiled in view of the likely impacts associated with the proposed power plant and gas transmission pipeline.

The EMP consists of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation (post-construction) stages of the project. The EMP has been designed keeping in view the regulatory and other requirements to ensure the following:

- Minimum disturbance to the native flora and fauna
- Compliance with the air, water, soil and noise quality norms
- Conservation of water to the extent possible through rainwater harvesting, wastewater recycling

9.2 Mitigation Plan

The proposed developments may have some impacts on the environment and society such as the change in land use, removal of vegetation, increased dust emissions etc. Health & Safety Plan along with the EMP has been drafted. Details of which are given below. Power plant and Gas pipeline shall be constructed by BEZA/Third party agency. EMP implementation shall also be BEZA who will intern implement it through the contractor.

9.2.1 Mitigation Plan for Pre-Construction, Construction Phase& Operation Phase

A summary of mitigation measures identified for the pre-construction, construction& operation phases of the Project is presented in ***Table 9-1***. This also identifies lead responsibility for implementing the mitigation measures and sources of funds for such implementation.

Table 9-1: Environmental Mitigation and Management Plan for Power plant (Construction & Operation Phase)

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Construction Phase							
Environmental Pollution	Air Pollution	B-	• Earthworks construction, site clearing, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, and hauling of materials will generate dust • Construction machinery and transportation vehicles will be generated SOx, NOx, smoke, soot and earth, sand and dust particles	• Periodic inspection and maintenance control will be conducted to reduce exhaust discharged from construction machines and vehicles. • The sprinkling of water at the construction site and haul roads • Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; • Raw materials excavated soil and other debris should be stored under covered sheds • Generators, compressors, and other equipment to be shut down when not infuse; • Provision of the face mask to workers to minimize inhalation of dust particles; • Low sulphur diesel should be used for running construction equipment and vehicles; • Air emission monitoring programme to be undertaken quarterly by the contractor, according to the design specified in the EMP and the contract specifications. The programme must include, as a minimum monitoring of SPM, CO, NO2, SO2, PM2.5 and PM10; • Strict fuel/chemical inventory and minimization of spillages to reduce	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			fugitive vapour emissions.			
Water Pollution	B-	• Effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work; • Waste will also be produced from the washing of aggregate and sand; • Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality.	• Avoid excavation activities during rains; • Prevent piling up of excavated soil, raw material and construction debris at the site by proper management and disposal; • Minimize run-off by using sprays for curing; • Maintaining the appropriate flow of water sprinklers at the site; • Construction of storm water drains along with sedimentation tanks with sandbags as partition as a barrier for direct flow of runoff to the canal; • Collection & Reusing of curing overflow, tire wash water etc. within site; • Construction of adequate nos. of toilets and proper sanitation system to prevent open defecation along the canals/rivers/water supply lines; • Construction of soak pits/septic tanks to dispose-off the domestic wastewater generated from labor camps to prevent disposal of sewage in surface water bodies; • Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies; • No debris/construction material should enter the water body in the	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			area. • No sewage or wastewater should be accumulated in any unlined structure; • Timely disposal of the construction/chemical/hazardous waste so as to prevent leaching of any pollutant to the ground; • The groundwater quality should comply with Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines;			
Waste	B-	• Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. • The household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. • If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise.	• Segregate waste to minimize waste material; • Waste should be segregated and disposed of in the separate place; • Reuse as much as possible with consideration of soil property;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Soil Pollution	B-	• Excavation work for structures, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. • Storage of raw material,	• Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management practices to prevent any spillage of raw materials;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		fuel and construction debris may contaminate the soil. • Soil may also contaminate through spills and leaks of fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.	• Construction debris should be stored under covered sheds and paved surface and should be disposed of regularly to designated sites; • Waste from labor camps can be segregated at the site. Food waste/wet waste should be composted in pits within the campsite; • Recyclable waste should be sold to the authorized dealers ensuring environmental friendly, and the remaining should be disposed of at designated sites through local agencies responsible for waste management in the area;			
Noise	B-	• Noise will be generated from the construction machinery, equipment and transportation vehicles;	• Vehicles and machinery should be regularly serviced and check for pollution control; • The worker who will be work high noise area should provide earplug; • No noise generating activity shall be carried out in the night; • Use low noise generating equipment; • Temporary noise barriers should be provided near the high noise generating areas like metal or tiles cutting sites, generator room etc.; • Any employee who may complain about ear related pain and or complication while at work to access medical attention at the expense of the contractor or project proponent; • Regular noise monitoring, especially	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				at the school and residential area located close to the project site should be carried out; • Machinery to be used should comply with the noise standards prescribed by DoE as well as EHS IFC Guideline 2007;			
	Sediment Quality	B-	• Inadequate handling of domestic solid waste, raw material, hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds.	• Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management practices to prevent any spillage of raw materials; • Construction debris should be stored under covered sheds and paved surface and should be disposed of regularly to designated sites; • Recyclable waste should be sold to the authorized dealers ensuring environmental friendly, and the remaining should be disposed of at designated sites through local agencies responsible for waste management in the area;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Natural Environment	Ecosystems	B-	• Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. • Canal water pollution may occur due to inadequate	• No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labor camps and prevent its disposal in the water body; • Toilets should be provided at the site to prevent contamination of water	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies. • Birds in the homestead vegetation will be disturbed	due to open defecation in nearby areas; • Vehicle washing/equipment cleaning should not be allowed near canal/ drains; • Wastewater from the washing area should be collected and should be used for curing purpose or wheel washing purpose; • Temporary storm water drainage system should be developed at the site to channelize the stormwater away from the debris storage area and raw material storage area; • All the raw material and debris should be stored in covered sheds on paved surfaces to minimize the contamination of rainfall run-off; • Diesel, paints, cement etc. should not be stored near the water bodies and drain;			
Hydrology	B-	• During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds.	• Natural drainage pattern should be maintained. Run-off assessment shall be made of the catchment area, and peripheral/garland drains shall be constructed around the power plant based on the assessment of catchment area (frequency, and storage area); • The stormwater drain shall have the provision of de-siltation before discharge to canal/waterbody;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	B-	• The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities • The vulnerable people who involved in agricultural work will be affected mostly by this project;	• Provide unskilled jobs and employment opportunities for vulnerable that may increase their participation and support them with income and livelihood. • Organising women in self-help group to operate canteens in the construction campsite; • Implementation of social welfare programs targeted at vulnerable groups including old aged, physically handicapped etc.	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Water Usage	B-	• The surrounding wells may be affected by the reduction of underground water level resulting from underground water intake during the construction work and labor camps.	• Water for curing can be saved by carrying out curing in the early morning or late evening and covering structures with gunny bag so as the moisture can be restored for a longer time; • Regular inspections at the site to monitor leakages in water storage tanks; • Creating awareness among construction workers about the importance of water conservation; • Adoption of the advanced technologies and machinery which helps in minimizing water requirement for construction; • Storing the curing run-off and wastewater from other construction activity and using the same for sprinkling;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
	Gender	B-	• Female laborers may be discriminated in wage at the	• Monitoring of payment to workers by the contractor shall be implemented	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		construction site	not to allow payment gaps between male and female			
Children's Right	B-	• Underage employment may occur at the construction stage.	• Child labor at the construction site during the project implementation shall be strictly prohibited since such practices are banned by both Bangladesh laws and JICA guidelines; • BEZA shall regularly monitor project sites to guide Contractors and their related firms to discourage child labor; • Introducing them to assistance organizations such as NGO and so forth	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Infectious Diseases	B-	• Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers.	• To provide surveillance for worker's health; • Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; • To provide treatment through standard case management in on-site and community health care facilities as necessary; • Educating project personnel and residents on risks, prevention and available treatment; • Promoting collaboration with local authorities to enhance access of worker's families and the community to public health services and promote immunization as necessary; • Promoting the use of repellents,	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			clothing, netting, and other barriers to prevent insect bites;			
Working conditions, including occupational safety	B-	**Occupational Health & Safety** • Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health; • May insect and snake bite in the labor camp; • Road Accident	• Provide adequate health care facilities and first aid within construction sites; • Provide OHS training program and information on basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure; • Provide adequate lavatory facilities for the number of people expected to work in the facility; • Provide adequate supplies and easy access to drinking water with a sanitary; • Provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; • Arrange for the provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; • Promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labelling of equipment,	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			communicate Hazard codes, electrical; • Establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • Identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
		Community Health & Safety • Traffic congestions on roads and possible disruption to the community usage during peak movement hours; • Inconvenience to the community in terms of air and noise pollution caused by the movement of vehicles; • Generation of dust and odour from the construction site which may have health-related impacts on the local community; • Fire Safety from the construction activities which may include handling and storage of flammable chemicals and materials; • Improper disposal and	• Provision of infrastructure for migrant labor such as water supply, electricity, sanitary facilities, medical aid and other basic amenities to avoid dependence on limited local resources; • Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area; • Creating awareness among the drivers about speed, traffic safety, use of horns etc. while driving through settlement areas; • Covering of trucks while carrying soil, sand, cement, aggregates etc. to minimise the spread of dust and spill over; • Avoiding unnecessary movement of the vehicle through settlement area to minimise disturbance and traffic safety related issues; • Creating awareness among children,	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		migration of sewage into the surroundings;	women, and old age people in particular and the community in general on traffic safety by using existing mediums such as school, women self-help groups, village union and religious occasions; • The sprinkling of water to suppress dust generation in the construction zone; • Provide training and create awareness about fire and safety among workers at the site; • Disposal of wastes at pre-identified waste dumping site to avoid unauthorized dumping;			
		Risk of Fire • Risk of fire might increase due to the implementation of the construction work • Faulty electrics are the biggest cause of workplace fires, loose wires, plugs that are overloaded • Old equipment can all make for a potential death trap • Discarded cigarettes can cause fires • Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present • Improper use of equipment, accidents, drinks being spilt	• Minimize the impact, the rule and the internal regulation for the power plant of Araihazar will be applied appropriate security and safety system for their implementation; • Maintain safe housekeeping practices that reduce the risk of fire danger; • Implement a program that includes preparation, prevention, and recognition of fire Risk; • Proper handling of combustible and flammable material; • Keep all fires and heaters well guarded, especially open fires; • Keep portable heaters and candles away from furniture and curtains; • Don't dry or air clothes over or near the fire or the cooker; • Do not smoke in the project site;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			over electrical equipment and leaving cooking unattended • The most common causes of fires in the workplace are human error.				
Others	Accidents	B-	• Accidents may occur due to the operation and movement of heavy equipment, vehicle and machinery.	• Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; • Provision of traffic signs, road mark, bump, zebra mark, guardrail and pole, and curbstones etc.;	Appointed Contractor	BEZA/Power Plant Developer	Contractor Cost
Operational Phase							
Environmental Pollution	Air Pollution	B-	• The exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution SOx or NOx without proper technologies and maintenance.	• Latest technology, methodology, and machinery involving minimal air emissions should be adopted by Power Plant; • Process emission if any shall be controlled with the installation of adequate air pollution control systems; • Complete combustion of the fuel occurs in the gas turbine. Almost no CO or SPM is produced; • A low-NOx burner/ water injection is used to minimize generation of the nitrogen oxides; • It is suggested to install a high stack to minimize the impact. • Air pollution monitoring should be carried out by the power plant to check the air pollution level; • Check leakage and reduce fugitive	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			emission of gas from the distribution pipeline system. • Exercise careful and minimum venting & purging of gas; • Maintain generator and other machine and equipment in good condition to operate with low exhaust particularly at the regulating & metering Station locations. • Power Plant should obtain clearance from DoE, Bangladesh. • Periodic renewal of ECC should be obtained by the Power Plant;			
Water Pollution	B-	• Plant effluent and domestic wastewater will be generated, and waste will also be produced. If inadequately handled, surface water and groundwater will be contaminated.	• The power plant has to arrange pre-treatment facility to treat their processed effluent and sewage they generate to meet a certain level of pollution load set by the operator; • Pre-treated wastewater will be treated in CETP/STP to meet national wastewater discharge standards as well as the international standard set forth by BEZA; • Storm and industrial wastewater will be collected in separate pipe networks to prevent contamination of stormwater draining to natural wetlands; • Power plant should treat the effluent and sewage generated by them so as to achieve zero discharge, and no untreated effluent should be discharged into any water body; • The stormwater system should be	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			inspected & cleaned before monsoon every year; • River/canal water quality shall be monitored periodically; • Groundwater quality shall be monitored periodically; • The groundwater quality should comply with Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines;			
Waste	B-	• The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. • The office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated;	• For the waste produced in the process of operation of the power plant, the waste management program including the reduction, reuse and recycling of the waste will be worked out; • Site drainage controls to isolate potentially contaminated areas from discharge to the environment; • Environmental training and awareness programs for plant workers should be required;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
Soil Pollution	B-	• Improper storage, handling, disposal of diesel fuel, lubricants, solid and hazardous waste may lead to contamination of the soil.	• Treatment of the effluents and sewage and ensuring proper disposal; • Water Treatment Plant (WTP) shall be installed before the operation; • Segregate non-hazardous solid waste from hazardous one and dispose of properly; • Plant waste generated should be stored in impervious storage tanks; • Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; • Common waste storage areas shall be	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			designated for plant domestic waste; • Recyclable waste should be sent to authorize vendors for recycling and rejected waste should be disposed of as per the norms specified by DoE for the particular waste; • Reduction or total elimination of effluent from the manufacturing process;			
Noise	A-	• The noise generation source during the operation includes the power plant operation, worker's commutation and traffic of vehicles for carrying the periodic inspection materials. Vehicles movement will create noise pollution; • The inhabitants of the surrounding area may have the noise problem.	• Need regular maintenance; • In the field of more detailed designing for the future, efforts must be made to achieve the estimated noise level resulting from the operation of the power generation facility. • Pumps should be fitted in the acoustic enclosure to reduce the noise generation; • Noise barriers will be mandatory for the plant generating noise during operations; • Plantation should be developed along the roads and boundary to form a continuous barrier that will reduce the noise level significantly; • Regular noise monitoring, especially at the school and residential area; • Use of ear-muffs and ear-plugs by power plant personnel working in the generator and turbine facilities of the power plant. • The building, Noise enclosure, Silencer and/or insulation lagging for	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				Gas Turbine.			
Natural Environment	Ecosystems	B-	• Plant's gaseous emission and excessive noise may disturb to the surrounding inhabiting floral and faunal species. • Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.	• Periodic monitoring shall be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact; • No waste shall be discharged in water bodies, i.e. canal and agricultural land etc. • WTP should be installed to treat the effluent generated and to re-use and recycle. • Native tree species will only be planted in the region;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
	Hydrology	B-	• Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.	• Natural drainage pattern should be maintained; • Run-off assessment shall be made of the catchment area, and peripheral/ garland drains shall be constructed around power plant site based on the assessment of catchment area. • The stormwater drain shall have the provision of de-siltation before discharge to retention canal/river; • Install of additional earth drain line around the boundary of the project area if a flood were to occur.	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Water Usage	B-	• Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes • Excessive withdrawal of groundwater may lead to depletion of aquifers without proper assessment of the depth of the existing wells and installed groundwater wells with supply capacities. • Total water consumption is 160 m^3/day of which 80 m^3/day will be used for gas turbine cooling, and rest 80 m^3/day will use for gas booster compressor;	• No objection certificate must be obtained from WARPO prior to install the deep well. • Water efficient technologies will be adopted in central utility service divisions and also at the plant process level; • Adoption of best management practices to prevent water wastage and minimize water loss; • Usage of water conservation fixtures to minimize water consumption; • Installation of the leakage detection system to minimize the water loss; • Regular monitoring of groundwater level in the area should be carried out. Estimated should be made to calculate the draught and recharge of the groundwater aquifers. More green space will be planted to foster aquifer recharge; • Groundwater aquifer assessment studies may be undertaken to assess the groundwater potential. • Treated effluent will be recycled;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
	Infectious Disease	B-	• There is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.	• Conduct mitigation measures stipulated in the international guidelines such as EHS Guidelines of IFC • Conduct Information, Education and Consultation Communication (IEC) campaign periodically to staff, employees, and immediate local communication concerning the risks,	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			dangers and impact and appropriate avoidance behaviour with respect to, of Sexually Transmitted Disease (STD) or Sexually Transmitted Infection (STI) in general and HIV/AIDS in particular, • Provide for STI and HIV/AIDS screening, diagnosis, counselling and referral to dedicated national STI and HIV/AIDS program.			
Working Conditions, including Occupational Safety	B-	**Occupational Health and Safety** • Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health.	• Provide adequate health care facilities and first aid within operation sites of the power plant; • Provide OHS training program and information on basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure; • Provide adequate laboratory facilities for the number of people expected to work in the facility; • Provide adequate supplies and easy access to drinking water with a sanitary means to provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; • Arrange for the provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; • Adequate preventive measures from	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labelling of equipment, communicate hazard codes, electrical; • Identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
		Community Health and Safety • The health and safety risks in the plant during operations include the potential for respiratory diseases, burns, allergies and industrial accidents among the employees and immediate neighboring communities • Emission & Noise generated from the operation of the power plant activities. These emissions may include compounds of Nitrogen and Carbon which may be harmful to the surrounding community; • Fire & Explosion Hazards;	• Adequate provision for suppression of dust and particulate matter originating at the source; • Developing a disaster management plan and community health and safety plan to deal with emergency situations; • Regular training of plant personnel on health and safety aspects; • Creating awareness among the general public around the plant about possible emergency situations and way to respond to them; • Develop an influx management plan to address the influx related issue; • Release of nitrogen and carbon compounds within the permissible limit so that human health is not affected;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
		Risk of fire • Risk of fire would increase due to activities of the power plants • Overloaded electrical	• The power plant shall install and maintain an effective fire alarm system and firefighting system for each building in the plot, and implement emergency drill with	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			systems could result in hotwiring or connections, or failed components might occur at operation phase. • Old equipment can all make for a potential death trap • Discarded cigarettes can cause fires • Human error.	reference to the rule and regulation; • Implement a program that includes preparation, prevention, and recognition of fire Risk; • Proper handling of combustible and flammable material; • Prohibit smoking in the project site; • Install approved smoke detectors on each floor.			
Others	Accident	B-	• Road accidents may occur due to plant vehicles and motorbikes. • Gas distribution line has risk due to the bursting of pipes or leakage.	• Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; • Provision of traffic signs, road mark, bump, zebra mark, guardrail and pole, and curbstones etc	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost
	Transboundary impact and climate change	B-	• Emissions of GHGs are generated from vehicle traffic and power plant operations.	• Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible;	EHS team of Plant Operation Company	BEZA/Power Plant Operation Company	O&M Cost

Table 9-2: Environmental Mitigation and Management Plan for Gas Transmission pipeline (Preconstruction, Construction & Operation Phase)

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Preconstruction Phase							
Environmental Pollution	Air Pollution	**B-**	• During the clearing of RoW removal of the existing structure will create some dust • Movement of heavy vehicles may generate dust and gas emission	• Selecting short and direct routes for all traffic; • Wetting onsite areas • Vegetation clearance during dry weather periods; • Maintaining generator engines and other heavy-duty engines in good repair, to reduce exhaust emissions;	Appointed Contractor	BEZA	Contractor Cost
	Noise	**B-**	• With the progress of construction work, the noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration • Disturbance to religious performance	• Traffic to and from the site to be controlled with respect to routing of vehicles and timing of vehicle movements (i.e. working hours); • Site activities during preconstruction works will to the extent practicable be limited to daytime working • Equipment will be maintained in good working order where appropriate; • Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc.) to minimize noise levels at offsite receptor locations.	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Natural Environment	Ecosystems	B-	• The gas Pipeline project has very limited impact on trees. A total of 225 fruits trees were identified of which 147 were large, 37 were medium, and 2 were and saplings. There were 29 large size timber trees and only 10 banana trees to be cut down due to the project. • Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. • Loss of species diversity • Loss of species due to the disposal of petroleum oil lubricants and toxic refuse	• Vegetation clearance will be minimized; • The site will be fenced, and site access will be strictly controlled; • Damage to habitat in non-work areas will be encouraged to re-grow to as near as possible its original condition. • Traffic to and from the site to be controlled with respect to routing of vehicles and timing of vehicle movements (i.e. working hours);	Appointed Contractor	BEZA	Contractor Cost
Social Environment	Involuntary Resettlement	A-	• The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. The entire land is privately owned and needs to be acquired. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition. • Value of surrounding land that is not acquired will decrease as the construction of structures	• The proper implement of resettlement action Plan (RAP); • Provide adequate compensation in time to PAPs; • The authority should be careful and take necessary measures that every displaced people can be resettled as per the law of the land; • Backfill the land properly; • Need proper action to restore the agricultural land in the previous condition;	DC Office/BEZA	DC office/ BEZA	DC office/BEZA

