



A 163 MW (NET) COMBINED CYCLE POWER GENERATION FACILITY AT FENCHUGANJ, BANGLADESH

VOLUME I: ESIA REPORT

ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT (ESIA) REPORT

FINAL REPORT

SEPTEMBER 2018

**ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT (ESIA)
OF
A 163 MW (NET) COMBINED CYCLE POWER
GENERATION FACILITY AT FENCHUGANJ, BANGLADESH**

Volume I: ESIA Report

SEPTEMBER 2018

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Quality Information

Document : Environmental Impact Assessment (EIA) of a 163 MW (net)
Combined Cycle Power Generation Facility at Fenchuganj,
Bangladesh

Project No. : EQMS#0017820033

Date : 11th September, 2018

Volume : 1 of 2 (Main ESIA Report)
2 of 2 (Annexes)

Revision History

Revision	Revision Date	Details	Authorized	
			Name/Position	Signature
2	11 th September 2018	Final Report	Kazi Farhed Iqubal ED, EQMS	
1	28 th June 2018	Final Report	Kazi Farhed Iqubal ED, EQMS	
0	16 th November 2017	Draft ESIA Report	Kazi Farhed Iqubal ED, EQMS	

Reporting History

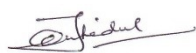
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0 EXECUTIVE SUMMARY

0.1 Introduction and Background

Planned and appropriate use of power is one of the pre-conditions for economic development of Bangladesh. There is a huge demand for electricity in our day-to-day life as well as in various sectors of the economy. The total power produced in the country is not enough to ensure adequate access to electricity. As of now, only 90 percent of the total population has access to electricity. Per capita electricity generation is only 464 kwh (Power Cell, 2018). In order to improve this situation, the Government has given the highest priority to power sector development and is committed to make electricity available to all by 2021.

The Government of Bangladesh (GoB) has adopted a strategy for the development of the power sector which envisages private participation. In line with this strategy, the GoB has decided to implement a new Greenfield 163 MW Combined Cycle Power Plant (CCPP) on Build, Own and Operate (BOO) basis under the Independent Power Producer (IPP) program in Sylhet District, Bangladesh.

Kushiara Power Company Limited (hereinafter referred to as KPCL) was signed the Power Purchase Agreement with the Bangladesh Power Development Board (BPDB) on 20 March 2013. The power plant is located to the left bank of the river Kushiara. The location of the proposed project site lies, geographically between 24°41'25.54"N; 91°55'7.80"E to 24°41'25.69"N; 91°55'6.72"E and 24°41'19.28"N; 91°55'6.80"E to 24°41'21.21"N; 91°55'1.39"E. The site is about 3.5 km from Sylhet-Moulavibazar Road to the west, about 28 km south-east of Sylhet and about 8 km road from Fenchuganj upazila. The aerial view of the proposed CCGT power plant has been shown in Figure 1.

The proposed power plant is expected to add 163 MW electricity to the national grid of the country which will improve the present electricity generation significantly and will trigger the national economic development. It will encourage industrial development and the development of associated facilities including communication, education, employment opportunity, etc. As such construction of the proposed plant will ultimately play an important role in poverty reduction and in the development of social safety net. Moreover, this gas based power plant will thereby play an important role in maintaining the widely-concerned environment through producing less pollutant than electricity generation by other types of fuel.

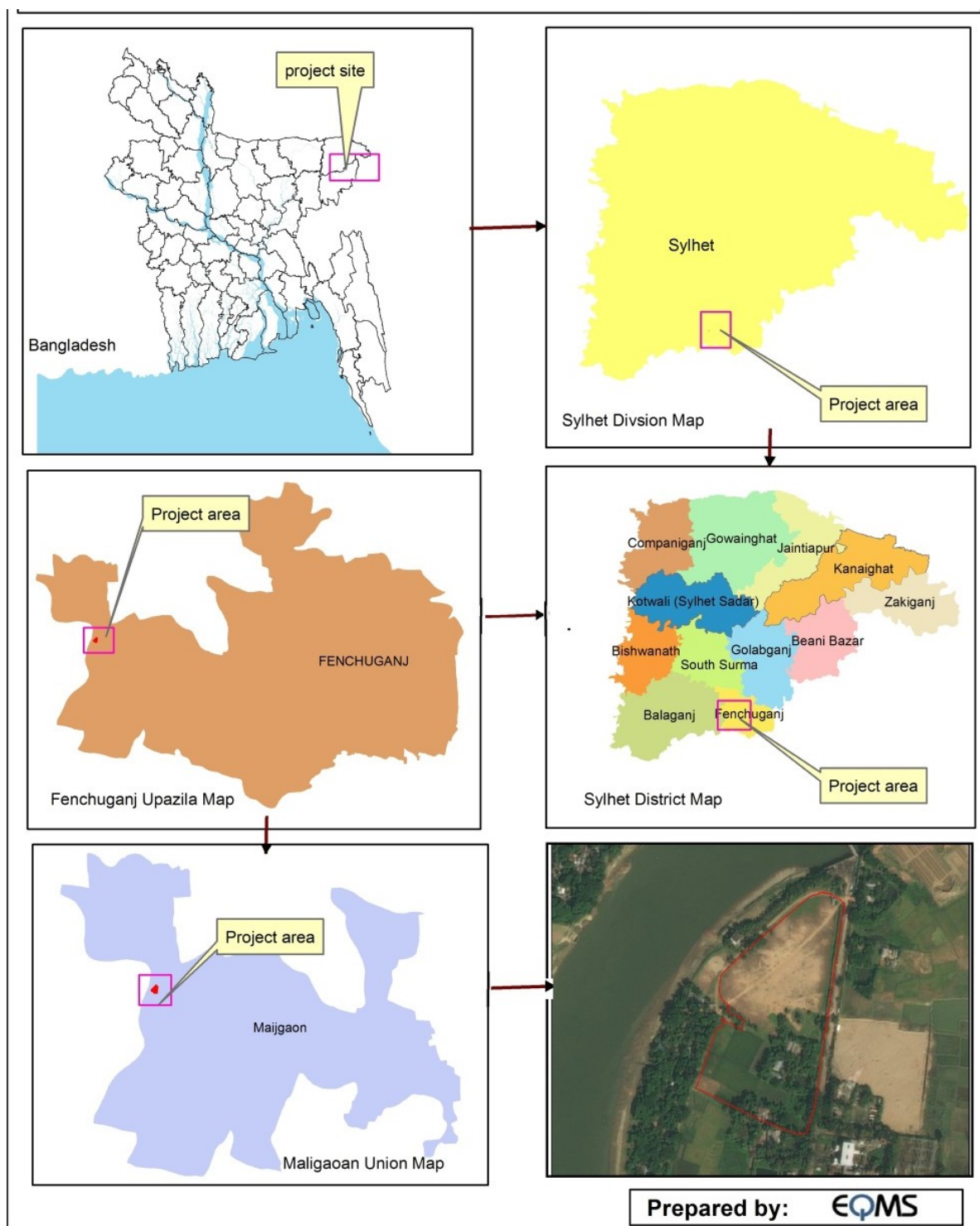


Figure 1: Location Map of the Proposed Power Plant

0.2 Policy, Legal and Administrative Framework

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

The activities of proposed gas based thermal power plant project of Bangladesh Government fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore, need to conduct IEE and EIA studies to obtain site and environmental clearance from the DoE. The ESIA has been prepared in accordance with the following:

- Applicable Bangladesh national, regional and local regulations;
- International conventions and agreements ratified by Bangladesh
- ADB's Safeguard Policy Statement (SPS) (2009) and specific requirements;
- IFC Performance Standards for Environmental and Social Sustainability (2012);
- IFC General Guidelines (2007) and for Thermal Power Plants (2008)

0.3 Project Description

0.3.1 Introduction

The proposed 163 MW gas-fired combined cycle power plant (CCPP) will be located in Fenchuganj upazila under Sylhet district, Bangladesh. The Project will be implemented on a Build, Own and Operate (BOO) basis for a period of 22 years. Natural gas will be delivered from the Jalalabad Gas Transmission and Distribution System Limited (JGTDSL) via a new pipeline of approximately 150 meter, connecting the power plant to the existing Valve Station owned by JGTDSL. Ground water will be extracted for the cooling system. A 230 kV switch yard will also be constructed at the site as part of the Project; while a 3.9 km new 230 kV transmission line will be constructed by the KPCL which will be handed over to the Power Grid Company of Bangladesh (PGCB) for power evacuation from the Project. the salient feature of the project has been shown in the following Table 1.

Table 1: Salient Feature of the Proposed Project

Name of project	163 MW gas fired combined cycle power plant
Name of project Company	Kushiara Power Company Limited
Registered Office	Baitul Hossain Building (6th Floor), 27 Dilkusha C/A, Dhaka-1000
Plant location	Garulikona, Fenchugonj, Sylhet, Bangladesh
Legal Status	Private Limited Company
Nature of Business	Power Generation
Nature of project	Gas based combined cycle power plant
Project Tenure	22 years
Total cost of the project	Tk. 1,167 crore
EPC cost	Tk. 1,047 crore

Total Plant Area	9.22 acres		
Electricity generation	Simple Cycle	Combined Cycle	Total
	109 MW	54 MW	163 MW
Off-taker	Bangladesh Power Development Board		
Gas supplier	Jalalabad Gas Transmission and Distribution System Ltd.		
Gen set supplier	General Electric International, INC		
RMS supplier	General Electric International, INC		
Gas Turbine Generator Model	9E.03		
Steam Turbine Generator Model	SC2-26		
Commencement date of project	8 January 2016		
Expected completion date	Single Cycle- 25 July 2017 Combined Cycle- 28 April 2018		
EPC contractor	Max Infrastructure Limited		
Technical & Engineering service provider	Mott MacDonald Limited, UAE		
Technical & Engineering plan review	Tata Consulting Engineers Limited, India		
Technical staff provider	SEPCO1 Engineering India (Private) Limited		
Total Manpower	670 persons (Site staff: 600 and Office staff: 70)		

Source: Kushiara Power Company Limited (KPCL)

0.3.2 Project Component

The key Project components are as follows:

- Gas Turbine;
- Heat Recovery Steam Generator;
- Steam Turbine;
- Steam Turbine Condenser;
- Fuel Gas Compression and Conditioning System;
- Water System including cooling water system;
- Electrical System
- Connection from switch yard to PGCB sub-station
- Air Conditioning and Ventilation System; and
- Control and Instrumentation System;
- New RMS for natural gas compression and conditioning
- New natural gas pipeline from JGTDSL Valve Station to the RMS of KPCL Project
- Civil works

0.3.3 Key Feature of the Site and Surroundings

Presently there is no structure within the project site. The project site is plain vacant land. There are two religious structures (Mosque and Graveyard) present adjacent to the project boundary. Details of areas surrounding the proposed project site are as under:

- The project site is located on the left bank of Kushiara River. Two water intake stations are presents near to the project site. Jalalabad Gas Transmission and Distribution System Limited (JGTDSL) valve station is located approximately 200m northeast side of the power plant. Approximately 150 m pipeline will connect to the RMS from the valve station. Two 90 MW BPDB power plants are located approximately 250 m and 350 m south-east direction from the power plant.



0.3.4 Means of access

Map showing the project area (KPCL Project area) and surrounding infrastructure, including the Kuthia River, Sylhet Moulabazar Hwy, and various project features (Valve Station, RMS, Jetty, Upgraded by KPCL, Existing Access Road, Gas Pipeline). The map includes a scale bar (0 to 500 meters) and a north arrow. Two inset photographs show the project area: one showing a dirt road and buildings, and another showing a paved road and a sign.

Figure 3: Access Road of the Proposed Power Plant

0.3.5 Gas Gathering Pipeline

Approximately 150 m gas pipeline from the existing valve station to the RMS will be designed and constructed by the Sponsor at its own cost under supervision of Jalalabad Gas Transmission & Distribution System Ltd. (JGTDSL). The constructed gas pipeline will be transferred to JGTDSL for operation and maintenance at no cost to JGTDSL. The Sponsor will install a Natural Gas Check Metering System within the power plant premises.



Figure 4: Gas Pipeline Route from JGTDSL Valve Station to New RMS

The RMS will include necessary equipment and materials for data (gas metering information) transfer between the JGTDSL.

0.3.6 Power Evacuation

The generated power will be evacuated to the National Grid through 230/132 kV Fenchuganj substation. The Facility will be connected to the 230-kV bus of Fenchuganj 230/132 kV substation by a single ckt 230 kV (O/H/U/G) line (Interconnection Line) from the Facility. The power evacuation route of the proposed project is shown in the following Figure 5.

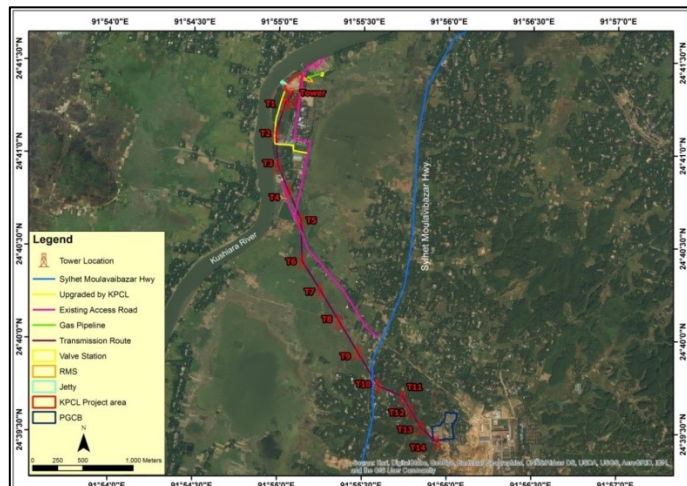


Figure 5: Transmission Line Route Alignment for Power Evacuation of the Power Plant

0.3.7 Project Status

Site Clearance Certificate has been obtained from DoE based on the IEE report on 23 August 2016. According to the ECR 1997, an EIA study was prepared and submitted to Department of Environment. The project got the EIA approval from DoE on 1 March 2017. KPCL obtain the Environmental Clearance Certificate from DoE on 21 June 2017.

0.3.8 Resources and Utility Demand

Land Requirement

Approximately 9.22 acres (922 decimal) of land is required for the Project. The required land has already purchased by the KPCL. Table 1 provides a summary of the land requirement for various components of the proposed.

Table 1: Land use Breakdown for Project and Associated facility

Project Component	Area (Decimal)	Percent (%)
Plant Area	200.64	22%
Road	166.43	18%
Open Space	235.38	26%
Plantation	150	16%
Dormitory	44.53	5%
Drainage	20.18	2%
Water Tanks	6.09	1%
Electrical Substation + Busduct + Transformer	42.22	5%
Control Buildings	23.38	3%
Store	15.35	2%
RMS	17.8	2%
Total Area	922	100%

Source: KPCL

Water Requirement

A circulatory water system has been planned for the proposed power plant. Total 209.6 m³/h water will be circulated in a closed cycle during operation period. It is estimated that 234.3m³/hr water will be required for meeting different demand of water including makeup of circulating water systems, service water, domestic water etc. All the required water will be supplied from the underground water. Water will be collected from five bore well and a water storage facility will be built with a total capacity of water requirement for twenty-four (24) hours by the facility plus firewater storage to meet the NFPA and the local fire code requirements.

The regular total requirement of water for this unit is 234.3m³/hr including the domestic requirement. The amount of liquid waste water would be about 47.5m³/hr, evaporative loss from the condenser cooling system would be about 174.7 m³/hr and other uses (make up water for generator CCCW, turbine washing, NO_x control water & boiler along with waste water reuse in the condenser cooling) would be about 8.2 m³/hr.

Gas Requirement

Natural Gas will be purchased from the Jalalabad Gas Transmission & Distribution System Ltd. (JGTDSL) under Gas Supply Agreement (GSA). Gas will be supplied through the existing Fenchuganj 20-inch (diameter) gas pipeline commissioned in the early eighties. This line has sufficient capacity to supply required gas (1.469 MMSCF/hr) for the plant.

0.4 Environmental and Social Baseline

A study area of 10 km from the project boundary has been taken into consideration for baseline survey. The baseline information was collected from both primary and secondary sources. Ambient air quality, noise level, surface and groundwater were collected and analyzed. The population and housing census, 2011 data of Bangladesh Bureau of Statistics

has been analysed for 5 km study area to know the demography and socio-economic condition of the study area. The primary socio-economic survey was conducted within 2 km radius from the project periphery. Two villages are located adjacent to the proposed power plant therefore survey team conducted 100% survey on all households on these villages.

0.4.1 Meteorology

Meteorological data for last thirty years (1986-2016) of Sylhet weather station were analyzed. Based on the data analysis it has been demonstrated that monthly average maximum temperature varies from 25.62°C to 33.4°C whereas monthly average minimum temperature varies from 12.97°C to 25.38°C.

Average Relative humidity in the project area is generally above 80% during May to October. The month of March is the driest with the average relative humidity around 66.95%. The monthly average relative humidity near the project area varies from 66.95% to 86.77% throughout the year.

The last 30 years data from the Sylhet meteorological station shows that the total rainfall is recorded as 4939 mm in 2010. According to the analysis of the historical data, a monthly highest average of total rainfall occurs in July 733.8 mm whereas monthly minimum rainfall recorded during the winter season (December and January).

0.4.2 Air Quality

The existing ambient air quality of the study area was monitored at four (4) locations during the monitoring period (August -September 2016). The monitoring parameters included Particulate Matter (SPM, PM₁₀ and PM_{2.5}), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), and Carbon Monoxide (CO). All the parameters except SPM and CO were monitored on 24-hourly basis during the duration of the study. SPM and CO were monitored as eight hourly averages.

The concentration of SPM (142.38-147.92µg/m³), PM₁₀ (112.7-128.7µg/m³), PM_{2.5} (22.51-27.89µg/m³), SO₂ (12.45-16.01µg/m³), NO_x (32.75-43.82µg/m³) and CO were found to be in compliance with the national standards presented under the ECR, 1997 (amended on 19th July 2005 vide S.R.O. No. 220-Law/2005).

0.4.3 Noise Level

Ambient noise levels in the project AOI were recorded from seven locations during the monitoring period (August 2016). Ambient daytime noise level (Leqday) was recorded in the range of 50.23 to 64.77 dB (A). Whereas, ambient night time noise level (Leqnight) in the study area varied in the range of 43.3 to 60.45 dB (A). Noise levels at two locations were recorded higher than the day and nighttime standard due to power plant construction work and operation of other power plant near the monitoring locations.

Noise also monitored at five locations after commissioning of the power plant. From the above it can be concluded that ambient noise levels in the rural and village setting of the Project AOI between May 2018- June 2018 were within the prescribed limits for Industrial landuse, which is 75dB(A) for day time and 70 dB(A) for night time at most of the locations for both Bangladesh and IFC standards. At that point of time, only NL-4 (In front of

Mosque) and NL-5 (In front of Moynu bibi house, Moynulpur) a mixed and residential landuse location was found to exceed the both day and night time limit due to the existing power plant operations. The noise level of both NL4 and NL5 were also exceed the standard during the August 2016.

0.4.4 Water Quality

Total eight water samples were collected during the survey period of which four were surface and four were groundwater. Analysis of the water quality shows both surface and groundwater quality was well within the standard for inland surface water of ECR, 1997 (Schedule 3).

0.4.5 Soil and Sediment Quality

Project site has been filled with sand materials to raise it avoid the flood level. The soil and sediment quality in the AOI varies from clayey loam to silt loam type. Low organic matter was found in the soil and sediment samples. Heavy metal also detected both soil and sediment samples.

0.4.6 Traffic

The road and traffic survey were conducted for 24 hours, once during the study period at the approach road to the proposed project and at the temporary jetty site on Kushiara River side.

Total no. of vehicles recorded in the road for 24 hours are 765 including 2 heavy vehicles, 26 medium vehicles, 419 light vehicles and 318 non- motorized vehicle. Maximum traffic volume of 99 vehicles in an hour was recorded between 1800 Hrs to 1900 Hrs. Frequency of the medium vehicle (4%), light vehicle (41.5%) and non-motorized vehicle (41.5%) respectively. A total 87 number of vessels recorded in 24 hours. Maximum vessel count of 12 in an hour was recorded between 1300 Hrs to 1400 Hrs.

0.4.7 Ecology

The project AOI is situated at the left bank of Kushiara River. An ecological assessment of flora and fauna in various habitats was undertaken. This covered terrestrial and aquatic ecosystems. The entire study area does not include any protected area earmarked by the GoB.

Crop field vegetation is a major type of the study area. Local inhabitant plant Dhaincha (*Sesbania rostrata*) at the end of Boro harvesting and this species is commonly found in all area. *Amaranthus spinosus*, *Cotula hemisphaerica* etc. are common species. Among the recorded 09 families, which are comprised of 12 Species where 3 family of Amaranthaceae, 1 family of Chenopodiaceae, Compositae, Convolvulaceae, Leguminosae, Rubiaceae, Theaceae & Cruciferae and 2 family of Euphorbiaceae were found.

A total of 60 homestead species of 44 Families were listed. Out of 60 species 38 are tree, 16 are shrub, 4 species are herb and 02 are vines. Common planted tree species are Aam (*Mangifera indica*), Supari (*Areca catechu*), Mehogani (*Swietenia mahagoni*), Lichi (*Litchi chinensis*) Kola (*Musa sp*), Guava (*Psidium guajava*) etc. Raintree (*Samanea saman*), Narikel (*Cocos nucifera*) and Supari (*Areca catechu*) occupied the top canopy. Homesteads are

commonly founds near the plain land which favor good growth of like Teak (*Tectona grandis*), Arjun (*Tectona grandis*) Freshwater Mangrove (*Barringtonia acutangula*) etc. Among the shrubs Dumur (*Ficus hispida*) is the most common of all species. Homestead flora consists of both native and exotic species and some of them are naturalized. *Albizia richrdiana*, *Psidium guajava*, Hairy Fig (*Ficus hispida*).

Terrestrial faunal components were recorded for mammals, avifauna, Amphibians, Reptiles, Butterflies, Dragonflies and Damselflies in the project AOI. Study enumerated 7 species of mammals, 13 species of birds, 16 species of amphibians and reptiles, 20 species of butterflies, 13 species of dragonflies and damselflies. None of mammals and bird species recorded is listed in IUCN for conservational significance.

Fish survey was conducted in the project AOI, enumerated 40 species of fishes. Among of them 6 species are endangered and 3 species were found vulnerable according to the IUCN red list 2015.

0.4.8 Socio-Economic Environment

This study has identified social impacts of the proposed project on the local community. Two adjacent villages situated within 2km radius from the proposed project site have been surveyed. Total 180 households within 2 km study area has been surveyed. According to the survey shows that 57.2% of the total surveyed populations, 980 in total, are male and the rest (42.8%) are female. Within the total population 21.6% are illiterate. Primary and secondary level education status are most significant; 32.9% and 34.1% respectively. Moreover, 8.7% intermediate and 2.8% graduate level education status are also found. Among the total populations 36.12% population involve in business/trade as well as 23.95% and 14.07% people involve in agriculture and agriculture labor.

Adarsha Gram and Moinpur villages are the closest receptors, situated within 300 meters radius, of the proposed power plant. For being the closest proximity survey team has conducted 100% census within these villages. A total amount of 61 households consisting 412 populations are residing in these two villages. Adarsha Gram is situated in the West and Southern West side from the proposed power plant. Adarsha Gram was established in Govt. Khash Land and people are living there since more than 25 years. A total of 54 households consisting 361 populations are currently residing in this village. On the other hand, Moinpur is situated in the Northern east side from the project site. Only a total of 7 households consisting 51 populations are currently living in Moinpur village.

Among the total of 412 populations, 87.62% people reside in Adarsha Gram and rest 12.38% people live in Moinpur. Gender ratio is similar in these two villages. In Adarsha Gram and Moinpur, male ratio is 52.35% and 52.94 and female ratio is 47.65% and 47.06% respectively. Major findings from the survey are as follows

- ❖ Male percentage is higher than female percentage of total population.
- ❖ Percentage of higher educational attainment is very low.
- ❖ Female's educational attainment is lower than that of male.
- ❖ Only 26.21% of total populations are engaged in economic activities.

- ❖ Populations, who are engaged in economic activities, among them most of the populations have BDT 6000 to 10000 monthly income.
- ❖ Female's engagement in economic activities is very low compared to male's engagement.
- ❖ Engaging in domestic work is the main reason for female for not engaging in economic activities.
- ❖ Only 20.75% of 18-21 age group is currently active in economic activities. Higher female percentage belongs to this group.
- ❖ In all workable age groups, where female percentage is higher there economic engagement is lower.

0.5 Key Environmental Impacts and Mitigation

All pre-construction, construction, and operation activities that were likely to cause environmental and social impacts were identified, and evaluated to assess their magnitude, duration, and potential receptors.

Construction Phase

The activities which have the potential to cause impacts on surrounding environment and receptors during the Construction of the power plant are identified as:

- site preparation, including raising the land;
- transportation of construction material and machinery for the power plant by barge along the Kushiara River and by road;
- construction of a temporary jetty, gas pipeline;
- excavation of equipment foundations and installation of power plant components;
- storage and handling of hazardous materials, waste and wastewater;
- accommodation and transportation for the construction workforce and KPCL Personnel

During the construction phase, contamination of soil, sediment and ground water may result from potential leaks and spills of oil, lubricants, or fuel from heavy equipment, improper handling of sanitary effluent, or chemical/fuel storage and sanitary and construction wastes. In addition, soil compaction and erosion may take place during civil works at project site, laying of pipelines, temporary jetty and laydown areas.

The construction contractor appointed by KPCL will carry out construction of the power plant. The construction contractor will handle, store and dispose of all waste in accordance with applicable GOB guidelines to prevent soil and ground water contamination. With other mitigation measures such as proper storage of chemicals and fuel, drip or spill trays for spills and leaks, site specific emergency response plan for soil clean -up and training by contractors, demarcating routes for heavy vehicle movement, retaining top soil for reuse, the impact to soil would be mostly negligible or minor.

The potential sources of impact to surface water and groundwater resources within the Project area during the construction phase will be from earthworks and jetty construction, sewage from construction labour camps, run-off from inappropriately stored waste.

Mitigation measures such as storage of chemicals at concreted laydown areas has been proposed to minimize contamination in the event of a spill. Septic tanks are proposed for sanitary wastewater. All wastewater discharges will be treated to meet the standards stipulated in Schedule 9 and 10 of ECR, 1997 and the applicable World Bank/ IFC General EHS Guidelines prior to discharge. Based on the mitigation measures proposed the impacts of increased sediment load to Kushiara River; and on surface and ground water quality are assessed as minor in nature. Surface run-off, erosion and sediment load will be further minimised by adopting good site practices.

In terms of air quality, the construction activities and machineries will generate dust and exhaust emissions respectively. The sensitive receptors are some scattered settlements located at a distance of approximately 150 to 200 m from the site boundary. The implementation of the good site management, such as dust suppression techniques, covering of stockpiles, regular maintenance of vehicles and equipment and cleaner fuels will be used to reduce the impact on ambient air quality.

For noise levels during the construction phase the worst case scenario predicted is that the nearest sensitive receptor (50 m from the southern boundary of the Project site) will have a high noise level. The construction contractor will ensure that construction noise is adequately controlled to avoid nuisance and not normally exceed the GOB Guidelines for Mixed Use Areas. Work will not be carried out at night without the approval of the local authorities. With the implementation of these measures, the noise impact from construction is expected to range from minor to moderate. Further mitigation measures as regular maintenance of construction equipment, noise barriers/enclosures etc are proposed to further reduce noise.

There would be some impact to the road and water ways due to increase in traffic during the construction phase of the Project. The mitigation measures proposed to reduce transportation impacts to As Low as Reasonably Practicable are use of waterways, avoiding peak traffic hours, safe driving speed limits, road safety initiatives as collaborating with community and responsible authorities for improving signage's, awareness of pedestrian and traffic safety etc.

The construction workforce of 670 workers will be exposed to occupational health and safety impacts arising from construction activities. Measures have been proposed to ensure that these risks are considered prior to the commencement of construction, and that all risks are communicated to the workforce. Appropriate Personal Protection Equipment (PPEs) will be provided and equipment maintained and inspected regularly. Taking this into account, the impact to the health and safety of workers has been assessed to be moderate.

Also Communities and residents of settlements in the close proximity of the Project site (within 500 m) and along the gas pipeline alignment (with 100 m) are the receptors, who will be exposed to health impacts from construction activities as prevalence of water and vector borne diseases and risk from increased traffic. The measures proposed such as vector control programmes, avoiding collection of stagnant water, creating awareness among project personnel, workers and community on traffic and health risks and prevention against those, would reduce the severity of the impact.

From an ecological perspective, the construction activities would result in clearing of vegetation and disturbance of amphibians, reptiles, avi-fauna and mammals (such as rats and mongoose) observed in and around the Project site. The construction of the floating jetty on the water body and impacts such as surface run-offs etc may have an impact on the aquatic ecology as fish, planktons etc of the Kushiara River. The baseline status of species richness at the Project site and associated infrastructure area with respect to the study area is low. The species occurring at the Project site and associated infrastructure are commonly present throughout the study area. Based on this the impact was assessed as minor. Further mitigation measures as minimum land clearing to the extent possible, green belt development to offset impacts, preference to local workers to control additional pressure on natural resources, undertaking awareness programs on resource conservation etc are also proposed.

In terms of social scenario, there is no resettlement as the project land was private land and KPCL bought the land from the landowner in a negotiation basis and after verifying the present land value. On the other hand, local unskilled people will get job opportunity during the power plant construction. The construction phase in one hand will generate employment, benefit local enterprises, while on the flipside will cause labour influx and will have noise and dust impacts to some extent. Therefore, the labour camp will be located outside the power generation complex.