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			is prohibited within the certain distance from the RoW. • Requisition of land for the project will also affect people of the project area. • The soil becomes compacted and will not be suitable for cultivation at least one crop season.				
	Local economies, such as employment, livelihood, etc.	B-	• PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. • Some industries' operation will be temporary closed for the pipeline installation. Workers of the factories will lose their job temporary.	• Income and livelihood restoration program can be provided to those who need a different job. • Compensation should be provided to the employees of the affected factory if they will lose income. • The standing crop should be compensated as per RAP	BEZA	BEZA	BEZA
	Misdistribution of Benefits and Damages	B-	• Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation.	• Establish GRC. • Establish external monitoring committee or assign external monitoring consultant.	BEZA	BEZA	BEZA
Construction Phase							
Environmental Pollution	Air Pollution	B-	• Emission of dust • Movement of heavy vehicles will emit a small amount of SOx, NOx and CO2	• The sprinkling of water at the construction site and haul roads • Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; • Provision of the face mask to	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			workers to minimize inhalation of dust particles • Maintaining generator engines and other heavy-duty engines in good condition, to reduce exhaust emissions; • Good housekeeping (i.e., strict fuel/chemical inventory and minimization of spillages, to reduce fugitive vapour emissions).			
Water Pollution	B-	• Surface water will be contaminated • Leaks and spills of oil, lubricants, fuel may impact on surface water • Improper handling of sewage and chemical	• Avoid excavation and backfilling activities during rains; • Construction of storm water drains along with sedimentation tanks with sandbags as partition as the barrier for direct flow of runoff to canal or river; • Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies; • The facilities shall be designed and operated to ensure that the risks of accidental releases and spills of environmentally hazardous compounds are minimized;	Appointed Contractor	BEZA	Contractor Cost
Waste	B-	• Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil • The domestic solid waste discarded from the	• Segregate waste to minimize waste material • Waste should be disposed of in the designated dumping site; • Recycled as possible with consideration of soil property; • Use bean at campsite;	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		camping ground of the workers includes cans, bottles and food remnants. • Hazardous waste may contaminate surface and groundwater as well as soil quality				
Soil Pollution	B-	• Vehicular oil and lubricants also pollute the soil quality. • Soil stability and compactness • Temporary loss of soil fertility • Storage of raw material, equipment fuel and construction debris may contaminate the soil.	• Restoration of disturbed soil to its original use or to an approved use; • Installing adequate runoff drainage channels to prevent flooding, inundation and silting; • Provision of a test separator and flare system sufficient to prevent accidental releases from equipment and vehicles during construction activities; • Raw material will be stored under covered sheds and paved surface; • Construction debris should be stored under covered sheds and paved surface and should be disposed of regularly to designated sites;	Appointed Contractor	BEZA	Contractor Cost
Noise	B-	• Noise from generators • Noise will be generated from the construction machinery and transportation vehicles. • Disturbance to religious performance • Exposure of employees to high noise level (above 85dB) continuous for 8 hours per day may result	• Vehicles and machinery should be regularly serviced and check for pollution control; • Equipment will be maintained in good working order where appropriate acoustic hoods will be provided; • Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc.) to minimize	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		in noise-induced hearing lose;	noise levels at offsite receptor locations. • The worker who will be work high noise area should provide earplug; • No noise generating activity shall be carried out in the night; • No construction activities to be undertaken during night hours to prevent any disturbance to nearby residents and labors in labor camps; • Regular noise monitoring, especially at the school and residential area. • Machinery to be used should comply with the noise standards prescribed by DoE as well as EHS IFC Guideline 2007;			
Offensive Odors	B-	• The amount of domestic solid waste will increase due to the inflow of a great number of workers. If such waste is inadequately handled, the odor may be produced by putrefaction;	• Before starting the construction work, the workers will be instructed to classify and collect garbage; • Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction;	Appointed Contractor	BEZA	Contractor Cost
Sediment Quality	B-	• The bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the crossing activities. • The waste lubricants will not only pollute the sediments of water bodies;	• Construction of storm water drains along with sedimentation tanks with sandbags as partition as a barrier for direct flow of runoff to canal or river; • Raw material will be stored under covered sheds and paved surface; • The fuel storage area should be proper containment; • Adoption of best management	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				practices to prevent any spillage of raw materials or waste lubricants;			
Natural Environment	Ecosystems	B-	• Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. • Many species of flora and fauna would frighten easily by vehicle horns and civil works that may become distressed. • Water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent waterbodies • Many species of wildlife are easily by vehicle horn and may become Distressed.	• Plantation of local trees to mitigate the loss of vegetation which will enhance the availability of breeding and roosting space for wildlife, especially birds. • The use of air horns to be limited to emergencies whilst near colonies inhabitants. Many species of birds or other wildlife; • The site will be fenced, and site access will be strictly controlled; • Damage to habitat in non-work areas will be encouraged to re-grow to as near as possible its original condition. • No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labor camps and prevent its disposal in the water body; • Toilets should be provided at the site to prevent contamination of water due to open defecation in nearby areas; • Vehicle washing/equipment cleaning should not be allowed near canal/drains; • Temporary storm water drainage system should be developed at the site to channelize the stormwater	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			away from excavation/filling area, debris storage area and raw material storage area;			
Hydrology	B-	• For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW. • Damage of irrigation networks	• Ensure completion of pipeline construction and backfilling work during the dry season. • Keep provision of the bypass drainage system, if the major streams are obstructed by the alignment during gas pipeline installation. • Construction of new culvert/pipe connection on the temporary road to drain out the overland flow in the critical crossing point. • Removal of spoiled earth of the RoW • If any irrigation canals are damaged or disrupted during project work, immediately the canals should be repaired or re-established. Loss of existing source of irrigation should be replaced by another source. • The interventions in the ponds should be completed within the shortest possible time;	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	B-	• In the Gas Pipeline project, out 253 households a total of 58 (22.92%) households were identified as vulnerable. Among them 20 are female-headed having no male income earner, 13 are elderly headed, and 25 were identified as extremely poor. • The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities • The vulnerable people who involved in agricultural and fishing work will be affected mostly by this project;	• Provide unskilled jobs and employment opportunities for the vulnerable group. • Giving preference in physically less demanding jobs in the worker camp/ construction such as cleaning, office assistant etc.; • Ensure the non-exploitation of women in terms of equal wage, opportunity, participation in decision-making etc. • Implementation of social welfare programs including ILRP targeted at vulnerable groups including women-headed households, old aged, physically handicapped etc. • Provide a special allowance to support livelihood.	Appointed Contractor	BEZA	Contractor Cost
	Local Economics, such as employment, livelihood	B-	• Only one (1) persons were identified as sharecroppers in the project area. A total of 52 workers will lose their livelihood earning source. • PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. • Some industries' operation	• If the agricultural crops are at the ripe stage, the project work may be delayed for allowing the farmers to harvest their crops. If the crops are damaged, farmers should be given financial compensation. • Give proper compensation to farmers and sharecroppers as per LAP • Keep the fish habitats as natural as possible by avoiding the	BEZA/ Appointed Contractor	BEZA	BEZA/Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		will be temporary closed for the pipeline installation. Workers of the factories will lose their job temporary. • On the other hand, an increase of job opportunity as construction workers or commercial opportunity to the workers is expected.	construction of any concrete structure; • Income loss can be mitigated by providing alternative job opportunities for PAPs; • All direct income loss must be adequately compensated within the RAP; • Provision of proper training to all workers for handling the construction activities;			
Land Use and Utilization of local resources	B-	• The Gas Pipeline requires approximately 8.86 acres of land. A large portion (8.17 acres) of land selected for gas pipeline project is found as an agricultural category, though at many places the owners of land developed the land for homestead purposes. • Impact on agriculture activities/ resources is anticipated; • Factory building will be damaged.	• The agricultural area which will be tentatively occupied during construction will be restored to the original state and returned to the landowner after construction. • Backfilling of soil should be done properly. • Soil should be kept clear from contamination during construction work. • Proper compensation for loss of structure should be ensured	Appointed Contractor	BEZA	Contractor Cost
Misdistribution of Benefits and Damages	B-	• Affected Landowners, factory workers, may not find the same income source.	• Give proper compensation to PAPs. • Establish GRC to support PAPs. • Provide ILRP to help PAPs to restore source of income • Assign external monitoring committee or consultant. • Provide job opportunity for PAPs	BEZA/Appointed Contractor	BEZA	BEZA/Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			during construction.			
Gender	B-	• Wives of those men who lose their land or jobs may suffer from adverse effects on their household economy. • Female laborers may be discriminated in wage at the construction site.	• Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female • Monitoring of gender equality should be conducted.	Appointed Contractor	BEZA	Contractor Cost
Children's Right	B-	• Impact on the educational opportunity on school children in PAHs of the Project; • Underage employment may occur at the construction stage.	• Child labor at the construction site shall be strictly prohibited • BEZA shall regularly monitor project sites to guide Contractors and their related firms to discourage child labor; • Social Support of sending children to school; • Introducing them to assistance organizations such as NGO and so forth	Appointed Contractor	BEZA	Contractor Cost
Infectious Diseases	B-	• Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers or the neighbouring community.	• The separate arrangement of accommodation for local workers with the direction of necessary 'code of conduct' is recommended. • To provide surveillance for worker's health; • Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; • To provide treatment through standard case management in on-site and community health care	Appointed Contractor	BEZA	Contractor Cost

Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			facilities as necessary; • Educating project personnel and area residents on risks, prevention, and available treatment about infectious diseases;			
Working conditions, including occupational safety	B-	• Noise and vibration cause of the movement of vehicles, heavy equipment and Lorries will impact on workers health as well as surrounding people. • Welding sparks and radiation from radioisotopes which are harmful to the human body will impact on the health of the workers; • Fire and explosion will impact the project personnel, neighbors; • The improper arrangement of sanitation and drinking water will impact on the health of the project personnel and workers. • May insect and snake bite in the labor camp; • Road Accident may occur	• Care should be taken to move/ operate and maintenance of vehicles, lorries and heavy construction equipment to minimize the level of noise and vibration; • The welding activities should be done in a restricted area. • Arrangement of adequate firefighting equipment, accessories. • Ensure all precautionary measures, i.e., proper storing and other flammable materials to reduce the possibility and risk of fire and explosion. • Enhance regular monitoring to the work site. • Adequate sanitation facilities and supply of pure drinking water will need to be ensured at the site and camps. • To provide adequate health care facilities and first aid within construction sites; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency procedure;	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				• To arrange for the provision of clean eating areas where workers are not exposed to the hazardous or noxious substances; • To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • Establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
Others	Accidents	B-	• Risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machinery. • Road accident may occur	• Need contingency fund for affected neighboring people to address accidental issues during the implementation period, • Need proper danger signs/ posters, road marks, poles, fences etc. to avoid the accident at the pipeline installation site, • Proper awareness program about possible accidents should be ensured for the neighbouring people; • Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors;	Appointed Contractor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Operational Phase							
	Soil Pollution	B-	• Pigging of the pipe for cleaning purposes may generate hazardous pollutants from TBS/CGS etc., If these pollutants are not safety disposed of, then the soils of the project areas will be polluted. • During maintenance, vehicles and machinery lubricant will be spilt over the soils • Handling, storage, transport and disposal of all hazardous materials have the impact to soils	• Solid and liquid wastes should not be spread over the project site. These are to be kept in containers for safe disposal elsewhere. • Segregate non-hazardous solid waste from hazardous one and dispose of properly; • Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; • Some chemicals like odorants, battery fluids etc. at control station plants and the radioactive isotopes which are occasionally used/ hired for NDT in pipeline O&M purposes are to be carefully handled, transported only in properly signed vehicles	TITAS	TITAS/BEZA	O&M
Social Environment	Working Conditions, including Occupational Safety	B-	• Leakage of high-pressure gas may create fire and other disasters during the operation phase • Human Safety • Handling, storage, transport and disposal of all hazardous materials have the impact to soils or ground/ surface water as a result as a result of leakages or spills during use • Fugitive emission of gas from the pipeline system	• Sharing information related possible risk and hazard; • Establish a network of information dissemination; • Organize training sessions for local people to train them in emergency response against possible disaster. • To provide adequate health care facilities and first aid within the operation site; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site-specific hazards, safe work practices, and emergency	TITAS	TITAS/BEZA	O&M

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				procedure;			
Others	Accident	B-	• Possible accidents may include leakage of light oil as a standby fuel or breakage of the gas pipeline in terms of equipment. • The possible accident may be breakage of the transmission line due to the earthquake and others natural disasters.	• Creating and implementing a safety education program • Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities • Management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program • Installation of fire prevention equipment and facilities; • Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning and facilities; • Working out safety regulations.	TITAS	TITAS/BEZA	O&M

9.3 Enhancement Plan

The proposed project involves the development of power plant and Gas transmission pipeline installation. These off-site facilities will be developed by BEZA & TGTDCL. Development of power plant & pipeline will attract the investors for uninterrupted electricity and gas supply and make the Economic Zone at Araihazar more accessible for trading and business. The proximity of the proposed project site to the Dhaka-Sylhet Highway adds to the suitability of the site for setting up the power plant. As enhancement plan, it is proposed that BEZA should develop a thick green belt all around the power plant site, proper stormwater drainage to prevent flooding and rainwater harvesting system to harvest rainwater and use it to meet daily water demand and reduce pressure on groundwater resources.

9.4 Contingency Plan

In order to be in a state of readiness to face adverse effects of accidents, a Contingency Plan is required to be prepared which includes an on-site and off-site emergency plan by the power plant. BEZA is committed to developing a Contingency Plan in consultation with district authorities and plant association. The Contingency Plan will have the following minimal components:

- Accidents preventions procedures/ measures
- Fire prevention planning and measures
- Firewater storage and foam system
- Accident/emergency response planning procedure
- Communication
- Emergency control center
- An emergency information system with role & responsibility and command structure
- Recovery procedure
- Assessment of damages and rectification
- Evaluation of functioning of the disaster management plan
- Accident investigation
- Clean-up and restoration

9.5 Monitoring Plan

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. A monitoring schedule has been sketched based on the environmental components that may be affected during the construction for 3 years' time and operation of the project for 1 year is given below in ***Table 9-3***.

Table 9-3: Environmental Monitoring Plan for power plant

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project Activity areas and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of Contractor	Contractor Cost
Ambient Air Quality	• Dust generation • GHG emission	SPM, PM 2.5,PM10,CO, SOx, NOx	At 4 Locations	24-hour	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq_{day}, Leq_{night} and hourly Leq	At 5 Locations (Important Sensitive Receptors)	24-hour	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Water	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	At 2 locations	Standard Analytical methods	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
	Groundwater quality	Drinking water quality parameters as per Schedule 3 of ECR 1997	At 2 locations	Standard Analytical methods	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Waste and Odor	Internal domestic/ kitchen waste	Solid waste, liquid waste, Hazardous waste	Waste disposable point	Waste a quality	Daily	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Soil	Soil Quality	pH, salinity, NH4+, total-P, heavy metals, oil &	Project Location	Standard analytical	Quarterly	Contractor/ 3rd Party	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
		grease		methods		Environmental Consultant	
Hydrology	• Groundwater level • Ground elevation level • Consumption of groundwater amount	Compliance with mitigation measures presented in the EMP	Well near the construction site	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Social Environment	• Vulnerable Group • Local economies, such as employment, livelihood, etc. • Misdistribution of Benefit and Damage • Gender • Children's Right	• Monitoring of the implementation status of Resettlement works such as a provision of an assistance package for project affected persons, and common assets; • Monitoring of the implementation status for CSR activities such as community support program	Around project site	Visual inspection of all active work areas	Once/year	BEZA	BEZA
Occupational Health and Safety	Accidents or incidents due to construction activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by contractor	As defined in H&S Plan	Contractor/ EHS Team of Contractor	Contractor Cost
Community Health and Safety	Community disturbance and potential safety hazard due to	Accidents, incidents and complaints	Approach Road	Incidents, accidents and community complaints	Based on occurrence	Contractor/ EHS and/or Community Liaison Officer of	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	road traffic					Contractor	
Operation Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project activity areas and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of BEZA	Included in operation and maintenance (O&M) cost
Air Pollution	Stack emissions concentrations	NOx, SOx, CO, SPM	3 Stack for exhaust emission	Standard methods	Half Yearly	3rd Party Environmental Consultant	O&M cost
	Ambient air quality	PM10, PM2.5, SOx, NOx, CO	At 2 Locations	Standard methods	Quarterly	3rd Party Environmental Consultant	O&M cost
Noise	Noise generation by Gas turbine & other operational activities	Sound Pressure Level	1 m from the noise generating equipment	Noise monitor	Quarterly	EHS Team or 3rd Party Environmental Consultant	O&M cost
	Ambient noise	Ambient noise levels	At 5 locations (Important Sensitive Receptors)	Noise monitor with data logger	Quarterly	3rd Party Environmental Consultant	O&M cost
Water	Groundwater quality	Drinking water quality parameters as per Schedule 3 of ECR1997	Borewell water to be used for domestic purposes and treated water quality to be used for drinking	Standard analytical methods	Quarterly	3rd Party Environmental Consultant	O&M cost
	Wastewater	Turbidity, pH, DO, Total	Treated water	Standard	Quarterly	3rd Party	O&M cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
		dissolved solids, oil & grease, total coliform, heavy metals	from ETP	analytical methods		Environmental Consultant	
	Surface water quality	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	At 2 locations	Standard analytical methods	Quarterly	EHS Team/3rd Party Environmental Consultant	O&M cost
Solid & hazardous waste	Internal domestic/ kitchen waste, and medical center waste	Solid waste	Waste disposable point	Waste a quality	Daily	Third Party Agency/BEZA	O&M Cost
Aquatic Ecology	Fisheries	Visible fish kills	The outlet of the discharge	Visual inspection	Fortnightly	Plant EHS Team	O&M Cost
Terrestrial Ecology	Ecology	Visible flora and fauna monitoring	Plant surrounding area of 2 km radius	Abundance, species composition	Half Yearly initial 2 years of operations. Any further monitoring based on the analysis of results	3rd Party Environmental Consultant	O&M cost
Works health and safety Monitoring	Accidents or incidents due to operation and maintenance activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrence etc.	Project activities areas	As to be defined in the H&S plan to be prepared BEZA	As defined in H&S plan	Plant Authority and monitored by BEZA	O&M Cost
Health Monitoring	Community disturbance and potential safety	Accidents, incidents and complains	Access Road	Accidents, incidents and complains	Based on occurrence	Plant Authority and monitored by BEZA	O&M Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	hazard due to road traffic						
	Public Concern	Complains	Neighbouring communities	As to be defined in the H&S plan to be prepared by BEZA	Continuous	Plant Authority and monitored by BEZA	O&M Cost
Disaster Management Plan (DMP) Monitoring	Earthquake	Structure Design	Project Area	As to be defined in the DMP to be prepared by BEZA	Continuous	Plant Authority and monitored by BEZA	O&M Cost
CSR Activities	Community Development	Activities/Programmes and No. of beneficiaries	Neighbouring communities around the Project activity areas	No. of beneficiaries and outcome of the activities	Periodic and need-based	Admin/ HR Manager and Station Manager	CSR Budget

Table 9-4: Monthly Environmental Monitoring Plan for Gas Transmission Pipeline Project

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Preconstruction & construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project site and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of Contractor	Contractor Cost
Ambient Air Quality	Dust generation	Check dust suppression activity	Project site	Visual Monitoring	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq_{day}, Leq_{night} and hourly Leq	At construction and nearest settlement and Important Sensitive Receptors (5 Locations)	24-hour	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Soil & Sediment	Soil pollution due to onsite pipeline installation	Check excavated soil is properly maintained and reuse	Construction site	Visual Monitoring	Regularly	Contractor	Contractor Cost
Water	Surface Water Quality	pH, TDS, EC, TSS, Fe, NH_3 - N, DO, COD, Turbidity, BOD5, Oil and Greases	Adjacent water body (4 location)	Standard Analytical methods	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Waste and Odor	Internal domestic/ kitchen waste	Solid waste, liquid waste, Hazardous waste	Waste disposable point	Waste a quality	Daily	Contractor/ 3rd Party Environmental	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
						Consultant	
Hydrology	• Groundwater level • Ground elevation level • Drainage system	Compliance with mitigation measures presented in the EMP	Well near the construction site	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Social Environment	• Involuntary Resettlement • Vulnerable Group • Local economies, such as employment, livelihood, etc. • Misdistribution of Benefit and Damage	• Monitoring of the implementation status of Resettlement works such as the provision of an assistance package for project affected persons, and common assets; • Monitoring of the implementation status for CSR activities such as community support program	Around project site	Visual inspection of all active work areas	Once/month	BEZA	BEZA
	Gender	- Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female	Construction Site	Visual inspection of all active work areas	Regularly	Contractor	Contractor Cost
	Children Right	- Check Child Labor	Construction Site	Visual inspection of all active work areas	Regularly	Contractor	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Infectious Diseases	Risk of HIV/AIDS	Ensuring that contractor's personnel and local community understand HIV-AIDS awareness campaign	Project site	Consultation with workers and community	Quarterly Monthly	Contractor/ EHS Team of Contractor	Contractor Cost
Occupational Health and Safety	Accidents or incidents due to Gas transmission pipeline construction	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by contractor	Monthly	Contractor/ EHS Team of Contractor	Contractor Cost
Operation Phase							
Soil and Sediment	Soil pollution due to gas pipeline installation	Check excavated soil is properly compacted	The row of gas pipeline	Visual Monitoring	Regularly	Contractor	Contractor Cost
Hydrology	Drainage system	Compliance with mitigation measures presented in the EMP	Well near the project activity area	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Accidents and Occupational Health and Safety	Accidents or incidents due to transmission pipeline construction	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas	As defined in operation phase Health & Safety Plan to be prepared by contractor	Quarterly	Contractor/ EHS Team of Contractor	Contractor Cost

9.6 Monitoring Indicators

The physical, biological and social components, which are of particular significance to the proposed project are listed below:

- Air quality
- Water quality
- Noise levels
- Solid & Hazardous Waste Management
- Re-plantation success / survival rate
- Soil Contamination & Soil Erosion

These indicators will be evaluated periodically based on the monitoring results, baseline conditions, predicted impacts and mitigation measures.

9.7 Cost Estimation for Environmental Mitigation Measures and Monitoring

BEZA will allocate a separate budget for environmental management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as acoustic enclosures for noise control, water and wastewater treatment etc. need to be included in the contract cost estimation and/or operating cost estimation. The environmental management budget estimation for the construction and operation phase of the Project is provided in Table 9-5 to Table 9-9. The Powerplant and Gas transmission pipeline Project authority will have to enforce the instructions from EMP and secure a budget to monitor instructed environmental parameters accordingly. The following table shows the overall cost for the power plant and Gas transmission pipeline project.

Environmental Management Budget for Power Plant:

Table 9-5: Environmental Management Cost (A) in BDT for Power Plant

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
01	Dust management by water sprayer	LS	-	-	300,000
02	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	50,000
03	Campsite waste disposal facilities	Nos.	-	-	200,000
04	First aid box for treatment of injuries in emergency situations	Nos.	-	-	50,000
05	Water Supply	Nos.	-	-	100,000
06	Sanitary facilities	Nos.	-	-	50,000
08	Water quality protection measures: soil pollution and sedimentation control at the construction site and prevention of spillages, leakages of polluting materials, etc. to be at the satisfaction of the engineer.	LS	-	-	100,000
09	Rehabilitation of ancillary sites including stockpile sites, brick crushing sites, borrow areas, workforce camps/ site office, etc. and turfing to the entire satisfaction of the	Sq.m	-	-	100,000

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
	engineer.				
10	Orientation to the technical personnel/ Construction worker associated with the power plant about the key issues of EMP	LS	-	-	Included in the construction cost
11	Ecology (Visible flora and fauna monitoring)	LS			Included in the construction cost
Total Environmental Management Cost (A)					**950,000**

Table 9-6: Environmental Management Cost (B) in BDT for Power Plant

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Operation Stage (Yearly)					
01	Campsite waste disposal facilities	Nos.	-	-	100,000
02	First aid box for treatment of injuries in emergency situations	Nos.	-	-	50,000
03	Water Supply	Nos.	-	-	Included in Operation & Maintenance Cost
04	Sanitary facilities	Nos.	-	-	Included in Operation & Maintenance Cost
05	Tree plantation and green area development plan	LS	-	-	200,000
06	Orientation to the technical personnel/ Operation worker associated with the power plant about the key issues of EMP	LS	-	-	Included in the Operation & Maintenance Cost
Total Environmental Management Cost (B)					**350,000**

Table 9-7: Environmental Monitoring Cost (C) in BDT/yr for Power Plant

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Air pollution	During Construction	Measurement of SPM, PM 2.5, PM10, CO, SOx, NOx	30,000	48	1,440,000
	During Operation	3 Stack Emissions	30,000	6	180,000
		2 Ambient Air Quality Measurement of PM10, PM2.5, SOx, NOx, CO	30,000	8	240,000
Water pollution (Surface & Ground Water)	During Construction	***Surface Water*** Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform,	30,000	16	480,000

Component	Stage	Item	Unit Cost	Quantity	Total Costs
		heavy metals ***Ground Water*** Drinking water quality parameters as per Schedule 3 of ECR 1997			
	During Operation	***Surface Water*** Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals ***Waste Water*** Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals ***Ground Water*** Drinking water quality parameters as per Schedule 3 of ECR 1997	30,000	16	480,000
Noise	During Construction	Periodical maintenance of construction vehicles and installation of sound insulation cover(Noise levels)	5,000	60	300,000
	During Operation	Power Plant Site and 2 closest receptor from power plant	5,000	12	60,000
Occupational Health & Safety and Community Health& Safety	During Construction	Accident or incidents due to construction activities, dangerous occurrences	-	-	Included in EMP Cost
	During Operation	Hazard due to road traffic	-	-	Included in EMP Cost
Ecology	Aquatic and Terrestrial Ecology	Visible flora and fauna monitoring	-	-	Included in EMP Cost
Total Environmental Monitoring Cost (C)					**3,180,000**
Environmental Training	During Operation	Orientation Workshop and follow up training program for capacity building/ institutional development program	-	LS	200,000
Environmental Training Costs (D)					**200,000**
Grand Total (A+B+C+D)					**4,680,000**

Environmental Management Budget for Gas Transmission Pipeline:

Table 9-8: Environmental Management Cost (A) in BDT for Gas Transmission Pipeline

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
01	Dust management by water sprayer	LS	-	-	200,000
02	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	50,000
03	Campsite waste disposal facilities	Nos.	-	-	200,000
04	First aid box for treatment of injuries in emergency situations	Nos.	-	-	100,000
05	Water Supply	Nos.	-	-	150,000
06	Sanitary facilities	Nos.	-	-	100,000
08	Water quality protection measures: soil pollution and sedimentation control at the construction site and prevention of spillages, leakages of polluting materials, etc. to be at the satisfaction of the engineer.	LS	-	-	100,000
09	Orientation to the technical personnel/ Construction worker associated with the Gas transmission Pipeline project about the key issues of EMP	LS	-	-	Included in the construction cost
10	Ecology (Visible flora and fauna monitoring)	LS			Included in the construction cost
Total Environmental Management Cost (A)					**900,000**

Table 9-9: Environmental Management Cost (B) in BDT for Gas Transmission Pipeline

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Operation Stage (Yearly)					
01	Accidents and Occupational Health & Safety and Community Health & Safety	LS	-	-	100,000
02	Orientation to the technical personnel/ Operation worker associated with the Gas transmission Pipeline project about the key issues of EMP	LS	-	-	Included in the Operation & Maintenance Cost
Total Environmental Management Cost (B)					**100,000**

Table 9-10: Monthly Environmental Monitoring Cost (C) in BDT for Gas Transmission Pipeline

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Involuntary Resettlement	Pre-Construction & During Construction	Monitoring of Compensation for impact	-	-	Included in RAP Cost
Air pollution	During Construction	Check dust suppression activity	LS		Included in EMP Cost
Water pollution (Surface Water)	During Construction	***Surface Water*** pH, TDS, EC, TSS, Fe, NH_3 - N, DO, COD, Turbidity, BOD_5, Oil and Greases	30,000	4	120,000
Noise	During Construction	At construction and nearest settlement and Important Sensitive Receptors (5 locations) Noise levels in Leq, Leq_{day}, Leq_{night} and hourly Leq	5,000	5	25,000
Soil and Sediment	During Construction	Visual Monitoring	-	-	Included in EMP Cost
Waste	During Construction	Waste disposal	--		Included in EMP Cost
Occupational Health & Safety and Community Health& Safety	During Construction	Accident or incidents due to construction activities, dangerous occurrences	-	-	Included in EMP Cost
	During Operation	Hazard due to road traffic	-	-	Included in EMP Cost
Ecology	Aquatic and Terrestrial Ecology	Visible flora and fauna monitoring	-	-	Included in EMP Cost
Total Environmental Monitoring Cost (C)					**145,000**
Environmental Training	During construction	Orientation Workshop and follow up training program for capacity building/ institutional development program	-	LS	100,000
Environmental Training Costs (D)					**100,000**
Grand Total (A+B+C+D)					**1,245,000**

9.8 Institutional Arrangement for EMP & EMoP

The main purpose of this environmental assessment is to delineate the correct measures to enhance the environmental sustainability of the proposed project through providing suggestion on design considerations, implementation, management and operation as suggested in the EMP and EMoP.

During Construction Phase of the Power Plant

The organizational structure for the operation and management of EMP and EMoP for the proposed power plant is shown in ***Figure 9-1*** below. The Contractor contracted by BEZA will assign an Environmental Manager for implementation of EMP and EMoP for construction of the power plant (including the substation and the transmission line) construction activities and will submit the environmental monitoring report to BEZA who acts as supervising entity. BEZA will submit the monitoring report to JICA on a quarterly basis.

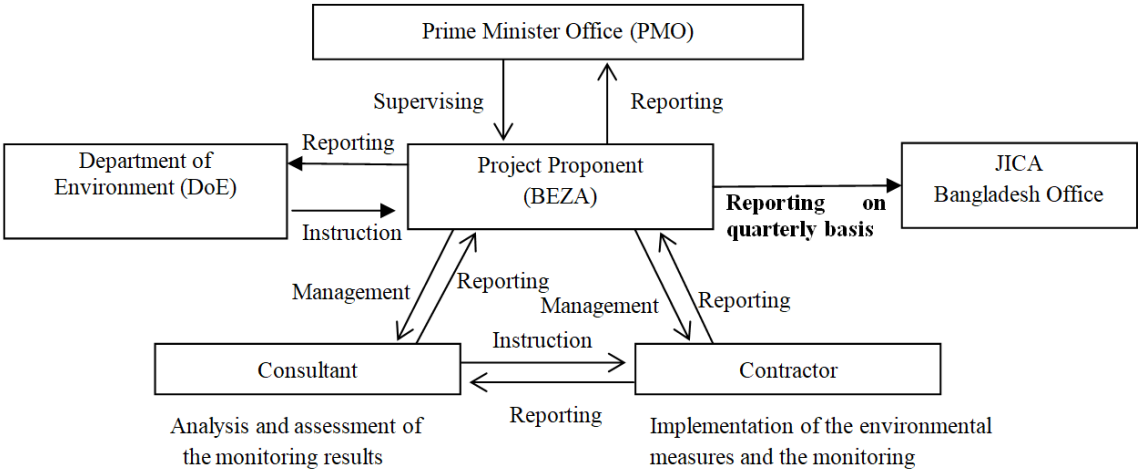


Figure 9-1: Implementation Structure / Mechanism of EMP and EMoP during Construction Phase of the Power Plant

Operation Phase of the Power Plant

The organizational structure for the operation and management of EMP and EMoP for the proposed power plant is shown in **Figure 9-2**. The operator contracted by or forms a joint venture with BEZA will assign an Environmental Manager for implementation of EMP and EMoP during operation of the power plant (including the substation and the transmission line) and will submit an environmental monitoring report to BEZA who acts as supervisor. BEZA will submit a monitoring report to JICA on a quarterly basis.

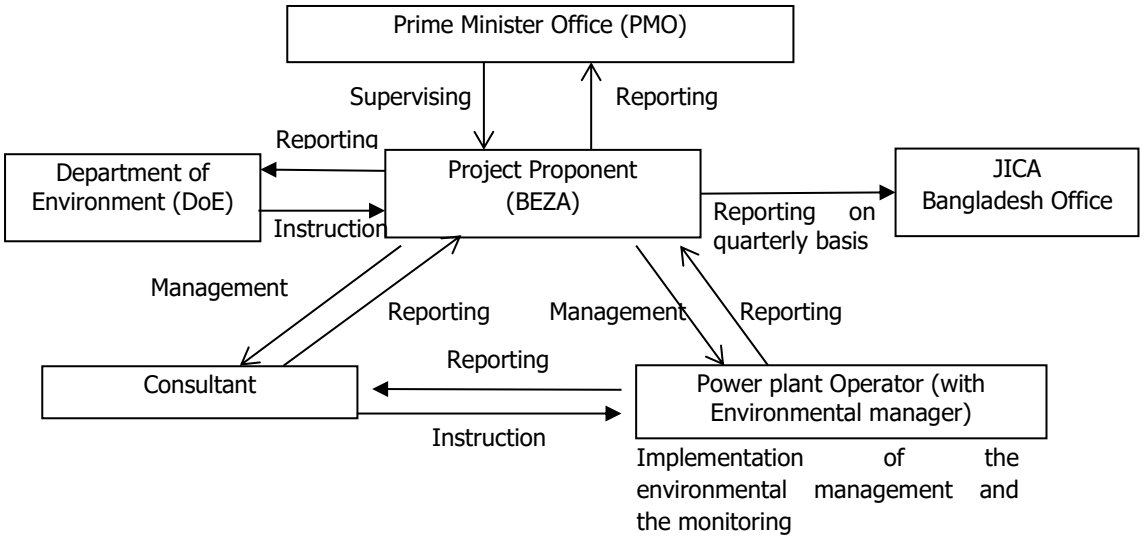


Figure 9-2: Implementation Structure / Mechanism of EMP and EMoP during Operation Phase of the Power Plant

Pre-Construction and Construction Phase of the Gas Transmission Line

The organizational structure for the operation and management of EMP and EMoP for Pre-construction and construction phase of the proposed Gas transmission line is shown in **Figure 9-3** below. The Contractor contracted by TITAS, who will procure and manage the contractor for the gas transmission line construction, will assign an Environmental Manager for implementation of EMP and EMoP. TITAS will submit the environmental monitoring report to BEZA who acts as supervisor. BEZA will submit the monitoring report to JICA on a quarterly basis.

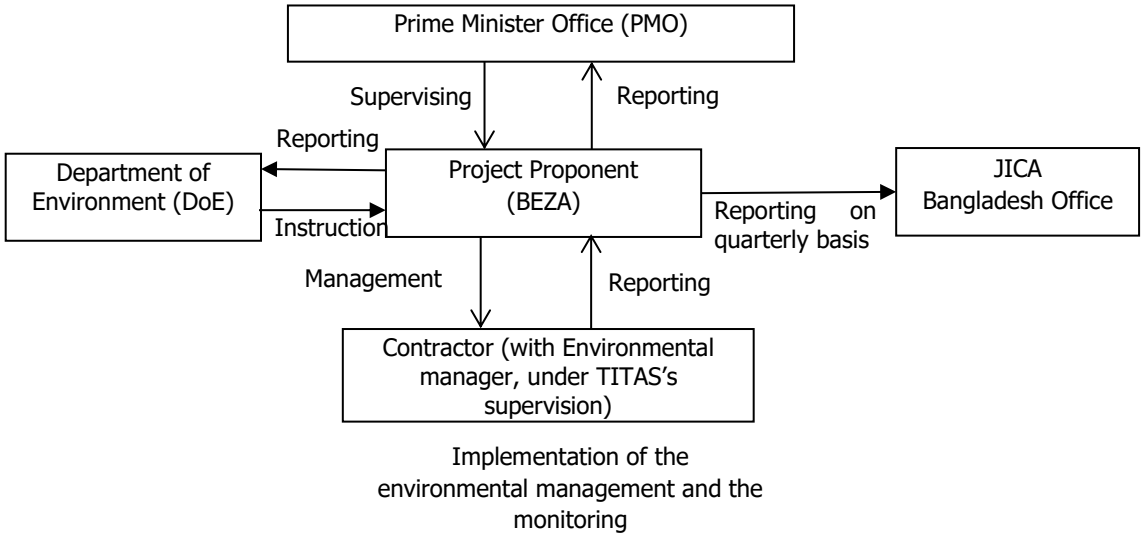


Figure 9-3: Implementation Structure / Mechanism of EMP and EMoP during Pre-construction Phase and Construction Phase of the Gas transmission line

Operation Phase of the Gas Transmission Line

The organizational structure for the operation and management of EMP and EMoP for the operation phase of the proposed Gas transmission line is shown in **Figure 9-4** below. TITAS will be the operator of the gas transmission line; thus TITAS will submit the environmental monitoring report to BEZA who acts as supervisor. BEZA will submit the monitoring report to JICA on a quarterly basis.

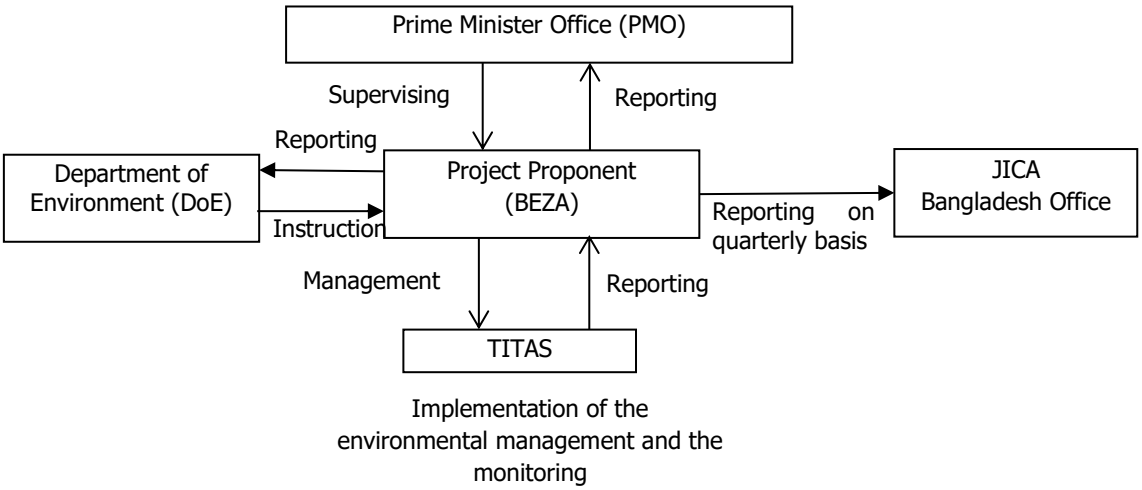


Figure 9-4: Implementation Structure / Mechanism of EMP and EMoP during Operation Phase of the Gas transmission line

CHAPTER 10: CONSULTATION WITH STAKEHOLDERS/PUBLIC CONSULTATION

10 CONSULTATION WITH STAKEHOLDERS/PUBLIC CONSULTATION

10.1 Focus Group Discussions (FGDs)

Focus group Discussion (FGD) is a small, but demographically diverse group of people and whose reactions are studied especially in market research or political analysis in guided or open discussions about a proposed project or something else to determine the reactions that can be expected from a larger population. It is a form of qualitative research consisting of interviews in which groups of people are asked about their perceptions, opinions, beliefs, and attitudes towards the project, service, concept, advertisement, idea or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members.

One discussion was held with the local people & Farmers at near the proposed Gas pipeline site, and 2nd discussion was held with the woman at near the Power plant. Date, location and the number of participants in each discussion are listed in ***Table 10-1***. Different categories of local people were grouped and discussed with many issues to capture their perceptions. The summary of focus group discussions (FGDs) is shown in ***Table 10-2***. Photographs of focus group discussion are shown in ***Annex B***.

Table 10-1: Details of Focus Group Discussions (FGDs) for Gas transmission Pipeline

Sl.	Date	Location of the FGD	Participants			Category of participants
			Total	Male	Female	
1.	24.10.2018	Dighi Borabo near the gas station	7	7	0	Land Owners, Factory Owners, Structure loser and Farmers
2.	16.11.2018	Panchbaria at Duptara union near the power plant	15	0	15	Woman

Table 10-2: Summary of Focus Group Discussion with Land Owners and Farmers

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are very positive about this project. Still, they do not get any kind of letters from Govt./DC's. Many survey works have already been started such as route survey and environmental baseline survey.	Consultants made a clear description on location, pipeline alignment, acquiring process about the proposed project. People are aware of the project in the study area.
Support of local people for the proposed project	Almost everyone suggested that to identify the best possible route and advised the consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during different stages of the project.	The consultants informed that during the design stage of the gas pipeline different alternative options have been considered;

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
Perception regarding the land acquisition	Most of the participants have a positive perception regarding the land acquisitions. However, this land acquisition will create landlessness for the limited affected peoples but for the growth of the country, and it can be acceptable if properly compensated.	All development projects require land acquisition which causes land loss. In compared to national development, this loss is very negligible. However, the landowners can be used this land for agricultural purpose after installation of the pipeline.
What are the characteristics of the lands those are going to be taken for the proposed project?	Proposed land is low in nature. Therefore, during the wet season no agricultural activities can be done. Thus most of the land is used for single cropping production especially in winter season. Most of the lands are used for paddy production, and the production rate is very high in these lands. Paddy produced approximately 25kg per decimal.	In this project, the government will require land acquisition that may cause agricultural loss. However, the landowners can be used this land for agricultural purpose after installation of the pipeline.
How do the landowners and farmers depend on the lands those are going to be taken for the proposed project? How does this dependency contribute to the livelihood?	Most of the landowners and farmers are involved in agriculture and other jobs too. Agricultural production contributes to enhancing the food availability and solvency for these affected households. However, there are some affected persons too who only depend on agricultural production for their livelihood.	Detailed RAP along with proper compensation packages and livelihood assistance will be proposed to prepare for all affected persons respective to all dependencies so that all affected persons can restore their livelihood after the land acquisition. The land will be backfilled properly and restored its previous condition.
How do other people who are not landowners depend on the acquired land? What are the common practices for renting lands to the sharecroppers?	Some people do sharecropping production. These people are usually landless. They do not have land, but they rent this land for a specific time duration to produce a crop for their livelihood. Almost everyone suggested that to identify the sharecropper's list and advised the consultants to consider them under compensation.	During PCM consultant explain that sharecroppers will be compensated according to RAP.
What should be done to minimize the Environmental impacts?	Everyone said that proponent should take precautions in environmental mitigations to minimize air pollution, noise pollution, water pollution, Soil pollution, sediment pollution etc.	The proponent will be monitored/ supervised the project site periodically as per EMP and EMoP.