Operation Phase

The operations of the proposed Project would result in generation of various types of non-hazardous and hazardous wastes from Office and Canteens; WTP, ETP and STP; gas turbine; laboratories; GT compressors; lube oil systems; DG sets; and power house and workshop area. These solid and nonhazardous wastes generated from the various areas during operations will be collected and segregated at the point of generation and stored in proper designated areas and disposed off through waste disposal contractors or authorized recyclers. It is planned that hazardous wastes generated from the proposed Project will be collected and stored in designated roofed-areas and/or barrels with concrete flooring and secondary containment and disposed off/ sold through contractors or treated prior to discharge. Further mitigation measures as proper labelling of hazardous wastes, periodic audits, spill response and emergency plans and manifest records will be maintained.

The potential sources of impact to surface and ground water resources during the operational phase of the Project will be from the abstraction of water from the ground for operations which would have an impact on ground water depletion during the lean season. All the wastewater generated at various areas of the plant will be segregated at the source of generation and treated at a wastewater treatment plant (ETP and STP) meeting the discharge standards of the GOB and the applicable World Bank Group environmental requirements. In addition, instrumentation will be used to monitor the Plant's compliance with the discharge limitations. In the event that effluent discharge is detected above the effluent discharge limit criteria, isolation valves will be automatically close and stop the discharge. The overall impact to the surface water quality (excluding temperature variations) is therefore assessed as minor.

Given the shallow nature of the groundwater table in the Project area, there is a risk of impact on the groundwater quality from the storage and handling of hazardous materials. The hazardous materials will be stored in a dedicated room and diesel will be stored in oil tank. The storage arrangements will include secondary containment measures and spill kits for spillage control. In addition, a chlorine adsorption system (scrubber type) will be provided as a control in the event of a chlorine leak. Given the control measures which will be implemented during operations, and adequate training of operational staff in spill response measures, the impact to groundwater from the plant operations is assessed as minor. Further measures adopted to reduce impacts to water quality are minimising use of antifouling and corrosion inhibiting chemicals, chlorinated biocides; collection and storage of waste oil and concrete linings to drainage/tanks to prevent seepage to ground etc.

The impact on air quality from operation of the Project will generate flue gas emissions containing NO_x and CO. Emissions of SO₂ are likely to be negligible. Particulate emissions are likely to be negligible; as natural gas is a gaseous fuel (there is no supplementary fuel to be used in the Gas Turbine).

Impacts due to the operation of plant were assessed by modelling projected emission rate of the plant operation by modelling in the AMS/EPA Regulatory Model (AERMOD). On the basis of the modelling results, it was analysed that the maximum ground level concentration in the study area will be well within the applicable national as well as international standards (WHO) for air quality and impact on air quality was predicted to be minor.

The Project will have a variety of operational activities that generate significant noise levels, including operation of turbines, pumps, cooling fans, water pumps, etc., and most of these will operate 24 hours. Noise levels will be mitigated through engineering control and wherever possible high noise equipment will be enclosed in noise-proofed buildings that effectively contain the noise. The nearest receptor is located adjacent to the project boundary in the western boundary. The predicted noise levels through model Sound Plan 7.4 that in the worst case scenario, the nearest receptor (73 m and 330 m) will have daytime noise of 66.13 dB (A) and 64.10 dB (A) and night time 64.54 dB (A) and 62.13 dB (A) respectively due to the higher background levels recorded during the baseline monitoring. The predicted noise levels at the closest receptor exceed the national standard due to the existing power plants operation. Among mitigation measures acoustic barriers, enclosures and plantations are proposed where required.

During the operation phase of the Project, the regular traffic and transportation will be limited to the movement of plant personnel and contracted workers during their working shifts. As the total manpower will be limited to 70, this will not lead to any traffic and transportation impact.

Impact on the ecology during the operational phase will be mostly to the floral and faunal components surrounding the project site and in the Kushiara River.

Increased noise levels from the operational Project would disturb the avifauna. However, the study area has dense homestead plantations, to which avifauna and other faunal species can move to and therefore the impact is assessed as minor.

Some of the social impacts predicted due to the operations of the Project are Employment Generation and In-Migration of Skilled workforce, Demand for lodging, housing and civic services, Increments in cost of living, Opportunity for local transporters and Risks of industrial accidents and fatalities to workers. The impacts as employment generation, demand lodging, housing and opportunity for local transporters would be positive where as other would be creating negligible impacts.

0.6 Analysis of Alternatives

As part of the alternative analysis, the no project scenario and with project scenario were compared along with alternatives on site location, and technology options. The critical and attentive issues for selection of power plant site are taken care of is listed below:

- No protected area in and around the 10 km area
- Preference of Non-productive Land: The non-productive land as an alternative just near the proposed agriculture land is preferable for environmental soundness.
- The power plant land is a privately-owned land and has no dispute with the locality. More on the land is out of the DOE identified twelve critically areas.

Combined cycle power plants are self-contained, light weight and they do not require bulk water. They can be quickly installed at a lower cost than other types of power plants. These units require less space, have lower installation and maintenance cost and have simple lubrication and ignition system. Specific fuel consumption does not increase with time in gas turbine plants as rapidly as other IC engine based power plants. Also, poor quality of fuel can be readily used in gas turbines. Their disadvantages are poor part load efficiency, special metal requirements, special cooling methods and short life. Gas turbine power plants are the most suitable plants that can be installed at selected load centers with fewer auxiliaries. Gas turbines can be brought on load quickly and surely.

Bangladesh is facing a major electrical power shortage for the last one decade. The shortfall aggravated during the last 2-3 years and the total power scenario is very complex one. The supply demand situation in this sector will drastically hamper the development in all sectors of life including those in agricultural, industrial, commercial and domestic sectors. There is no alternative than to add more power generating units to the existing power system of Bangladesh within a shortest possible time frame. This is due not only to the increase in demand, but also due to aging of the existing power generating units most of which will near their life cycle very shortly. Both, base load and peaking plants are necessary to be added to the system, so that the whole system can run economically and efficiently. Technically a gas fired power plant is necessary to have more energy efficient power generation systems with higher output. Considering the nature of the peaking demand the proposed gas fired power plant seems to be the most suitable option.

0.7 Information Disclosure, Consultation and Participation

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

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

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

0.8 Grievance Redress Mechanism

Grievances primarily related to any serious event such as accidents involving the community, labor related major disputes such as non-payment of wages or work related injuries or fatalities, major intrusion of project on any community resource, and other issues for which the aggrieved party in his or her free will wants to register a grievance or complaint.

GRM shall be monitored to ensure that the stakeholders are having no or limited issues with the project and in case there are concerns, they are being adequately addressed as per the mandate. In order to keep track on the effectiveness of GRM, it is the responsibility of KPCL Environment and Social team to compile and maintain database on grievances for periodic review. The mechanism shall be based on two components, internal monitoring and reporting and external monitoring and reporting which shall run simultaneously. Mostly this shall be aligned with simultaneous process monitoring rather than doing it separately all the time.

0.9 Environmental Management Plan

Many of the mitigation measures suggested during the construction phase of the Project associated with good construction and housekeeping practices are also included in the “Specification Manual for Construction Contractor” prepared by KPCL for the Engineering, Procurement and Construction (EPC).

The construction phase of the Project is anticipated to two years, whereas the operation phase of the Project is 22 years, as per the Power Purchase Agreement (to be signed between KPCL and the BPDB). However, the design life of the Project is about 30 years and KPCL will be responsible for ensuring that the mitigation measures in the ESMP are implemented throughout the life span of the Project.

Monitoring

Key roles and responsibilities of the project developer (KPCL) and EPC contractor have been defined for implantation and monitoring. For environmental monitoring, physical, biological and social environmental management components of particular significance have been identified as performance indicators. A comprehensive monitoring plan for each performance indicator has been prepared for all phases of the Project which gives parameters to be measured, methods to be used, sampling locations, frequency of

measurements, detection limits, cost and responsibilities for implementation and supervision.

Institutional Framework

Prior to commencement of major civil works at site, a suitably qualified in-house/ external expert will be appointed by the EPC contractor in consultation with Project Developer to develop and deliver a training program on implementation of EMP, environmental monitoring and reporting in line with the applicable reference framework for the Project.

Prior to the commencement of the Plant operation, a suitably qualified in-house/ external environmental expert will be engaged by KPCL to develop and deliver a training program on operation phase environmental monitoring and reporting. The topics will be mostly same as that during the construction phase. The reporting and verification will be quarterly during construction phase and semi-annual during operation phase and the reports will be submitted to the DOE and lenders.

Training

Prior to commencement of major civil works at site, a suitably qualified in-house/ external expert will be appointed by the EPC contractor in consultation with KPCL to develop and deliver a training program on implementation of the EMP. The training will help in capacity building and implementation of the EMP during the construction phase of the Project.

Also prior to the commencement of the Plant operation, a suitably qualified in-house/ external environmental expert will be engaged by the Project Company to develop and deliver a training program on operation phase environmental monitoring and reporting.

Plans

The EPC Contractor will prepare and implement a Health and Safety Plan, Construction environment management Plan and traffic management Plan prior to commencing work and emergency response plan.

During Operations Phase, Project developer needs to follow HSE and Social Management system, prepare Waste management, spill response and emergency plan and Emergency Response and Disaster Management Plan.

0.10 Conclusion

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

The environmental and social assessment of the Project ascertains that the Project is unlikely to cause any major environmental impacts. Many of the impacts are localised and short-term or temporary in nature and can be readily addressed based on the in-built mitigation

measures in the engineering design of the Project. The effective implementation of the EMP and adherence with the GOB and IFC guidelines will assist in minimising the environmental impacts to acceptable levels.

Major environmental and social impact of the project would be water pollution, air pollution and noise pollution in construction and post-construction/ operation phase due to wastewater, gaseous emission and noise from power plant, These problems would be overcome by taking proper mitigation measures as stated in EMP. There are also very significant positive impacts during construction like local people job opportunities and increase business opportunities.

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

CHAPTER 1: INTRODUCTION

1. INTRODUCTION

1.1 Background

Planned and appropriate use of power is one of the pre-conditions for economic development of Bangladesh. There is a huge demand for electricity in our day-to-day life as well as in various sectors of the economy. The total power produced in the country is not enough to ensure adequate access to electricity. As of now, 90 percent of the total population has access to electricity. Per capita electricity generation is only 464 kWh (Power Cell, 2018). In order to improve this situation, the Government has given the highest priority to power sector development and is committed to make electricity available to all by 2021. Several programmes have already been taken up to implement short, medium and long term plans for the balanced development of power sector to scale up electricity generation. FY 2016-17, a total of 57,276 million-kilowatt hour (MkWh) net energy (26,599 MkWh in public sector and 26,020 MkWh in private sector including (IPP, SIPP, Rental and REB) was generated. Of the total generation, the public-sector power plants generated 46.44 percent while private sector generated 45.43 percent. The share of gas, hydro, coal and oil based energy generation was 66.44 percent, 1.77 percent, 1.76 percent and 21.96 percent respectively.

Kushiara Power Company Limited (KPCL) has proposed to set up a gas fired Combined Cycle Power Plant at Fenchuganj as per decision of the Government toward awarding the task in favor of the proponent. KPCL hence seeks to construct and operate the above proposed power plant at Fenchuganj in the district of Sylhet about 28 km south east of the city Sylhet and about 8 km road distance from Fenchuganj town.

This environmental baseline report has been based on the findings of a field study on the baseline environmental and socio-economic conditions pertaining to the project area proposed to accommodate a gas based combined cycle power plant proposed by Kushiara Power Company Limited (KPCL) at Garulikona mauza in Maijgaon union of Fenchuganj upazila under Sylhet district. The proposed power plant will have a generation net capacity of 163 MW. The proposed site is situated in an area of 9.22 acres of land to the west of the Sylhet- Moulavibazar road, east of the Kushiara River at Garulikona under upazila Fenchuganj in district of Sylhet.

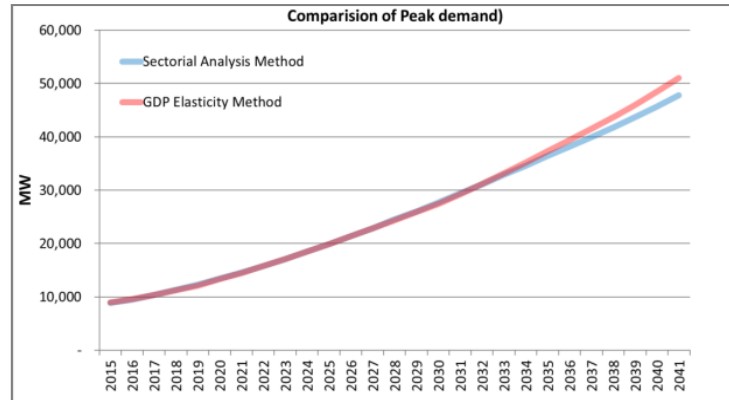
This project already obtained the environmental clearance certificate from department of Environment (DoE) (Annex K).

1.2 Need of the Project

At present total installed electricity generation capacity is more than 10000MW and generating 6,000 MW to 6,400 MW on an average. Against this generation, the daily average demand at the generation and is about 7,000 MW (with DSM) while electricity demand growth is 12% per annum. The demand of power is rising with the economic development of the country. Figure 1-1 shows peak power demand forecast upto 2041 based on sectorial analysis and GDP elasticity method.

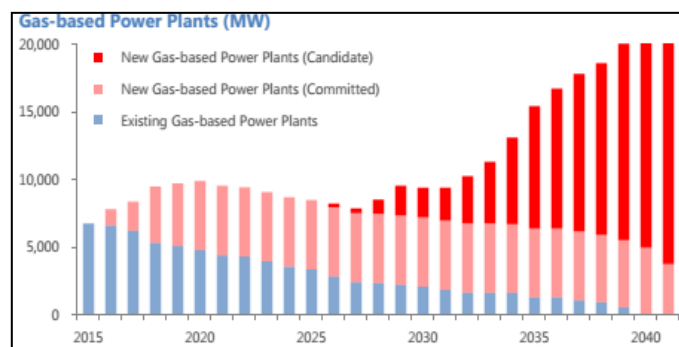
Figure 1-1 shows power demand trend from 2015 to 2041. Power demand is almost double in 2025. To meet the increasing power need in various sectors, GOB has adopted PSMP 2016. Power plants with a total output capacity of approximately 14,000 MW are to be constructed in the next ten years as per PSMP 2016. The proposed 163 MW gas based combined cycle power plant of Kushiara Power Company Limited will contribute to meet PSMP 2016 power generation target. **Figure 1-2** shows power development plan for gas based power plants.

As per PSMP 2016 new gas based power plants need to be established to maintain the power demand of Bangladesh. The proposed Kushiara Power Company Limited of 163 MW gas based combined cycle power plant (CCPP) would supplement in implementing such plan.



Source: PSMP, 2016

Figure 1-1: Power demand forecast for different scenarios



Source: PSMP, 2016

Figure 1-2: Annual power generation trend for gas based power plant

1.3 Importance of the Project

The proposed power plant is expected to add 163 MW electricity to the national grid of the country which will improve the present electricity generation significantly and will trigger the national economic development. It will encourage industrial development and the development of associated facilities including communication, education, employment opportunity, etc. As such construction of the proposed plant will ultimately play an important role in poverty reduction and in the development of social safety net. Moreover, this gas based power plant will thereby play an important role in maintaining the widely-concerned environment through producing less pollutant than electricity generation by other types of fuel.

1.4 Scope of the ESIA Study

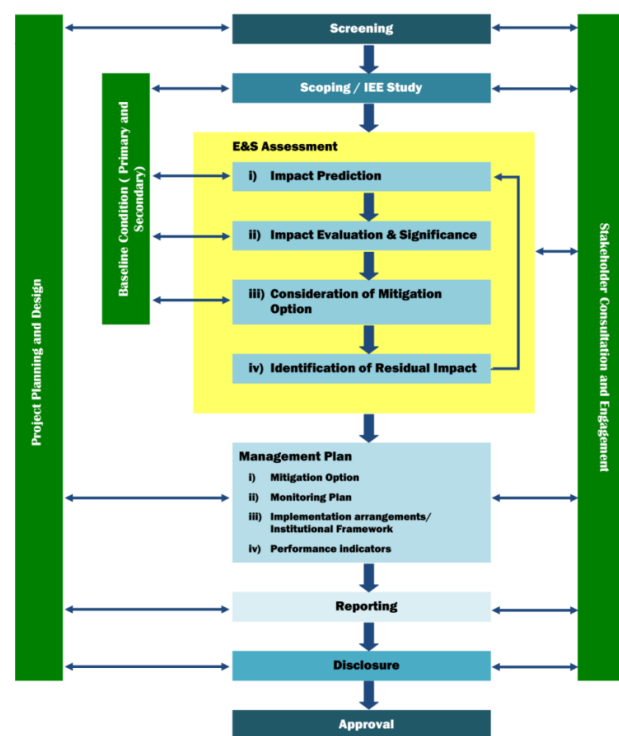
The scope of the study is to carry out environmental impact assessment of the proposed Project to address all the applicable environmental requirements, including the laws, by laws and rules of Bangladesh Government and the World Bank Group's operational policies, guidelines including environment, health and safety guidelines.

In compliance to the GoB rules and the WB's policies the EIA study presents its analyses under the following headings.

- a) Description of the proposed project
- b) Description of the Environment (baseline conditions)
 - ✓ Physical environment
 - ✓ Biological environment
 - ✓ Socio-cultural environment
- c) Legislative and regulatory considerations
- d) Determination of the potential environmental and social impacts of the proposed project;
- e) Risk assessment and consequence analysis of the project;
- f) Formulation of an Environmental and Social Management Plan and associated/specific mitigation plans for identified impacts;
- g) Formulation of stakeholder Consultation and Grievance Redress Mechanism for the Project

1.5 Methodology

The ESIA of the 163 MW combined cycle power plant to be constructed at the location of Garulikona Mouza, Fenchuganj upazila has been conducted following the IFC performance standard (2012), Equator Principle - III (2013) and EIA Guidelines for Industries of DoE in 1997 in accordance with the requirement of the Environment Conservation Rules, 1997 under the Environment Conservation Act 1995. ESIA process involves identification of the key impacts on natural and social environment and evaluation of the significant impacts along with recommendation of measures as well as listing of unresolved environmental issues.



Source: EQMS

Figure 1-3: Impact Assessment Process

The ESIA includes collection of baseline information, indication of important environmental and social components through scoping session, setting up of spatial and temporal boundaries for assessing impacts, impact assessment and evaluation, suggestion of mitigation measures and providing an environmental management plan. The ESIA methodology follows the overall impact assessment approach illustrated in Figure 1-3.

Initial step of an ESIA 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 10 km radius from the periphery of project boundary). Setting up of boundaries is an important step and the elements used for the scoping were 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 ESIA study. The unresolved critical issues and resolution of issues have been discussed in the EMP.

The ESIA report of the gas based 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 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 enrichment of ESIA study of gas fired power plant.

The baseline has covered a detail description of the physical environment, water resources, land resources, agriculture, fisheries, eco-systems 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 ground water 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 ESIA study.

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

1.6 Study Area Boundary

The selected site for the construction of 163 MW combined cycle Power Plant is at Fenchuganj Upazila, Sylhet district (**Figure 1-4**). The proposed project has been bounded with existing settlement and agricultural land on the north, BPDB Power Plant and

settlement on south-east Side, Settlement and Agricultural Land on the north and Approach road, Agricultural Land and Settlement in the East and Kushiara River in the west. For establishing environmental baseline condition and for the assessment of impacts associated with the interventions, an area of 10km radius from the periphery of the plant has been considered based on nature of the proposed project and EIA Guidelines for Industries of Department of Environment. The 10 km study area map is shown in Figure 1-5.

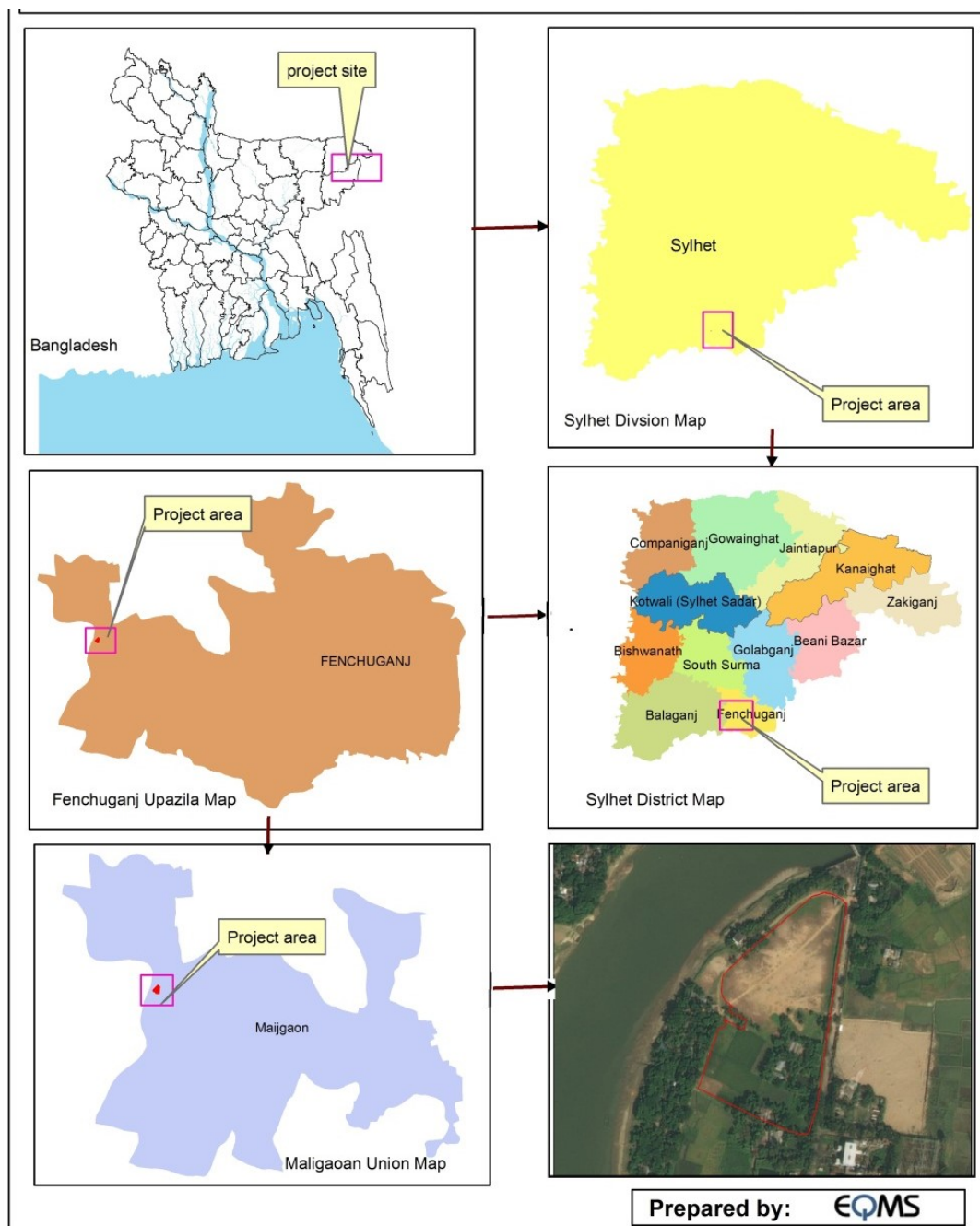


Figure 1-4: Location Map of the Proposed Power Plant

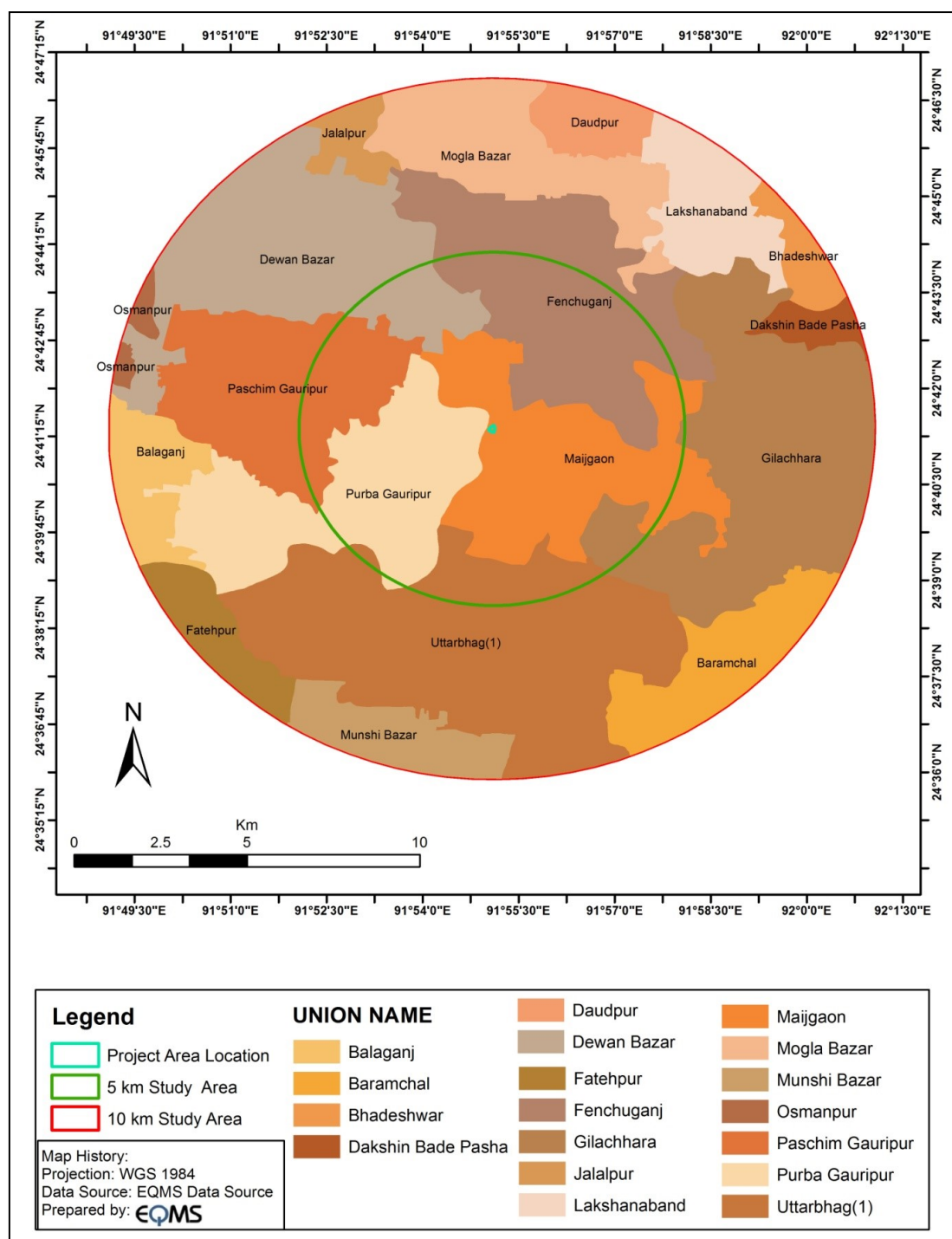


Figure 1-5: 10 km Study Area Map

1.7 Contents of the ESIA Report

The content of the EIA study has been structured based on DOE and World Bank Requirement. The structure of the EIA report is as follows:

Chapter 1 describes the introduction containing background, purposed and scope, approach and methodology, limitations, and list of the members of EIA study team.

Chapter 2	is on policy, legal and administrative framework describing the relevant policy and legal frameworks of national and international standard for the EIA process.
Chapter 3	covers detailed project description of the proposed power plant comprising of project activities, project plan, design, specification, project schedule, resources and utilities demand.
Chapter 4	describes the environmental baseline condition with detail on physical environment, biological environment and environmental quality.
Chapter 5	Anticipated environmental impact and mitigation measures presents all the predicted impacts of the project during pre-construction, construction and post-construction phases and evaluates all the predicted impacts as well as suggest mitigation measures.
Chapter 6	describes the Analysis of Alternatives of the project.
Chapter 7	Information Disclosure, Consultation and Participation, comprises public consultations and disclosures conducted at different sites of the study area.
Chapter 8	Grievance Redress Mechanism
Chapter 9	presents the Environmental and Social Management Plan (EMP) with mitigation measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.
Chapter 10	is the risk assessment and management
Chapter 10	is the concluding chapter of the EIA report with conclusion and recommendations

CHAPTER 2: POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

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

The activities of proposed gas based power plant project of Bangladesh Government fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore an EIA study is pre-requisite to obtain environmental clearance from the DoE. The proposed project already got the site clearance and environmental clearance from Department of Environment (DoE).

The following activities have been carried out under the ESIA study:

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

2.2 Environment Related Policies in Bangladesh

The GOB has developed a policy framework that requires environmental issues to be incorporated into economic development planning. The Key tenets of the various applicable policies are detailed in the following subsections.

2.2.1 National Environmental Policy, 1992

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

- Maintaining ecological balance and ensuring sustainable development of the country through protection, conservation and improvement of the environment;
- Protecting the country from natural disasters;
- Identifying and regulating all activities that pollute and destroy the environment;
- Ensuring environment-friendly development in all sectors;

- Ensuring sustainable and environmentally sound management of the natural resources; and
- Promoting active association, as far as possible, with all international initiatives related to environment.