Table 10-3: Summary of Focus Group Meeting with Women

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
The general perception about the project and the awareness about	Most of the women are in favour of the project and have been made aware of the proposed project	Acceptance of the project

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
the proposed project.	through the various surveys and talking with consultants	
Support of woman for the proposed project?	Everybody said that they would support the project and request the consultants to ensure job opportunity for women	The Consultants informed that the woman would get the job as per their skill.
How a woman will be benefited from the proposed project?	All participants think that power plant development will contribute the national economic growth and it may create some job opportunity for a woman.	The Consultants informed that the EZ would take electricity support from this Power plant. And some job opportunity will be created.
Any critical issue or concern by the local people regarding the project? or Any criteria you would like to see considered during project design, construction and operation stage?	Respondents urged that environmental hotspots (like school, hospital, graveyard etc.) won't be affected. Additionally, They added that dust suppression, noise mitigation and proper drainage system must be considered.	Dust suppression measures and noise mitigation will be considered. BEZA will construct a drainage line around the project boundary to pass the stormwater.
Protected areas (national parks protected forest, religiously sensitive sites, historical or archaeological sites), if any	The proposed project does not pass any protected or ecological critical area.	The nearest sites with terms of cultural or religious significance are far from the proposed power plant.
Any requirements from woman community?	All the women requested the proponent to construct a Community clinic for children and woman.	BEZA has the plan to implement some social welfare programs for neighbour communities.

10.2 Public Consultation Meetings (PCMs)

a) Accountability and Community Participation

As per the JICA Environmental Guidelines, BEZA has disclosed the project information and provided opportunities for stakeholders, particularly project-affected stakeholders including landless sharecroppers, to participate the EIA preparation. Based on the past records in Bangladesh, stakeholders' participation could lead timely land acquisition and resettlement as well as fewer conflicts during the construction and operation stages between project proponents and local stakeholders. Unlike the government-funded projects, it is particularly important to understand the community needs for livelihood recovery assistance, which are not provided by the government-funded projects but are mandatory for the JICA funded projects. BEZA has been committed to complying with the JICA Environmental Guidelines and adapted to enhance the benefits of the project-affected persons (PAPs) throughout the project activities and livelihood recovery assistance programs.

b) The Public Consultation Meeting (Scoping phase) for the Gas Transmission Pipeline EIA preparation and Stakeholder Meeting for the EIA preparation

Public consultation meetings for the Gas transmission pipeline EIA preparation were held at 2 locations adjacent to the project site. PCM at the 1st location was held on 24th October 2018 at the

Paurashava office of one of the major project impacted communities (Tarabo Paurashava, Tarabo). PCM at the 2nd location for the Gas transmission pipeline EIA preparation was held on 30th October 2018 in front of Kazibari mosque of one of the major project impacted communities (Madanganj, Bandar). PCM at the 3rd location for the Powerplant EIA preparation was held on 16th November 2018 at Panchbaria of one of the major project impacted communities (Panchbaria, Duptara). Prior to the notice, BEZA consulted with the local leader and was requested to conduct the consultation/meeting where there is enough space for more than 100 persons under the shadow. The venue was selected in terms of easy accessibility from villages in and around Gas transmission project site and Power plant the meeting place capacity of the building. The project proponent prepared the invitation letter together with the notice of the meeting in Bengali language and announced to the invitees, who are residents in Ward-9 under Tarabo Paurashava, residents of Madanpur union, residents of Duptara union and relevant governmental organizations, non-governmental organizations (NGOs), community-based organizations (CBOs) and anyone who are interested.

Information on the meeting was announced to the invitees one week in advance before the meeting by sending invitation letters to the respective invitees.

As per the JICA Environmental Guidelines, advanced newspaper notice of the consultation was published on 18th October,18 for PCM at Location-1, 23th October,18 for PCM at Location-2 & 11th November,18 for PCM at Location-3 **(*Annex D*)**.

The presentation and handouts were prepared and explained in the Bengali language. The opinions from the participants were received in the question and answer session. Additionally, separately talked with participants so that those who are hesitant to speak out in public could share their views and comments. Furthermore, female assistants were also available for the female participants who need any help.

c) Summarized Outcomes of PCMs (Scoping phase)

PCM for a 1st location for the Gas transmission pipeline EIA preparation was held on 24th October 2018 at the Paurashava office of one of the major project impacted communities (Tarabo Paurashava, Tarabo). The consultation/meeting was participated by roughly 44 persons for location 1**.**The list of participants from these groups and attendance sheet is shown in ***Annex C***.

PCM for a 2nd location for the Gas transmission pipeline EIA preparation was held on 30th October 2018 in front of Kazibari Mosque of one of the major project impacted communities (Madanpur, Bandar). The consultation/meeting was participated by roughly 33 persons**.** The list of participants from these groups and attendance sheet is shown in ***Annex C***.

PCM for the 3rd location for the Power Plant EIA preparation was held on 16th November 2018 at Panchbaria Village of one of the major project impacted communities (Panchbaria, Duptara). The consultation/meeting was participated by roughly 54 persons**.** The list of participants from these groups and attendance sheet is shown in ***Annex C***.

In the consultation meeting, after the explanation on the project outline planned in Gas transmission pipeline project, which passes through the industrial area, residential and commercial areas and the expected key environmental and social benefits as well as potential negative impacts were explained during the preconstruction, construction and operation stage. In addition, survey items of the baseline EIA study and future schedule for the EIA were presented to the participants. At the end, a question and answer session was organized in all the meetings. As a whole, seven questions were raised from the participants and discussed with the project proponent and coordinating organization. Key points raised by the participants are shown in Table 10-5 & Table 10-6.

Table 10-4: Summary of Public Consultation Meeting for EIA at the Scoping Stage

Time and Date	**1st Location:** Date: 24 October 2018 Day: Wednesday Time: 11:00 AM to 12:00 AM **2nd Location:** Date: 30 October 2018 Day: Friday Time: 11:00 AM to 12:00 AM **3rd Location:** Date: 16 November 2018 Day: Friday Time: 03:00 PM to 05:00 PM
Venue	**1st Location:** Paurashava Auditorium Room, Tarabo Paurashava, Rupganj, Narayanganj **2nd Location:** Kazibari Mosque, Madanganj, Bandar, Narayanganj **3rd Location:** Panchbaria Village, Duptara, Araihazar, Narayanganj
Invitees	**1st Location:** - Deputy Commissioner (DC), Narayanganj - Mayor, Tarabo Paurashava, Rupganj, Narayanganj - Upazila Nirbahi Officer, Rupganj, Narayanganj - Social Specialist, EQMS - Environmental Specialist, EQMS - Counsellor, Ward no-9, Tarabo paurashava - Local residents in and around Gas Transmission Pipeline area - Other organizations and individuals who are interested in the Project **2nd Location:** - Deputy Commissioner (DC), Narayanganj - Upazila Nirbahi Officer, Bandar, Narayanganj - Chairman, Madanpur, Bandar, Narayanganj - Social Specialist, EQMS - Environmental Specialist, EQMS - Member, Ward no-3, Madanpur, Bandar - Local residents in and around Gas Transmission Pipeline area - Other organizations and individuals who are interested in the Project **3rd Location:** - Chairman, Dupatara, Araihazar, Narayanganj - Member, Panchbaria, Union: Duptara, Araihazar, Narayanganj - Environmental Specialist, EQMS - Local residents in and around Power Plant area - Other organizations and individuals who are interested in the Project
Attendee	**1st Location:** 44 people (men: 39, women: 5) Age range: 22-70 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons Some participants including the 5 women refused to sign in the participant list. They

	did not want to disclose their identity. **2nd Location:** 33 people (men: 33, women: 0) Age range: 22-70 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons **3rd Location:** 54 people (men: 46, women: 8) Age range: 28-85 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Women, Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons
Agenda	- A brief explanation on the past EIA-related studies - Project description on layout plan, construction process and land acquisition process. - Major positive and negative findings on the draft scoping results - The scope of the EIA study - Further schedule of EIA
Language Used	In local language: Bangali language

Table 10-5: Key Points Raised by the Participants at Public Consultation Meeting (1st Location)

Participants	Comment/Question	Response
Md. Shariful Islam Land Owner, Dighi Barabo	• We are very positive in any kind of government development. Landowners like us have to pay for it for a better future, and we are ready for it. However, if we get the proper land value as compensation compared to market price, we may survive. Otherwise, we will be marginalized or landless. • We heard that new law on land acquisition had been updated in 2017. Where the DC's payment rate has been amended 1.5 times to 3 times. • What would be the DC's rate in the proposed project? • How will the legal landowners be paid?	• Consultant: We are working on the revised gazetted act. We have already approached our administrative procedure. All the Landowners will be compensated as per new gazette. • Consultant: After reviewing all land ownership deeds, R.S. allocation holders' name and the relevant documents, an actual legal owner will be identified and compensated;
Md. Anowar Resident, Dighi Barabo	• Some structures need to be demolished at Dighi Barabo site. Are they compensated for the structure?	• Consultant: At the scoping stage, we tried to minimize the adverse impact as much as possible and design this project. We redesigned our project for not affecting the residential settlements. But some structures will be affected by this project. They will be compensated for their structural loss.

Md. Ashiqur Rahman Resident, Dighi Barabo	• When the construction work starts, land excavation will occur. The surface drainage system will be affected by this project. Consequently, adjacent low lands will be inundated during the wet season. Is BEZA aware of this situation?	• Consultant: The contractor will work excavation work at dry season. In addition, they will not block any kind of drainage system.
Shakil Resident, Dighi Barabo	• He suggests that to identify the best possible route to minimize structure loss and advised the consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during Preconstruction and construction stages of the project.	• Consultant: The contractor should follow the Environmental Management Plan (EMP) & Environmental Monitoring Plan (EMoP), and the proponent will be supervised the progress

Table 10-6: Key Points Raised by the Participants at Public Consultation Meeting (2nd Location)

Participants	Comment/Question	Response
Md. Solayman Resident, Ward-3, Madanpur	• Should be reduced Air Pollution • Job facilities should be available for local people • Gas pipeline transmission should be done considering possible impacts on nature, environment and local people's livelihood	Consultant: • Employment opportunities will be created at the construction stage; • Proper mitigation measures will be applied to minimizing the possible impacts on Environment & Ecology.
Kazi Rabiul Resident, Ward-3, Madanpur	• Project area stands in agricultural land. So proper plan should be taken to minimize the impact on agriculture. • Improve drainage system beside agricultural land otherwise in rainy season lower land will be gone under water • Will give proper compensation to the affected people and land loser? • Improve irrigation system	Consultant: • The proponent will be minimized environmental pollution and reduce minimum pollution on soil quality; • The landowners will be compensated as per govt. land acquisition rules. • Should be improved irrigation canal and drainage system at construction period
Nuru Mia Resident, Ward-3, Madanpur	• The gas pipeline will bring economic growth in our area. • Need to mitigate environmental pollution like air, water, noise etc.	Consultant: • The Air, Noise, Water quality will be monitored as per the DoE standard; • Proper mitigation measures will be applied as per EMP
Md. Khalik Businessman, Ward-3, Madanpur	• Strictly discourage child labor. • Limit migrate workers' employment opportunity	Consultant: • The contractor will be strictly discouraged on child labor. • The contractor will be hired local people for constriction work.

Table 10-7: Key Points Raised by the Participants at Public Consultation Meeting (3rd Location)

Participants	Comment/Question	Response
Md. Jillur Rahman, Businessman, Panchbaria	He raised that nothing has been specifically mentioned about the female workers in regard to the employment of local people. He mentioned that he would be in favour of establishing power plant at Araihazar EZ if the local people are in favour of the power plant at AEZ.	Consultant: In regard to the employment of female workers, he mentioned that there would be no discrimination with female workers. Workers of all genders will have equal opportunity.
Mubarak Mia, Farmer, Panchbaria	He also raised that no power plant shall be constructed unless the local people are fully motivated in terms of their job opportunity and assurance of no negative impacts on the environment.	Consultant: He also assured that people of both genders would enjoy equal opportunity in terms of employment and compensation etc.
Mobarak Hossain, Local resident, Panchbaria	We want a gate in Panchbaria village side so that the workers can easily enter the power plant.	Consultant: BEZA will take necessary steps to easy entrance and exit in the power plant for workers.
Dulal Mia, Farmer, Panchbaria	• For filling the power plant area, the adjacent lower land may go underwater through heavy rain. • If agricultural land affected by the landfilling & construction work. Then BEZA should give us proper compensation on our damages.	Consultant: • Around the boundary wall, BEZA will construct a drainage line to pass the stormwater. • The contractor will give proper restitution based on the damages.
Kiron, Member, Panchbaria	Civil construction, vehicle movement, the operation of equipment, construction of internal road may generate dust, noise and water pollution. Please take proper mitigation measures to reduce the impact	Consultant: The contractor/BEZA will apply proper mitigation measures as per EMP and EMoP at construction and operation stage.
Shahida Mosarraf, Chairman, Duptara	We expect that this company will enhance it's helping hand as a part of social responsibility for developing this locality by contributing to the development of school, college and hospital etc.	Consultant: BEZA has the plan to implement some social welfare programs for neighbour communities.

Photographs of PCM & FGD

Public Consultation Meeting (Location-1)

Public Consultation Meeting (Location-2)

Public Consultation Meeting (Location-3)

Focus Group Discussion with local residents & Farmers

Focus Group Discussion with the woman

CHAPTER 11: RISK ASSESSMENT

11 RISK ASSESSMENT

11.1 Introduction

The problem of protecting human health and the environment may best be defined as the management of risk. The failure to manage risk effectively and to establish priorities rationally translates ultimately into a failure to protect health, safety, and the environment. Through the use of risk assessment, concerned authorities can estimate the relative level of risks posed by different substances, products and activities and can establish priorities in determining whether, and how, to regulate.

Risk assessment is the technical process for estimating the level of risks posed by operational processes or products, i.e. the probability that given harm will occur because of the processes or products. Risk assessment is applied to a substance, proceeds in four major steps:

Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause

- Dose-response assessment: predicting the degree of adverse effects at a given exposure level
- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

Risk management options are then evaluated in a proposed solution to provide the reduction of risk to the exposed population. Specific actions that are identified and selected may include consideration of engineering constraints as well as regulatory, social, political and economic issues related to the exposure. Quantitative assessment of risks associated with hazard identification, dose-response assessment, exposure estimation and risk characterization was beyond the scope of the present study. However, this study takes a qualitative approach to identify common hazards within the power plant and recommends measures for managing these risks with accidents and external threats.

11.2 Risks Assessment

The process of electricity generation from oil or gas is by no means risk-free because of high temperature and pressure conditions within the plants, rotating machinery and high voltages involved. Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the oil/gas based power plants put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometimes loss of life. It is therefore essential that a risk management plan should be devised in order to both reduce the risk of accident and to take the correct action during accidents. Important risks of accidents in power plants leading to disasters or emergency situations may occur during the following events:

- Risks during an emergency: Fire, Explosion, Oil/acid spillage, Toxic chemical spillage, Electrocution
- Risks due to natural disasters: Flood, Earthquake, Storm, Lightning
- Risks due to external threats: Sabotage, Political instability, Water/food poisoning

In power plants, accidents can occur at two different levels. First, these may occur due to fires, explosions, oil or chemical spillage and spontaneous ignition of inflammable materials. In such events, operators working inside the plant and at various strategic hazard locations will be affected.

Second, risks are also associated with external threats of sabotage. Failure of automatic control/warning systems, failure of fuel oil storage tanks and chemical release and handling also pose a great degree of associated risks.

11.3 Managing the Risks

As mentioned earlier, in order to reduce the risks associated with accidents, internal and external threats, and natural disasters, a risk management program is essential. Risk management planning can be done during the design and planning stage of the plant as well as during plant operation. While risk management is mainly preventive in nature during the plant operation stage, the design and planning stage of the plant can incorporate changes in basic engineering to include safety design for all processes, safety margins for equipment, and plant layout. The following steps among others are important in managing the risks mentioned.

- Gas storage is to be designed with adequate precautions in respect of fire hazard control.
- Storage of hazardous substances should be stored in protected areas;
- With respect to plant operation, safe operating procedures should be laid down and followed to ensure safety, optimum operation and economy;
- A firefighting group with adequate manpower and facilities such as water tank of sufficient capacity, $C0_2$ tank, foam tank, portable fire extinguishers should be provided and facilities located at strategic locations, e.g. generator area, high voltage panel, control rooms and fuel tank area;
- Regular checks on safe operating practices should be performed;

In order to achieve the objective of minimizing risks at the Araihazar Power plant, the unit will be trained to act in a very short time in a pre-determined sequence to deal effectively and efficiently with any disaster, emergency or major accident to keep the loss of life, human injury, material, plant machinery and impacts on the environment to the minimum.

CHAPTER 12: EMERGENCY RESPONSE PLAN & DISASTER IMPACT ASSESSMENT

12 EMERGENCY RESPONSE PLAN & DISASTER MANAGEMENT PLAN

12.1 Introduction

An Emergency Response Plan (ERP) is a written document, which is required for an organization according to occupational health safety standards and must be displayed at every job site with a certain number of employees (usually five to ten). It is a detail step-by-step procedure to follow in an emergency such as fire, chemical spill or a major accident. An emergency response plan also includes information such as whom to notify, who should do what, and location of emergency stock. The Emergency Response Plan includes any measures that should be in place at all facilities to combat an accident resulting from fire, explosion or due to any natural calamities (e.g. Earthquake, cyclones and flood).

12.2 Purpose

This Emergency Response Plan has been developed to provide an organizational and procedural framework for the management of emergencies in the Powerplant and Gas pipeline project. The purpose of an ERP is to facilitate and organize employer and employee actions during workplace emergencies. Well-developed emergency plans and proper employee training (such that employee understands their roles and responsibilities within the plan) will result in fewer and less severe employee injuries and less structural damage to the facility during emergencies. A poorly prepared plan likely will lead to a disorganized evacuation or emergency response, resulting in confusion, injury and property damage. To respond immediately for any kind of emergency/ hazardous condition as well as to take proper action immediately/ in a short time to normalize or minimize the situation as soon as possible.

12.3 Scope

This Emergency Response Plan covers those designated actions managers and employees must take to ensure employee and consumer safety from technological and natural hazards as well as other emergencies. This plan includes: emergency escape procedures and emergency escape route assignments, procedures for employees who have to stay to operate critical plant operations after they evacuate, procedures to account for employees after emergency evacuation has been completed, rescue and medical duties for those employees who are to perform them, the preferred means of reporting fires and other emergencies; and individuals who can be contacted for further information about the plan. All of this operation depends on power plant site and RoW of Gas pipeline site and surrounding environment and Senior Manager, ERP coordinators, HOD.

12.4 Objectives

In general, the objectives of a plan describe what we expect to achieve by a plan. Even if the nature of the research or plan has not been clear to a person from the hypotheses, s/he should be able to understand the research from the objectives. An emergency plan specifies the aim and procedures for handling sudden or unexpected situations. For Emergency Response Plan some select outstanding objectives are given below-

1. To identify the various types of natural, manmade and technological disasters and hazards, this may impact on the Project
2. The consequence of these hazards in the Project
3. To propose some necessary action plan for minimizing the worst situations.

4. To conduct safety operation to save life and properties
5. To build up awareness among employee to prevent fatalities and injuries
6. To ensure proper duty at the hazardous period and communication system
7. To ensure the duty of management to take emergency action in a short time
8. Reduce damage to buildings, stock and equipment. Acceleration the resumption of normal operation
9. To find out the means are available to stop or prevent the situation.
10. To ensure Occupational Health & Safety

12.5 Potential Emergencies

Any incident affecting the entire building, which may place life and property in a disaster and hazard, is considered an emergency. Outside emergency services will be required, as will major efforts from various governmental agencies. Various kinds of emergencies are as follows:

Examples of technological hazards are

1. Fire
2. Explosion
3. Gas Leak
4. Electric power or gas cut
5. Building collapse
6. Chemical hazard
7. Major structure failure
8. Spills of flammable liquids
9. Accidental release of toxic substances
10. Terrorist activities, riot, bomb threat, hostage incident, sabotage
11. Exposure to ionizing radiation
12. Loss of water supply
13. Loss of communication
14. Crash or collision

Examples of natural hazards are

1. Flood
2. Cyclone
3. Earthquakes
4. Tornadoes
5. Sever extremes of in temperature (cold or hot)

12.6 Plan for Sudden Fire in the Project area

Warn other plant buildings, and gather assembly point outside of the building. Ensure one operator is always present at Hydrant system area when using the fire Hydrant system and ensure the last person has come out from the room but not lock the door. Remain available to give vital information to Crisis Management Team professional firefighters about location, size, occupants, and shut off valves.

Steps to Safety in the fire incident

- Call to the Control room or Emergency Response Team
- Isolate the area by shutting doors when exiting.
- Use stairs; never take the elevator during a fire.
- Never attempt to re-enter the building unless cleared to do so by the Fire Department.
- If able, assist people with special needs.

If Caught in Smoke

- Drop to hands and knees and crawl towards the nearest exit.
- Stay low, and smoke will rise to ceil level first.
- Hold your breath as much as possible; breathe through your nose and use a filter such as a shirt, towel or handkerchief.

If Trapped in a Room for Smoke

- Close as many doors as possible between you and the fire.
- Wet and place cloth material around or under the door to help prevent smoke from entering the room.
- If the room has an outside window, be prepared to signal to someone outside.

Clothing on Fire (Stop, Drop and Roll):

- Direct or assist a person to roll around on the floor to smoother the flames.
- Only drench with water is immediately available.
- Obtain medical attention.
- Call Control Room
- Report incident to Senior Authority

12.7 Plan for Sudden Flood Protection

There are two types of floods, which occur in Bangladesh: annual floods (Barsha) that inundate up to 20% of the land area; and low frequency floods of high magnitude that inundate more than 35% of the area (bonna). The major floods that occurred in 1954, 1955, 1974, 1984, 1987, 1988, 1993, 1998, 1999, 2000, 2007 and 2017 have been very destructive and caused a serious threat to lives and economy.

In order to confirm the real site flood levels of Araihazar, hearing surveys have been conducted for residents and Upazilas of Project sites. The main target high water levels are obtained from hearing surveys of local residents (patriarchs) who experienced the 1988 and 1998 floods, then converted to the altitude of digital mapping. According to the results of these surveys, the past average flood water level of Araihazar was + 6.3 m. The past flood water levels of Araihazar was affected by the high water level of the nearby rivers and can be treated as a static water surface for simplicity's sake.

12.7.1 Short-Term Protection Plan

(a) Factory Perimeter: When the flood is imminent a sandbag wall (3'/covered with polythene roller sheet to be created around the factory necessary preparations for this to be made soon after getting the flood

(b) Plants/Systems/Machinery: Removal/shifting of machinery will not feasible. Therefore, these are to be protected through building the wise secondary wall and water pumping facilities.

(c) Stores/ Warehouses:

- Racking system to be used to increase the height
- Emergency shifting of un-racked items to higher places

(d) Dangerous Chemicals: To be shifted to a higher and safer place in case of flood

(e) Power Stations: Power Stations are considered to be at risk-free height. All the holes at the cable tray (inlets/outlets) to be made fully watertight for preventing any leakage

(f) WTP: Considered to be at risk-free height. However, the pipeline system to be made absolutely leakage free to avoid any contamination of water;

(g) Labor Sheds: Sandbag walls to be made for protection

(h) Vehicles: In extreme case all vehicles to be moved to a higher and safer place

12.7.2 Long-Term Protection Plan

The long-term protection plan is given below

a. An embankment may be made for flood water.
b. All the production floor levels may increase.
c. All the machine bases may be increased.
d. All the Power Stations bases may be increased.

12.7.3 Other Action Plan

a. Flood Protection Cell: Factory in charge, Deputy Manager Admin, manager HRM, Deputy Manager Compliance will constitute this cell. To be activated once Orange Alert is declared. Coordinate all flood protection activities.

b. Flood Level Monitoring System: The river water level to be monitored and recorded in the Control Room.

Flood Alert:

Orange Alert	Orange Alert to be enforced when flood water is within 2' of Plant level. Preparations for temporary protection to be started at this state.
Red Alert	Red Alert to be enforced when flood water is within 1' of Plant level.

12.8 Emergency Procedure

Safety Operating Procedure of Emergency Response Plan means executing the systematic operation of any Emergency, which can occur inside the Power Plant.

Based on these events, the required actions are determined. For Example

1. Declare emergency
2. Siren/Sound and alert
3. Evacuate danger zone
4. Close main shutoffs
5. Call for external aid
6. Initiate rescue operation
7. Attend to casualties
8. Fight against the hazard.

The final consideration is a list and the location of resources needed

1. Medical supplies
2. Auxiliary communication equipment
3. Power generator
4. Chemical and radiation detection equipment
5. Emergency protective clothing
6. Mobile equipment
7. Firefighting equipment
8. Ambulance
9. Rescue equipment
10. Trained personnel

Any person noticing the emergency shall report to their Department Head/Shift Executive/Shift Supervisor either in person or through the intercom. The Department Head/Shift Executive/Shift

Supervisor on receipt of the emergency shall visit the site to assess the situation. If the situation is an emergency, then he/she calls for an emergency.

12.9 Emergency Communication

Emergency communication is a system that is organized for the primary purpose of supporting one way or two-way communications of emergency messages between both individuals and group of individuals. These systems are commonly designed to integrate the cross-communication of messages between a variety of communication technologies, forming a unified communication system intended to optimize communications during emergencies.

At the emergency, period needs to communicate with the Control Room or Emergency Response Team for informing hazard nature, affected persons/materials quantity, location etc. The person should report activity to emergency responders when they arrive on the scene.

- Keep all kind of electronic communication system functions like mobile phone and computer networking system.
- Notify the emergency according to its degree.
- Notice the emergencies to the emergency response team.
- Use alarm bells, visual alarms or other forms of communication to reliably alert employees to an emergency.
- Mark specific areas where employees should gather during an alarm or an emergency announcement.
- The effective rescue operation to save lives and properties
- Only responsible team (Emergency Rescue Team) will conduct the operation.
- If any case of failure or additional help a definite number of persons can move on according to call for Emergency Rescue Team.
- Ensure availability of rescue equipment's list.
- The sound communication system of the road.
- No need to overcrowd in incident area, and it need for a sound communication.
- Need to review incident reports for the past five years
- Ensure a vital Evacuation Plan
- Availability of medical equipment

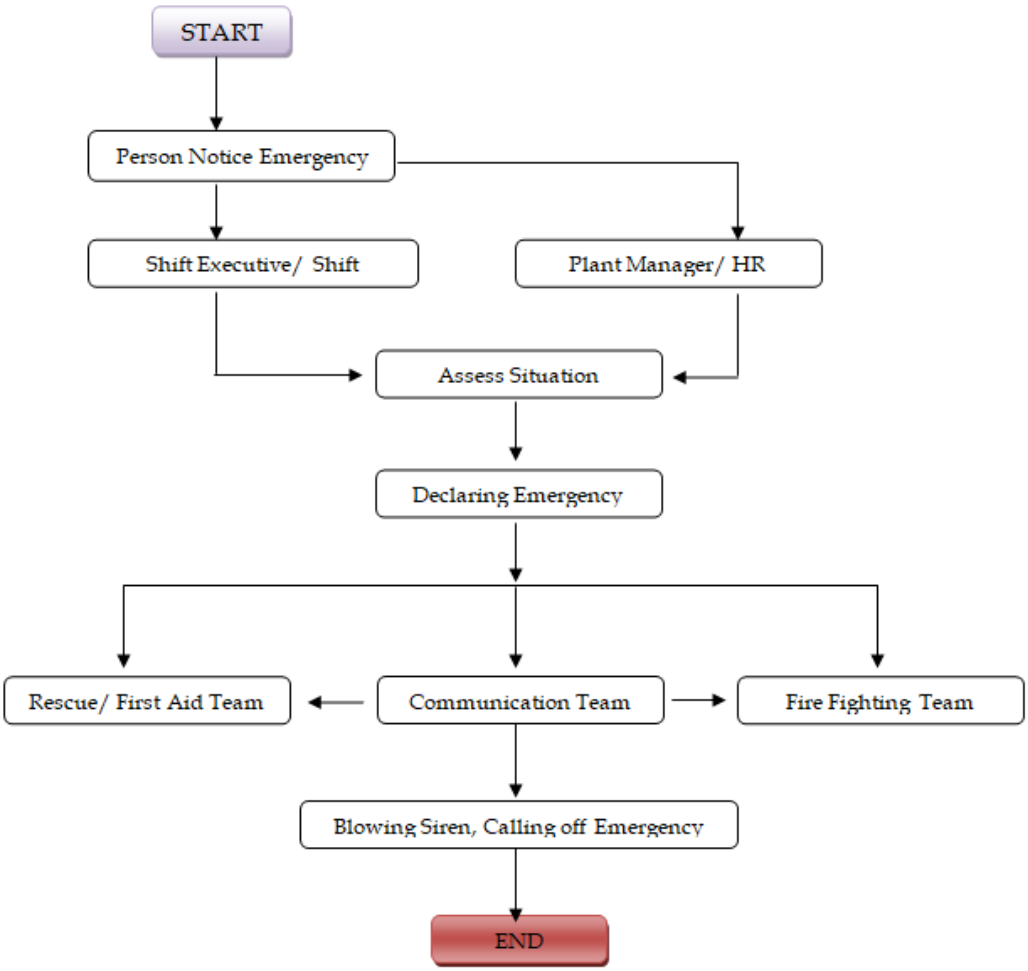


Figure 12-1: Emergency Communication System

12.10 Activities Due to Emergency

The attendee of the incident place shall inform the Control Room & Emergency Response Team in case of emergency.

- Stop work immediately and vacate the workplace.
- Shut down the electrical connection.
- All employees will go to the designated Fire Assembly Point located & mark in the specific area of the power plant.
- Any Emergency Response Team member or designated person shall notify the fire department and fire service and important person by phone.
- Once the fire department has been notified, and it is safe to do so, trained Fire Fighting team may attempt to extinguish small fires. All fires need to be reported to the senior authority.
- When the incident place has been evacuated a head count shall be done by the designated person accounting for all employees on place including those who may be trying to extinguish the fire.
- A List of personnel on the place, updated and current will be kept in the Personnel office.
- The Emergency Response Team is responsible for ensuring the requirement of the fire department and gives all pertinent information.
- The facility should provide first aid attendants as well as medical equipment suitable for the people if any injury took place during the incident and quickly react to give maximum medical facility.

12.11 Record Keeping

The record is a combination of information and helps employers and workers to understand industrial hazards its causes and implementation of the proper task. Record keeping of any incident shows requires steps need to be taken and weakness of the previous incident. For proper recordkeeping need to maintain some regular procedure as-

- Emergency Response Plan
- Emergency training records
- Previous incident record
- Module and materials used for training
- Emergency preparedness drill/rehearsal
- Evaluation feedback from training and emergency drills;
- Records and information about previous incidents

12.12 Responsibility

ERP Coordinators: Any person of Emergency Response Team can act as a responsible person during the working day. They are responsible for handling any types of emergency individually and follow up the all-preventive procedure followed by the respective team. They communicate to all the industries, all local administrative personnel or offices during emergency occur.

Shift Executive: Shift Executive is acting as a site controller's role during night shift operation and will be continuing the role until any above mention person comes to the plant. Security supervisor is to assess all types of emergency work with the shift executive**.**

Security supervisor: Security supervisor is acting as a site controller role during Holiday or weekly off day, and he will be continuing the role until any above mention persons come to the plant.

First Aid Team: The member of the first aid team is very responsive to handle any type of personal injury / accident, communicate the same to the crisis management team, and follow up their guidance and procedure as illustrated below**.**

12.13 Emergency Response for Natural Hazards

12.13.1 Flood

- Evacuate the people from the flooded area and send them to a safe area.
- The switch of the power supply from the affected area.
- Remove all types of obstructions from the drainage system.
- Coordinate with the Emergency Response Team and take action as per their guideline.
- In cases of any accident in human life, please call first aid team and get medical attention as soon as possible.
- Call local fire brigade through the communication system in case of worst or out of control situation.
- In case of over flood polyethene and sandbag to protect adverse effect

12.13.2 Cyclone

- Switch off the Power Supply of Sub-station.
- Close all the in & outdoors where possible wind enters.
- Open windows, exhaust at the top of the walls if present and allow the wind to go from the top which enters into the industry/plant shades.
- Instruct all the associates including workmen not to allow them to go outside till the wind & cyclone effect reduces to the normal level

- After the cyclone, inform to Emergency Response Team to investigate the property loss in the industry for further action.

12.13.3 Earthquake

- Isolate electrical supply where ever it is possible.
- Do not use elevators.
- All electric connection of the power plant should be cut off on that time. In addition, the important thing is that everybody will go to a safe place from near the building.
- Ensure fire and siren alarm system in all floors. During an earthquake, all the employees will come down in a safe place in a row through stair after hearing the alarm.
- Have to follow the instruction regarding earthquake
- Have to evacuate as per evacuation plan
- We should have Rescue Team to help the injured employees or who get down. And they will also take the injured employees in a safe place
- Isolate all pipelines of steam, gas pipeline, compressed air, fuel and CO_2 when they are not in use.
- Check availability of security personnel and have a chat with them in view of likely immediate action to be taken;
- Empty such tanks which are installed in vertical and relatively unstable conditions;
- Take a review of material storage and ensure that maximum of such material is removed from places from where it can fall down. Uniform Material distribution at the lowest height from floor is the safest way of storage.
- Ensure caps on all compressed gas cylinders,
- Immediate ready to use all Emergency equipment like stretchers, breathing equipment, PPEs, Dewatering, portable welding gas cutting equipment, Spill kits, emergency lights, Battery operated public address equipment, Ropes, lifting tackles, trolleys, emergency medical equipment, etc.
- Emergency transport vehicle shall be parked in open so that it is free from any falling object;
- Identify critical and weak areas of the building and organize to support them adequately to prevent collapse.
- Check storage of Hazardous Chemicals to comply with normal storage safety requirements.
- Keep Fire Hydrant accessible, Keep newest and good conditioned fire hoses and Fire extinguishers readily available.
- Remove unwanted combustible material.
- Review that room heater, electric hotplates and other sources of ignition that are normally used in winter situations are operated, handled and stored safely;
- Ensure that flammable liquids, i.e. Petrol, Diesel and other petroleum products are stored under secondary containment with due precautions.
- Over and above ensure that personnel are alert and do not panic;
- Ensure the average 6 feet height of raw materials and finish good.

12.14 Emergency Response Plan for Other Hazards

12.14.1 Fire

- Evacuate the people from Fire occurred surrounding area and send through safe exit direction.
- Remove unwanted combustible material.
- Keep cool and do not panic.
- Inform to substation and electrician to get the affected area isolated from the power supply.
- Keep Fire Hydrant accessible.
- Keep newest and good conditioned fire hoses and Fire Extinguishers readily available.

- Ensure one operator is always present at Hydrant system area when using the fire Hydrant system.
- If the fire is very small, use the correct Fire Extinguisher for extinguishing the fire.
- Try to isolate the fire by removing the surrounding inflammable material from within reach of fire.
- In case of big fire use local Hydrant system for extinguishing the fire
- If the fire is beyond the control inform the security or higher authority to call local fire Brigade and Inform Senior manager (Power plant In charge/Gas pipeline In charge) or Emergency Response Team.
- On arrival of the fire brigade pave the way for them reach the exact site of the fire.
- In case of any accident in human life, please call first aid team and get medical attention as quickly as possible.

12.14.2 Fatal Accidents

- During emergency operation, if there is any injured person, carry out victim /causality to the security room and Conference Room also OHS Room beside the support of company recommended the nursing home.
- Call First Aid Team and carry out the first aid with the help of first aid item.
- Inform to Emergency Response Team.
- If the accident is severe, then call emergency vehicle and immediately rush the injured person to a local hospital or company recommended nursing home. Phone numbers are available in bellow.
- Fill in the accident report form with the help of a witness and deposit the same to the Emergency Response Team.

12.14.3 Utility Failure

Examples of utility failure that may occur are an electrical outage, plumbing failure/flooding, natural gas leak, steam line break, ventilation problems and/or elevator failure. In the event of a failure, immediately notify Emergency Response Team.

- For emergencies and potential danger or after hours call to the Control room
- In a situation where a building needs to be evacuated, please proceed to the building specific evacuation area.
- Turn off the equipment, machines and computers.
- Assist disabled persons as needed.
- Do not use elevators.
- Stay at the designated evacuation area until the fire department or designated representative has given the "all clear" to re-enter the building.

CHAPTER 13: CONCLUSION AND RECOMMENDATIONS

13 CONCLUSION AND RECOMMENDATIONS

Due to the scarcity of electricity, BEZA has intended to construct power plant at Araihazar Economic Zone and installed Gas transmission pipeline from Haripur TBS to Dighi Barabo CGS for the requirement of Economic Zone. From the social and economic point of view, the project is very much important. Therefore, there is no doubt about the necessity of establishment of the power plant and Gas transmission Pipeline. However, the question arises how the plant will be established in an environmental friendly manner at the proposed site. The environmental studies reveal the possible environmental issues and mitigation measures to reduce the environmental impacts of the project.

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

Thus the proposed Gas pipeline project activities have also no significant adverse environmental impact so far as a time-bound execution program with the application of advanced environmentally friendly construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the pipeline system. Benefits in the project area will not be that significant except for some short-term employment and business opportunities during the construction phase.

As such, the execution of the project would stand environmentally sound and socio-economically sustainable with due adoption of the recommended mitigation measures and environmental management and monitoring processes.

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

ANNEX A- APPROVED TOR FROM DOE

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

Memo No: 22.02.0000.018.72.111.18. 905 Date: 10 /09/2018

Subject: **Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) for the proposed 50 MW Power Plant at Araihazar Economic Zone including Substation, Electricity Transmission Line and Gas Transmission Line from the Horipur TBS to Dighibarabo CGS.**

Ref: Your Application dated 29/08/2018.

With reference to your letter dated 29/08/2018 for the subject mentioned above, the Department of Environment hereby gives approval of TOR for Environmental Impact Assessment (EIA) for the proposed Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) for the proposed 50 MW Power Plant at Araihazar Economic Zone including Substation, Electricity Transmission Line and Gas Transmission Line from the Horipur TBS to Dighibarabo CGS subject to fulfilling the following terms and conditions.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein.

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary.
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references).
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared).

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project.

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Noise, Vibration, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:
   - Population: Demographic profile and ethnic composition
   - Settlement and housing
   - Traffic and transport
   - Public utilities: water supply, sanitation and solid waste
   - Economy and employment: employment structure and cultural issues in employment
   - Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.
7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

   Appropriate models shall be used for prediction of potential impacts of the project on surface water and ambient air quality using updated data. Model prediction shall be compared with national water and air quality standards and specific sensitivity data of the organisms known to be present in the project area (likely impacted area) for impact assessment.
8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).
9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)
10. Risk assessment, risk management, system of valuation of environmental and properties damage, damage compensation issues shall be addressed
11. Emergency Response Plan & disaster Impact Assessment
12. Conclusion and Recommendations

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III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable Environmental Clearance fee in a treasury Chalan, the applicable VAT on clearance fee in a separate treasury Chalan, the No Objection Certificates (NOC) from local authority, NOC from forest department (if it is required in case of cutting any forested plant, private or public) and NOCs from other relevant agencies for operational activity etc. to the Head Office of DOE in Dhaka with a copy to the Narayanganj District Office of DOE in Narayanganj and Sylhet Divisional Office of DoE in Sylhet.