The Environmental Policy of 1992 requires specific actions with respect to the industrial sector which are as follows:

- To introduce gradually corrective measures in polluting industries;
- To conduct EIAs for all new public and private industrial developments;
- To ban, or find environmentally sound alternatives for, the production of goods that cause environmental pollution; and
- To minimize waste and ensure sustainable use of resources by industry.

The policy also states that EIA's should conduct for any development activity and the DOE is directed to review and approve all Environmental Impact Assessments.

2.2.2 National Environmental Management Action Plan, 1995

The National Environmental Management Action Plan (NEMAP) 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 related to the environment during the period 1995 to 2005; it also 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 the natural environment;
- Conservation of habitats and bio-diversity;
- Promotion of sustainable development; and
- Improvement of the quality of life of the people.

To attain the above-mentioned objectives, the plan groups all the relevant necessary actions under four headings, namely: *institutional*, *sectoral*, *location- specific* and *long-term issues*.

The *institutional* aspects reflect the need of inter- sectoral cooperation to tackle environmental problems which need new and appropriate institutional mechanisms at national and local levels. The *sectoral* action reflects the way the Ministries and agencies are organized and makes it easier to identify the agency to carry out the recommended actions. The *location-specific* action focuses particularly on acute environmental problems at local levels that need to be addressed on a priority basis. The *long-term* actions include environmental degradation to such degree that might become even more serious and threatening, if cognizance is not taken immediately.

2.2.3 National Conservation Strategy, 1992

The National Conservation Strategy, 1992 provides recommendations for sustainable development of the industrial sector. The key aspects of the strategy are as follows:

- All industries shall be subject to an EIA and the adoption of pollution prevention/control technologies shall be enforced;
- Hazardous or toxic materials / wastes shall not be imported as raw materials for industry;
- Import of appropriate and environmentally-sound technology shall be ensured; and
- Dependence on imported technology and machinery should gradually be reduced in favour of sustainable local skills and resources.

2.2.4 Other Policies relevant to Environment

Additional Bangladesh policies, their key features and applicability to the subject Project are detailed in Table 2-1.

Table 2-1: Policies relevant to Environment

Policy	Key Features	Applicability
The National Forest Policy, 1994	• Afforestation of 20% land • Bio-diversity of the existing degraded forests • Strengthening of the agricultural sector • Control of Global warming, desertification • Control of trade in wild birds and animals • Prevention of illegal occupation of the forested land, tree felling and hunting of wild animals	Not applicable, as no diversion of forest land is involved in the Project.
National Land Transport Policy, 2004	• All new roads and major improvements will be subjected to an EIA • Funding will be provided for mitigation measures • The Government will publish environmental standards for new roads and new design standards addressing environmental issues	Not applicable, as no new road construction is involved in the Project.
The National Water Policy, 1999	• Protection, restoration and enhancement of water resources • Protection of water quality, including strengthening regulations concerning agrochemicals and industrial effluent • Sanitation and potable water • Fish and fisheries • Participation of local communities in all water sector development	Applicable for the preservation of water quality.
National Land use Policy, 2001	• Deals with several land uses including: agriculture (crop production, fishery and livestock), housing, forestry, industrialization, railways and roads, tea and rubber • Identifies land use constraints in all these sectors	Not applicable, as land use of the Project site is industrial and owned by KPCL.
Draft Wetland Policy, 1998	• Establishment of principles for the sustainable use of wetland resources • Maintenance of the existing level of biological diversity • Maintenance of the functions and values of	Not directly applicable, however may be applicable once the draft policy is finalised

Policy	Key Features	Applicability
	wetlands • Promotion and recognition of the value of wetland functions in resource management and economic development	
National Fisheries Policy, 1998	• Preservation, management and exploitation of fisheries resources in inland open water • Fish cultivation and management in inland closed water. • Prawn and fish cultivation in coastal areas • Preservation, management and exploitation of sea fishery resources	Not Applicable, the plant will use ground water for cooling and domestic purpose.
The Energy Policy, 1996	• Provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy source and environmentally sound sustainable energy development programmes • Highlights the importance of EIA's for any new energy development project	Applicable as subject Project is a Power Plant
The Power Policy, 1995	• Is an integral part of the Energy Policy and deals with policy statement on demand forecast, long term planning and project implementation, investment terms, fuels and technologies, load management, institutional issues, private sector participation, technology transfer and research programme, environmental policy and legal issues	Applicable as subject Project is a Power Plant
Industrial Policy, 1999	• Deals with industrial development, direct foreign investments, investment by public and private sector, introduction of new appropriate technology, women's participation, infrastructure development and environmentally sound industrial development	Applicable as the Project is a private industrial development

2.3 Environment and Social Related Legislation in Bangladesh

The main Acts and Regulations guiding environmental protection and conservation in Bangladesh are outlined in the following subsections.

2.3.1 Bangladesh Environmental Conservation Act, 1995 (subsequent amendments in 2000 and 2002)

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 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 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 environment.

2.3.2 Environment Conservation Rules (ECR), 1997 (subsequent amendments in 2002 and 2003)

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).

Other Relevant National Legal Instruments for the Project **Table 2-2** presents an outline of other National legal instruments that will have relevance to the proposed Project with respect to the social and environmental considerations.

Table 2-2: National Legal Instruments relevant to the Project

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
The Environment Conservation Act, 1995 and subsequent amendments in 2000 and 2002	Department of Environment, Ministry of Environment and Forests,	• Define Applicability of environmental clearance • Regulation of development activities from environmental perspective • Framing applicable limits for emissions and effluents • Framing of standards for air, water and noise quality • Formulation of guidelines relating to control and mitigation of environmental	Applicable

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
		pollution, conservation and improvement of environment • Declaration of Ecologically critical areas	
Environmental conservation Rules, 1997 and subsequent amendments in 2002 and 2003	Department of Environment, Ministry of Environment and Forests	• Declaration of Ecologically critical areas • Requirement of environmental clearance certificate for various categories of projects • Requirement of IEE/EIA as per category • Renewal of the environmental clearance certificate within 30 days after the expiry • Provides standards for quality of air, water and sound and acceptable limits for emissions/ discharges from vehicles and other sources	Applicable Projects falls under Red Category and require environmental clearance
Environment Court Act, 2000 and subsequent amendments in 2002	Ministry of Environment and Forests and judiciary	• GoB has given highest priority to environment pollution • Passed 'Environment Court Act, 2000 for completing environment related legal proceedings effectively	Applicable for completing environmental legal requirements effectively
The Vehicle Act, 1927; The Motor Vehicles Ordinance, 1983; and The Bengal Motor Vehicle Rules, 1940	Bangladesh Road Transport Authority	• Exhaust emissions • Vehicular air and noise pollution • Road / traffic safety • Vehicle Licensing and Registration • Fitness of Motor Vehicles • Parking by-laws.	Applicable for proposed Project in relation to road transport
The Removal of Wrecks and obstructions in inland Navigable Water Ways Rules 1973	Bangladesh Water Transport Authority	• Removal of wrecks and obstructions in inland navigable waterways	Applicable as Kushiara River - inland navigable waterway will be used for transport of heavy equipment for the Project
Water Supply and Sanitation Act, 1996	Ministry of Local Government, Rural Development and cooperatives	• Management and control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly applicable when considering water usage management and sanitation

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
			facilities for the project
The Ground Water Management ordinance, 1985	Upazila Parishad	• Management of ground water resources • Installation of tube- wells at any place after license from Upazila Parishad only	Proposed Project will use surface water source however, should groundwater also be required then licenses will need to be obtained prior to installation of any tube-wells.
The Forest Act, 1927 and subsequent amendments in 1982 and 1989	Ministry of Environment and Forests	• Categorization of forests as reserve, protected and village forests • Permission is required for use of forest land for any non-forest purposes	Not applicable as the Project is not on forest land
The Private Forests ordinance Act, 1959	Regional Forest Officer, Forest Department	• Conservation of private forests and for the afforestation on wastelands	Not applicable as proposed Project is not affecting plantations on surrounding land.
Bangladesh Wild Life (Preservation) Act, 1974	Ministry of Environment and Forest; Bangladesh Wild Life Advisory Board	• Preservation of Wildlife Sanctuaries, Parks, and Reserve forest	Not applicable as the Project AOI does not have any wildlife areas
National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment and Forest Bangladesh Wild Life Advisory Board	• Conserve, and restore the biodiversity of the country for well-being of the present and future generations • Maintain and improve environmental stability for ecosystems • Ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations • Guarantee the safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country • Stop introduction of invasive alien species, genetically modified organisms and living modified organisms	Applicable for conservation of biodiversity in the study area including Kushiara River
National Water	Town development	• The characterization of water	Not applicable as

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
Bodies Protection Act, 2000	authority/Municipalities	bodies as rivers, canals, tanks or flood plains identified in the master plans formulated under the laws establishing municipalities in division and district towns shall not be changed without approval of concerned ministry	the plant will use ground water
The Protection and Conservation of Fish Act 1950 subsequent amendments in 1982	Ministry of Fisheries and Livestock	Protection and conservation of fish in Government owned water bodies	Applicable for the conservation of fish as the outfall point will be the Kushiara River
The Embankment and Drainage Act 1952	Ministry of Water Resources	An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion and other damage by water	Not applicable due to the site location
Antiquities Act, 1968	Ministry of cultural Affairs	This legislation governs preservation of the national cultural heritage, protects and controls ancient monuments, regulates antiquities as well as the maintenance, conservation and restoration of protected sites and monuments, controls planning, exploration and excavation of archaeological sites	Not applicable as the study area reportedly does not have any likely cultural heritage or ancient monuments of national or international significance. However, in case, any such evidence of archaeological findings arise, the Project will need to act in conformance to the Act
The Acquisition and Requisition of Immovable Property ordinance 1982 and subsequent amendments in	Ministry of Land	Current GOB Act and Guidelines, relating to acquisition and requisition of land	Not applicable as the project site land is government land and further land is not required for the project

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
1994, 1995 and 2004			
The Building Construction Act 1952 and subsequent amendments	Ministry of Works	This act provides for prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable
The Factories Act, 1965 Bangladesh Labor Law, 2006	Ministry of Labor	This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions	Applicable
Ozone Depleting Substances (Control) Rules, 2004	Ministry of Environment and Forests	- Ban on the use of Ozone depleting substances - Phasing out of Ozone depleting substances	Applicable
Noise Pollution (Control) Rules 2006	Ministry of Environment and Forests	- Prevention of Noise pollution - Standards for noise levels	Applicable

Source: Websites of DOE, Legislative and Parliamentary Affairs Division:: Bangladesh Laws and Bangladesh Board of Investment: Business laws

2.4 Administrative Setup related to Environment in Bangladesh

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

- Department of Environment (DOE);
- Forest Department (FD);
- Bangladesh Forest Industries Development Corporation (BFIDC);
- Bangladesh Forest Research Institute (BFRI); and
- Bangladesh National Herbarium (BNH).

Other Related Organizations

There are several other organizations under the administrative framework which would govern social and environmental functions related to the proposed Project, namely:

- Forest Department (FD);
- Ministry of Land: Land reform and land acquisition directorate;
- Ministry of water resources: Bangladesh Water Development Board; and
- Local Government Engineering Department (LGED).

2.4.1 Department of Environment (DOE)

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 ESIA 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 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 ESIAs prepared for projects in Bangladesh.

Environmental Clearance Process

As mentioned in the *Section 2.3.2*, ECR has classified projects to be assessed by the DOE in four categories based on the severity of impacts on IECs:

- Green;
- Orange A;
- Orange B; and
- Red

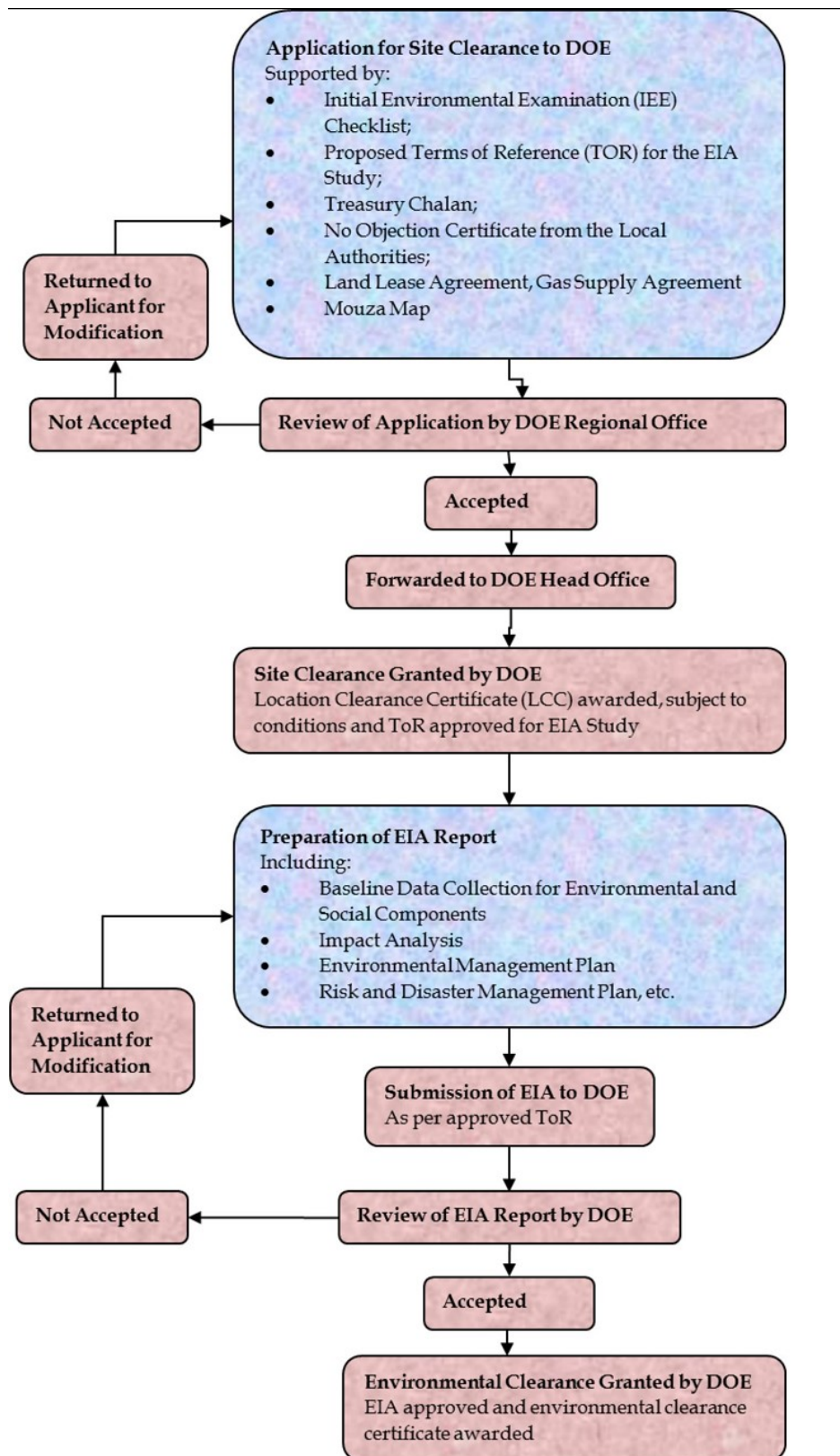
The EIA process consists of three stages, screening, IEE, and detailed EIA:

- 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 plants project fall under the Red category as referred below:

- Item 6: power plants;

The process for obtaining an Environmental Clearance Certificate (ECC) for the proposed Project is outlined in Figure 2-1.



Source: ECR'1997

Figure 2-1: Flow Chart of EIA Process Applicable to the Project

2.5 Relevant International Treaties and Conventions

Bangladesh is party to a number (30)¹ of international environmental conventions, treaties and agreements. The international treaties and conventions relevant to the Project and their status are detailed in **Table 2-3**.

Table 2-3: Project Relevant International Treaties and Conventions

Environment related International convention and Treaties	Status
International Plant Protection Convention (Rome, 1951.)	01.09.78 (ratified)
International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (as amended on 11 April 1962 and 21 October 1969.))	28.12.81 (entry into force)
Plant Protection Agreement for the South East Asia and Pacific Region (as amended) (Rome, 1956.)	04.12.74 (accessed) (entry into force)
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969.)	04.02.82 (entry into force)
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) ("Ramsar Convention").	20.04.92 (ratified)
Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972.)	03.08.83 (accepted) 03.11.83 (ratified)
Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973.) ("CITES convention")	18.02.82 (ratified)
United Nations Convention on the Law of the Sea (Montego Bay, 1982.)	10.12.82 (ratified)
Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985.)	02.08.90(accessed) 31.10.90(entry into force)
Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987.)	02.08.90 31.10.90 (accessed) (entry into force)
London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990)	18.03.94(accessed) 16.06.94(entry into force)
Copenhagen Amendment to the Montreal protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	27.11.2000 (accepted) 26.2.2001 (entry into force)
Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997	27.7.2001 (Accepted) 26.10.2001 (Entry into force)
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989.)	01.04.93 (accessed)
International Convention on Oil Pollution Preparedness, Response and Cooperation (London, 1990.)	30.01.90 (signed) In the process of ratification
United Nations Framework Convention on Climate Change, (New York, 1992.)	09.06.92 (signed) 15.04.94 (ratified)
Convention on Biological Diversity, (Rio De Janeiro, 1992.)	05.06.92 (signed) 03.05.94 (ratified)
International Convention to Combat Desertification, (Paris 1994.)	14.10.94 signed) 26.01.1996 (ratification)

¹ Department of Environment (DoE)

Environment related International convention and Treaties	Status
	26.12.1996 (entry into force)
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976.)	03.10.79 (accessed) (entry into force)
Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (New York, 1994.)	28.07.96 (signed)
Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Paris, 1993.)	14.01.93 (signed)
Convention on persistent Organic Pollutants, Stockholm	23.5.2001 (signed) 12.03.2007 (ratified)
Kyoto protocol to the United Nations Framework Convention on Climate Change	21.8.2001 (accessed)

2.6 Development Agency's Guidelines

Under the study health and safety guidelines of few development agencies will be reviewed. This will include "ADB's Safeguard Policy Statement, 2009", "Environmental, Health, and Safety Guidelines of the International Finance Corporation Guideline (IFC) Performance Standard" and "World Bank Environmental Policies".

2.6.1 ADB's Safeguard Policy Statement, 2009

In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS builds upon ADB's previous safeguard policies on the Environment, Involuntary Resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in the project design and implementation.

The SPS applies to all ADB-financed and/or ADB-administered projects and their components, regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. ADB works with borrowers and clients to put into practice the requirements of SPS.

The SPS supersedes ADB's Involuntary Resettlement Policy (1995), Policy on Indigenous Peoples (1998), and Environment Policy (2002). In accordance with the SPS, these previous policies apply to all projects and tranches of multi-tranche financing facility projects that were reviewed by ADB's management before 20 January 2010.

The objectives of ADB's safeguards are to:

- Avoid adverse impacts of projects on the environment and affected people, where possible;
- Minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and assist

borrowers and clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

ADB's SPS sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:

- a. Environmental safeguards;
- b. Involuntary Resettlement safeguards; and
- c. Indigenous Peoples safeguards.

To help borrowers and clients and their projects achieve the desired outcomes, ADB adopts a set of specific safeguard requirements that borrowers and clients are required to meet in addressing environmental and social impacts and risks. These safeguard requirements are as follows:

- a. Safeguard Requirements 1: Environment (Appendix 1 of SPS);
- b. Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS);
- c. Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS); and
- d. Safeguard Requirements 4: Special Requirements for Different Finance Modalities (Appendix 4 of SPS).

In addition, ADB does not finance activities on the prohibited investment activities list (Appendix 5 of SPS). Furthermore, ADB does not finance projects that do not comply with its safeguard policy statement, nor does it finance projects that do not comply with the host country's social and environmental laws and regulations, including those laws implementing host country obligations under international law.

Consultation and Disclosure requirements of ADB

ADB's Safeguard Policy and Public Communications Policy (2011) sets out disclosure requirements for various ADB activities, including safeguard requirement. Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS); and Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS) sets out the need for meaningful consultation and information disclosure during project preparation and operation to the affected population and other ely stakeholders. Key requirements include:

- a. Information Disclosure: The borrower/client will submit the following documents to ADB for disclosure on ADB's website as per the applicability with respect to the Project:
 - Draft EIA including draft EMP;
 - Final EIA/IEE;
 - Updated EIA/IEE and corrective active plan;
 - Environmental Monitoring Reports.
 - Resettlement Plan (RP)
 - Indigenous Peoples Plan (IPP)
- b. Information disclosure to affected people or stakeholders: The borrower/client will provide relevant environmental information in a timely manner, in an accessible place and in a form and language(s) understandable to affected people and other

stakeholders. For illiterate people, other suitable communication methods will be used.

- c. Consultation and Participation: The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
- d. Timing and Frequency for consultation and participation: Meaningful consultation begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle,

ADB Project Categorization

The SPS, 2009 further outlines a classification system for the categorization of projects. The classification tentatively occurs at the project identification stage, during the initial screening of anticipated impacts. However, classification is an ongoing process, and the classification can be changed at any time with the concurrence of the Chief Compliance Officer (CCO), as more detailed information becomes available and a project proceeds.

Environment

A project's environment category is determined by the category of its most environmentally sensitive component, including direct, indirect, induced, and cumulative impacts. Each proposed project is scrutinized as to its type, location, scale, sensitivity and the magnitude of its potential environmental impacts. The level of detail and comprehensiveness of the EIA or IEE are commensurate with the significance of the potential impacts and risks.

A proposed project is assigned to one of the following categories depending on the significance of the potential environmental impacts and risks:

- Category A: Projects that could have significant environmental impacts. An Environmental Impact Assessment (ESIA) is required.
- Category B: Projects that could have some adverse environmental impacts, but of less significance than those for category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report.
- Category C: Projects those are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.
- Category FI: Projects that involve a credit line through a financial intermediary (FI) or an equity investment in a FI. The FI must apply an environmental management system, unless all subprojects will result in insignificant impacts.

Involuntary Resettlement

A project's involuntary resettlement category is determined by the category of its most sensitive component in terms of involuntary resettlement impacts. The involuntary resettlement impacts of an ADB-supported project are considered significant if 200 or more persons will experience major impacts, which are defined as (i) being physically displaced from housing, or (ii) losing 10% or more of their productive assets (income generating). The level of detail and comprehensiveness of the resettlement plan are commensurate with the

significance of the potential impacts and risks. A proposed project is assigned to one of the following categories depending on the significance of the probable involuntary resettlement impacts:

- Category A: A proposed project is classified as category A if it is likely to have significant involuntary resettlement impacts. A resettlement plan, including assessment of social impacts, is required;
- Category B: A proposed project is classified as category B if it includes involuntary resettlement impacts that are not deemed significant. A resettlement plan, including assessment of social impacts, is required;
- Category C: A proposed project is classified as category C if it has no involuntary resettlement impacts. No further action is required; and
- Category FI: A proposed project is classified as category FI if it involves the investment of ADB funds to, or through, a financial intermediary (paragraphs 53–58).

Projects are also classified on the basis of impacts to indigenous people, however is not applicable for this Project.

Categorization of Proposed Project

Categorization for the proposed Project was undertaken by using ADB's Rapid Environmental Assessment (REA), Involuntary Resettlement (IR) and Indigenous People (IP) Assessment checklists during the scoping exercise. The REA checklist of the Project for the Thermal Power Plant Sector has been presented in Annex B. The findings of the assessment are presented in Table 2-4.

This is a Category B project according to IFC PS and ADB SPS-2009 because the environmental and social risks and impacts associated with this Project are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures.

The key potential environmental and social issues associated with the Project during both construction and operation relate to air emissions (dust during construction, and NO_x, particulates and greenhouse gases during operations), noise, occupational health and safety risks, community health and safety risks (e.g. explosions, traffic accidents), solid and hazardous waste generation, and wastewater generation. There are also likely to be cumulative impacts related to the operation of multiple power plants at the Fenchuganj Power Station.

Table 2-4: Project Categorization as per ADB Safeguards

Sl.	Criteria	Relevance	Remarks	Category
1. Environmental Categorization				
a	Unprecedented	Change in landuse	The land was used mainly for brick kiln and partially agricultural land and homestead. Additional land will be required for the transmission line tower, gas pipeline.	Based on irreversible, diverse and cumulative impacts, it should be categorized as 'B'

Sl.	Criteria	Relevance	Remarks	Category
b	Diverse	Nature of activities	The area already a power plant hub as there are four gas based power plant and all are in operation. So the nature of activities is not diverse for the area. the exiting as well as proposed plant are gas based	
c	Irreversible	Environmental issues and impacts of the Project are anticipated during the construction and operation of the power plant and the laying of the natural gas pipeline and transmission line	Irreversible impacts due to the project include: • Air emission and dust • Change in air quality • Increased noise and vibration • Land use change • Affected aquatic ecology • Loss of agricultural land • Health and safety	
d	Cumulative	Two 90 MW gas based power plant, a 51 MW gas based engine power plant and a 50 MW gas based engine power plant are in operation in the neighborhood	Cumulative impacts on physical, biological and socio-economic environmental condition	
2. Involuntary Resettlement Categorization				
a	Unprecedented	Land	Requirement of brick kiln land, agricultural and homestead land for project development	Now the project site is already developed and all land owners got their land value as per the market price. No further land is required for the project development. Hence on Involuntary Resettlement, the project shall be categorized as 'C'
b	Adverse	Land acquisition	The total land of the project was voluntarily purchased from respective land owner. No claim was raised during the discussion with the land seller.	
c	Irreversible	Project affected household	Land seller got the proper market price of the land and displaced household construct their house close to the previous location	
3. Indigenous People Categorization				
a	Presence	Existing of indigenous people	No indigenous people are present within the project AoI	In case of no foreseen adverse impact. Project shall be categorized as 'C'
b	Impact	Impact on indigenous/.ethnic/scheduled tribes	No adverse impact foreseen	

The following Performance Standards (PSs) are applicable to this investment project, current information indicates that the investment will have impacts, which must be managed in a manner consistent with the following PSs:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts
- PS2: Labor and Working Conditions
- PS3: Resource Efficiency and Pollution Prevention
- PS4: Community Health, Safety and Security

The proposed site is owned by KPCL through willing buy and sell. As the site is vacant, no physical or economic resettlement is required, and therefore, PS5 Land Acquisition and Involuntary Resettlement do not apply.

The Project is not expected to have any significant impact on terrestrial or aquatic biodiversity or ecosystem services, and therefore, PS 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources are not applicable. The Project is located adjacent to the Kushiara River. The Project, as currently designed, will not have an impact on river hydrology or water quality, and therefore, is unlikely to affect aquatic fauna in the River.

The Project will construct a temporary floating jetty on the left bank of the river Kushiara adjacent to the project to transport plant machinery. No indigenous people were identified in the area affected by the project; therefore, PS7 does not apply. As the plant is located in an area that was recently developed with clean fill, no archaeological or historically important structures are present in the area, and the probability of finding significant cultural resources in the Project area is low, therefore PS8 does not apply. In addition, the WBG EHS General Guidelines and Guidelines for Thermal Power Plants apply to this Project.

As the project has been categorized as Category 'B' with respect to environmental categorization, the specific requirements of ADB and IFC are:

- An EIA study is essential for this Project;
- The EIA must include an Environmental Management Plan (EMP) that outlines specific mitigation measures, environmental monitoring requirements, and related institutional arrangements, including budget requirements;
- Consultation with groups affected by the proposed project. The consultation needs to be carried out as early as possible in the project cycle so that views of affected groups are taken into account in the design of the Project and its environment mitigation measures;
- The provisions for the EMPs must also be fully reflected in the Project administration memorandums; and
- To ensure proper and timely implementation of the EMPs and adherence to the agreed environmental covenants, ADB requires borrowers or executing agencies to submit semi-annual reports on implementation of EMPs, and that this requirement will be reflected in the loan agreements.

2.6.2 International Finance Corporation (IFC) Performance Standards

The Performance Standards (PS) (January 2012) established by IFC stipulates that the Project shall meet certain requirements throughout the life cycle of an investment by IFC or other relevant financial institution such as other DFIs (eg. FMO) or commercial banks, which are signatory to the Equator Principles, 2006. A brief description of the Performance standards is provided in Table 2-5.

Table 2-5: IFC Performance Standards

Performance Standards	Specific Areas
Performance Standard 1	Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2	Labor and Working Conditions
Performance Standard 3	Resource Efficiency and Pollution Prevention
Performance Standard 4	Community Health, Safety and Security
Performance Standard 5	Land Acquisition and Involuntary Resettlement
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources
Performance Standard 7	Indigenous Peoples
Performance Standard 8	Cultural Heritage

Source: IFC Performance Standards, January, 2012

These PS and guidelines provide ways and means to identify impacts and affected stakeholders and lay down processes for management and mitigation of adverse impacts. A brief on the requirements as laid down in the performance standards is described in the following subsections.

Following sub section tries to provide the requirements of the specific PS, so as to set up the context for matching the requirements of these PS during the various stages of the life cycle of the Project.

PS 1: Assessment and Management of Environmental and Social Risks and Impacts

The PS 1 requires Social and Environmental Assessment and Management Systems for managing social and environmental performance throughout the life cycle of this Project and runs through all subsequent PSs. The main elements of PS 1 include:

- a) A Social and Environmental Assessment to understand the social and environmental impacts and risks;
- b) A Management Program for mitigating the impacts and minimizing the risks identified in the assessment;
- c) Establishing and ensuring organizational capacity and requisite trainings to the staff to implement the Management Programme;
- d) Engagement with the community to ensure free prior informed consultation (FPIC), community grievance redress constructive relationship all through the project life cycle; and

- e) Adequate monitoring and reporting systems to measure and report the effectiveness of the Management Programs.