10.09.18

(Syed Nazmul Ahsan)
Director (Environmental Clearance)
Phone # 02-8181673

Manager (Planning & Development)
Bangladesh Economic Zone Authority
Level-12, Monem Business District,
111 Bir Uttam C.R Dutta Road
Karwanbazar, Dhaka-1205

Copy Forwarded to :

1) Secretary, Ministry of Environment, Forest and Climate Change, Bangladesh Secretariat, Dhaka.
2) Secretary, Power Division, Ministry of Power, Energy & Mineral Resources, Bangladesh Secretariat, Dhaka.
3) Chairman, Bangladesh Power Development Board, WAPDA Bhaban (1st floor), Dhaka-1000.
4) Director, Department of Environment, Dhaka Regional Office, Dhaka.
5) Director, Department of Environment, Sylhet Divisional Office, Sylhet.
6) Deputy Director/ Office In-charge, Department of Environment, Narayanganj District Office, Narayanganj.
7) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

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ANNEX B- PHOTOGRAPHS OF FGD & PUBLIC CONSULTATION MEETING

<table>
<tr><td> 
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<tr><td>Public Consultation Meeting (Location-1)</td><td>Public Consultation Meeting (Location-2)</td></tr>
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<tr><td colspan="2">Public Consultation Meeting (Location-3)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Focus Group Discussion local resident & Farmers</td><td>Focus Group Discussion with the woman</td></tr>
</table>

ANNEX C- PARTICIPANT LIST OF PUBLIC CONSULTATION MEETING

মতবিনিময় সভা

পরিবেশগত এবং সামাজিক প্রভাব মূল্যায়ণ

"হরিপুর টি.বি.এস. হইতে দিঘী বোরাব পর্যন্ত গ্যাস ট্র্যান্সমিশন লাইন,

তারাবো পৌরসভা, রূপগঞ্জ, নারায়ণগঞ্জ"

স্থানঃ তারাবো পৌরসভা অডিটোরিয়াম

তারিখঃ ২৪-১০-২০১৮ সময়ঃ সকাল ১১.০০ টা

Attendance Sheet (উপস্থিতির তালিকা)

No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
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No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
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মতবিনিময় সভা

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"হরিপুর টি.বি.এস. হইতে দিঘী বোরাব পর্যন্ত গ্যাস ট্র্যান্সমিশন লাইন, রূপগঞ্জ, সোনারগাঁ, বন্দর

স্থানঃ কাজীবাড়ি মসজিদ প্রাঙ্গন

তারিখঃ ৩০-১০-২০১৮ সময়ঃ সকাল ১০.০০ টা

Attendance Sheet (উপস্থিতির তালিকা)

No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
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১৫.	মো: বিপুল	ব্যবসা	30	"	01943426959	[signature]
১৬	কাজী [illegible]	ড্রাইভার	৩৭	"	01817119014	[signature]
১৭.	মো: সাইদুল্লাহ	ব্যবসায়ী	৩৫	"	01725659567	[signature]

No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
১৮	জাকির	প্রবাসী	৪০	M	0 -	জাকির
১৯	সাদেক	চাকুরী	৫৬	M	01864030617	Sadek
২০	ফজলুল রহমান ছাব্দার	-	৫৭	M	01719390226	ফজলুল রহমান
২১	বিপ্লব হোসেন	ব্যবসা	৪৭	M	01920835614	বিপ্লব
২২	শফিকুল ইসলাম	ব্যবসা	২৭	M	01922049576	শফিকুল
২৩	আহম্মদ উদ্দিন	"	৭০	M	01818480960	আহম্মদ উদ্দিন
২৪	মো: মজিবুর রহমান	"	৫০	M	01718742171	মো: মজিবুর রহমান
২৫	মাহিউর কাজী	-	৫০	M	-	মাহিউর
২৬	বাচ্চু	"	৬৫	M	-	বাচ্চু
২৭	বাধন	ছাত্র	26	M	01971803861	বাধন
২৮	রাজু	ছাত্র	22	m	01963159476	রাজু
২৯	আবু হানিফ	-	৫৫	M	0176096809	[illegible]
৩০	আবু কালাম	ব্যবসা	৪২	M	01916984044	আবু কালাম
৩১	জজ মিয়া	কৃষি	৭০	M	-	-
৩২	রফিকুল ইসলাম	ব্যবসা	৪৮	M	01711276307	রফিকুল ইসলাম
৩৩	নাসির উদ্দিন	"	৫২	M	01992505434	NASIR

মতবিনিময় সভা

পরিবেশগত এবং সামাজিক প্রভাব মূল্যায়ণ
"৪০ মেঃ ওয়াট পাওয়ার প্ল্যান্ট,
দুপ্তারা, আড়াইহাজার

স্থানঃ পাঁচবাড়িয়া

তারিখঃ ১৬-১১-২০১৮ সময়ঃ বিকাল ০৩.০০ টা

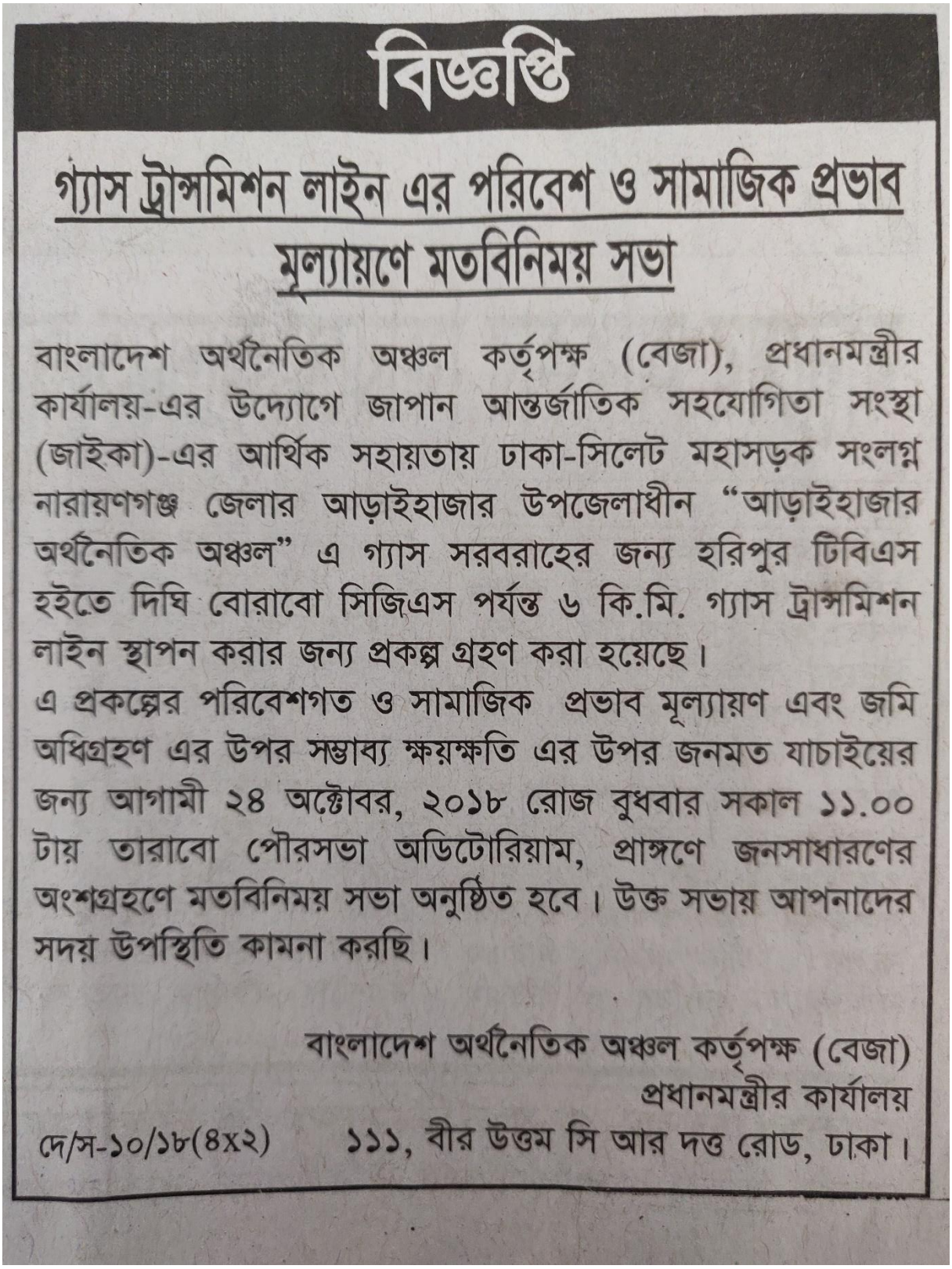
Attendance Sheet (উপস্থিতির তালিকা)

No. (নং)	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
১।	[illegible]	[illegible]	৫৩		[illegible]	[illegible]
২।	[illegible]	[illegible]	২৮		[illegible]	[illegible]
৩।	[illegible]	[illegible]	৩১		[illegible]	[illegible]
৪।	[illegible]	[illegible]	৫০		[illegible]	[illegible]
৫।	[illegible]	[illegible]	৩২		[illegible]	[illegible]
৬।	[illegible]	[illegible]	২৫		[illegible]	[illegible]
৭।	[illegible]	[illegible]	৪৪		[illegible]	
৮।	[illegible]	[illegible]	৪৩		[illegible]	[illegible]
৯।	[illegible]		৫০			
১০।	[illegible]	[illegible]	৫০		[illegible]	[illegible]
১১।	[illegible]	[illegible]	৩৫		[illegible]	[illegible]
১২।	[illegible]	[illegible]	২৯		[illegible]	[illegible]
১৩।	[illegible]	[illegible]	৪৮		[illegible]	
১৪।	[illegible]	[illegible]	৩৫		[illegible]	[illegible]
১৫।	[illegible]	[illegible]	৬০		[illegible]	[illegible]
১৬।	[illegible]	[illegible]	৫৫		—	[illegible]
১৭।	[illegible]	[illegible]	৪৩		[illegible]	[illegible]
১৮।	[illegible]	[illegible]	৫২		[illegible]	[illegible]
১৯।	[illegible]	[illegible]	২৮		[illegible]	[illegible]
২০।	[illegible]	[illegible]	৬৭			[illegible]
২১।	[illegible]	[illegible]	৪৭		[illegible]	[illegible]
২২।	[illegible]		৬৩			
২৩।	[illegible]		৩৭		[illegible]	
২৪।	[illegible]	[illegible]	৩০		[illegible]	[illegible]
২৫।	[illegible]	[illegible]	৫০			[illegible]

No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
২৫/	আবুল আলম [illegible]	[illegible]	৪৫	পুরুষ	০১৬৭৭০৭৬৭৭	Azad
২৬/	Fazul Islam	Business	40	male	01846607512	Fazul Islam
২৭	আয়েশা/মিন বেগম	গৃহিনী	৪২	মহিলা	01710834551	[illegible]
২৮	সাহেনা হাসান	গৃহিনী	৫০	মহিলা	01746925491	সাহেনা হাসান
২৯	নিলিমা বেগম	গৃহিনী	৪৫	মহিলা	0171083455[illegible]	নিলিমা
৩০	লিপি বেগম	গৃহিনী	৩৫	মহিলা	01747340842	লিপি
৩১	সাহমুদা বেগম	গৃহিনী	৪০	মহিলা	01715389505	সাহমুদা
৩২	শাহিনুর আক্তার	গৃহিনী	৩০	মহিলা	01819096379	Shahinur
৩৩	হেনা বেগম	গৃহিনী	৫০	মহিলা	01819096379	হেনা বেগম
৩৪/	[illegible]	[illegible]	৪৫	পুরুষ	017091526	Aman
৩৫/	মো: [illegible] আমিন	[illegible]	৬০	পুরুষ	0[illegible]	[illegible]
৩৬/	আমজাদ হোসেন	চাকুরি	৩০	পুরুষ	01746023475	আমজাদ
৩৭/	মো: [illegible]	[illegible]	৫০	পুরুষ	018770599	[illegible]
৩৮/	[illegible]	ব্যবসায়ী	৫৫	পুরুষ	01713528[illegible]	[illegible]
৩৯/	মো: [illegible] হোসেন ([illegible])	[illegible]	৫২	পুরুষ	01756037562	[illegible]
৪০/	মনজিবুর	ব্যবসায়ী	৫০	পুরুষ	0195[illegible]412	[illegible]
৪১/	[illegible]	ব্যবসায়ী	৫৫	[illegible]	0171352[illegible]	[illegible]
৪২/	আমিন	ব্যবসায়ী	৪০	পুরুষ	[illegible]	[illegible]
৪৩/	[illegible]	ব্যবসায়ী	৫৫	পুরুষ	01990411[illegible]	[illegible]
৪৪/	কামাল	কৃষি	৪২	পুরুষ	01746023475	কামাল
৪৫/	জাহাঙ্গীর আলম	ব্যবসা	৪০	পুরুষ	01813032629	
৪৬/	সাকির			পুরুষ		
৪৭/	আবু সিদ্দিক	কৃষি	৩৮	পুরুষ		আবু সিদ্দিক
৪৮	[illegible]					
৪৯	মো: [illegible]	কৃষি			01670141197	[illegible]

No. নং	Name (নাম)	Occupation (পেশা)	Age (বয়স)	Sex (লিঙ্গ)	Mobile No/ (মোবাইল নম্বর)	Signature (স্বাক্ষর)
01	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
02	[illegible]	[illegible]	[illegible]	[illegible]	01730428170	[illegible]
03	[illegible]					
04	[illegible]					
05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]					

ANNEX D- NEWSPAPER ADVERTISEMENTs



বিজ্ঞপ্তি

গ্যাস ট্রান্সমিশন লাইন এর পরিবেশ ও সামাজিক প্রভাব মূল্যায়ণে মতবিনিময় সভা

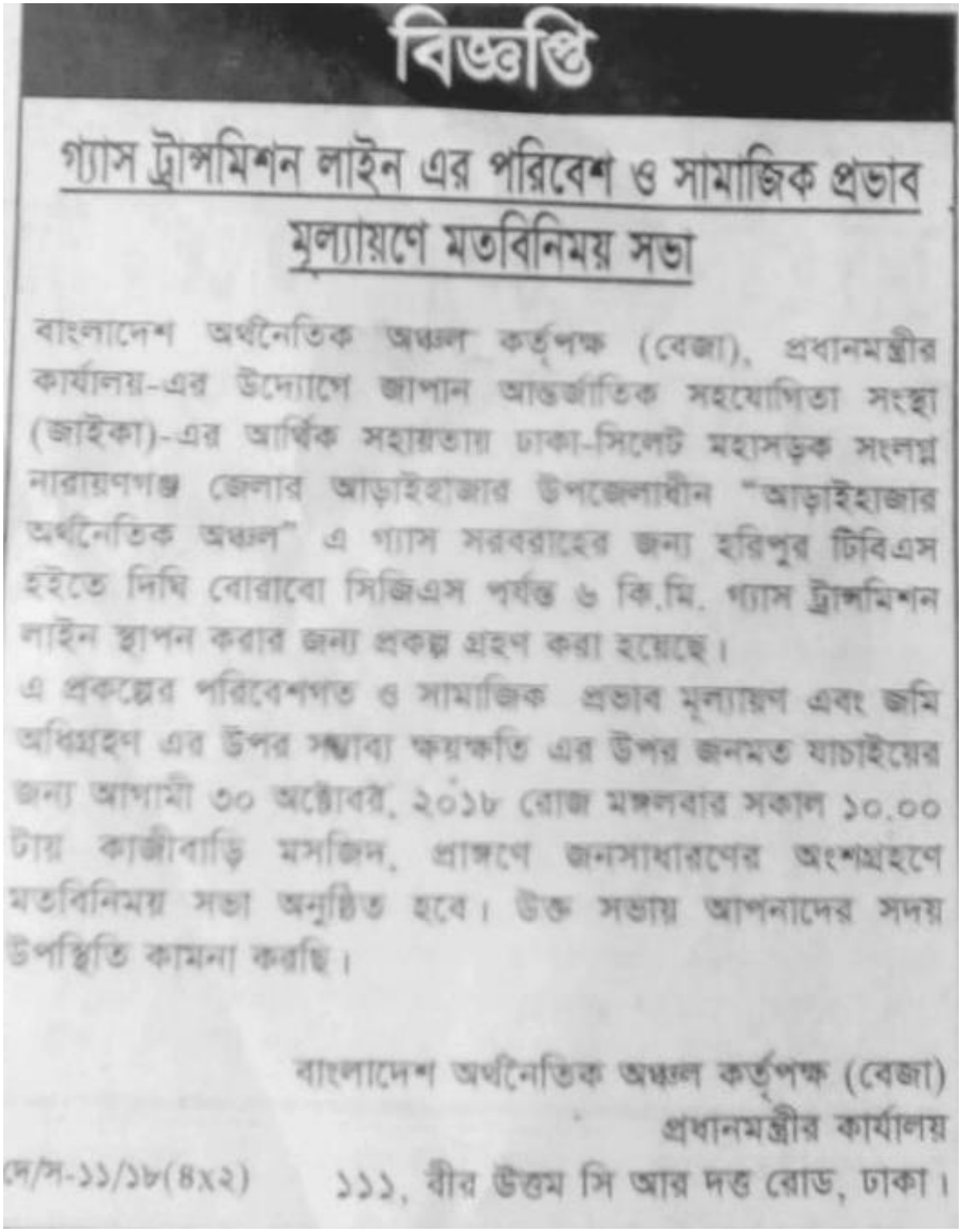
বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা), প্রধানমন্ত্রীর কার্যালয়-এর উদ্যোগে জাপান আন্তর্জাতিক সহযোগিতা সংস্থা (জাইকা)-এর আর্থিক সহায়তায় ঢাকা-সিলেট মহাসড়ক সংলগ্ন নারায়ণগঞ্জ জেলার আড়াইহাজার উপজেলাধীন "আড়াইহাজার অর্থনৈতিক অঞ্চল" এ গ্যাস সরবরাহের জন্য হরিপুর টিবিএস হইতে দিঘি বোরাবো সিজিএস পর্যন্ত ৬ কি.মি. গ্যাস ট্রান্সমিশন লাইন স্থাপন করার জন্য প্রকল্প গ্রহণ করা হয়েছে।

এ প্রকল্পের পরিবেশগত ও সামাজিক প্রভাব মূল্যায়ণ এবং জমি অধিগ্রহণ এর উপর সম্ভাব্য ক্ষয়ক্ষতি এর উপর জনমত যাচাইয়ের জন্য আগামী ২৪ অক্টোবর, ২০১৮ রোজ বুধবার সকাল ১১.০০ টায় তারাবো পৌরসভা অডিটোরিয়াম, প্রাঙ্গণে জনসাধারণের অংশগ্রহণে মতবিনিময় সভা অনুষ্ঠিত হবে। উক্ত সভায় আপনাদের সদয় উপস্থিতি কামনা করছি।

বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা)
প্রধানমন্ত্রীর কার্যালয়
১১১, বীর উত্তম সি আর দত্ত রোড, ঢাকা।

দে/স-১০/১৮(৪x২)

Newspaper Advertisement for Public Consultation meeting (Location-1)



বিজ্ঞপ্তি

গ্যাস ট্রান্সমিশন লাইন এর পরিবেশ ও সামাজিক প্রভাব মূল্যায়ণে মতবিনিময় সভা

বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা), প্রধানমন্ত্রীর কার্যালয়-এর উদ্যোগে জাপান আন্তর্জাতিক সহযোগিতা সংস্থা (জাইকা)-এর আর্থিক সহায়তায় ঢাকা-সিলেট মহাসড়ক সংলগ্ন নারায়ণগঞ্জ জেলার আড়াইহাজার উপজেলাধীন "আড়াইহাজার অর্থনৈতিক অঞ্চল" এ গ্যাস সরবরাহের জন্য হরিপুর টিবিএস হইতে দিঘি বোরাবো সিজিএস পর্যন্ত ৬ কি.মি. গ্যাস ট্রান্সমিশন লাইন স্থাপন করার জন্য প্রকল্প গ্রহণ করা হয়েছে।

এ প্রকল্পের পরিবেশগত ও সামাজিক প্রভাব মূল্যায়ণ এবং জমি অধিগ্রহণ এর উপর সম্ভাব্য ক্ষয়ক্ষতি এর উপর জনমত যাচাইয়ের জন্য আগামী ৩০ অক্টোবর, ২০১৮ রোজ মঙ্গলবার সকাল ১০.০০ টায় কাজীবাড়ি মসজিদ, প্রাঙ্গণে জনসাধারণের অংশগ্রহণে মতবিনিময় সভা অনুষ্ঠিত হবে। উক্ত সভায় আপনাদের সদয় উপস্থিতি কামনা করছি।

বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা)
প্রধানমন্ত্রীর কার্যালয়
১১১, বীর উত্তম সি আর দত্ত রোড, ঢাকা।

দে/স-১১/১৮(৪x২)

Newspaper Advertisement for Public Consultation meeting (Location-2)

বিজ্ঞপ্তি

পাওয়ার প্ল্যান্ট এর পরিবেশ ও সামাজিক প্রভাব মূল্যায়ণে মতবিনিময় সভা

বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা), প্রধানমন্ত্রীর কার্যালয়-এর উদ্যোগে জাপান আন্তর্জাতিক সহযোগিতা সংস্থা (জাইকা)-এর আর্থিক সহায়তায় ঢাকা-সিলেট মহাসড়ক সংলগ্ন নারায়ণগঞ্জ জেলার আড়াইহাজার উপজেলাধীন আড়াইহাজার অর্থনৈতিক অঞ্চল, এ বিদ্যুৎ সরবরাহের জন্য দুপ্তারা ইউনিয়নের পাঁচগাঁও মৌজাস্থ পাওয়ার প্ল্যান্ট স্থাপন করার জন্য প্রকল্প গ্রহণ করা হয়েছে।

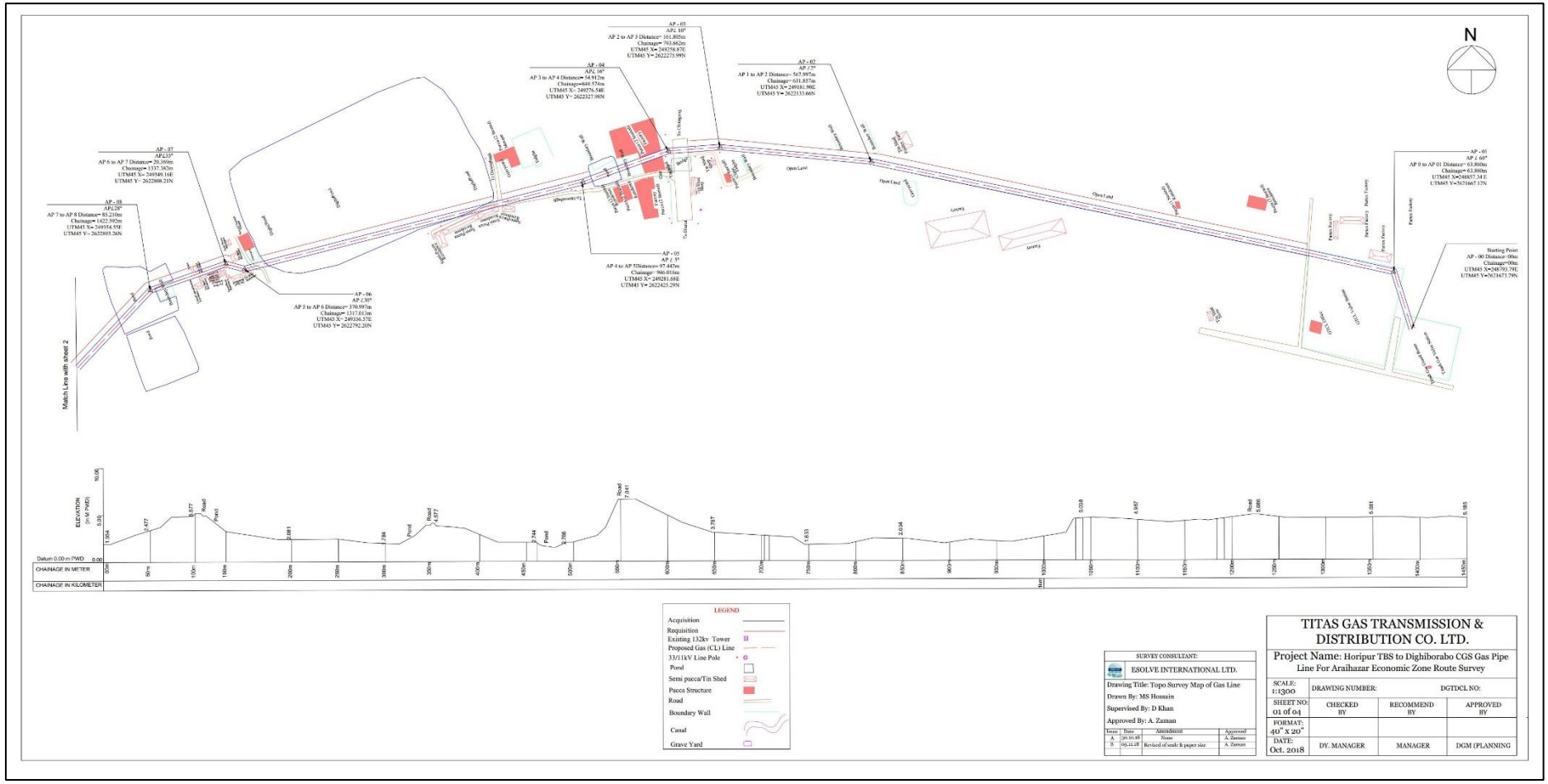
এ প্রকল্পের পরিবেশগত ও সামাজিক প্রভাব মূল্যায়ণ এবং জমি অধিগ্রহণ এর উপর সম্ভাব্য ক্ষয়ক্ষতি এর উপর জনমত যাচাইয়ের জন্য আগামী ১৬ নভেম্বর, ২০১৮ রোজ শুক্রবার বিকাল ৩.০০ টায় 'পাঁচবাড়িয়া ভূঁইয়াবাড়ি ঘাটপাড়' প্রাঙ্গণে জনসাধারণের অংশগ্রহণে মতবিনিময় সভা অনুষ্ঠিত হবে। উক্ত সভায় আপনাদের সদয় উপস্থিতি কামনা করছি।

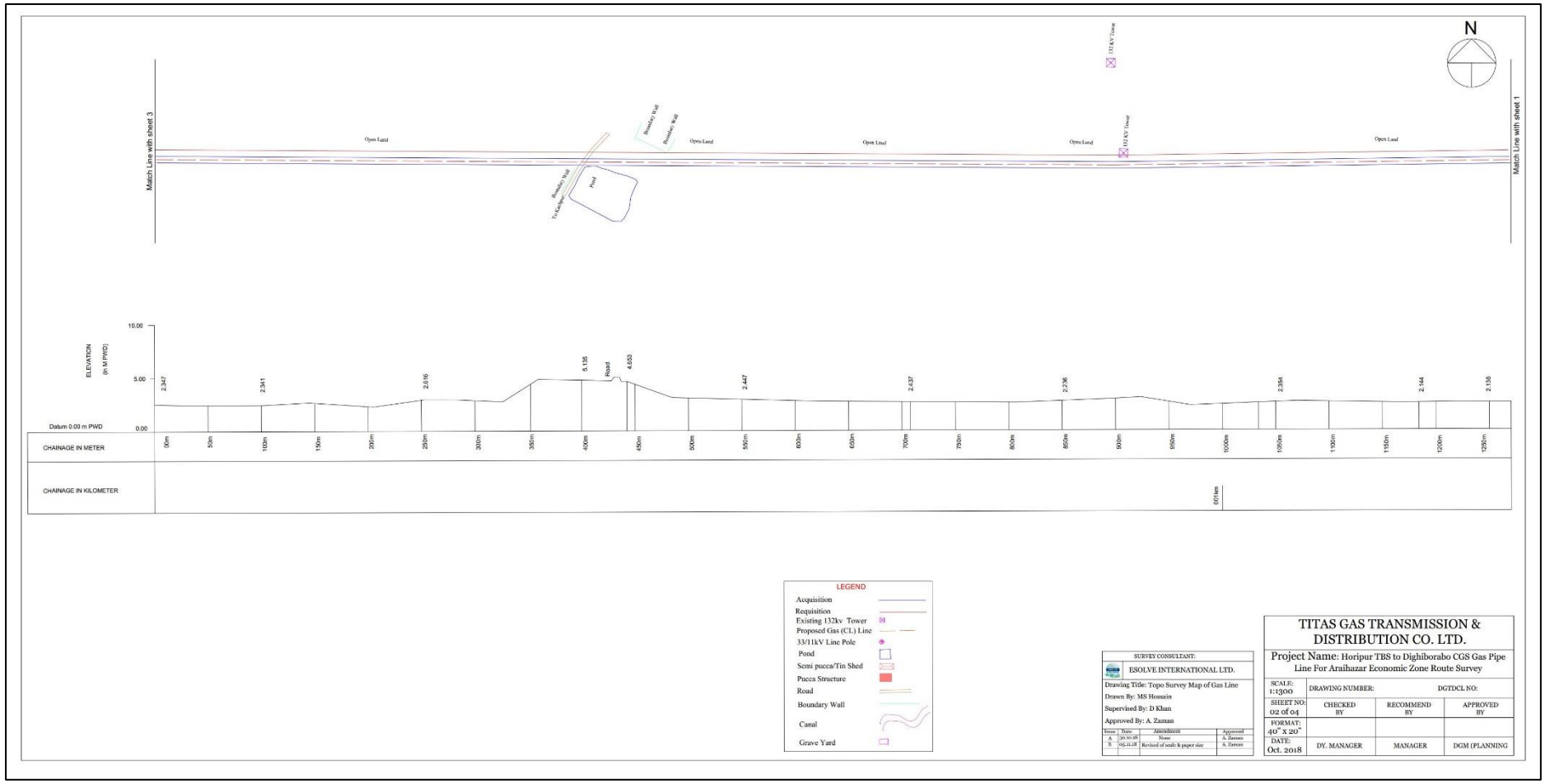
বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেজা)
প্রধানমন্ত্রীর কার্যালয়
১১১, বীর উত্তম সি আর দত্ত রোড, ঢাকা।

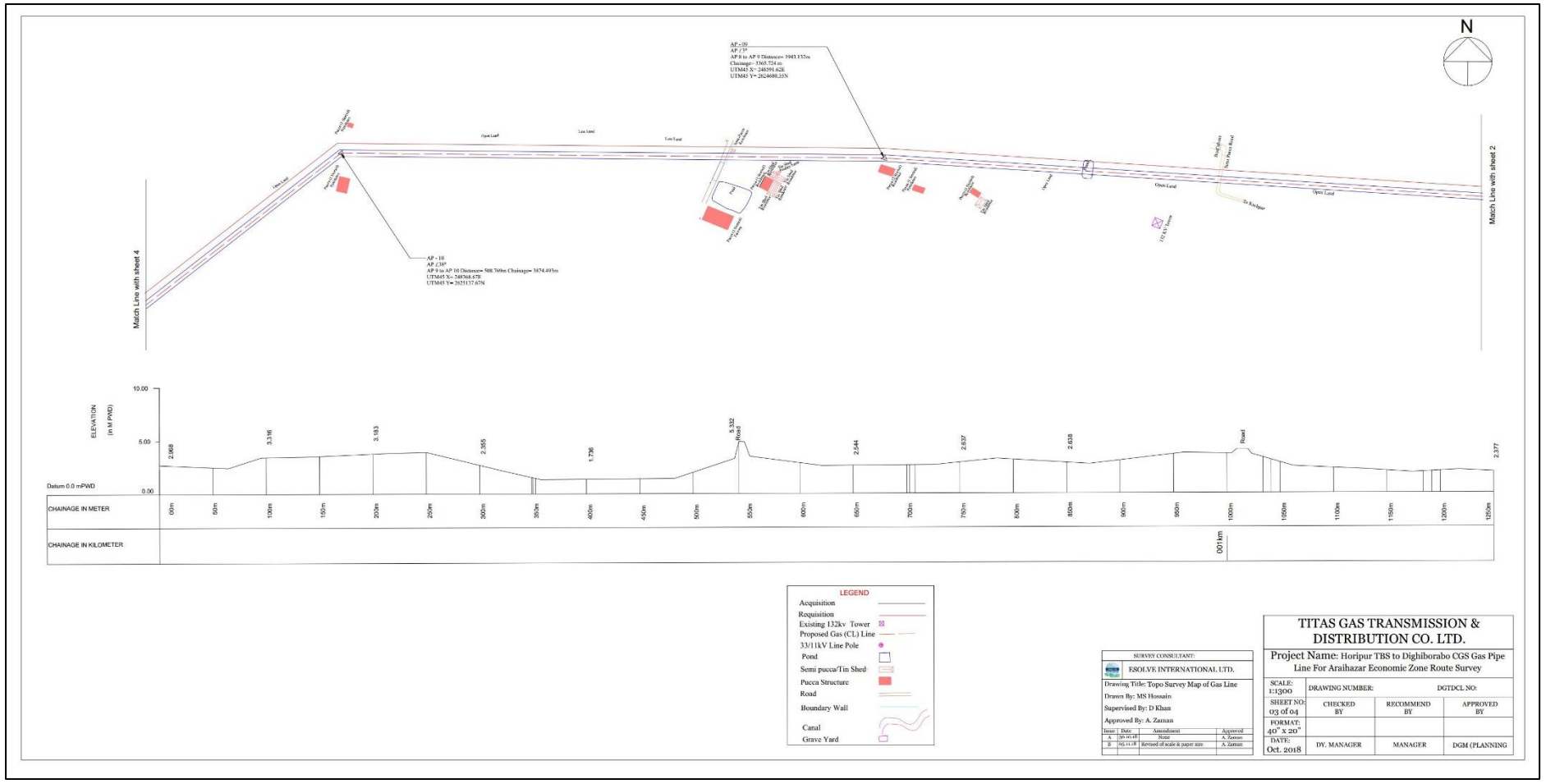
দে/স-১২/১৮ (২ x ৪")

Newspaper Advertisement for Public Consultation meeting (Location-3)

ANNEX E- PROPOSED GAS TRANSMISSION PIPELINE




N
Match Line with sheet 3
Match Line with sheet 1
Open Land
Boundary Wall
Pond
132 KV Tower
ELEVATION (in M PWD)
10.00
5.00
0.00
Datum 0.00 m PWD
2.347
2.341
2.616
5.135
Road
4.653
2.447
2.437
2.236
2.384
2.144
2.158
CHAINAGE IN METER
CHAINAGE IN KILOMETER
LEGEND
Acquisition
Requisition
Existing 132kv Tower
Proposed Gas (CL) Line
33/11kV Line Pole
Pond
Semi pucca/Tin Shed
Pucca Structure
Road
Boundary Wall
Canal
Grave Yard
SURVEY CONSULTANT:
ESOLVE INTERNATIONAL LTD.
Drawing Title: Topo Survey Map of Gas Line
Drawn By: MS Hossain
Supervised By: D Khan
Approved By: A. Zaman
TITAS GAS TRANSMISSION & DISTRIBUTION CO. LTD.
Project Name: Horipur TBS to Dighiborabo CGS Gas Pipe Line For Araihazar Economic Zone Route Survey
SCALE: 1:1300
DRAWING NUMBER:
DGTDCL NO:
SHEET NO: 02 of 04
CHECKED BY
RECOMMEND BY
APPROVED BY
FORMAT: 40" X 20"
DATE: Oct. 2018
DY. MANAGER
MANAGER
DGM (PLANNING


N
Match Line with sheet 4
Match Line with sheet 2
AP - 10
AP ∠38°
AP 9 to AP 10 Distance= 508.769m Chainage= 3874.493m
UTM45 X= 248568.67E
UTM45 Y= 2625137.67N
ELEVATION (m M PWD)
Datum 0.0 mPWD
CHAINAGE IN METER
CHAINAGE IN KILOMETER
LEGEND
Acquisition
Requisition
Existing 132kv Tower
Proposed Gas (CL) Line
33/11kV Line Pole
Pond
Semi pucca/Tin Shed
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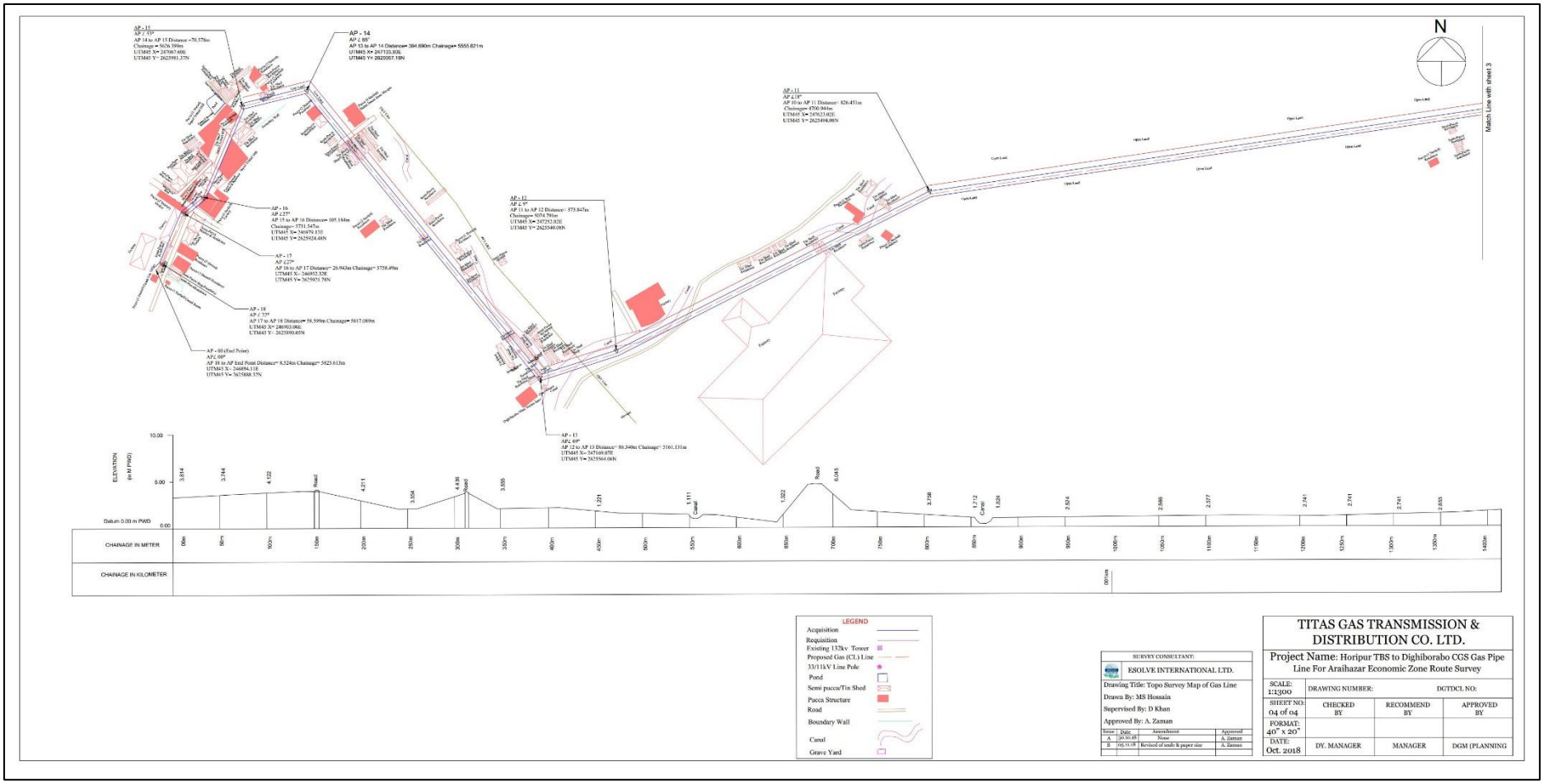
Project Name: Horipur TBS to Dighiborabo CGS Gas Pipe Line For Araihazar Economic Zone Route Survey
SCALE: 1:1300
DRAWING NUMBER:
DGTDCL NO:
SHEET NO: 03 of 04
CHECKED BY
RECOMMEND BY
APPROVED BY
FORMAT: 40" x 20"
DATE: Oct. 2018
DY. MANAGER
MANAGER
DGM (PLANNING


N
Match Line with sheet 3
ELEVATION (in M PWD)
Datum 0.00 m PWD
CHAINAGE IN METER
CHAINAGE IN KILOMETER
LEGEND
Acquisition
Requisition
Existing 132kv Tower
Proposed Gas (CL) Line
33/11kV Line Pole
Pond
Semi pucca/Tin Shed
Pucca Structure
Road
Boundary Wall
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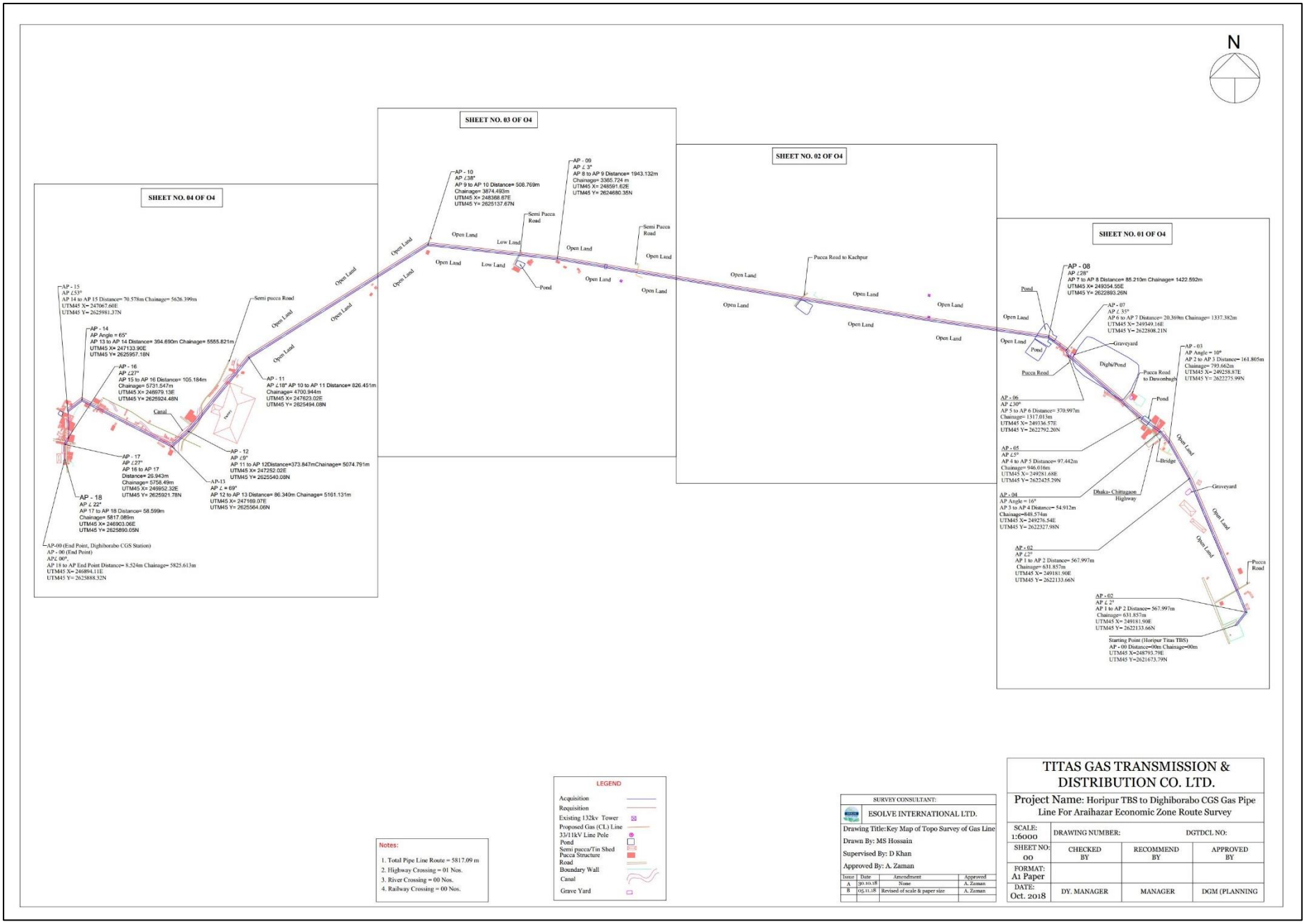
Project Name: Horipur TBS to Dighiborabo CGS Gas Pipe Line For Araihazar Economic Zone Route Survey
SCALE: 1:1300
DRAWING NUMBER:
DGTDCL NO:
SHEET NO: 04 of 04
CHECKED BY
RECOMMEND BY
APPROVED BY
FORMAT: 40" x 20"
DATE: Oct. 2018
DY. MANAGER
MANAGER
DGM (PLANNING