The social and environmental performance is a continuous process to be initiated by the management and would involve communication between the organization, its workers and local communities directly affected by the Project. The PS requires that Project proponent initiate regular assessment of the potential social and environmental risks and impacts and consistently tries to mitigate and manage strategy on an ongoing basis.

PS 2: Labor and Working Conditions

The economic growth through employment creation and income generation is recognized and balanced protecting the basic rights of workers. PS 2 is guided by the various conventions of International Labor Organization (ILO) and outlines the minimum requirements of working conditions, protection to the workforce (including issues of child and forced labor) and ensuring occupational health and safety of both its 'employees' as well as 'non employees' working through contractors. The PS requires:

- a) Establishment of a sound worker-management relationship;
- b) Encouraging equal opportunity and fair treatment of workers;
- c) Promoting compliance with national labor and employment laws;
- d) Promoting healthy and safe working conditions for workers.

PS 2 requires project proponents to conduct its activities in a manner consistent with the four core labor standards (child labor, forced labor, non discrimination, and freedom of association and collective bargaining). In addition, PS 2 also addresses other areas such as working conditions and terms of employment, retrenchment, and occupational health and safety issues.

Some of these requirements refer to the applicable national law. Whereas national law establishes standards that are less stringent than those in PS 2, or are silent, the project proponent is expected to meet the requirements of PS 2.

PS 3: Resource Efficiency and Pollution Prevention

PS 3 outlines the approach to pollution prevention and abatement in line with internationally disseminated technologies and practices with objectives to:

- a) avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from activities; and
- b) Promote the reduction of emissions that contribute to climate change.

PS 3 requires a project to avoid, minimize, or reduce adverse impacts on human health and environment by adopting pollution preventive and control technologies throughout the Project life cycle.

PS 3 outlines a project approach to Pollution Prevention and Abatement (PPA) in line with internationally disseminated technologies and practices. It describes the measures to take into account the potential impact of emissions on the ambient conditions (such as ambient air quality) and seek to avoid or minimize these impacts within the context of the nature and significance of pollutants emitted.

PS 4: Community, Health, Safety and Security

PS 4 concentrates on the responsibility that must be undertaken by the client to avoid or minimize the risks and impacts to the community's health, safety and security that may arise from project activities. PS 4 require a project to evaluate risks and impacts to the health and safety of the affected community during the Project life cycle and establish measures to avoid minimize and reduce risks and impacts from the Project.

PS 4 recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. However, projects can also increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials.

The performance standard details out project proponents responsibility to avoid or minimize the possible risks and impacts to community health, safety and security that may arise from project activities.

PS 5: Land Acquisition and Involuntary Resettlement

The objectives of this PS are to:

- a) Avoid or at least minimize the involuntary resettlement wherever feasible by exploring alternative project designs;
- b) Mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by:
 - Providing compensation for loss of assets at replacement cost; and
 - Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- a) Improve or at least restore the livelihoods and standards of living of displaced persons; and
- b) Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

PS 5 require a project to consider various processes and systems to avoid/minimise social and economic impacts related to land acquisition and resettlement.

This PS applies to physical or economic displacement resulting from the following types of land transactions:

- a) Type I: Land rights for a private sector project acquired through expropriation or other compulsory procedures;
- b) Type II: Land rights for a private sector project acquired through negotiated settlements with property owners or those with legal rights to land, including customary or traditional rights recognized or recognizable under the laws of the country, if expropriation or other compulsory process would have resulted upon the failure of negotiation; and
- c) This PS does not apply to resettlement resulting from voluntary land transactions (ie market transactions in which the seller is not obliged to sell and the buyer

cannot resort to expropriation or other compulsory procedures if negotiations fail). The impacts arising from such transactions shall be dealt with as under PS1, though sometimes, when risks are identified, the project proponent may decide to adhere to PS 5 requirements even in willing buyer-seller cases.

PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS 6 aims at protecting and conserving biodiversity, the variety of life in all its forms, including genetic, species and ecosystem diversity and its ability to change and evolve, is fundamental to sustainable development. The components of biodiversity, as defined in the Convention on Biological Diversity, include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. This PS addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as incorporate sustainable management of renewable natural resources.

PS 6 recognizes that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity—and its ability to change and evolve, is fundamental to sustainable development. It reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner.

PS 7: Indigenous Peoples

PS 7 acknowledges the possibility of vulnerability of indigenous people owing to their culture, beliefs, institutions and living standards, and that it may further get compromised by one or other project activity throughout the life cycle of the project. The PS underlines the requirement of avoiding / minimizing adverse impacts on indigenous people in a project area, respecting the local culture and customs, fostering good relationship and ensuring that development benefits are provided to improve their standard of living and livelihoods.

PS 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. The term “indigenous people” is more clearly defined in the IFC Guidance Note for PS 7.

Objectives of PS 7 underscore the need to avoid adverse project impacts on Indigenous Peoples’ communities living in the project’s area of influence, or where avoidance is not feasible, to minimize, mitigate or compensate for such impacts through mechanisms that are tailored to their specific cultural characteristics and expressed needs of the Indigenous Peoples, in a manner commensurate with the scale of project risks and impacts.

PS 8: Cultural Heritage

PS 8 aims to protect the irreplaceable cultural heritage and to guide clients on protecting cultural heritage in the course of their business operations. In addition, the requirements of this PS on a project’s use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

PS 8 recognizes the importance of cultural heritage with an objective to:

- a) Protect cultural heritage from the adverse impacts of project activities;
- b) Support its preservation; and
- c) Promote the equitable sharing of benefits from the use of cultural heritage in business activities.

The PS requires the project proponent to comply with relevant national law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage and other relevant international law.

2.6.3 IFC Project Categorization

As part of its review of a project's expected social and environmental impacts, IFC uses a system of social and environmental categorization. This categorization is used to reflect the size of impacts understood as a result of the client's social and environmental assessment and to specify IFC's institutional requirements. Similar to ADB, the IFC categories are:

- a) Category A Projects: Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;
- b) Category B Projects: Projects with potential limited adverse social or environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures;
- c) Category C Projects: Projects with minimal or no adverse social or environmental impacts, including certain financial intermediary (FI) projects with minimal or no adverse risks;
- d) Category FI Projects: All FI projects excluding those that are Category C projects.

IFC therefore categorizes project primarily according to the significance and nature of impacts. IFC defines the project's area of influence as the primary project site(s) and related facilities that the client (including its contractors) develops or controls; associated facilities that are not funded as part of the project (funding may be provided separately by a client or a third party

including the government), and whose viability and existence depend exclusively on the project and whose goods or services are essential for the successful operation of a project; areas potentially impacted by cumulative impacts from further planned development of a project; and areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location. The area of influence does not include potential impacts that would occur without a project or independently of a project.

Project Classification as per IFC Performance Standards

With reference to the IFC's environmental and social screening criteria, it is anticipated that the proposed Project will fall under **Category B** for the following reasons:

Irreversible: Environmental and social impacts of the project are anticipated during the construction and operation of the power plant. The irreversible impacts will encompass increase noise and vibration during the plant construction and operation, change in air quality due to existing projects, affected aquatic ecology and surface water quality due to

waste water discharge from the power plant, occupational health and safety issues, community health and safety issues, risks due to storage and handling of highly flammable chemicals and associated development in the area. These impacts will be irreversible in nature without any mitigation measures and hence require proper attention to mitigate and minimise the overall impact in the project influence area.

Cumulative: Cumulative impacts on physical, biological and socioeconomic environmental conditions are anticipated due to existing 2X90 MW BPDB power plants, 51 MW engine based power plant by Barakatullah Elctro Dynamics Limited and 50 MW engine based power plant by Energyprima.

Unprecedented: The Project site is a developed land, already earmarked for the 163 MW gas fired power plant. Total four gas based power plant are in operational close to the proposed project location. Gas pipeline, RMS, jetty, boundary wall, switch yard, transmission line have to be constructed for the project. The Project and its impacts are therefore having precedence; however, the electricity generation will enhance economic development of the country, which is to some extent unprecedented.

2.6.4 IFC EHS Guidelines

The Environmental, Health, and Safety (EHS) General Guidelines (April 30, 2007) will be applicable for this Project. In addition to that, IFC's Sector specific EHS Guidelines for Thermal Power Plants (December 19, 2008) will also apply.

2.7 Equator Principle

The Equator Principles, is "a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making". The Equator Principles are a voluntary set of standards which are developed to support implementation of environmental and social policies and the Principles are outlined under 10 headings as noted under:

Principle 1: Review and Categorisation;

Principle 2: Environmental and Social Assessment;

Principle 3: Applicable Environmental and Social Standards;

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

Principle 5: Stakeholder Engagement;

Principle 6: Grievance Mechanism;

Principle 7: Independent Review;

Principle 8: Covenants;

Principle 9: Independent Monitoring and Reporting and

Principle 10: Reporting and Transparency.

Though not immediately recognizable from the list of principles, the proponents of the Equator Principles take cognizance of climate change, biodiversity, and human rights, and stressed that negative impacts on project-affected ecosystems, communities, and the climate

should be avoided where possible. If these impacts are unavoidable they should be minimized, mitigated, and/or offset (for details of the principles see Annex C).

2.8 Applicable EHS Standards

The Project shall have to comply with Bangladesh environmental, health and safety laws and World Bank Group Guidelines with special attention to comply with the Bangladesh (GOB Environmental Conservation Rule 1997) and World Bank Group requirements regarding air emissions (December 2008).

Therefore, the EHS standards as stipulated in ECR 1997 and amendments thereof as well as in the IFC EHS guidelines (General and Thermal Power Plant specific) for air quality, surface and ground water quality, ambient noise levels, emissions and effluent discharge will be applicable. Further, from transmission lines, electro-magnetic field and corona noise effects may have some impacts, which will be used by the proposed project as well.

The ADB SPS policy Statement 2009 (SPS) states, "During the design, construction, and operation of the project the borrower/client will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. These standards contain performance levels and measures that are normally acceptable and applicable to projects." For this purpose IFC EHS guidelines are recommended.

The relevant environmental standards (national as well as international) for thermal power plants as applicable to the proposed Project are presented in Annex A.

2.9 Regulatory Approvals of the Project

KPCL has gotten the following approvals from the respective authorities.

Table 2-6: Regulatory Approvals of the Project

S/N	Certificate/NOC	Approval Authority	Status (Yes/No)
1	Deep Tube Wells Approval	Union Parishad, Fenchugonj, Sylhet	Yes
2	EIA approval	Department of Environment	Yes
3	Electricity Generation License	Bangladesh energy Regulatory Commission (BERC)	Yes
4	Gas Pipeline Construction Approval	Jalalabad Gas T&D System Ltd. (JGTDSL)	Yes
5	Interconnection with PGCB 230KV S/S	Power Grid Company of Bangladesh (PGCB)	Yes
6	Jetty Construction Approval	Bangladesh Intra Water Transport Authority (BIWTA)	Yes
7	No Objection Certificate	Fire Service and civil defense, Sylhet	Yes
8	Permission for 150 KVA 110.415 KV Substation	Ministry of Power, Energy and Mineral Resources	Yes
9	Permission for Gas turbine ignition transformer	Bangladesh Atomic Energy regulatory Authority	Yes
10	Site Clearance Certificate	Union Parishad, Fenchugonj, Sylhet	Yes
11	Site Clearance Certificate	Department of Environment	Yes

S/N	Certificate/NOC	Approval Authority	Status (Yes/No)
12	Trade License	Union Parishad, Fenchugonj, Sylhet	Yes
13	Adhoc Import Registration Certificate	Bangladesh Investment Development Authority (BIDA)	Yes
14	DCCI membership	Dhaka Chamber of Commerce and Industries	Yes
15	Exemption from taxation on its income	National Board of Revenue (NBR)	No
16	Registration with BIDA	Bangladesh Investment Development Authority (BIDA)	Yes
17	Annual Return	Registrar of Joint Stock Companies and Firms (RJSC)	Yes
18	Audit Report	Certified by Auditor	Yes
19	Credit rating report	Any Credit Rating Agency	Yes
20	Exemption from stamp duties	Ministry of Finance	No
21	Form-XII	Registrar of Joint Stock Companies and Firms (RJSC)	Yes
22	Income Tax clearance certificate	National Board of Revenue (NBR)	Yes
23	Schedule-X	Registrar of Joint Stock Companies and Firms (RJSC)	Yes
24	Tax Identification Number Certificate	National Board of Revenue (NBR)	Yes
25	Trade License	Dhaka South City Corporation	Yes
26	Value Added Tax Certificate & BIN	National Board of Revenue (NBR)	Yes
27	Tax Exemption certificate of foreign employees	National Board of Revenue (NBR)	Yes
28	INSURANCE: Erection All Risk	Insurance Company	Yes
29	INSURANCE: Operational Package Insurance	Insurance Company	Yes
30	Simple Cycle & Combined Cycle COD Certificate	Bangladesh Power Development Board (BPDB)	Yes
31	Bank Guarantee to Jalalabad Gas T&D System Ltd.	Pubali Bank Ltd.	Yes
32	MOA & AOA	Registrar of Joint Stock Companies and Firms (RJSC)	Yes
33	Business Identification Number	National Board of Revenue (NBR)	Yes
34	Certificate of Incorporation	Registrar of Joint Stock Companies and Firms (RJSC)	Yes
35	Permission to Setup Three Deeptubewell	local Union Porishod, Fenchugonj, Sylhet	Yes
36	Contract Agreement Waste Collection, Transportation & Dispose	Agreement with M/S Rima Enterprise	Yes
37	Bangladesh Independent Power Producers' Association Certificate	BIPPA	Yes
38	Form-23B	Selected Auditor: SF Ahmed	Yes
39	Registration of Mortgage/Charge	Registrar of Joint Stock Companies and Firms (RJSC)	Yes

Source: Kushiara Power Company Limited

CHAPTER 3: PROJECT DESCRIPTION

3. PROJECT DESCRIPTION

3.1 Introduction

The proposed 163 MW gas-fired combined cycle power plant (CCPP) will be located in Fenchuganj upazila under Sylhet district, Bangladesh. The Project will be implemented on a Build, Own and Operate (BOO) basis for a period of 22 years. Natural gas will be delivered from the Jalalabad Gas Transmission and Distribution System Limited (JGTDSL) via a new pipeline of approximately 150 meter, connecting the power plant to the existing Valve Station owned by JGTDSL. Ground water will be extracted for the cooling system. A 230 kV switch yard will also be constructed at the site as part of the Project; while a 3.9 km new 230 kV transmission line will be constructed by the KPCL which will be handed over to the Power Grid Company of Bangladesh (PGCB) for power evacuation from the Project. the salient feature of the project has been shown in the following Table.

Table 3-1: Salient Feature of the Proposed Project

Name of project	163 MW gas fired combined cycle power plant		
Name of project Company	Kushiara Power Company Limited		
Registered Office	Baitul Hossain Building (6th Floor), 27 Dilkusha C/A, Dhaka-1000		
Plant location	Garulikona, Fenchugonj, Sylhet, Bangladesh		
Legal Status	Private Limited Company		
Nature of Business	Power Generation		
Nature of project	Gas based combined cycle power plant		
Project Tenure	22 years		
Total cost of the project	Tk. 1,167 crore		
EPC cost	Tk. 1,047 crore		
Total Plant Area	9.22 acres		
Electricity generation	Simple Cycle	Combined Cycle	Total
	109 MW	54 MW	163 MW
Off-taker	Bangladesh Power Development Board		
Gas supplier	Jalalabad Gas Transmission and Distribution System Ltd.		
Gen set supplier	General Electric International, INC		
RMS supplier	General Electric International, INC		
Gas Turbine Generator Model	9E.03		
Steam Turbine Generator Model	SC2-26		
Commencement date of project	8 January 2016		
Expected completion date	Single Cycle- 25 July 2017 Combined Cycle- 28 April 2018		
EPC contractor	Max Infrastructure Limited		
Technical & Engineering service	Mott MacDonald Limited, UAE		

provider	
Technical & Engineering plan review	Tata Consulting Engineers Limited, India
Technical staff provider	SEPCO1 Engineering India (Private) Limited
Total Manpower	670 persons (Site staff: 600 and Office staff: 70)

Source: Kushiara Power Company Limited (KPCL)

3.2 Location

The site proposed for 163 MW gas fired Combined Cycle Power Plant (CCPP) by Kushiara Power Company Limited. For accommodating the power plant is located to the left bank of the river Kushiara. The location of the proposed project site lies, geographically between 24°41'25.54"N; 91°55'7.80"E to 24°41'25.69"N; 91°55'6.72"E and 24°41'19.28"N; 91°55'6.80"E to 24°41'21.21"N; 91°55'1.39"E. The site is about 3.5 km from Sylhet-Moulavibazar Road to the west, about 28 km south-east of Sylhet and about 8 km road from Fenchuganj upazila. The aerial view of the proposed CCGT power plant has been shown in **Figure 3-1**.

3.3 General Layout

All buildings and structures will be located according to the site layout plan. The General Layout will be composed of main block area and auxiliary area. The main block will be composed of gas turbine hall, HRSG, steam turbine hall, main transformer, and HV unit auxiliary transformer. The auxiliary area will be composed of boiler make-up water treatment plant and industrial waste water treatment plant and chemical dosing room and mechanical draft counter flow cooling tower and C.W. pump house and mechanical accelerate clarifier and raw water intake pump house and comprehensive water pump house and service & firefighting water basin and raw water basin and potable water basin and filter and sanitary waste water treatment plant. The road network has designed within the range of 1m away from site boundary. The cable trenches, pipe trenches of the plant designed outdoor in the plant and fence will be construct along the perimeter of plant, switchgear yard, transformer bays and gas treatment station. The layout of the power plant has been presented in Figure 3-2.

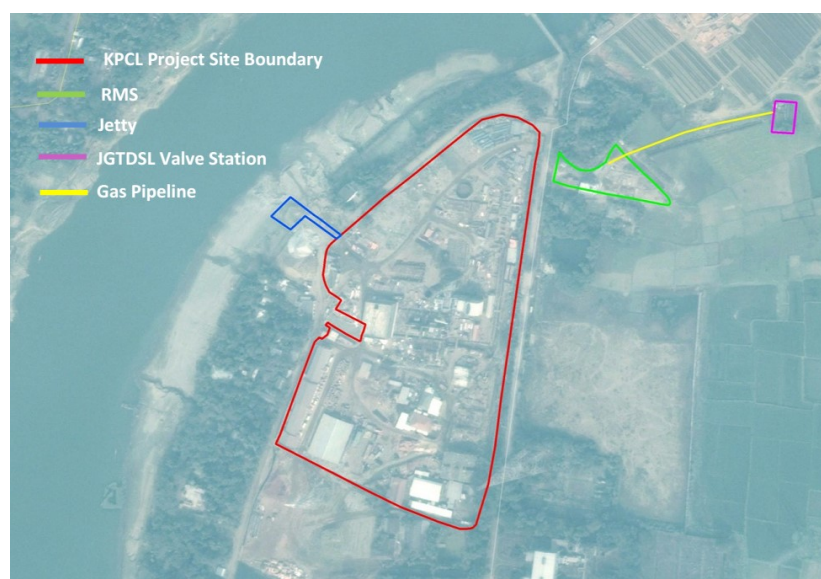


Figure 3-1: Aerial View of Proposed Project Site

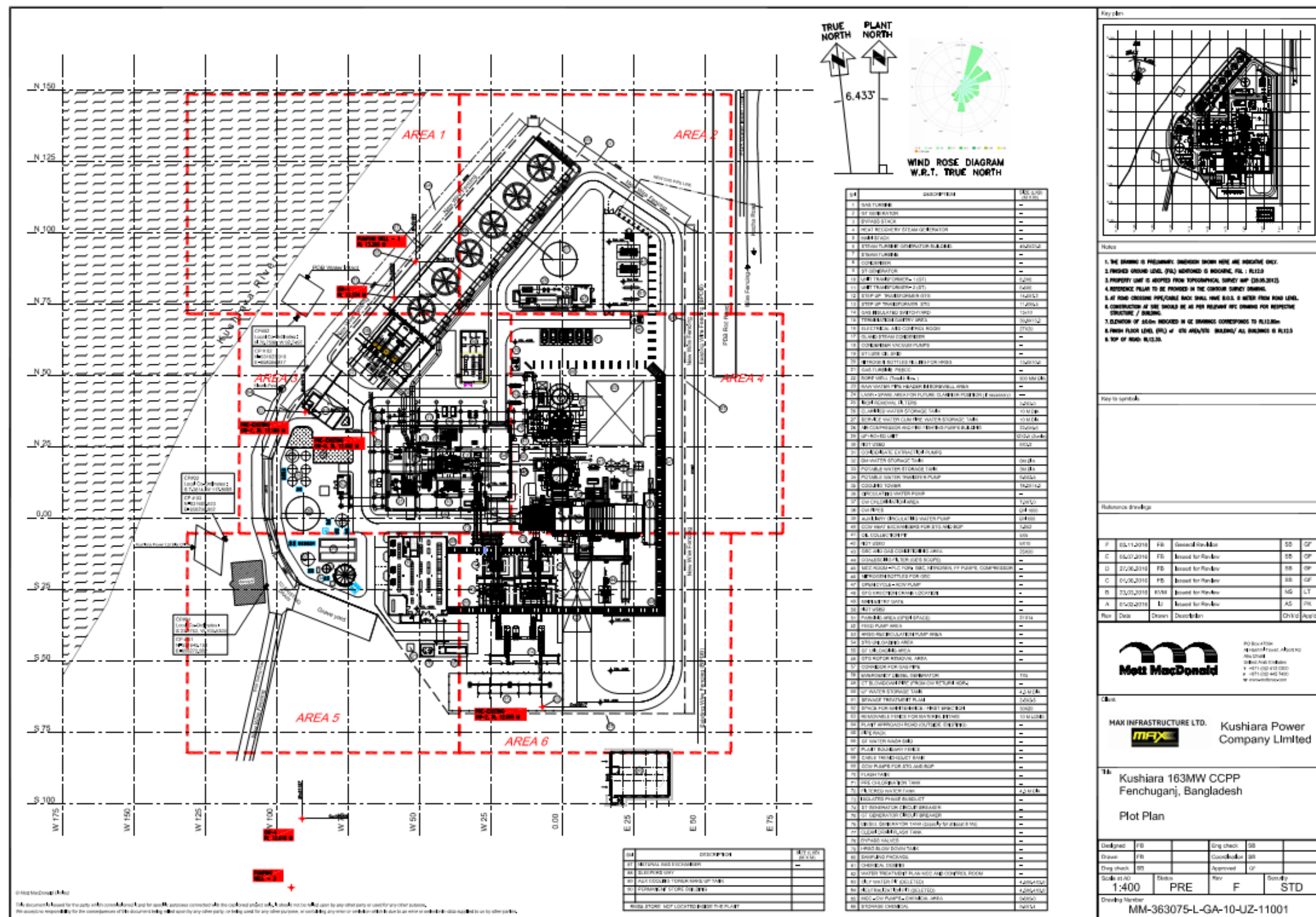


Figure 3-2: General Layout Plan of the Proposed Project

3.4 Key Feature of the Site and Surroundings

Presently there is no structure within the project site. The project site is plain vacant land. There are two religious structures (Mosque and Graveyard) present adjacent to the project boundary. Details of areas surrounding the proposed project site are as under:

- **North:** Settlement and Agricultural Land
- **South East Side:** BPDB Power Plant and settlement
- **South West Side:** Graveyard and Mosque
- **South Side:** Settlement and Agricultural land
- **East:** Approach road, Agricultural Land and Settlement
- **West:** Kushiara River

The project site is located on the left bank of Kushiara River. Two water intake stations are present near to the project site. Jalalabad Gas Transmission and Distribution System Limited (JGTDSL) valve station is located approximately 200m north east side of the power plant. Approximately 150 m pipeline will connect to the RMS from the valve station. Two 90 MW BPDB power plants are located approximately 250 m and 350 m south-east direction from the power plant. Another two gas based engine power plants are located approximately 500 m and 640 m south of the power plant. There is a settlement cluster located close to the project site. There are two brick kiln near to the project site which are approximately 350 m north and 1.4 km south of the project site. Present surrounding settings of the proposed power plant is shown in the following Figure 3-3. Pictorial view of the site and surrounding features has been presented in the following Figure 3-4.

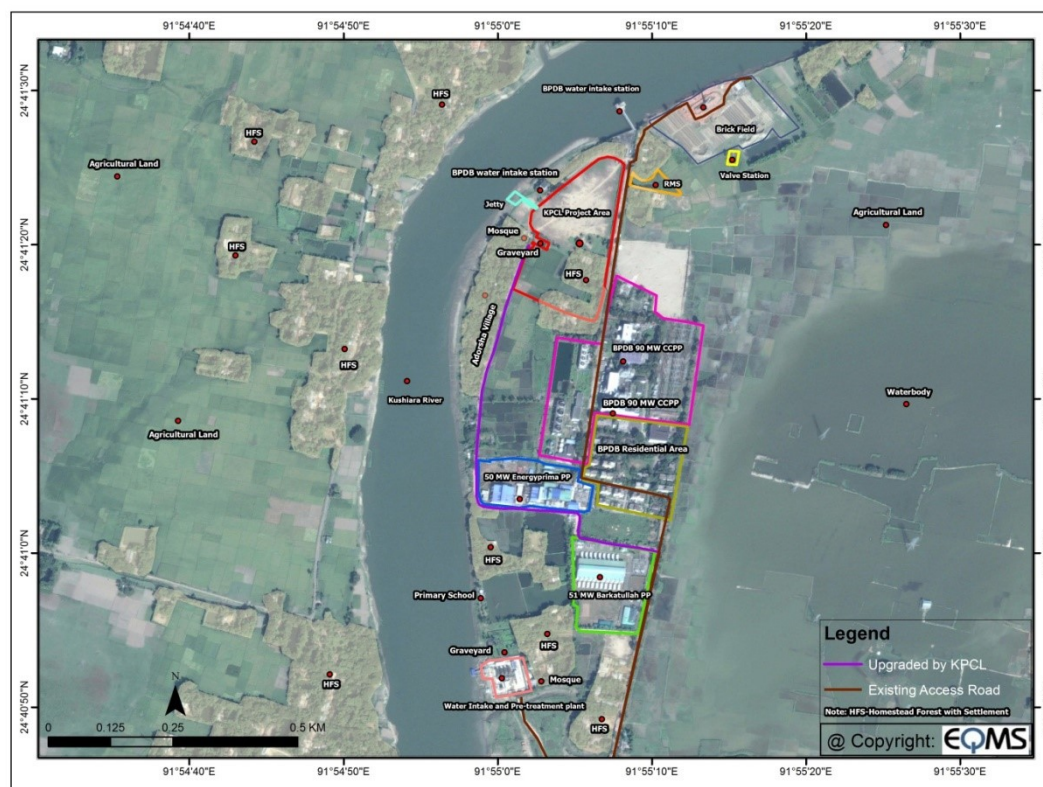


Figure 3-3: Site and Surroundings of the Proposed Project



Figure 3-4: Pictorial View of Surrounding Key Features of Power Plant

3.5 Mean of Access

The proposed site of the 163 MW gas fired Combined Cycle Power Plant (CCPP) project is located about 3.0 km from the Sylhet-Moulavibazar road to the west, about 28 km south-east of Sylhet and about 8 km road distance from Fenchuganj upazila town. Therefore, the power project site can be reached by road from Sylhet or Dhaka or from Fenchuganj. Fenchuganj is also at close proximity with Sylhet and most readily communicable through road and railway links. Significant volumes of heavy goods can also be transported by road.

The site is connected to Dhaka-Moulavibazar-Sylhet highway by a 3.0 km access road of which 2.12 km road constructed by BPDB for their existing 90MW unit-1 and unit-2 gas fired combined cycle power plant. The access road is in good condition for transportation of project materials, from the port to the site on long vehicles.

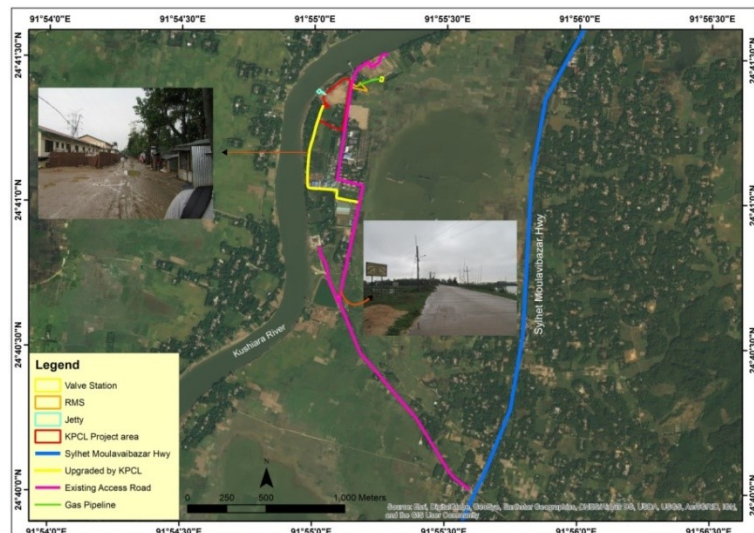


Figure 3-5: Access Road of the Proposed Power Plant

Another 0.91 km road is existing unpaved road which has been upgraded by KPCL for carrying out the construction materials as well as communication. The Dhaka Moulavibazar-Sylhet highway is connected to Chittagong port through Dhaka-Chittagong highway. Kushiara River is connected to the main inland river network down to Mongla Port to the south and Chittagong Port through the Bay-of-Bengal. Imported plant and equipment can be transported to the site by this river route through all the seasons of the year.