N
SHEET NO. 04 OF O4
SHEET NO. 03 OF O4
SHEET NO. 02 OF O4
SHEET NO. 01 OF O4
AP - 15
AP ∠53°
AP 14 to AP 15 Distance= 70.578m Chainage= 5626.399m
UTM45 X= 247067.60E
UTM45 Y= 2625981.37N
AP - 14
AP Angle = 65°
AP 13 to AP 14 Distance= 394.690m Chainage= 5555.821m
UTM45 X= 247133.90E
UTM45 Y= 2625957.18N
AP - 16
AP ∠27°
AP 15 to AP 16 Distance= 105.184m
Chainage= 5731.547m
UTM45 X= 246979.13E
UTM45 Y= 2625924.48N
AP - 17
AP ∠27°
AP 16 to AP 17
Distance= 26.943m
Chainage= 5758.49m
UTM45 X= 246952.32E
UTM45 Y= 2625921.78N
AP - 18
AP ∠ 22°
AP 17 to AP 18 Distance= 58.599m
Chainage= 5817.089m
UTM45 X= 246903.06E
UTM45 Y= 2625890.05N
AP-00 (End Point, Dighiborabo CGS Station)
AP - 00 (End Point)
AP∠ 90°,
AP 18 to AP End Point Distance= 8.524m Chainage= 5825.613m
UTM45 X= 246894.11E
UTM45 Y= 2625888.32N
AP - 11
AP ∠18° AP 10 to AP 11 Distance= 826.451m
Chainage= 4700.944m
UTM45 X= 247623.02E
UTM45 Y= 2625494.08N
AP - 12
AP ∠9°
AP 11 to AP 12Distance=373.847mChainage= 5074.791m
UTM45 X= 247252.02E
UTM45 Y= 2625540.08N
AP-13
AP ∠ = 69°
AP 12 to AP 13 Distance= 86.340m Chainage= 5161.131m
UTM45 X= 247189.07E
UTM45 Y= 2625564.06N
AP - 10
AP ∠38°
AP 9 to AP 10 Distance= 508.769m
Chainage= 3874.493m
UTM45 X= 248368.87E
UTM45 Y= 2625137.67N
AP - 09
AP ∠ 3°
AP 8 to AP 9 Distance= 1943.132m
Chainage= 3365.724 m
UTM45 X= 248591.62E
UTM45 Y= 2624680.35N
AP - 08
AP ∠28°
AP 7 to AP 8 Distance= 85.210m Chainage= 1422.592m
UTM45 X= 249354.56E
UTM45 Y= 2622893.26N
AP - 07
AP ∠ 35°
AP 6 to AP 7 Distance= 20.369m Chainage= 1337.382m
UTM45 X= 249349.16E
UTM45 Y= 2622808.21N
AP - 06
AP ∠30°
AP 5 to AP 6 Distance= 370.997m
Chainage= 1317.013m
UTM45 X= 249336.57E
UTM45 Y= 2622792.20N
AP - 05
AP ∠5°
AP 4 to AP 5 Distance= 97.442m
Chainage= 946.016m
UTM45 X= 249281.68E
UTM45 Y= 2622425.29N
AP - 04
AP Angle = 16°
AP 3 to AP 4 Distance= 54.912m
Chainage=848.574m
UTM45 X= 249276.54E
UTM45 Y= 2622327.98N
AP - 03
AP Angle = 10°
AP 2 to AP 3 Distance= 161.805m
Chainage= 793.662m
UTM45 X= 249258.87E
UTM45 Y= 2622275.99N
AP - 02
AP ∠2°
AP 1 to AP 2 Distance= 567.997m
Chainage= 631.857m
UTM45 X= 249181.90E
UTM45 Y= 2622133.66N
AP - 02
AP ∠ 2°
AP 1 to AP 2 Distance= 567.997m
Chainage= 631.857m
UTM45 X= 249181.90E
UTM45 Y= 2622133.66N
Starting Point (Horipur Titas TBS)
AP - 00 Distance=00m Chainage=00m
UTM45 X=248793.79E
UTM45 Y=2621673.79N
Open Land
Low Land
Semi pucca Road
Semi Pucca Road
Pucca Road to Kachpur
Pucca Road
Pucca Road to Dawonbagh
Canal
Pond
Graveyard
Digh/Pond
Bridge
Dhaka- Chittagaon Highway
Notes:
1. Total Pipe Line Route = 5817.09 m
2. Highway Crossing = 01 Nos.
3. River Crossing = 00 Nos.
4. Railway Crossing = 00 Nos.
LEGEND
Acquisition
Requisition
Existing 132kv Tower
Proposed Gas (CL) Line
33/11kV Line Pole
Pond
Semi pucca/Tin Shed
Pucca Structure
Road
Boundary Wall
Canal
Grave Yard
SURVEY CONSULTANT:
ESOLVE INTERNATIONAL LTD.
Drawing Title:Key Map of Topo Survey of Gas Line
Drawn By: MS Hossain
Supervised By: D Khan
Approved By: A. Zaman
Issue | Date | Amendment | Approved
A | 30.10.18 | None | A. Zaman
B | 05.11.18 | Revised of scale & paper size | A. Zaman
TITAS GAS TRANSMISSION & DISTRIBUTION CO. LTD.
Project Name: Horipur TBS to Dighiborabo CGS Gas Pipe Line For Araihazar Economic Zone Route Survey
SCALE: 1:6000
DRAWING NUMBER:
DGTDCL NO:
SHEET NO: 00
CHECKED BY
RECOMMEND BY
APPROVED BY
FORMAT: A1 Paper
DATE: Oct. 2018
DY. MANAGER
MANAGER
DGM (PLANNING

ANNEX F- APPLICABLE STANDARDS

Table1: Heavy Metal Contents of the Natural Soil

Metal Concentrations in the Soil			
Element	**Symbol**	**Common Range (ppm or mg/kg)**	**Average Concentration (ppm or mg/kg)**
Aluminum	Al	10,000-300,000	71,000
Antimony	Sb	2-10	not available
Arsenic	As	1-50	5
Barium	Ba	100-3,000	430
Beryllium	Be	0.1-40	6
Boron	B	2-100	10
Bromine	Br	1-10	5
Cadmium	Cd	0.01-0.7	0.06
Cesium	Cs	0.3-25	6
Chlorine	Cl	20-900	100
Chromium	Cr	1-1,000	100
Cobalt	Co	1-40	8
Copper	Cu	2-100	30
Fluorine	F	10-4,000	200
Gallium	Ga	0.4-300	30
Gold	Au	not available	1
Iodine	I	0.1-40	5
Lanthanum	La	1-5,000	30
Lead	Pb	2-200	10
Lithium	Li	5-200	20
Magnesium	Mg	600-6,000	5,000
Manganese	Mn	20-3,000	600
Mercury	Hg	0.01-0.3	0.03
Molybdenum	Mo	0.2-5	2
Nickel	Ni	5-500	40
Radium	Ra	8 × 10-5	not available
Rubidium	Rb	5-500	10
Selenium	Se	0.1-2	0.3
Silver	Ag	0.01-5	0.05
Strontium	Sr	50-1,000	200
Thallium	Tl	not available	5
Tin	Sn	2-200	10
Tungsten	W	not available	1
Uranium	U	0.9-9	1
Vanadium	V	20-500	100
Yttrium	Y	25-250	50

Metal Concentrations in the Soil			
Element	**Symbol**	**Common Range (ppm or mg/kg)**	**Average Concentration (ppm or mg/kg)**
Zinc	Zn	100-300	50
Zirconium	Zr	60-2,000	300

Source: USEPA office of solid waste and emergency response, hazardous waste land treatment, SW-874 (April 1983, page 27)

Table 2: Bangladesh Standard for Inland Surface Water

Best practice based classification	Parameter			
	pH	**BOD mg/l**	**DO mg/l**	**Total Coliform Number/100**
Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000or less
Water usable by fisheries	6.5-8.5	6 or less	5 or more	-
Water usable by the various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
Water usable for irrigation	6.5-8.5	10 or less	5or more	1000 or less

Source: Rule 12, Schedule-3, ECR. 1997, Bangladesh

Table 3: Bangladesh Standards for Drinking Water

Parameters	Units	Bangladesh Standards
Aluminum	mg/l	0.2
Ammonia (NH3)	mg/l	0.5
Arsenic	mg/l	0.05
Balium	mg/l	0.01
Benzene	mg/l	0.01
BOD5 20°C	mg/l	0.2
Boron	mg/l	1.0
Cadmium	mg/l	0.005
Calcium	mg/l	75
Chloride	mg/l	150- 600
Chlorinated alkanes	mg/l	0.01
1,1 dichloroethylene	mg/l	0.01
1,2 dichloroethylene	mg/l	0.03
Tetrachloroethylene	mg/l	0.03
Trichloroethylene	mg/l	0.09
Chlorinatedphenols pentachlorophenol	mg/l	0.03
2.4.6 trichlorophenol	mg/l	0.03
Chlorine (residual)	mg/l	0.2

Parameters	Units	Bangladesh Standards
Chloroform	mg/l	0.09
Chromium (hexavalent)	mg/l	0.05
Chromium (total)	mg/l	0.05
COD	mg/l	4
Coliform (fecal)	n/100 ml	0
Coliform (total)	n/100 ml	0
Color	Hazen unit	15
Copper mg/l	mg/l	1
Cyanide	mg/l	0.1
Detergents	mg/l	0.2
DO	mg/l	6
Fluoride	mg/l	1
Hardness (as CaCO3)	mg/l	200-500
Iron	mg/l	0.3-1.0
Kjeldahl Nitrogen (total)	mg/l	1
Lead	mg/l	0.05
Magnesium	mg/l	30-35
Manganese	mg/l	0.1
Mercury	mg/l	0.001
Nickel	mg/l	0.1
Nitrate	mg/l	10
Nitrite	mg/l	<1
Odor	mg/l	Odorless
Oil and grease	mg/l	0.01
pH	mg/l	6.5-8.5
Phenolic compounds	mg/l	0.002
Phosphate	mg/l	6
Phosphorus	mg/l	0
Potassium	mg/l	12
Radioactive materials (gross alpha activity)	Bq/l	0.01
Radioactive materials (gross beta activity)	Bq/l	0.1
Selenium	mg/l	0.01
Silver	mg/l	0.02
Sodium	mg/l	200
Suspended particulate matters	mg/l	10
Sulfide	mg/l	0
Sulfate	mg/l	400
Total dissolved solids	mg/l	1000

Parameters	Units	Bangladesh Standards
Temperature	°C	20-30
Tin	mg/l	2
Turbidity	JTU	10
Zinc	mg/l	5

Source: Rule 12, Schedule-3, ECR.1997, Bangladesh

Table 4: IFC Effluent Guidelines for Effluent Quality Standard

Parameter	Unit	Maximum allowable value for discharge in surface water
pH	-	6.0-9.0
Total Suspended Solids (TSS)	mg/l	50
Oil and Grease	mg/l	10
Total Residual Chlorine	mg/l	0.2
Chromium (total)	mg/l	0.5
Copper	mg/l	0.5
Iron	mg/l	1.0
Zinc	mg/l	1.0
Lead	mg/l	0.5
Cadmium	mg/l	0.1
Mercury	mg/l	0.005
Arsenic	mg/l	0.5
Temperature increase by thermal discharge from the cooling system	°C	• The site-specific requirement to be established by the EA. • Elevated temperature areas due to the discharge of once-through cooling water(e.g., 1° Celsius above, 2° Celsius above, 3° Celsius above ambient water temperature) should be minimized by adjusting the intake and outfall design through the project-specific EA depending on the sensitive aquatic ecosystems around the discharge point.

Source: IFC EHS guideline for the thermal power plant, 19 December 2008

Table 5: Bangladesh Standards for Waste from Industrial Units or Project Waste

Parameters	Units	Inland Surface Water
Ammonical Nitrogen (as elementary N)	mg/l	50
Ammonia (as free ammonia)	mg/l	5
Arsenic	mg/l	0.2
BOD5 20°C	mg/l	50
Boron	mg/l	2
Cadmium	mg/l	0.50
Chloride	mg/l	600

Parameters	Units	Inland Surface Water
Chromium (as total Cr)	mg/l	0.5
COD	mg/l	200
Chromium (as hexavalent Cr)	mg/l	0.5
Copper	mg/l	0.5
Dissolved Oxygen (DO)	mg/l	4.5-8
Electrical Conductivity (EC)	micro mho/cm	1200
Total Dissolved Solids	mg/l	2100
Fluoride (as F)	mg/l	2
Sulfide (as S)	mg/l	1
Iron (as Fe)	mg/l	2
Total Kjeldahl Nitrogen (as N)	mg/l	100
Lead (as Pb)	mg/l	0.1
Manganese (as Mn)	mg/l	5
Mercury (as Hg)	mg/l	0.1
Nickel (as Ni)	mg/l	1.0
Nitrate (as elementary N)	mg/l	10
Oil and Grease	mg/l	10
Phenolic Compounds (as C6H5OH)	mg/l	1.0
Dissolved Phosphorus (as P)	mg/l	8
pH	mg/l	6-9
Selenium (as Se)	mg/l	0.05
Zinc (as Zn)	mg/l	5
Temperature	°C	Summer-40, Winter-45
Suspended Solids (SS)	mg/l	150
Cyanide (as Cn)	mg/l	0.1

Source: Rule- 13, Schedule-10, ECR.1997, Bangladesh

Table 6: IFC Indicative Values for Treated Sanitary Sewage Discharges

Pollutants	Units	Guideline values
pH	-	6-9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/ 100ml	400

Source: IFC EHS General Guidelines 30 April 2007

Table 7: Bangladesh Standards for Sewage Discharge

Pollutants	Units	Standard limit for discharge into the surface and inland water bodies
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	°C	30
Coliform number	Per 100 ml	1000

Source: Rule- 12, Schedule-9, E.C.R.1997, Bangladesh

Table 8: WHO* Ambient Air Quality Guidelines

Parameters	Guideline value	Averaging period
PM 10 (µg/m^3)	20	Annual
	50	24 hour
PM 2.5 (µg/m^3)	10	Annual
	25	24 hour
NOx	40	Annual
	200	1 hour
SOx	20	24 hour

Source: WHO guideline available at www.who.int/en

*World Health Organization (WHO) Ambient Air Quality Guideline Values (2005 and 2000), which are also being referred to the World Bank and IFC's General EHS Guidelines (2007)

Table 9: Ambient Air Quality Standards of Bangladesh

Parameter	Standard	Average time
Carbon Monoxide (mg/m^3)	10	8 hour
	40	1 hour
SPM (µg/m^3)	200	8 hour
PM 10 (µg/m^3)	50	Annual
	150	24 hour
PM2.5 (µg/m^3)	15	Annual
	65	24 hour
NOx (µg/m^3)	100	Annual
Ozone (µg/m^3)	235	1 hour
	157	8 hour
SOx (µg/m^3)	80	Annual
	365	24 hour

Source: Bangladesh Gazette 19th July 2005 under ECR 1997

Table 10: Bangladesh standards for ambient sound level

Category area	Day (dB)	Night (dB)
Silent Zone*	50	40
Residential Area	55	45
Mixed Area**	60	50
Commercial Area	70	60
Industrial Area	75	70

Source: Bangladesh Gazette 7th September 2006 under ECR, 1997

* Area up to the radius of 100 m around hospitals or educational institutions or special institutions/establishments identified/to be identified by the government designated as a silent zone where the use of horns of vehicles or other audio signals, and loudspeakers are prohibited)

** Mainly residential area, and simultaneously used for commercial and industrial purposes.

Table 11: The WB/IFC Noise Level Guidelines*

Receptor	One hour LAeq (dB)	
	Daytime (07:00 –22:00)	Night time (22:00 –07:00)
Residential, institutional, educational**	55	45
Industrial, commercial	70	70

Source: IFC EHS General Guidelines 30 April 2007

* Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

** For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).

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

Table 6 (C) - Emissions Guidelines (in mg/Nm³ or as indicated) for Boiler

Note:

- Guidelines are applicable for new facilities.
- EA may justify more stringent or less stringent limits due to ambient environment, technical and economic considerations provided there is compliance with applicable ambient air quality standards and incremental impacts are minimized.
- For projects to rehabilitate existing facilities, case-by-case emission requirements should be established by the EA considering (i) the existing emission levels and impacts on the environment and community health, and (ii) cost and technical feasibility of bringing the existing emission levels to meet these new facilities limits.
- EA should demonstrate that emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards, and more stringent limits may be required.

Combustion Technology / Fuel	Particulate Matter (PM)		Sulfur Dioxide (SO_2)		Nitrogen Oxides (NOx)		Dry Gas, Excess O_2 Content (%)
Boiler	NDA	DA	NDA	DA	NDA	DA	
Natural Gas	N/A	N/A	N/A	N/A	240	240	3%
Other Gaseous Fuels	50	30	400	400	240	240	3%
Liquid Fuels (Plant >50 MWth to <600 MWth)	50	30	900 – 1,500[a]	400	400	200	3%
Liquid Fuels (Plant >/=600 MWth)	50	30	200 – 850[b]	200	400	200	3%
Solid Fuels (Plant >50 MWth to <600 MWth)	50	30	900 – 1,500[a]	400	510[c] Or up to 1,100 if volatile matter of fuel < 10%	200	6%
Solid Fuels (Plant >/=600 MWth)	50	30	200 – 850[b]	200			6%

General notes:

- MWth = Megawatt thermal input on HHV basis; N/A = not applicable; NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly; CFB = circulating fluidized bed coal-fired; PC = pulverized coal-fired; Nm^3 is at one atmospheric pressure, 0 degree Celsius; MWth category is to apply to the entire facility consisting of multiple units that are reasonably considered to be emitted from a common stack. Guideline limits apply to facilities operating more than 500 hours per year. Emission levels should be evaluated on a one hour average basis and be achieved 95% of annual operating hours.
- a. Targeting the lower guidelines values and recognizing issues related to quality of available fuel, cost effectiveness of controls on smaller units, and the potential for higher energy conversion efficiencies (FGD may consume between 0.5% and 1.6% of electricity generated by the plant). b. Targeting the lower guidelines values and recognizing variability in approaches to the management of SO_2 emissions (fuel quality vs. use of secondary controls) and the potential for higher energy conversion efficiencies (FGD may consume between 0.5% and 1.6% of electricity generated by the plant). Larger plants are expected to have additional emission control measures. Selection of the emission level in the range is to be determined by EA considering the project's sustainability, development impact, and cost-benefit of the pollution control performance. c. Stoker boilers may require different emissions values which should be evaluated on a case-by-case basis through the EA process.

Comparison of the Guideline limits with standards of selected countries / region (as of August 2008):

- Natural Gas-fired Boiler – NOx
  - Guideline limits: 240
  - EU: 150 (50 to 300 MWth), 200 (> 300 MWth)
- Solid Fuels-fired Boiler - PM
  - Guideline limits: 50
  - EU: 50 (50 to 100 MWth), 30 (> 100 MWth), China: 50, India: 100 - 150
- Solid Fuels-fired Boiler – SO_2
  - Guideline limits: 900 – 1,500 (Plant > 50 MWth to < 600 MWth), 200 – 850 (Plant ≥ 600 MWth)
  - EU: 850 (50 – 100 MWth), 200 (> 100 MWth)
  - US: 180 ng/J gross energy output OR 95% reduction (≈ 200 mg/Nm3 at 6% O_2 assuming 38% HHV efficiency)
  - China: 400 (general), 800 (if using coal < 12,550 kJ/kg), 1,200 (if mine-mouth plant located in non-double control area of western region and burning low S coal (<0.5%))

Source: EU (LCP Directive 2001/80/EC October 23 2001), US (NSPS for Electric Utility Steam Generating Units (Subpart Da), Final Rule – June 13, 2007), China (GB 13223-2003)

ANNEX G- LAYOUT OF POWER PLANT

ANNEX H- NO OBJECTION CERTIFICATE