Chittagong port is largest port of Bangladesh at the mouth of Karnafully River. Mongla Port is the second largest port in Bangladesh in the Bagerhat District of southwestern Bangladesh, about 48 km. south of Khulna city. It serves the Southwestern part of Bangladesh (essentially the whole of Western Bangladesh). Both the ports have container handling facility and bulk handling facilities. The Meghna River is connected to the Chittagong Port through the Bay-of-Bengal to the east. Inland river networks connect the Chittagong Port and Mongla port to the Meghna River that is navigable throughout the year. The Site is connected to the Meghna River through Kushiara River is navigable during except dry season. Other construction material will be transported through the road network which is quite good to carry out the materials. The access road of the proposed plant has been shown in the following Figure 3-5.

3.6 Temporary Jetty

A temporary jetty will be constructed on the left bank of the Kushiara River near to the project site for unloading the equipment of the power plant. BIWTA has given the license to KPCL with some condition for establishing a temporary earthen jetty which will be 50 feet X 30 feet = 1500 ft² or 140 m² in size along with 14 m² RCC drain and use of 15% foreshore of the Kushiara River. The location of the Jetty has been shown in the following Figure 3-6.

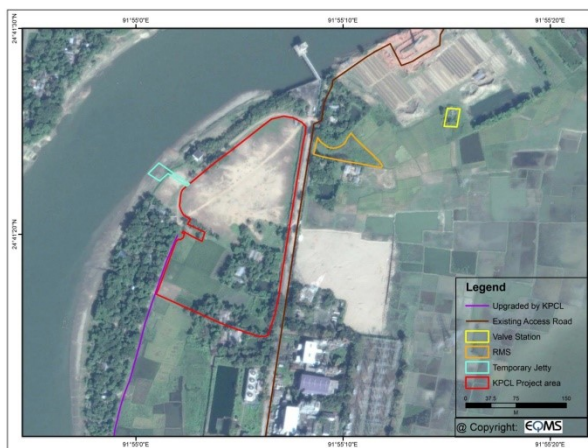


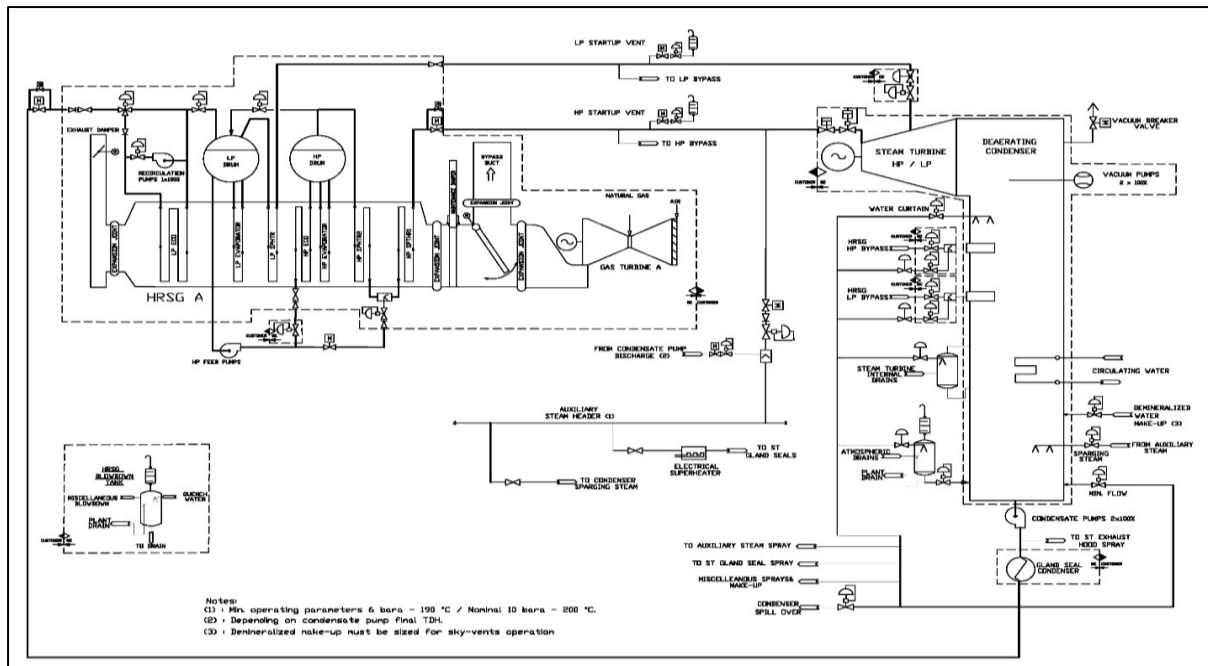
Figure 3-6: Location of Temporary Jetty of the Proposed Power Plant

3.7 Size and Magnitude of Operations

KPCL Combined Cycle Power Plant will consist of one set of gas turbine generating unit, one set of HRSG and one steam turbine generating unit. The Plant configuration will be 1:1:1 using one GE Frame 9E.03 gas turbine, one SC2-26 Steam Turbine and one Heat Recovery Steam Generator from GE. The design condition is ambient dry bulb temperature: 32°C, Relative humidity 85%, Cooling water temperature: 28.5°C, Seismic coefficient 0.2g. The overall performance of the CCPP based on 100%load is outlined in Table 3-2 and the basic process flow of the proposed power plant is shown in the following Figure 3-7.

Table 3-2: Overall Performance of Facility

Description	Units	Simple Cycle	Combined Cycle	Reference Site Conditions
Plant Gross Output	KW	111,528	170,135	Barometric Pressure 1.013B, Ambient Dry Bulb Temperature 32°C, Relative Humidity (R.H.) 85%, Cooling Water Temperature 28.5°C.
Auxiliary Power and Losses	KW	1,735	4,284	
Step-up Transformer Losses	KW	557	850	
Gas Booster Power Losses	KW	Included	Included	
Total Losses	KW	2,292	5,135	
Net Power Output at High Voltage(230 kV) side of Generator Step-up Transformer	KW	109,236	165,000	
Net Heat Rate(based on HHV basis)	kJ/kWh	11,921	8,015	
Noise Level(World Bank Group Guidelines) @ Facility boundary	db(A)	70	70	
Noise Level(World Bank Group Guidelines @ 1 meter	Equipment db(A)	85	85	



Source: KPCL

Figure 3-7: Process Flow Diagram of the Proposed Project

3.8 Key Component of the Project

The key Project components are as follows:

- Gas Turbine;
- Heat Recovery Steam Generator;
- Steam Turbine;
- Steam Turbine Condenser;
- Fuel Gas Compression and Conditioning System;
- Water System including cooling water system;
- Electrical System
- Connection from switch yard to PGCB sub-station
- Air Conditioning and Ventilation System; and
- Control and Instrumentation System.
- New RMS for natural gas compression and conditioning
- New natural gas pipeline from JGTDSL Valve Station to the RMS of KPCL Project
- Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP)

3.8.1 Gas Turbine

The project will have a heavy duty, single shaft 9E.03 gas turbine with 19 stage of air compressor, 14 stage of combustor that will be directly coupled to a 50 Hz generator. A new and clean 9E.03 combustion turbine makes 109 at a heat rate of 10,403 kJ/kWh (LHV) under reference conditions. The gas turbine (GT) will be installed within an acoustic, ventilated enclosure with fire detection and protection system. The GT will have all associated ancillary equipment and systems required for the safe, efficient and reliable operation of the

unit under simple and combined cycle modes. The combustion turbine specifications are shown below Table 3-3.

Table 3-3: Gas Turbine Generator Specification

Particular	Unit	Details
Combustion turbine manufacturer	1	GE
Model/Type	-	9E.03
Net Output	MW	109 MW (Gas)
Heat Rate at 100% load	kJ/kWh	10,403 (LHV)
RPM	-	3,000

The Gas Turbine Generator (GTG) will be installed in a GT building. The GTG will be capable of operation with their exhaust gases passing into the associated heat recovery steam generator, or as simple open cycle turbine generator, exhausting directly to atmosphere via an exhaust gas damper and the bypass stack, located on the exhaust ducting upstream of the heat recovery boiler.

All cooling requirements for the turbine shall be met using heat exchangers, fed from either the Closed-Circuit Water (CCW) system or Cooling Water System (CWS).

Control of emissions of NO_x will be achieved by Dry Low NO_x (DLN) burners. The gas turbine will be equipped with dual fuel systems, capable of burning the specified fuel gas and backup fuel oil.

3.8.2 Heat Recovery Steam Generator (HRSG)

The heat recovery steam generator (HRSG) is a primary component in the bottoming cycle of a combined cycle power plant. It provides the thermodynamic link between the gas turbines and steam turbines. Each HRSG solution is custom engineered to meet your desired operating flexibility and performance requirements.

GE's HRSG units are cost-effectively designed for heavy cycling operations that allow owners to reduce the cost of electricity, boost performance, increase reliability, and enhance flexibility. Numerous options are available, such as supplementary firing, SCR for NO_x abatement, CO catalyst for emissions reduction, and exhaust gas bypass systems for simple cycle gas operation in a combined cycle installation.

Table 3-4: Heat Recovery Steam Generator Specifications

High Pressure Section	
-Maximum continuous capacity	87.1 kg/s
-Rated steam outlet pressure	127.8 Bar(a)
High Pressure Section	
-Rated steam outlet temperature	569°C
Intermediate Pressure Section	
-Maximum continuous capacity	96.01 kg/s
-Rated steam outlet pressure	25.15 Bar(a)
-Rated steam outlet temperature	569°C

Low Pressure Section	
-Maximum continuous capacity	6.72 kg/s
-Rated steam outlet pressure	3.97 Bar(a)
-Rated steam outlet temperature	308°C

3.8.3 Steam Turbine

The ST will be of proven design and directly coupled to a 50 Hz generator to produce 54 MW. The ST exhaust and condenser configuration will be in accordance to manufactures standard design. It will be sized to pass the entire quantity of steam generated by the HRSG over the full range of ambient temperature specified.

The condensing steam turbine generator will be of proven design and complete with all auxiliary oil and steam system. The steam turbine will be directly coupled to a 50 Hz generator. The STG will be designed to ensure a long creep life, cycle duty and start-up.

The STG will be installed indoors for environmental protection (e.g., dust and rain) and to produce acoustic attenuation. The STG building will include an overhead traveling crane suitable for lifting the maximum heavy load for maintenance activities and suitable indoor laydown areas for plant maintenance. The tm turbine will be sized to pass the entire quality of steam generated by HRSG over the full range of ambient temperatures specified. The STG specification is outlined in the following table.

Table 3-5: Steam Turbine Generator Specification

Particular	Unit	Details
Combustion turbine manufacturer	1	GE
Model/Type	-	SC2-26
Net Output	MW	54 MW (Gas)
Steam conditions	-	90 bar-a/535°C

3.8.4 Steam Turbine Condenser

Steam condenser is a device in which the exhaust steam from steam turbine is condensed by means of cooling water. The main purpose of a steam condenser in turbine is to maintain a low back pressure on the exhaust side of the steam turbine. After releasing from nozzles, the steam has to expand to a great extent for converting available energy into it to usable mechanical work. So, if the steam after doing it, work does not get condensed, it will not give required space to other steam behind it, to expand to its required volume. Condensation of steam in a closed system creates an empty place by reduction of volume of the low-pressure steam.

3.8.5 Water Treatment System

3.8.5.1 Water Pre-Treatment Plant

Raw water is first entering into Aeration tank. After that the aerated water is going to the clarification unit. Subsequently, the clarified water is passing through Mn filter and the final filtered water is getting stored in a clean water pool. The filtered water from the clean water pool is distributed to CW system, industrial & fire water system and DM water

plant.

Here, aerated water will be used to backwash Mn filter. Also, roots type air blower will be used for air scouring backwash filter and also to provide sufficient amount of air in the aeration unit.

The flow diagram of water pre-treatment plant is shown in the following Figure 3-8.

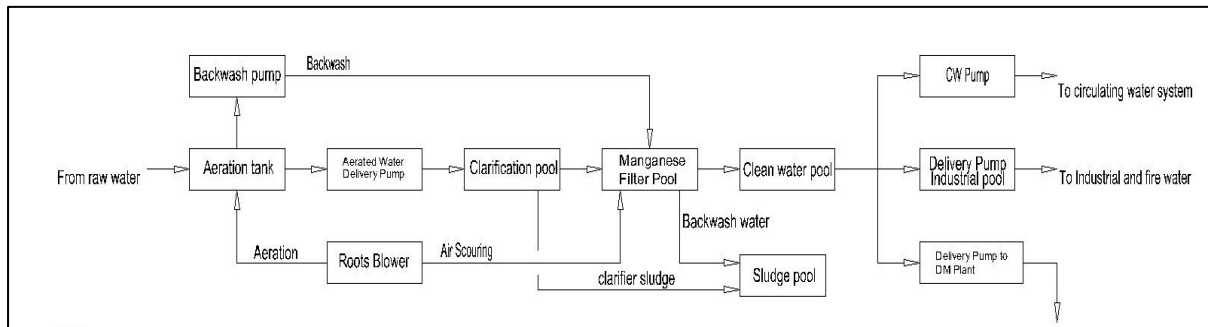


Figure 3-8: Flow Diagram of Water Pre Treatment Plant (WPTR)

3.8.5.2 Demineralization and Potable Plant

Filtered water from water pre-treatment unit will enter into activated carbon filter. After that filtered water will enter into Strong acid cation exchanger and subsequently it will pass the degasifier. The degassed water will be stored in an intermediate storage tank. From the intermediate tank, water will be delivered in the strong base anion exchanger and mixed bed unit respectively. After passing from mixed bed DM water will be stored in the desalination water tank and it will be delivered by a DW pump. A separate line will come out after strong base anion exchanger unit. The water of this line will pass the ultraviolet sterilizer, pH adjuster and mineralize dosing device respectively. Finally, the water will be used as potable water.

Again, Strong Acid Cation exchanger and Strong Base Anion exchanger will be regenerated Acid and Alkali respectively. Mixed Bed unit will be regenerated by both Alkali and Acid. The regeneration waste from these three units will go into wastewater treatment system. The flow diagram of demineralization and potable plant is shown in the following Figure 3-9.

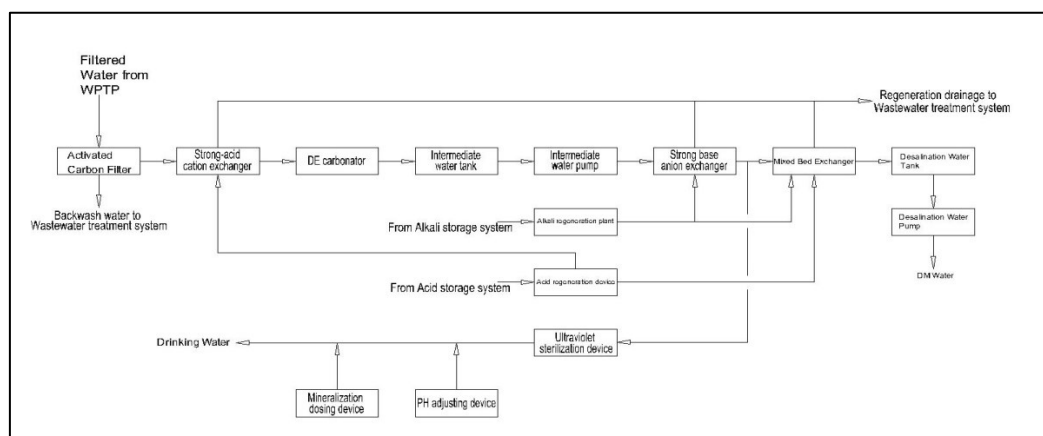


Figure 3-9: Flow Diagram of Demineralization & Potable Plant

3.8.5.3 CW Chlorination Skid

NaOCl dosing system will provide NaOCl to a dosing device and it will be dosed into the dosing points.

3.8.5.4 Mobile Oil Water Separator

Oily wastewater will enter into oil separator tank and after that it will pass through mobile oil separator device to oily waste sewage. The flow diagram of mobile oil water separator is shown in the following **Figure 3-10**.

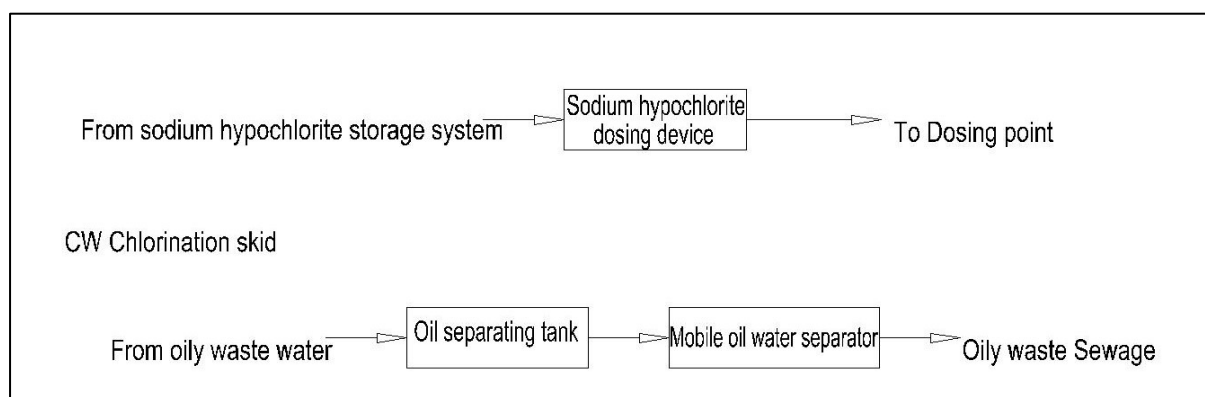


Figure 3-10: Flow Diagram of Mobile Oil Water Separator

3.8.5.5 Chemical Storage System

1. Acid will be unloaded through an acid tolerant pump and will be delivered into the acid storage tank. From acid storage tank
2. Acid will be delivered into the acid point.
3. Alkali will also be unloaded through an alkali tolerant pump and delivered into the alkali storage tank. From alkali storage tank, it will be delivered into alkali point.

Sodium hypochlorite will also be unloaded through a chemical resistant pump directly into the storage tank and from storage tank it will be delivered in hypochlorite dosing points. The flow diagram of diagram of chemical storage system is shown in the following **Figure 3-11**.

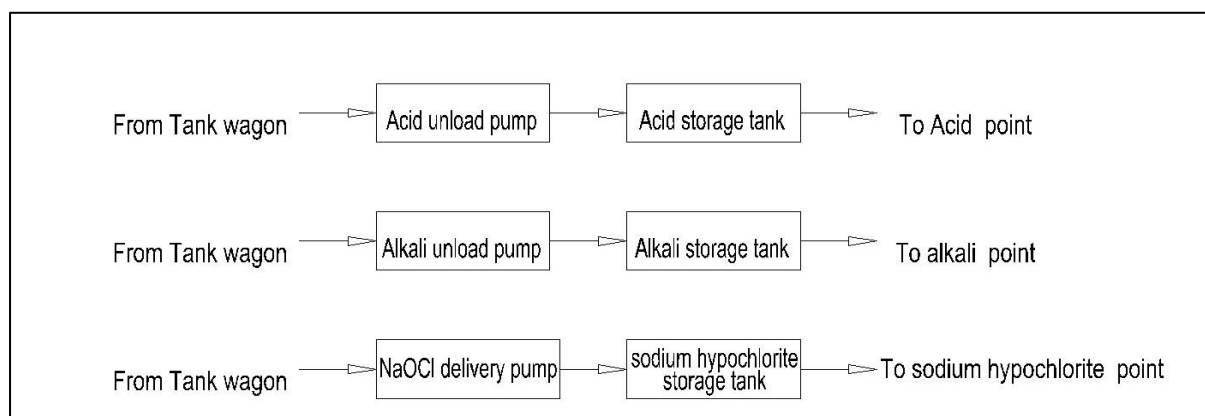


Figure 3-11: Flow Diagram of Chemical Storage System

3.8.6 Effluent Treatment Plant

Wastewater from all sources will enter into the aeration tank. A roots type air blower will provide air into aeration tank. A delivery pump will deliver water from aeration tank to pH adjusting tank. Subsequently, water will enter into a reaction tank, flocculation tank and lamella clarifier tank. From lamella clarifier clarified water will enter into the clear water pool and then in the drainage system.

pH dosing, PAC dosing and PAM dosing systems will provide all the necessary chemical dosing for pH adjusting system, reaction tank and flocculation system respectively. The flow diagram of effluent treatment plant is shown in the following Figure 3-12.

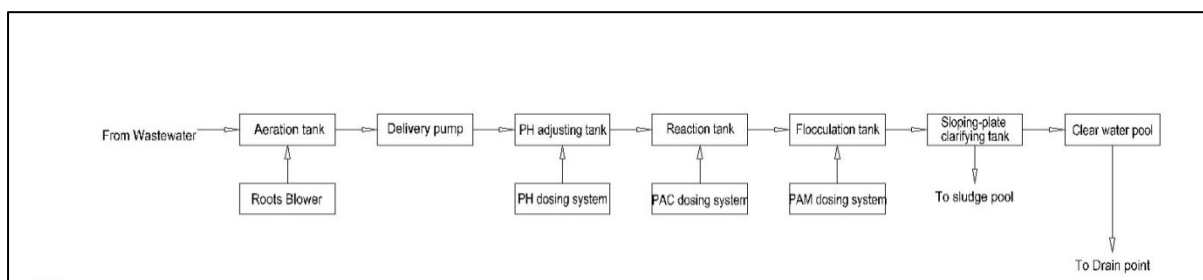


Figure 3-12: Flow Diagram of Effluent Treatment Plant

3.8.7 Sewage Treatment Plant

Sewage from domestic systems will come into manual grid system and then a submersible pump will deliver this sewage to SBR integrated processing equipment. From SBR integrated processing equipment the final filtered product will go into the drainage system and sludge will be pumped through a sludge pump into sludge pool. The flow diagram of sewage treatment plant is shown in the following Figure 3-13.

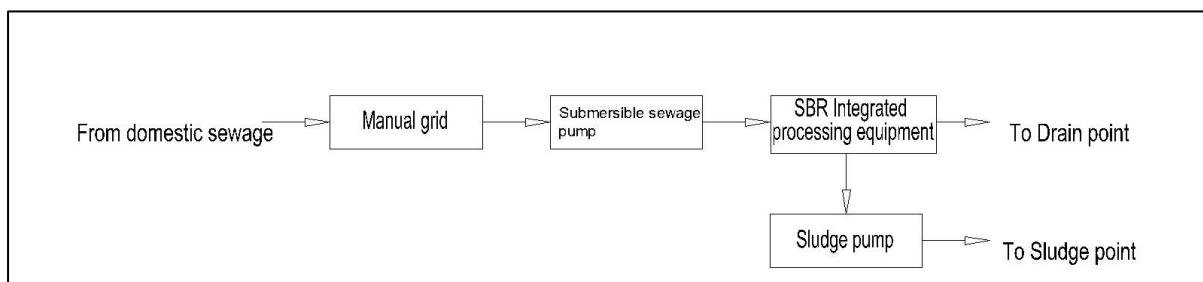


Figure 3-13: Flow Diagram of Sewerage Treatment Plant

3.9 Resources and Associated Facilities Required for the Project

3.10.1 Land

Approximately 9.22 acres (922 decimal) of land is required for the Project. The required land has already purchased by the KPCL. Table 3-6 provides a summary of the land requirement for various components of the proposed.

Table 3-6: Land use breakdown for project and associated facility of KPCL

Project Component	Area (Decimal)	Percent (%)
Plant Area	200.64	22%

Project Component	Area (Decimal)	Percent (%)
Road	166.43	18%
Open Space	235.38	26%
Plantation	150	16%
Dormitory	44.53	5%
Drainage	20.18	2%
Water Tanks	6.09	1%
Electrical Substation + Busduct + Transformer	42.22	5%
Control Buildings	23.38	3%
Store	15.35	2%
RMS	17.8	2%
Total Area	922	100%

Source: KPCL

3.10.2 Water

A circulatory water system has been planned for the proposed power plant. Total 209.6 m³/h water will be circulated in a closed cycle during operation period. It is estimated that 234.3m³/hr water will be required for meeting different demand of water including makeup of circulating water systems, service water, domestic water etc. All the required water will be supplied from the underground water. Water will be collected from five bore well and a water storage facility will be built with a total capacity of water requirement for twenty-four (24) hours by the facility plus firewater storage to meet the NFPA and the local fire code requirements.

The water requirement for the proposed power plant is summarized in **Table 3-7**. The regular total requirement of water for this unit is 234.3m³/hr including the domestic requirement. The amount of liquid waste water would be about 47.5m³/hr, evaporative loss from the condenser cooling system would be about 174.7 m³/hr and other uses (make up water for generator CCCW, turbine washing, NO_x control water & boiler along with waste water reuse in the condenser cooling) would be about 8.2 m³/hr. Water balance diagram of the proposed project is shown in the Figure 3-14.

Table 3-7: Water Requirement of Proposed Power Plant

SL No	Items	m ³ /hr
Distribution		
1	Cooling Water System	209.6
2	Quenching Water	6.7
3	Service Water	2
4	DM Water Tank (With Blowdown 2 m ³ /hr)	10.2
4(i)	<i>Makeup water for Generator CCCW</i>	1
4(ii)	<i>Water for turbine washing</i>	0.5

SL No	Items	m ³ /hr
4(iii)	<i>Make up water for Boiler</i>	6.7
5	Make up water for HVAC & GBC Cooler	5
6	Potable water (Office & Dormitory)	0.8
Total Distribution (A)		234.3
Waste Generated		
1	Clarifier & Sand Filter loss as sludge	4.7
2	Service Water & potable water	2.8
3	DM Plant Blow down	5.1
4	Cooling Tower Blow down	34.9
Total discharge to the Garden/Agriculture Field (B)		47.5
Losses, Uses and Evaporation		
1	Reuse of BD Quenched Water & HRSG Blow down in Condenser Cooling	3.9
2	Other Uses (Make up water for generator CCW, turbine washing & Boiler)	8.2
3	Condenser Cooling water evaporation + drift	174.7
Total (C)		186.8
Total Waste, Losses and Uses (B+C)		234.3

Source: KPCL

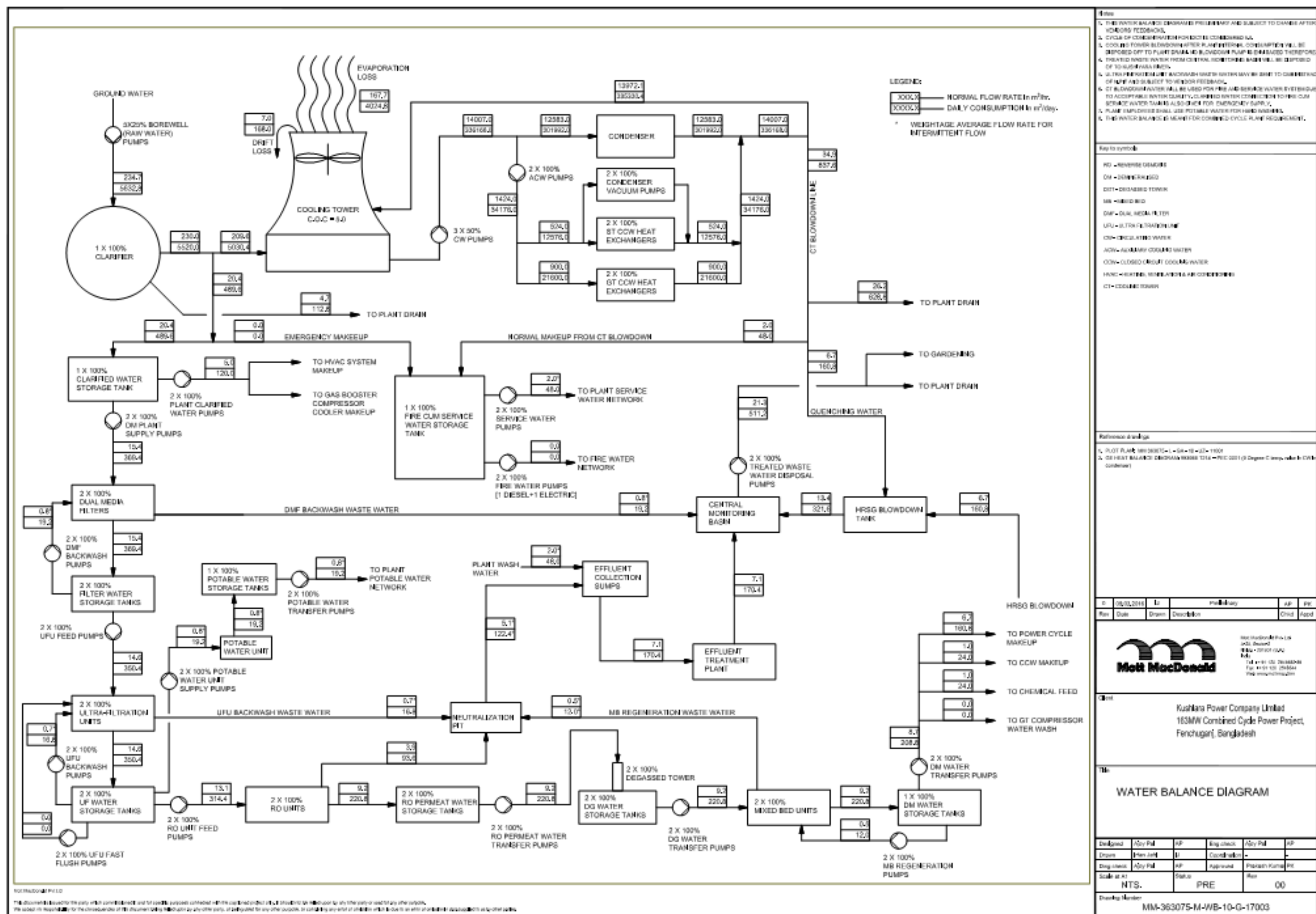


Figure 3-14: Water Balance Diagram of the Proposed Project

3.10.3 Gas Requirement

Natural Gas will be purchased from the Jalalabad Gas Transmission & Distribution System Ltd. (JGTDSL) under GSA. Gas will be supplied through the existing Fenchuganj 20-inch (diameter) gas pipeline commissioned in the early eighties. This line has sufficient capacity to supply required gas (1.469 MMSCF/hr) for the plant.

Approximately 150 m gas pipeline from the existing valve station to the RMS will be designed and constructed by the Sponsor at its own cost under supervision of Jalalabad Gas Transmission & Distribution System Ltd. (JGTDSL). The constructed gas pipeline will be transferred to JGTDSL for operation and maintenance at no cost to JGTDSL.



Figure 3-15: Gas pipeline Route from JGTDSL Valve Station to New RMS

The Sponsor will install a Natural Gas Check Metering System within the power plant premises. The RMS will include necessary equipment and materials for data (gas metering information) transfer between the JGTDSL.

The fuel gas system will include provisions of check metering facilities, on-line analysis facilities, fuel gas separators, pressure reducers, heaters or other facilities required to treat the gas to meet the requirements of the gas turbine manufacturer.

The delivered gas will have Btu content not less than 900 Btu (HHV) per SCF and not temperature less than 59°F (15°C) and not more than 140°F (60°C). The composition of the supplied gas composition for the power plant is shown in the following Table 3-8. The gas pipeline route from the existing valve station to new RMS has been shown in the following Figure 3-15.

Table 3-8: Supplied Gas Composition for the power plant

Constituent	Minimum Percent by Volume	Maximum Percent by Volume
Methane (CH ₄)	85.00	100
Ethane (C ₂ H ₆)	0	6.00
Propane (C ₃ H ₈)	0	5.00
Butane (C ₄ H ₁₀)	0	3.00
Pentane (C ₅ H ₁₂) and higher	0	2.00
Hydrogen Sulphide (H ₂ S)	0	0
Carbon dioxide (CO ₂)	0	2.00

Constituent	Minimum Percent by Volume	Maximum Percent by Volume
Nitrogen	0	3.00
Oxygen(O2)	0	1.00
Inert (the total combined Nitrogen, Oxygen, Carbon dioxide and any other inert compound)	0	5.00

Source: KPCL

3.10.4 Transmission Line

The generated power will be evacuated to the National Grid through 230/132 kV Fenchuganj substation. The Facility will be connected to the 230-kV bus of Fenchuganj 230/132 kV substation by a single ckt 230 kV (O/H/U/G) line (Interconnection Line) from the Facility.

This Interconnection Line & equipping of one 230 kV bay at Fenchuganj 230 kV switchyard will be implemented by the Sponsor. The extended 230 kV bay will be handed over to PGCB at no cost after commissioning. In addition, KPCL will install, maintain & operate separate synchronizing breaker. . The power evacuation route of the proposed project is shown in the following Figure 3-16.

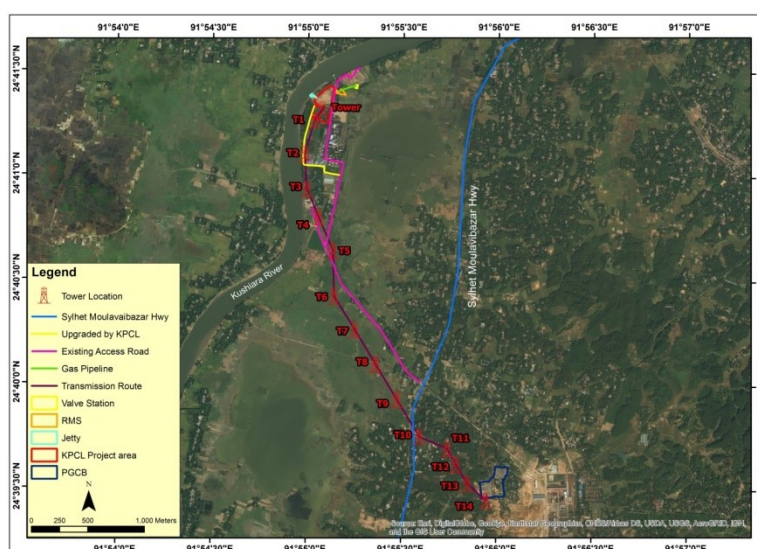


Figure 3-16: Transmission Line Route Alignment for Power Evacuation of the Power Plant

The Sponsor will provide communication links to the SCADA system including adequate Remote Terminal Unit (RTU) points to accommodate the PGCB and the National Load Dispatch Center (NLDC) requirements. The required land has been arranged and developed by the Company at its own cost in consultation with PGCB.

3.10 Project Implementation Schedule

The implementation of the Project Development Schedule is as follows:

Nature of work	Target date of accomplishment
Land acquisition	1-Sep-15
Appointment of EPC Contractor	5-Sep-15
Land and Land Development	15-Aug-16
Building & civil work	31-Jan-17
L/C opening for Machinery import - simple cycle	30-Nov-16
Simple cycle Machinery at site	31-Dec-16

Nature of work	Target date of accomplishment
Installation and erection of machinery of simple cycle	31-Jan-16
Simple cycle commercial operation	25-July-17
L/C opening for Machinery import - Combined cycle	31-Dec-16
Combined cycle Machinery at site	3-Apr-17
Combined cycle commercial operation	28-April-18

3.11 Operation and Maintenance

The Project Sponsor has appointed O&M Solutions, Mauritius to operate and maintain the plant for six years' maintenance cycle. The minimum staff to be deployed at Plant during Operational Phase, both in executive as well as non-executive categories, shall not be less than the Staffing Plan: Plant Manager (1 person), Shift in Charge (4 persons), Maintenance in Charge (1 person), Manager Electrical (1 person), Manager C&I (1 person).

KPCL intends the persons deployed by OMS to assume full responsibility of day to day operation of the plant. The persons are also meant to supervise the operation team members of KPCL and they shall report to the top management employed by the sponsors in the plant.

3.12 Decommissioning

The design life of the power plant is estimated to be 22 years. If the Power Purchase Agreement, Gas Supply Agreement and the other relevant agreements are not extended or renewed and an alternative economical fuel is available, the power plant may be retrofitted to support alternative power generation. This option would be possible, provided the required retrofits and new emission rates meet the applicable standards and guidelines.

If retrofitting is not feasible and the operational life of the Power Plant expires, the power plant will be decommissioned according to the requirements of the authorities at that time.

CHAPTER 4: ENVIRONMENTAL AND SOCIAL BASELINE

4. ENVIRONMENTAL AND SOCIAL BASELINE

4.1 Introduction

To establish an understanding of the environmental and socio-economic baseline of the Project area, baseline monitoring and intensive field study was carried out on August 2016 – September 2016. Baseline data has been compiled for:

- Land use Patterns;
- Topography;
- Geology;
- Soil Quality;
- Hydrology and Drainage;
- Surface Water and Ground Water Quality;
- Natural Hazards;
- Climatic Conditions and Meteorology;
- Air Quality;
- Noise Levels;
- Terrestrial and Aquatic Ecology; and
- Socio-Economic Environment.

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

- Physical Environment;
- Biological Environment; and
- Socio-economic Environment

4.2 Objective and Methodology

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

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

- Study area of 10 km radial zone from the boundary of the proposed Project location was selected for the baseline studies;
- The environmental and social field monitoring and survey was carried out on August 2016 – September 2016;
- Primary data was collected through environmental monitoring and field survey for water, air, soil, noise and ecology;
- Social baseline of the study area was captured through social surveys involving field consultations, interviews, meeting with stakeholders, discussions with government departments and secondary data review etc.; and
- Secondary data was collected from government reports, academic institutes, websites, published literature, interactions with government department and stakeholders etc.

4.3 Project Location

The selected site for the construction of 163 MW combined cycle Power Plant is at Fenchuganj Upazila, Sylhet district. The proposed project has been bounded with existing settlement and agricultural land on the north, BPDB Power Plant and settlement on south-east Side, Settlement and Agricultural Land on the north and Approach road, Agricultural Land and Settlement in the East and Kushiara River in the west. For establishing environmental baseline condition and for the assessment of impacts associated with the interventions, an area of 10 km radius from the periphery of the plant has been considered based on nature of the proposed project and EIA Guidelines for Industries, prepared by the DoE in 1997.

4.4 Area of Influence (AoI)

The project area and the potential impact area have been considered for this ESIA study as the Project's area of influence. For the "Core area", the physical location of the proposed power plant and the gas pipeline alignment has been taken into consideration.

For the "Buffer area", the geographic extent of the environmental and socioeconomic impacts resulting from implementation of the proposed power plant during construction and operational phases has been taken into consideration. Thus a buffer studies area of 10 km radius was surveyed for the overall baseline data mapping for environmental parameters. For the ecological and social baseline study, a buffer study area of 5 km was considered. The buffer study areas were selected with a view to capture the baseline in detail and also it was felt that the impacts from the power plant would be largely confined to these buffer areas. The 10 km study area map is shown in Figure 1-5.

No structure is present within the project site. The project site is plain vacant land. There are two religious structures (Mosque and Graveyard) present outside the south west corner of the project boundary. Details of areas surrounding the proposed project site are as under:

- **North:** Settlement and Agricultural Land
- **South East Side:** BPDB Power Plant and settlement
- **South West Side:** Graveyard and Mosque
- **South Side:** Settlement and Agricultural land
- **East:** Approach road, Agricultural Land and Settlement
- **West:** Kushiara River

Present settings of the proposed power plant area shown in the following **Figure 4-2**.

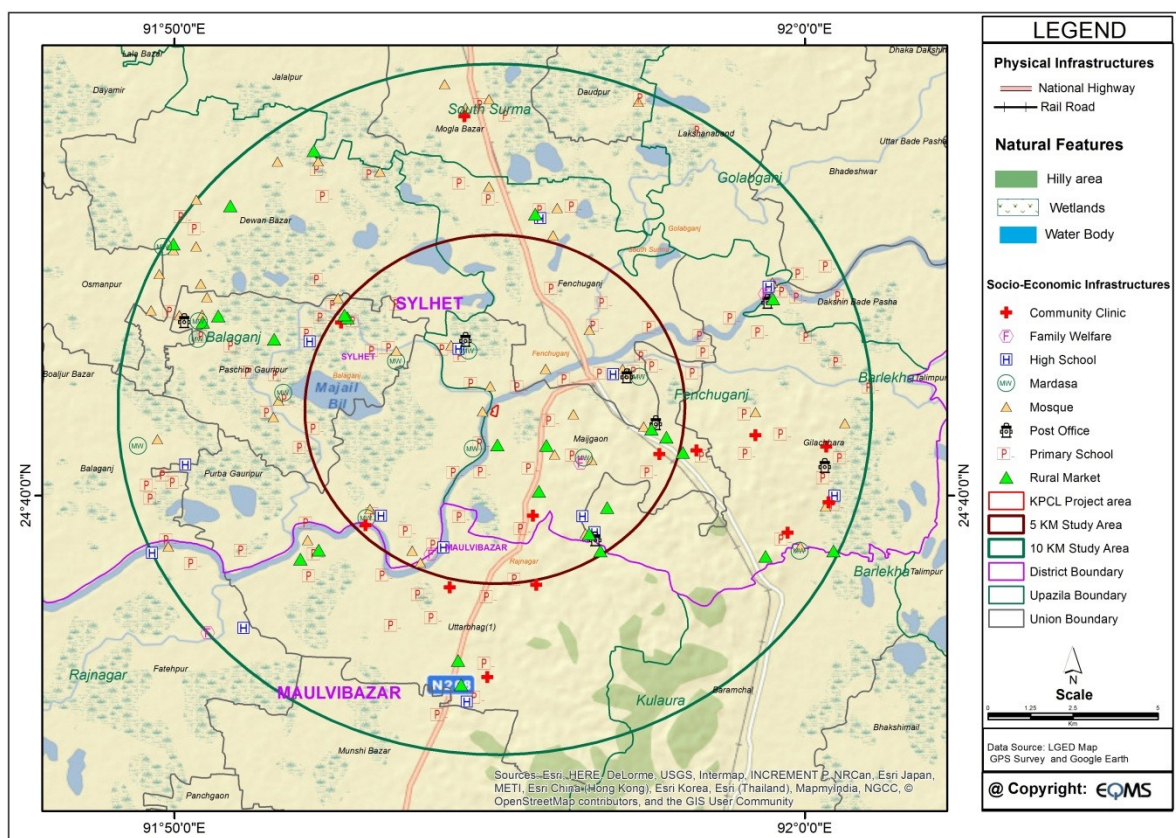


Figure 4-1: Baseline Map of the Proposed Power Plant

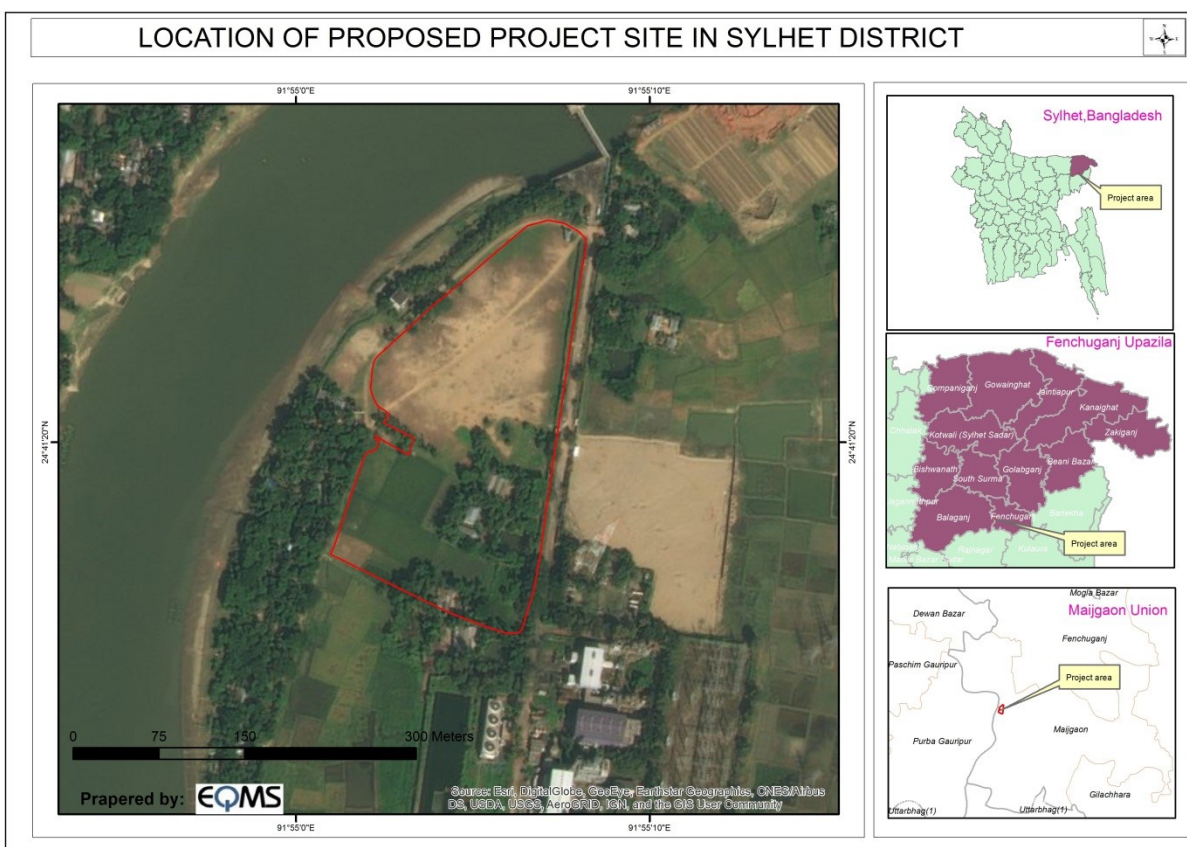


Figure 4-2: Google Image Showing the Proposed Project Footprint Area

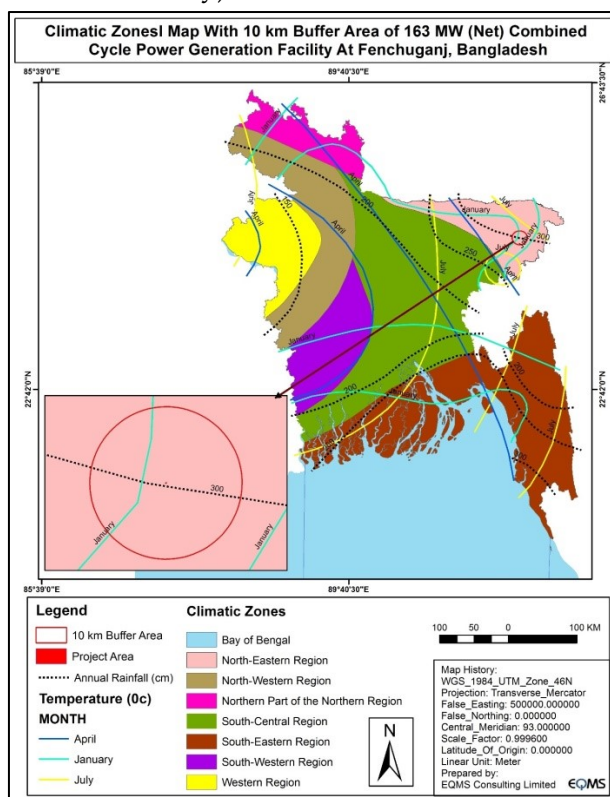
4.5 Physical Environment

4.5.1 Climate

The climate of Bangladesh is heavily influenced by Asiatic monsoon. The monsoonal influence results in three distinct seasons:

- Pre-monsoon hot season (from March to May);
- Rainy monsoon season (from June to September); and
- Cool dry winter season (from October to February)

Bangladesh is located in the tropical monsoon region, and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. From a climatic point of view, three distinct seasons can be recognized in Bangladesh - the cool dry season from November through February, the pre-monsoon hot season from March through May, and the rainy monsoon season which lasts from June through September. January is the coolest month, with temperatures averaging near 26°C, and April the warmest, with temperatures from 33 to 36°C. Most places receive more than 1,525 mm of rain a year, and areas near the hills receive 5,080 mm per year. Most rains occur during the monsoon (June-September) and little occurs in winter (November-February). Moderate rains are also reported in the months of March, April and October.



Source: Bangladesh Meteorological Department (BMD)

Figure 4-3: Climate Region Map of Bangladesh

Climatic sub-regions of Bangladesh are presented in **Figure 4-3** and as per that, the Sylhet District falls in the North-Eastern zone. This district, because of its location just south of the foothills of the Himalayas, where monsoon winds turn west and northwest, receives the greatest average precipitation in Bangladesh. The mean maximum temperature is rarely above 32°C, but mean minimum is 10°C and below. Average humidity is even more than in the south-eastern zone.

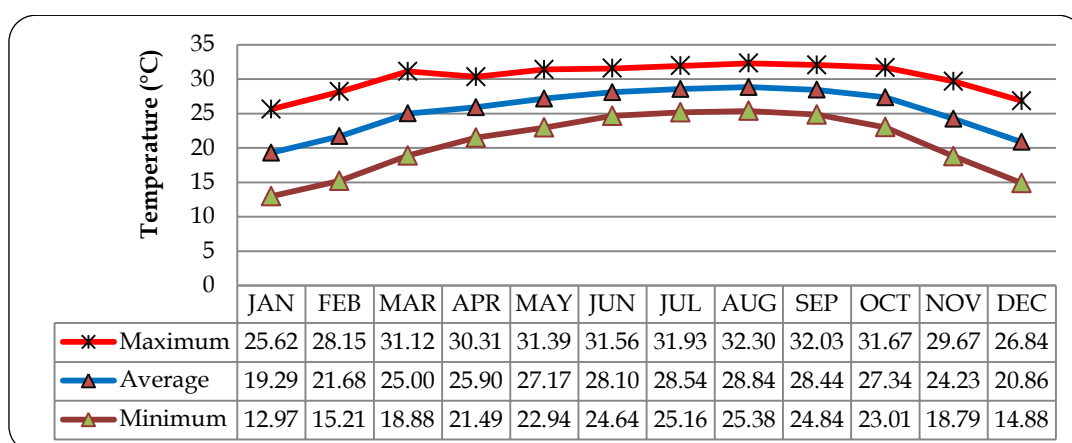
The Study Area is characterized by moderate rainfall, as well as somewhat mild summers and cloudy, cool winters. Mean daily maximum temperature reaches 32°C - generally in the month of April, and mean daily minimum temperature may at times fall below 12°C - usually in January. Average humidity is relatively high, often exceeding 80%, and most rainfall occurs during the monsoon season (Rashid, 1991).

Long-term average climatic data collected at the nearby Dhaka weather station (2001 to 2010) reflect the monsoonal effects on climate in this region:

- Mean monthly maximum temperature 38.8 (°C)
- Mean monthly minimum temperature 13.2 (°C)
- Mean annual relative humidity 78%
- Mean annual rainfall 3863 (mm)

4.5.1.1 Temperature

The monthly average minimum and maximum temperatures recorded at the Sylhet weather station are presented below in **Figure 4-4**. The lowest average temperature recorded in the past 30 years was in January 2007 (12.2°C). The highest average temperature reached 33.4°C in August 2008. Throughout the year, the highest temperatures are generally in March through October, and the lowest temperatures are from December to February (**Figure 4-4**).

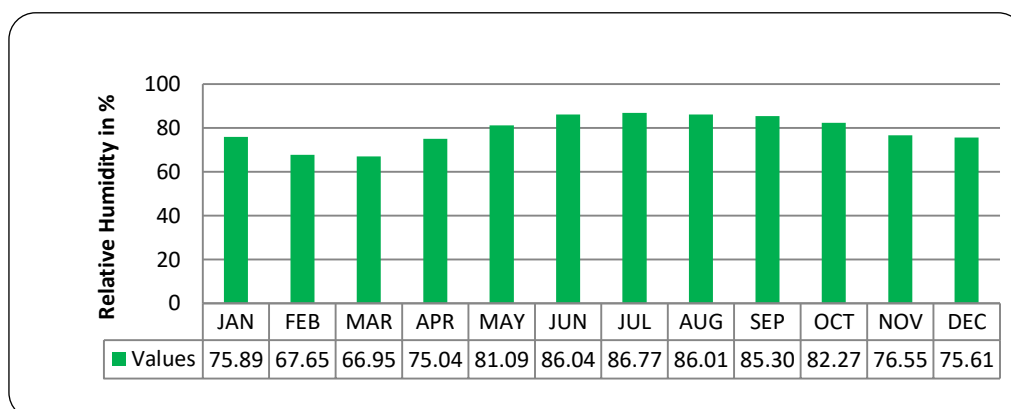


Source: Bangladesh Meteorological Department, Dhaka

Figure 4-4: Average Minimum and Maximum Temperatures (1986-2016), Sylhet Weather Station

4.5.1.2 Humidity

Relative humidity remains fairly constant from January to December, though on average it is higher in April to October as shown **Figure 4-5**. This observed change in humidity correspond with the pre-monsoon and dry seasons within the study area.

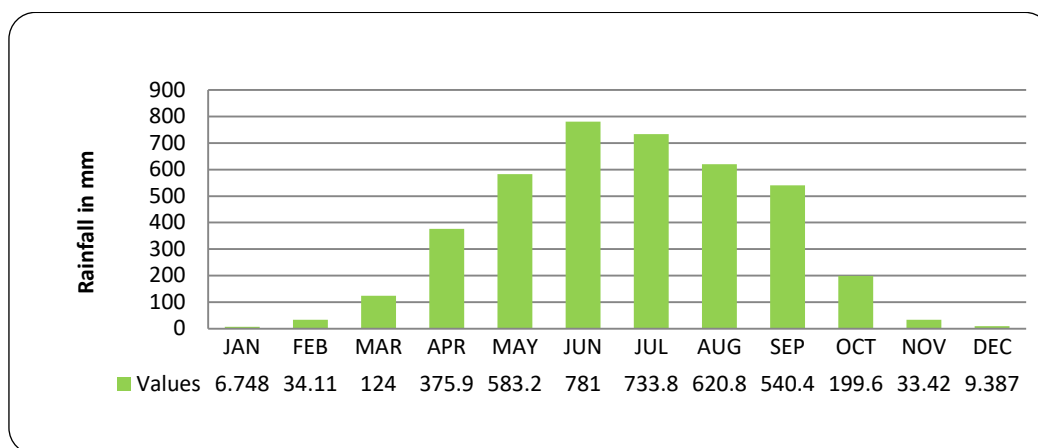


Source: Bangladesh Meteorological Department, Dhaka

Figure 4-5: Average Monthly Humidity (1986-2016), Sylhet Weather Station

4.5.1.3 Rainfall

The monthly and yearly rainfall recorded at the Sylhet weather station is shown in **Figure 4-6**. The records show that average monthly rainfall is highest from April through to September. The highest annual rainfall (4,939 mm) recorded within the last 10 years was in the year of 2010, while the lowest annual rainfall (3,287 mm) was recorded in 2009.

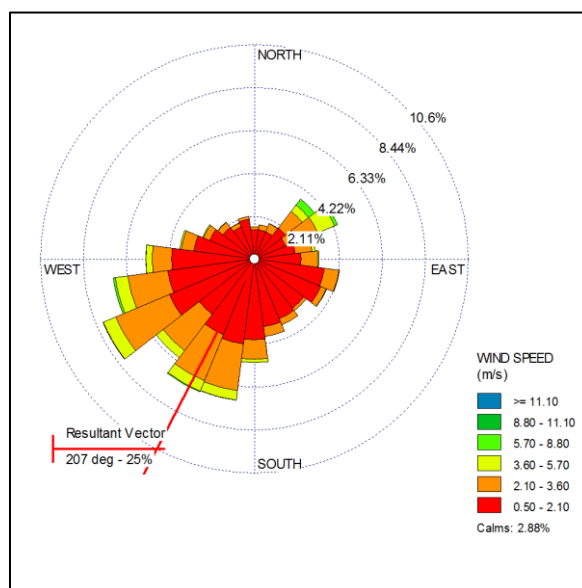


Source: Bangladesh Meteorological Department, Dhaka

Figure 4-6: Average Monthly Rainfall (1986-2016), Sylhet Weather Station

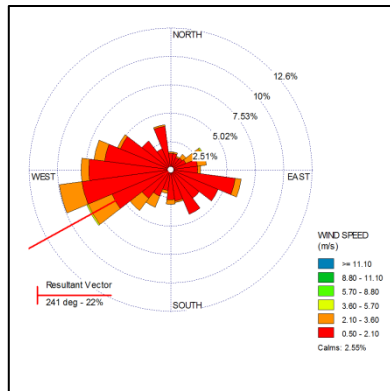
4.5.1.4 Wind Speed and Wind Direction

The wind direction in Sylhet meteorological station is generally from East to West direction. Maximum wind speed recorded in Sylhet is 17 knots in the East to West direction and average wind speed is 2.44 knots. Monthly wind roses based on the meteorological data collected from BMD for Sylhet observatory are presented in **Figure 4-8**. Annual and Seasonal wind roses are shown in **Figure 4-7** and **Figure 4-9**.

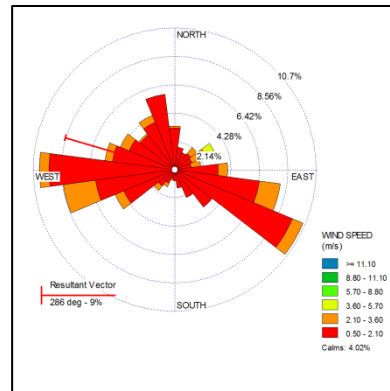


Source: Bangladesh Meteorological Department, Dhaka

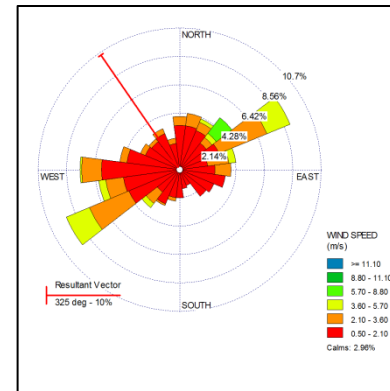
Figure 4-7: Annual Wind Rose Diagram, 2016



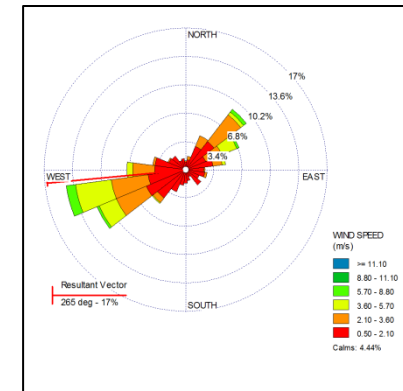
January



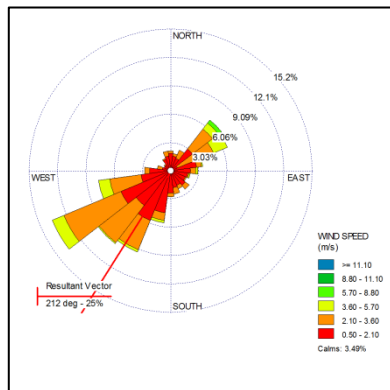
February



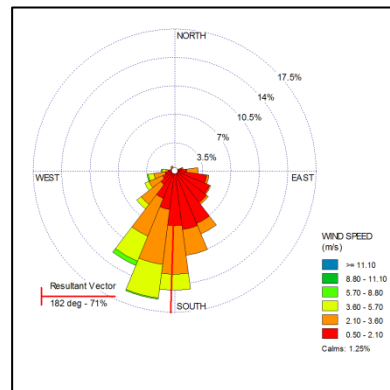
March



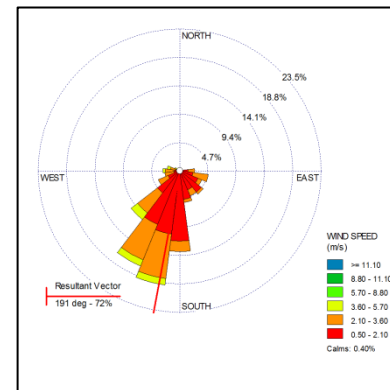
April



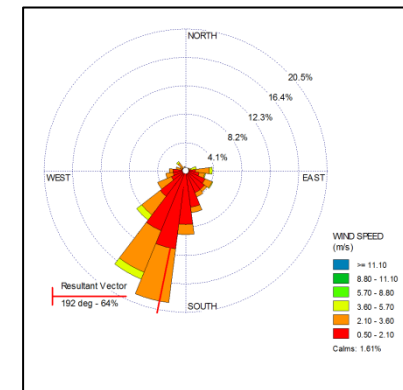
May



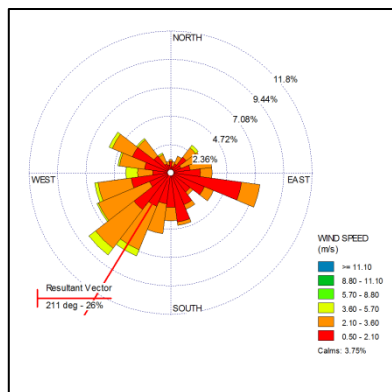
June



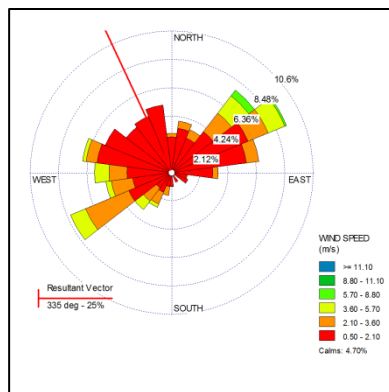
July



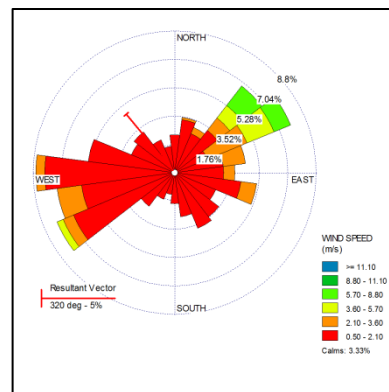
August



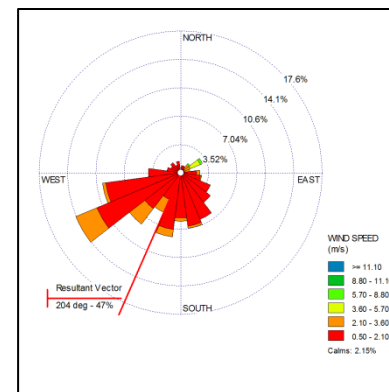
September



October



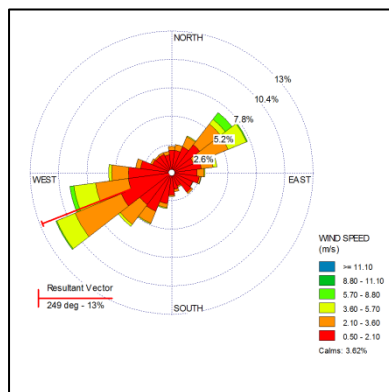
November



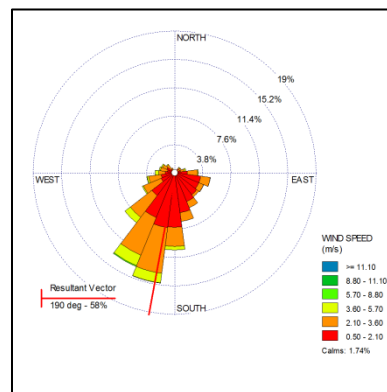
December

Source: Bangladesh Meteorological Department, Dhaka.

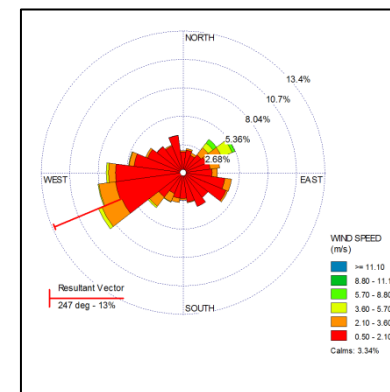
Figure 4-8: Monthly Wind Rose Diagram, 2016



Pre Monsoon



Monsoon



Post Monsoon

Source: Bangladesh Meteorological Department, Dhaka

Figure 4-9: Seasonal Wind Rose Diagram, 2016

4.6 Land Types

Project site is located in Maijgaon union of Fenchuganj upazila. Total area of the Maijgaon union is 1720.65 ha. The major land type of the Maijgaon union is Medium Low Land (39%) followed by Medium High Land (28%) and Low Land (20%). Union wise land type of the Fenchuganj upazila is shown in **Table 4-1**.

Table 4-1: Union wise land type of Fenchuganj Upazila

Union	Area (ha)	Land Type (%)
Fenchuganj	5382.59	HL-4, MHL-29, MLL-45, LL-17, VLL-5
Gila Chhara	4310.93	HL-13, MHL-24, MLL-37, LL-20, VLL-6
Maijgaon*	1720.65	HL-8, MHL-28, MLL-39, LL-20, VLL-5

Source: www.landzoning.gov.bd (accessed in August 2016)

Note: HL= High land, MHL= Medium high land, MLL= Medium low land and LL= Low land

*Project site located in this union

4.7 Land Use

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

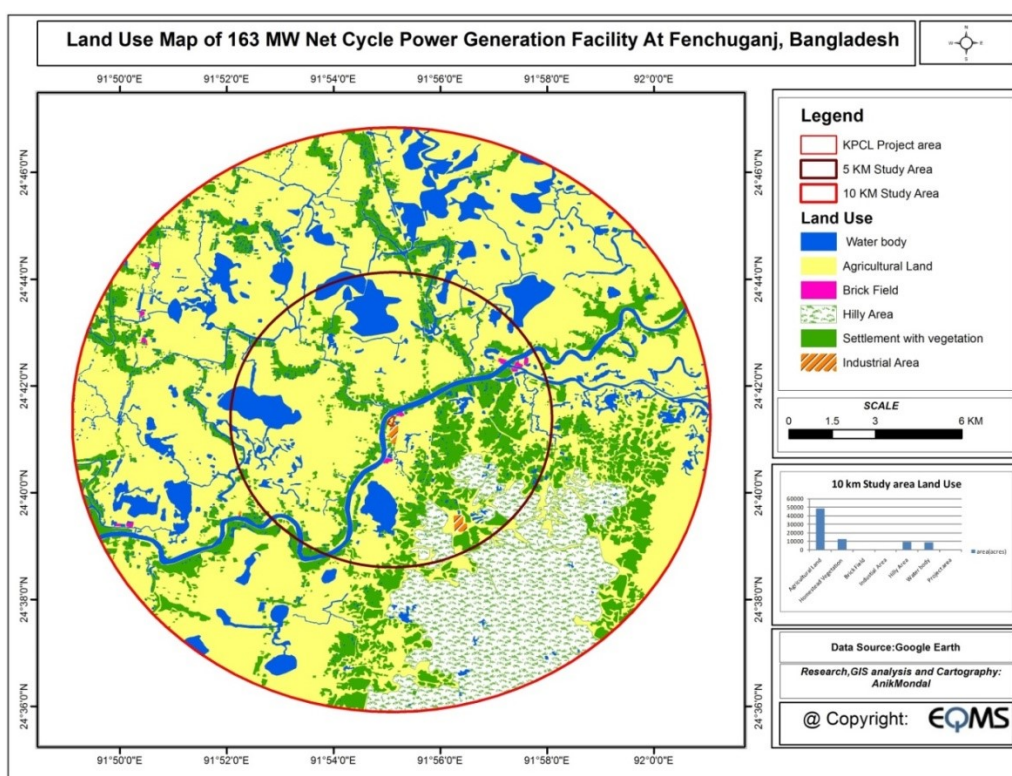
- To study the land use/cover in the 10 km radius areas of the proposed KPCL project site and provide inputs for environmental planning of the proposed plant by analyzing the existing land use/land cover scenario; and
- To establish the existing base line scenario using a GIS database for incorporation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

The evaluation of the existing environmental status of the study area was considered 0-10 km. This revealed that the land use/land cover consists mainly of agricultural land, settlement with homestead vegetation and water bodies. **Table 4-2** describes the existing land use composition around 10 km of the project study area. **Figure 4-10** shows the Land use/Land cover map shows the land use pattern within 10 km of the study area.

Table 4-2: Existing Land Use Composition Around 10 km of the Project Study Area

Criteria	5 Km		10 Km	
	Area (Acres)	Percentage (%)	Area (Acres)	Percentage (%)
Agricultural Land	12115	60.26	48777.9	61.74617
Homestead Vegetation	4116.99	20.486	12425.3	15.72874
Brick Field	47.3211	0.23	80.1371	0.101443
water body	83.9507	0.42	8382.8398	10.61153
Industry	1051.54	5.23	87.548302	0.110824
Hilly Area	2690.41	13.38	9238.4199	11.69458
Project area	5.30024	0.03	5.30024	0.006709
Total Area	20105.21	100	78997.4441	100

Source: Google earth image analysis



Source: Google earth

Figure 4-10: Land use/Land cover map shows the land use pattern within 5 Km &10 km of the study area

4.8 Agriculture Resources

4.8.1 Cropping Pattern and Intensity

Crop land areas are occupied with rice production in Fenchuganj Upazila. Other crops like mustard, wheat, sugarcane, vegetables etc. are also included in cropping pattern of this upazila. Land utilization and cropping pattern in Fenchuganj Upazila depend on effective/planned use of land resources, availability of irrigation facilities, use of technologies etc. Cropping intensity of this upazila is about 161%. Out of the total cultivable land in Fenchuganj Upazila single cropped area occupied (53%), double cropped (33%) and triple cropped (14%). Cropping pattern and intensity of the study area is provided in **Table 4-3**.

Table 4-3: Cropping Pattern and Intensity of Fenchuganj Upazila

Upzila	NCA (Ha)	Major Cropping pattern	Area	% of NCA	Intensity (%)
Fenchuganj	5,191	Boro - Fallow - Fallow	1557	30	161
		Fallow-Fallow-T.aman	1038	20	
		Boro-Fallow-T.ama	727	14	
		Fallow-T. aus-T. aman	675	13	
		Vegetable-Vegetable-T. aman	623	12	
		Boro-B. aman	260	5	
		Others	311	6	
		Total	5,191	100	

Source: www.landzoning.gov.bd (accessed in August 2016)

Note: NCA- Net Cultivable Area

4.8.2 Cropped Area

Multiplicity of cropping systems has been one of the main features of the upazila. Farmers are harnessing their life style by producing various crops round the year. At the same time, the pressure of population on land and other natural resources along with rapid urbanization are major factors for changing land-use patterns rapidly which have adverse effect upon upazila's agricultural land. These changes are again causing reduction of agricultural production and the loss of biodiversity. In addition, the availability of land per capita is decreasing and thereby people are becoming landless and marginalized. Overexploitation, mismanagement and changes in land use pattern are taking place at an unprecedented rate. However, there has been a positive change in adoption of modern technologies like high-yielding varieties of rice and other crops, irrigation and mechanized cultivation in this area. It is recognized that a change has taken place in production of different crops including fruit and vegetable in this region. A sizeable and optimum crop land should be earmarked with more reality in the land zoning initiative to be recognized as a best effort in a long run. Out of the total cultivable land in Fenchuganj Upazila, single cropped area covers 2,777 ha, double cropped area 1,700 ha and triple cropped area 715 ha (Table 4-4).

Table 4-4: Cropped Area and Cropping Intensity of Fenchuganj Upazila

Union	Single		Double		Triple		Cropping Intensity (%)
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	
Fenchuganj	1792	56	992	31	416	13	157
Gila Chhara	610	48	470	37	191	15	167
Maijgaon*	375	52	238	33	108	15	163
Total	2777	53	1700	33	715	14	161

Source: www.landzoning.gov.bd (accessed in August 2016)

Note: *Project site located in this union

4.8.3 Crop Production

According to district statistics (2011) of Bangladesh Bureau of Statistics (BBS) major crop in the Fenchuganj Upazila is Aman rice which occupied 4660 acres and production is 10535 metric ton followed by Boro rice which occupied 3840 acres with production is 13393 metric ton. The crop production in the Fenchuganj Upazila is given in the Table 4-5.

Table 4-5: Crop Production Status in Fenchuganj Upazila

Crop name	Area (acre)	Production (metric ton)
Aus	2550	6375
Aman	4660	10535
Boro	3840	13393
Wheat	0	0
Jute	0	0
Sugarcane	0	0
Potato	28	126
Sweet potato	27	37.8
Rape & mustard	63	6

Crop name	Area (acre)	Production (metric ton)
Ground nut	0	0
Til	0	0
Pepper	73	18
Onion	11	22
Garlic	3	3
Turmeric	5	7
Ginger	3.8	4.56
Tomato	28	84
Radish	97	339.5
Bean	27	9.18
Pumpkin	21.25	52
Parble (potol)	0	0
Cabbage	6.75	14.1
Brinjal	57	109
Lady's finger	11	34.5
Arum	4.2	5.25
Cauliflower	17.5	14.08
Cucumber	10.75	46.4
Papaya	0	14.55
Guava	5.3	218
Lime and lemon	9.85	104.7
Jackfruits	50	786
Banana	120	86.1
Pineapple	15	55.5
Mango	1	10
Litchi	2	10
Blackberry	0	0
Melon/melon (bangi)	31	110.6

Note: Area in acre and production in metric ton

Source: District Statistics 2011 (BBS)

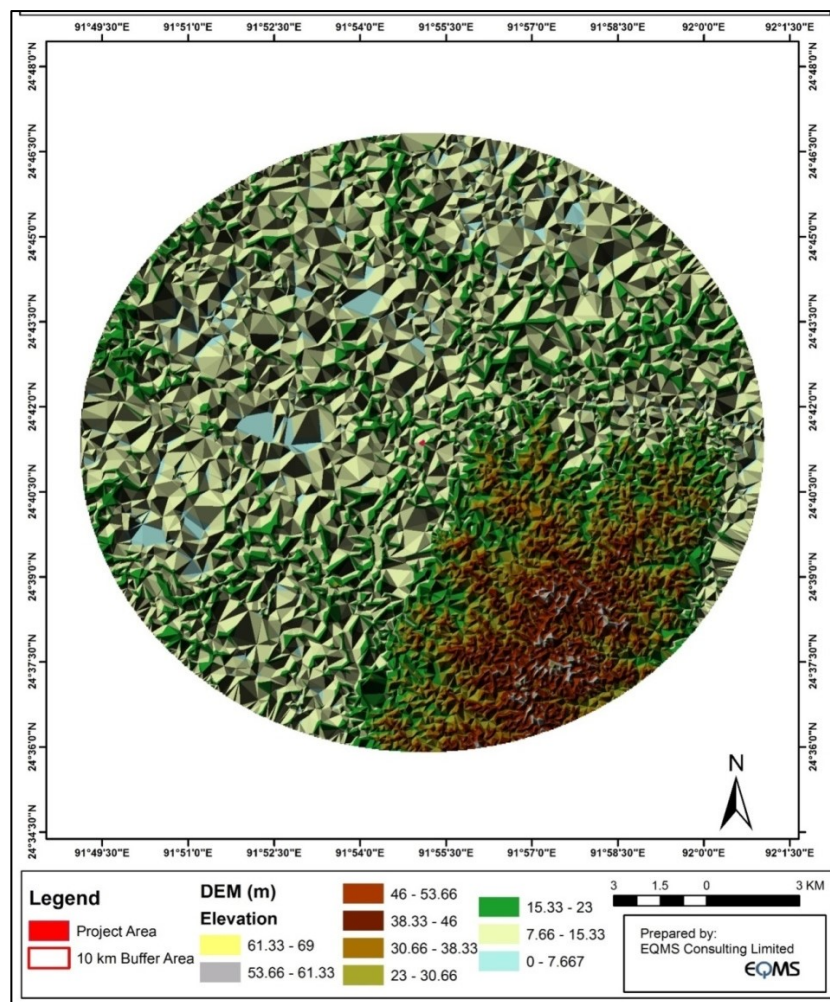
4.9 Topography

A digital elevation model (DEM) or 3-D representation of the terrain surface of 10km study radius is shown in **Figure 4-7**. The proposed power plant location, its 10-km buffer area as well as the other linear features are shown in the Relief maps with the height range.

Contour of the study area are generated from the Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) relief maps. Topo sheets were not available for the study area and therefore all the relevant information is extracted from the Shuttle Radar Topography Mission (SRTM) DEM only. All the processing was done in the ARC GIS 10.1 software.

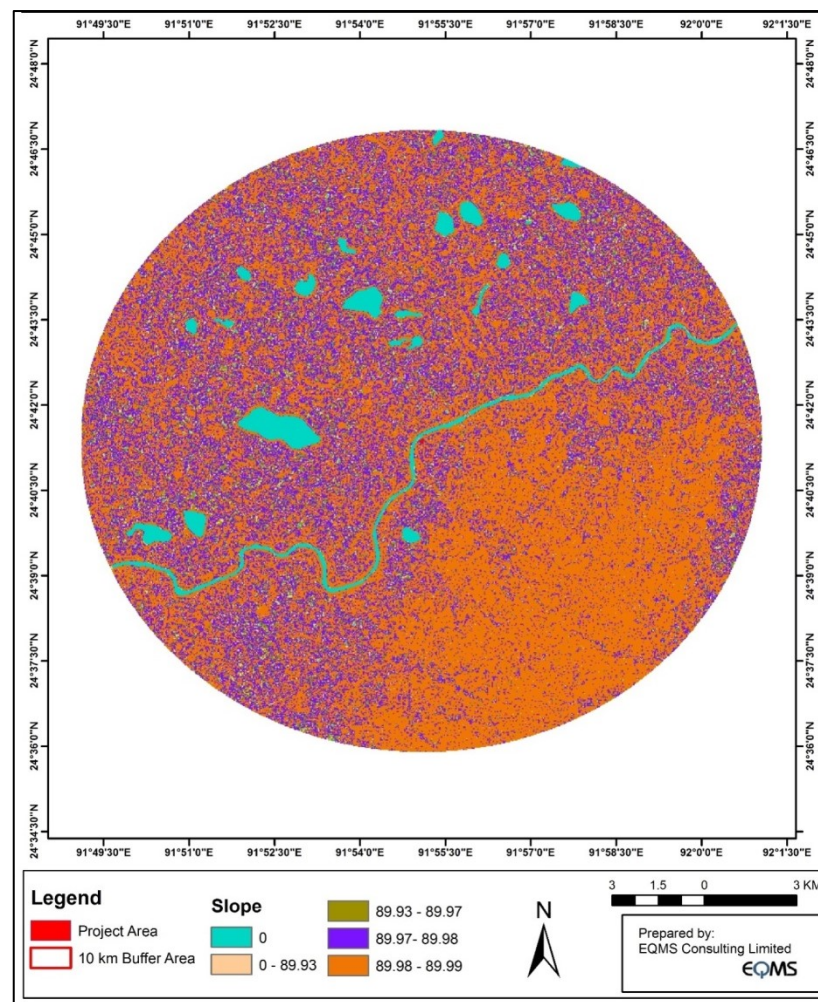
Contour map derived from DEM shows that the topography of the 10km study area is predominantly a high terrain with maximum elevation in the northern and southern part on the bank of project area. The highest elevation levels are 18.7m whereas lowest is 0-3.78m. The project area located relatively plain land region with 17m high (**Figure 4-11**).

A slope map of the 10-km study radius is represented in **Figure 4-12**. The area has considerable slope (89.97-89.99 degree predominantly). The slope of the project site is 0.89 degree.



Source: Shuttle Radar Topography Mission (SRTM)

Figure 4-11: Digital Elevation Model of the project area



Source: Shuttle Radar Topography Mission (SRTM)

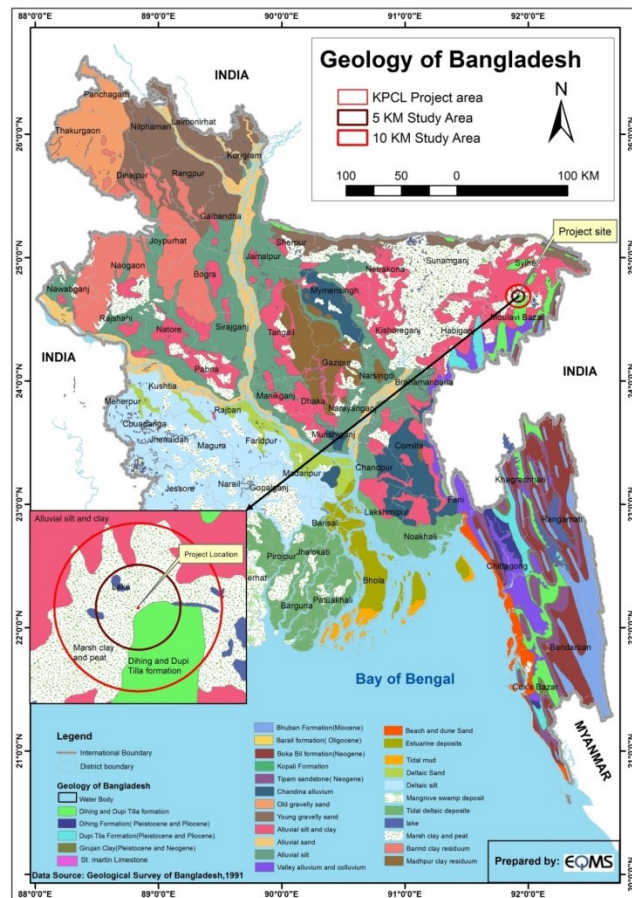
Figure 4-12: Slope Map of the 10 km Study Area

4.10 Geology

The geology profile of Bangladesh is reflective of country's location, as Bangladesh is riverine country. The geological evolution of Bangladesh is related to the uplift of to the Himalayan mountains and outbuilding of deltaic landmass by major River systems having their origin in the uplifted Himalayas. This geology is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments were deposited as a mega delta built out and progressed towards the south.

Geology of Study area

The study area falls under three geological zones. The project site is fall under the Marsh clay and peat geological zone. The geological map of Bangladesh indicating the project site is shown in **Figure 4-13**.



Source: Geological Survey of Bangladesh, 2001

Figure 4-13: Geological Map of Bangladesh

Marsh clay and peat—Grey or bluish-grey clay, black herbaceous peat, and yellowish-grey silt. Alternating beds of peat and peaty clay common in bus and large structurally controlled depressions; peat is thickest in deeper parts. Thin beds of peat and clay are interbedded with alluvial silt in the north- central Syihet depression. Chains of linear lakes north of the Ganges River and south of the Shillong Plateau the Syihet depression suggest these areas are subsiding.

4.11 Traffic

Moulvibazar-Rajnar-Fenchuganj-Sylhet Road is the main highway to go to site through a connecting 3 km long approach road. Construction materials and other facilities can be reached to the project site by road and by Kushiara River. The 3 km long approach road is already exist which was constructed by BPDB during their Power hub construction (Section 3.5). For major construction materials transportation, KPCL will use temporary jetty. (Location of jetty has been mention in Section 3.6. EQMS has done traffic survey for traffic impact in the beginning of approach road and jetty area. (

Figure 4-14)

4.11.1 Road Traffic

The road traffic survey was conducted for 24 hours, once during the study period at one location at the approach road to the proposed project. The traffic survey was conducted for both way movement of vehicles and categorization as Medium vehicle (tractor/ power tiller), light vehicle (private car, auto rickshaw, CNG, motor cycle) and non-motorized vehicle (rickshaw, cycle etc.).

Total no. of vehicles recorded in the road for 24 hours are 765 including 2 heavy vehicles, 26 medium vehicles, 419 light vehicles and 318 non-motorized vehicle. Maximum traffic volume of 99 vehicles in an hour was recorded between 1800 Hrs to 1900 Hrs. Frequency of the medium vehicle (4%), light vehicle (41.5%) and non-motorized vehicle (41.5%) respectively.

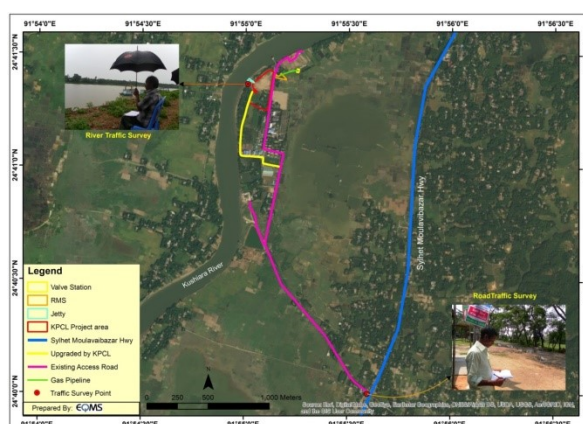
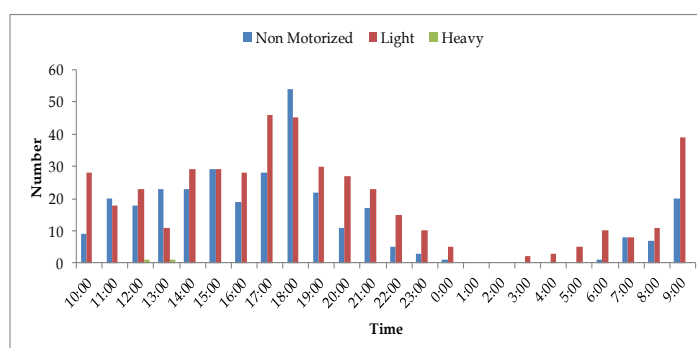


Figure 4-14: Location of Traffic Survey



Source: EQMS Study team, August 2016

Figure 4-15: Hourly Road Traffic Volume

A summary of traffic survey results is presented in Table 4-6 and hourly movements of vehicles are presented in Figure 4-15.

Table 4-6: Status of Road Traffic

Sl#	Vehicle type	Numbers/Time
1.	Total traffic volume (Nos)/24 hr	765
2.	Average traffic volume/hr	32
3.	Max Traffic volume (Nos)/hr	99
4.	Min traffic volume (Nos)/hr	0
5.	Minimum traffic flow hours	1800 Hrs to 1900 Hrs
6.	Maximum traffic flow hours	100 Hrs to 200 Hrs 200 Hrs to 300 Hrs

Source: EQMS Study team, August 2016

Movement of man, material and machinery to the site is expected during the construction and operation stages of the project. This is likely to result in an increase in traffic movement on the project surrounding area. It is understood that equipment can be transported to the project site by road after improvement of the Earthen existing road.

4.11.2 River Traffic

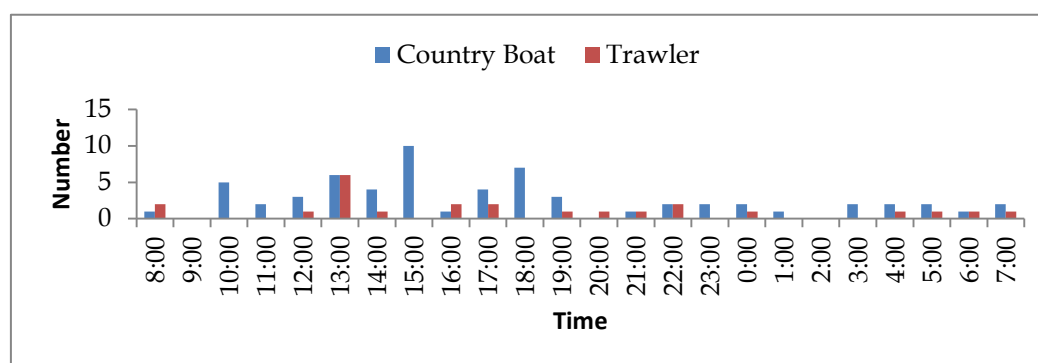
The river traffic survey was conducted continuously for 24 hours, once during the study period at the temporary jetty site in Kushiara River side. The river traffic survey was done for both way movement of vessels and categorized as fishing boat (motorized), trawler (goods carrying), passenger service boat (large), fishing boat (Non- motorized).

A total 87 number of vessels recorded in 24 hours, details status shows in **Table 4-7** and depicted in **Figure 4-16**.

Table 4-7: Status of River Traffic

Sl#	Vehicle type	Near to the Jetty Area
1.	Total Vessel count (Nos)/24 hr	87
2.	Average Vessel count /hr	3.625
3.	Max Vessel count (Nos)/hr	12
4.	Min Vessel count (Nos)/hr	0
5.	Max Vessel Movement Hours	1300 Hrs -1400 Hrs
6.	Min Vessel Movement Hours	900 Hrs -1000 Hrs 1400 Hrs -1500 Hrs

Source: EQMS Study team, August 2016



Source: EQMS Study team, August 2016

Figure 4-16: Hourly movement of River Traffic at jetty site of Kushiara river

4.12 Natural Hazards

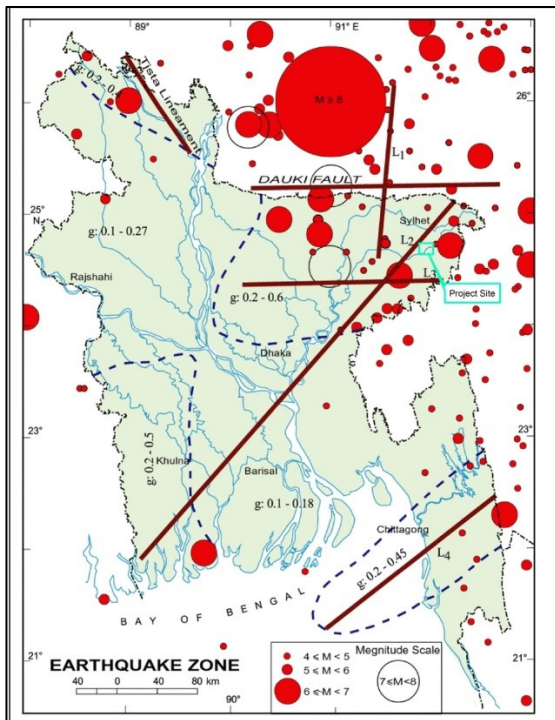
4.12.1 Seismicity

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

The study area is located over the Indian plate, in the vicinity of the Sylhet fault (depicted as L2 in **Figure 4-17**). The typical maximum magnitude of earthquakes experienced around this fault line is between five and six on the Richter scale.

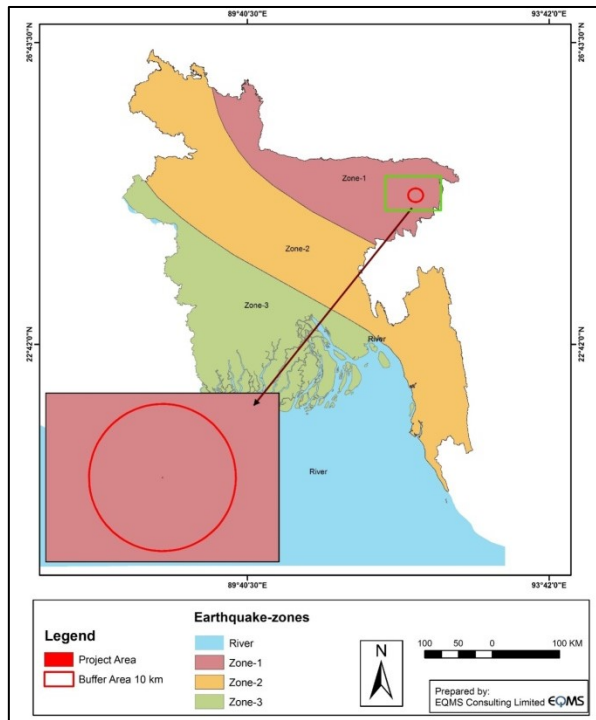
Bangladesh can be divided into three Seismic Zones, as described by the ranges of the seismic coefficient. Zone I is the most severe area for earthquake intensity and frequency and Zone III is the least severe (GSB, 1979). The study area falls within Zone I, which is comprised of the northern and eastern regions of Bangladesh, and is the most seismically

active region in the country. The location of the Project, relative to the seismic zones is provided in **Figure 4-18**.



Source: Banglapedia, 2009

Figure 4-17: Fault Lines within Bangladesh



Source: BNBC, 2006

Figure 4-18: Seismic Zones within Bangladesh

4.12.2 Cyclone and Storm Surges

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. The project area is not prone to cyclones. These cyclones occur in two seasons, April-May and October-November – i.e. before and after the monsoon.

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

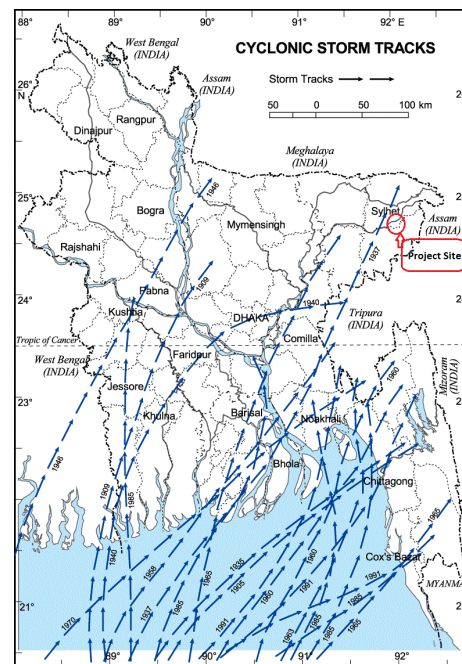
- Depression (winds up to 62 km/hr);
- Cyclonic storm (winds from 63 to 87 km/hr);
- Severe cyclonic storm (winds from 88 to 118 km/hr); and
- Very severe cyclonic storm of hurricane intensity (winds above 118 km/hr).

Key cyclonic storm tracks and cyclone affected area in Bangladesh have been shown in Figure 4-19 and Figure 4-20.

4.12.3 Floods

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

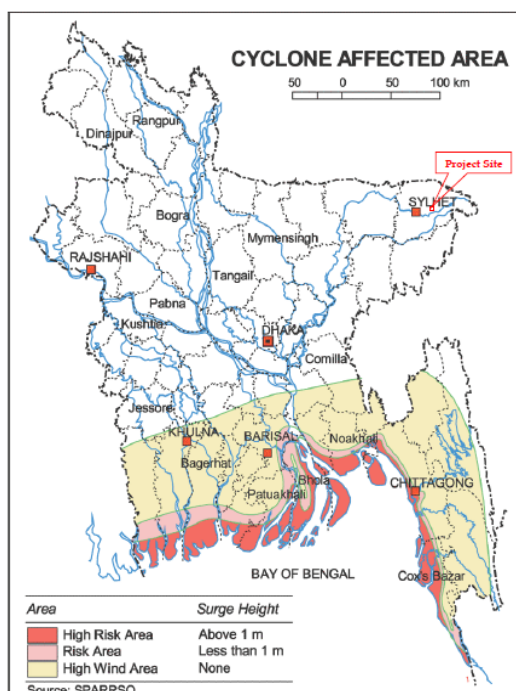
Floods of Bangladesh can be divided into three categories: (i) monsoon flood - seasonal, increases slowly and decreases slowly, inundate vast areas and causes huge loss to the life and property; (ii) flash flood-from sudden torrential flows, following a brief intense rainstorm or the bursting of a natural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



Source: <http://www.islandnet.com/~see/weather/events/sigcyclonebangladesh.htm>

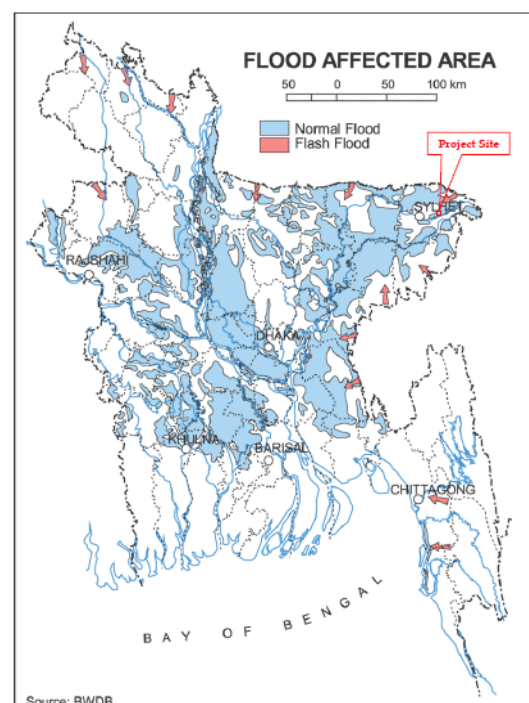
Figure 4-19: Cyclonic Storm Tracks in Bangladesh

Figure 4-21 shows the flood affected areas of Bangladesh. Both the Normal and flash floods occur in the Sylhet region.



Source: Banglapedia, 2009

Figure 4-20: Cyclone Affected Areas of Bangladesh



Source: Banglapedia, 2009

Figure 4-21: Flood Prone Areas of Bangladesh

4.13 Air Quality

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study area. The site is situated in the Fenchuganj Upazila and around the industrial area. The air quality monitoring locations were selected based on the locations of settlements and receptors within the study area. Logistical factors such as consent of villagers, mainly the house owners, power connection, accessibility, security, etc. were also taken into account in finalizing the monitoring stations.

4.13.1 Sources of Emission

The study area is industrial area and having major industrial set up comprising of power plants etc. In this stage, assessment was made to identify the existing and potential emission sources. The air pollution sources in and around the study area are mainly road dust, power plant emission, industrial emission, engine vehicles, windblown dust from agricultural lands and exposed earth, and domestic cooking.

4.13.2 Methodology of Air Quality Monitoring

The existing ambient air quality of the study area was monitored at four (4) locations during the monitoring period (August -September 2016). The monitoring parameters included Particulate Matter (SPM, PM₁₀ and PM_{2.5}), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), and Carbon Monoxide (CO). All the parameters except SPM and CO were monitored on 24-hourly basis during the duration of the study. SPM and CO were monitored as eight hourly averages.

4.13.3 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 were based on the following aspects covered in field survey plan developed prior to the field work:

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

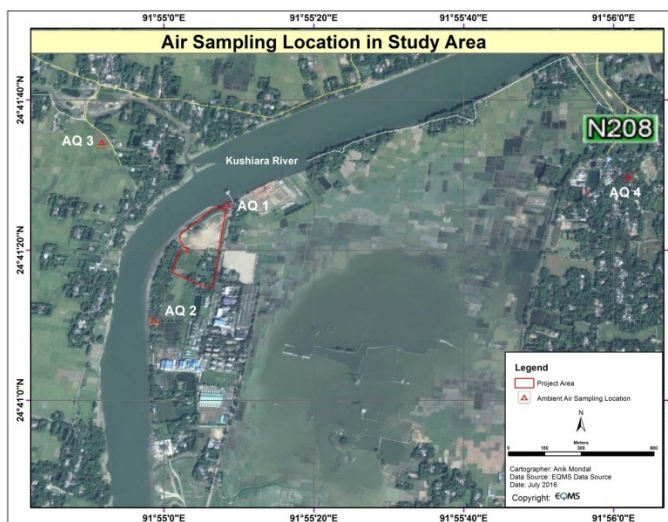


Figure 4-22: Air Quality Sampling Location

The particulate and gaseous samples collected during the monitoring have been analyzed as per the procedures specified in Table 4-8. Total four air quality samples were collected during the study period. The geographical locations and setting of the ambient air quality monitoring locations has been presented in Table 4-9 and depicted in Figure 4-22.

Table 4-8: Methodology for Analysis of Ambient Air Quality

Sl.	Parameter	Analysis procedure
1.	SPM	Gravimetric method
2.	PM10	Gravimetric method
3.	PM2.5	Gravimetric method
4.	SO ₂	Colorimetric method at 560nm using spectrophotometer (West-Gaeke method)
5.	NO _x	Colorimetric method at 540 nm using spectrophotometer (Jacob and Hochheiser method)
6.	CO	Digital CO meter

Table 4-9: Ambient Air Quality Sampling Locations

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting	Distance from Project Boundary
1.	Adjacent to the project site (North Side of the Project)	AQ1	24°41'26.10"N 91°55'8.40"E	Represent pollution Source	Project site
2.	In front of Adarsha Gram Primary School	AQ2	24°41'9.70"N 91°54'58.71"E	South west side of the project; closest residential receptor's area	250 meter
3.	In front of Abdul's House	AQ3	24°41'34.39"N 91°54'51.72"E	West side of the project; closest residential area receptor's area	500 meter
4.	In front of Abdus samad house	AQ4	24°41'29.8"N 91°56'2"E	East side of the project; closest residential area receptor's area	1500 meter

4.13.4 Ambient Air Quality in the Study Area

The monitored ambient air quality is summarized in Table 4-10.

Table 4-10: Ambient Air Quality in the Study Area

Location	Observed	Concentration in (µg/m ³)					
		SPM	PM10	PM _{2.5}	SO ₂	NO _x	CO
AQ1	Maximum	147.92	128.7	27.89	16.01	43.82	2350
	Minimum	142.38	112.7	22.51	12.45	32.75	2150
	Average	144.74	117.27	24.98	13.66	36.56	2271.67
AQ2	Maximum	147.64	119.52	26.94	13.87	42.34	2200
	Minimum	138.16	112.46	20.03	10.58	30.96	2040
	Average	142.52	116.33	22.72	11.98	37.33	2150.00
AQ3	Maximum	140.36	113.44	21.18	10.2	35.82	1850
	Minimum	114.36	99.74	12.93	9.02	29.33	1730
	Average	129.23	107.52	17.71	9.64	31.63	1783.33
AQ4	Maximum	106.47	92.47	13.54	9.02	18.71	1230
	Minimum	99.32	85.65	10.26	7.12	10.14	1090
	Average	103.44	87.72	11.77	8.37	14.28	1168.33
Standards							
Bangladesh**	8 hourly	200	-	-	-	-	10000
	24 hourly	-	150	65	365	-	-
	Annual	-	50	15	80	100	-
WHO***	24 hourly	-	50	25	20	-	10000
	Annual	-	20	10	-	40	-

^a CO concentrations and standards are 8-hourly only.

^b 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.

^c Averaging period 8 hour

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

4.13.5 Analysis and Discussion of Result

SPM

The 8-hourly average SPM concentration in ambient air in the study area was recorded in the range of 99.32 – 147.92 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum SPM concentration was reported from AQ1 as 147.92 $\mu\text{g}/\text{m}^3$. SPM concentrations at this location are primarily due to existing traffic and power plant emission. SPM level at all locations were reported below the National Ambient Air Quality Standards of Bangladesh (NAAQS).

PM₁₀

The 24-hourly average PM₁₀ concentration in ambient air in the study area was recorded in the range of 85.65-128.7 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum PM₁₀ concentration was reported from near the project site point (AQ1) as 128.7 $\mu\text{g}/\text{m}^3$. PM₁₀ concentrations at this location are primarily due to traffic movement and existing power plant emission. PM₁₀ level at all locations were reported below the National Ambient Air Quality Standards of Bangladesh (NAAQS).

PM_{2.5}

The 24-hourly average PM_{2.5} concentration in ambient air in the study area was recorded in the range of 10.26 – 27.89 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum PM_{2.5} concentration was reported at AQ1 as 27.89 $\mu\text{g}/\text{m}^3$. PM_{2.5} levels at all the locations were reported well within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh (65 $\mu\text{g}/\text{m}^3$).

SO₂

The 24-hourly average SO₂ concentration in ambient air in the study area was recorded in the range of 7.12– 16.01 $\mu\text{g}/\text{m}^3$. The maximum SO₂ was recorded at AQ1. SO₂ concentration at all the locations were well below 365 $\mu\text{g}/\text{m}^3$, which is the 24-hourly National Ambient Air Quality Standard (NAAQS) for SO₂ in Bangladesh.

NO_x

The 24-hourly average NO_x concentration was recorded in the range of 10.14 – 43.82 $\mu\text{g}/\text{m}^3$. Average concentrations of NO_x were reported low at AQ3 & AQ4 due to their rural setting, whereas at AQ1 & AQ2, the levels are slightly higher due to the traffic movement and industrial settings. The annual Bangladesh standard guideline value for NO_x is 100 $\mu\text{g}/\text{m}^3$ and present 24 hourly average concentrations at all the locations are well below these values.

CO

CO concentrations are reportedly low at all the monitoring locations while comparing with the Bangladesh Standards (10000 $\mu\text{g}/\text{m}^3$).

4.14 Ambient Noise Levels

Noise levels were recorded at seven locations in the study area during the monitoring period of August 2016. The noise level was monitored during the plant construction. Noise levels were recorded in the form of sound pressure levels using Center 322-data logger sound level meter. The details of noise monitoring locations are given in Table 4-11 and depicted in Figure 4-23.

Noise levels were also recorded at five locations in the study area during May 2018 during the plant operation period. The details of noise monitoring locations are given in Table 4-12 and Figure 4-24.

The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations are chosen in such a way that representative data could be recorded all over the block.

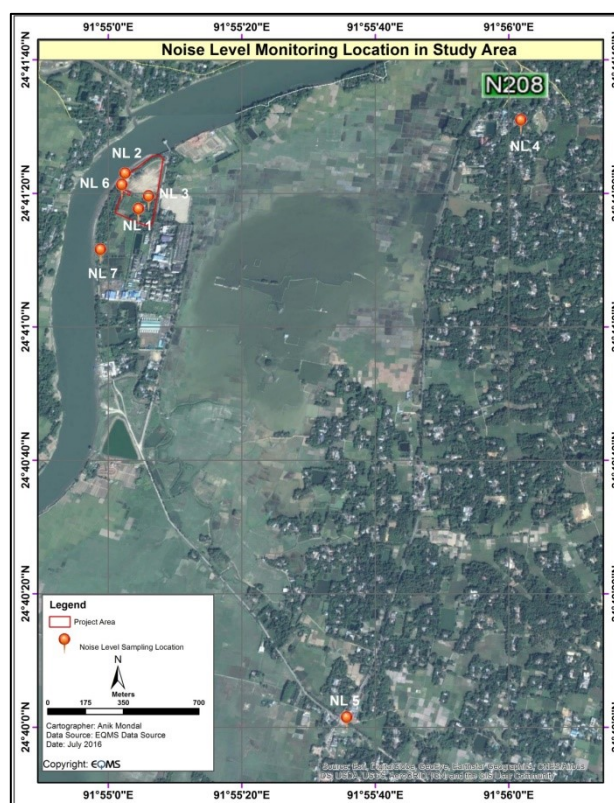


Figure 4-23: Noise Level Monitoring Locations (August 2016)

The sound level is recorded in form of A-weighted equivalent continuous sound pressure level (Leq) values with the use of A-weighting filters in the noise-measuring instrument.

Table 4-11: Details of Ambient Noise Monitoring Locations Carried out during August 2016

Code	Location	Geographic location	Location setting
NL1	Project site	24°41'17.1"N, 91°55'4.5"E	Industrial
NL 2	Kushiara River Side	24°41'22.4"N, 91°55'2.5"E	Mixed
NL 3	Project Site	24°41'19"N, 91°55'6"E	Industrial
NL 4	Infront of Abdus Samad house, Moynulpur	24°41'30.4"N, 91°56'1.8"E	Residential
NL 5	Palbari point	24°40'0.9"N, 91°55'35.7"E	Commercial
NL 6	In front of project mosque	24°41'20.42"N, 91°55'2.05"E	Mixed
NL 7	In front of Moynu bibi house, Moynulpur	24°41'11"N, 91°54'58.8"E	Residential

Noise level monitoring was carried out for 24 hours during monitoring period with 1-min equivalent sound pressure levels. At all the locations, measurement was taken at 1-min intervals over a 24 hour period. The equivalent noise levels have been converted to hourly equivalent noise levels. Finally, the measurements were carried out by dividing the 24 hours into two parts, i.e. daytime, which is considered from 0600 to 2100 hours and night from 2100 to 0600 hours. At each location, day time Leq has been computed from the hourly sound pressure level values measured between 0600 to 2100 hours and night time Leq has

been computed from the hourly sound pressure level values measured between 2100 to 0600 hours.

Table 4-12: Details of Ambient Noise Monitoring Locations Carried out during May 2018

Code	Location	Geographic location	Location setting
NL1	North-East Corner of the Project Boundary	24°41'25.3"N 91°55'07.7"E	Industrial
NL 2	South Side of the Project Boundary	24°41'16.0"N 91°55'03.9"E	Industrial
NL 3	South-West Corner of the Project Boundary	24°41'17.2"N 91°55'01.0"E	Industrial
NL 4	In front of Mosque	24°41'20.8"N 91°55'01.6"E	Mixed
NL 5	In front of Moynu bibi house, Moynulpur	24°41'11.0"N 91°54'58.6"E	Residential

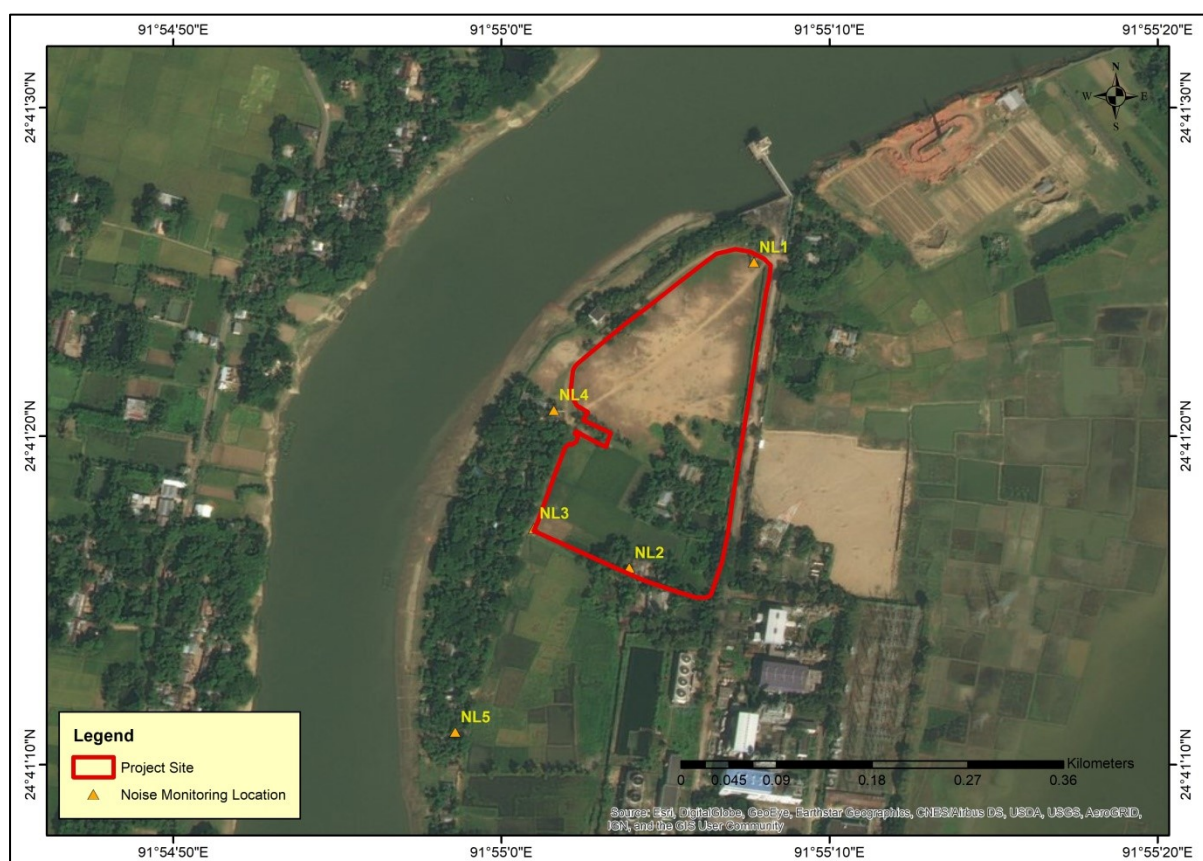


Figure 4-24: Noise Level Monitoring Locations (May 2018)

The recorded noise levels in the Project AOI during August 2016 are summarized in Table 4-13. The equivalent sound pressure level (Leq) during day and night time measured during the monitoring period is presented in Figure 4-25.

Table 4-13: Noise Level in the Study Area, August 2016

Location Code	Average Noise level (dB(A))				Location Setting	Applicable Standard* (dB(A))		World Bank Standard** (dB(A))	
	Leq _{day}	Leq _{night}	L _{max}	L _{min}		Day	Night	Day	Night
NL1	64.77	59.62	71.1	58.8	Industrial	75	70	70	70
NL2	61.31	57.5	70.5	55.30	Industrial	75	70	70	70
NL3	63.42	58.94	68.17	55.32	Industrial	75	70	70	70

Location Code	Average Noise level (dB(A))				Location Setting	Applicable Standard* (dB(A))		World Bank Standard** (dB(A))	
	Leq _{day}	Leq _{night}	L _{max}	L _{min}		Day	Night	Day	Night
NL4	50.23	43.3	66.9	38.46	Residential	55	45	55	45
NL5	61.17	53.6	75.4	58.49	Commercial	70	60	-	-
NL6	62.71	57.82	65.3	60.44	Mixed	60	50	-	-
NL7	63.11	60.45	68.8	58.32	Residential	55	45	55	45

Exceeding Standard

Source: Field Survey by EQMS (August, 2016)

Note: The time from 0600 hrs to 2100 hrs is counted as daytime and from 2100 hrs to 0600 hrs is counted as night time.

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

**Environmental, Health, and Safety (EHS) Guidelines: General EHS Guidelines: Environmental

Ambient daytime noise level (**Leq_{day}**) was recorded in the range of 50.23 to 64.77 dB (A). Whereas, ambient night time noise level (**Leq_{night}**) in the study area varied in the ranged of 43.3 to 60.45 dB (A). Maximum noise levels (**L_{max}**) at the monitoring locations were recorded in the range of 65.3 to 75.4 dB(A) and the minimum noise levels (**Leq_{min}**) at the monitoring locations were recorded in the range of 38.46 to 60.44 dB(A).

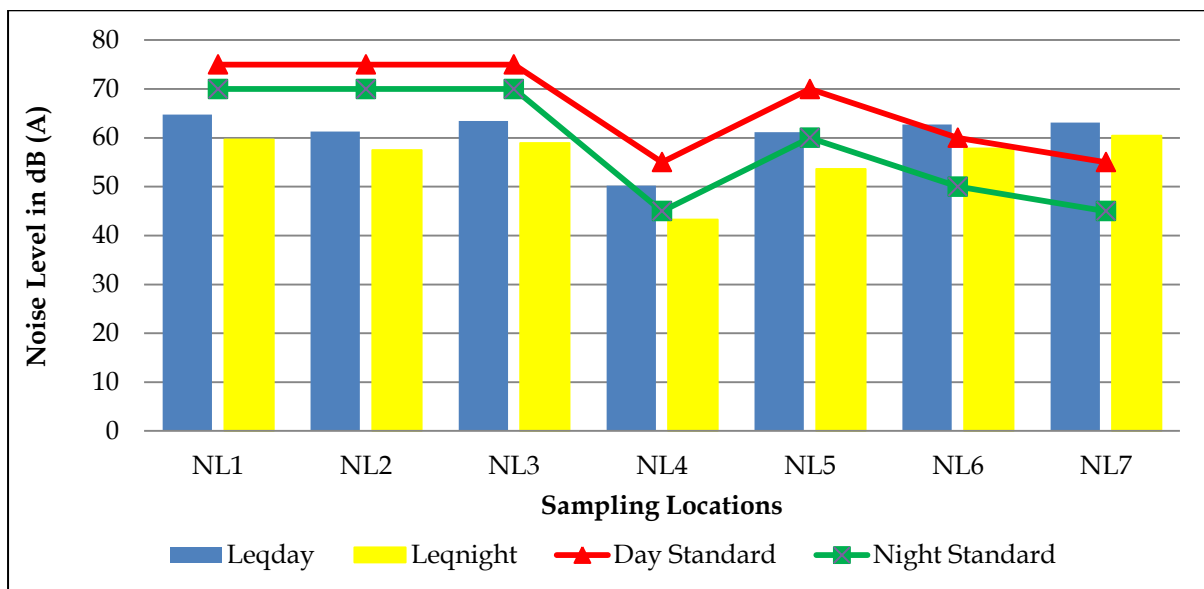


Figure 4-25: Noise Levels Recorded in the Study Area, August 2016

The recorded noise levels in the Project AOI during Feb 2015 are summarized in Table 4-14. The equivalent sound pressure level (Leq) during day and night time measured during the monitoring period is presented in Figure 4-26.

Table 4-14: Noise Level in the Study Area during May 2018 to June 2018

Location Code	Average Noise level (dB(A))				Location Setting	Applicable Standard* (dB(A))		World Bank Standard** (dB(A))	
	Leq _{day}	Leq _{night}	L _{max}	L _{min}		Day	Night	Day	Night
NL1	73.18	65.24	85	52	Industrial	75	70	70	70

Location Code	Average Noise level (dB(A))				Location Setting	Applicable Standard* (dB(A))		World Bank Standard** (dB(A))	
	Leq _{day}	Leq _{night}	L _{max}	L _{min}		Day	Night	Day	Night
NL2	60.10	61.94	75.9	52.5	Industrial	75	70	70	70
NL3	61.86	61.25	75.9	52.5	Industrial	75	70	70	70
NL4	64.72	65.71	86.5	48.2	Mixed	60	50	-	-
NL5	71.89	62.10	94.6	52.5	Residential	55	45	55	45

Exceeding Standard

Source: Field Survey by EQMS (May-June, 2018)

Note: The time from 0600 hrs to 2100 hrs is counted as daytime and from 2100 hrs to 0600 hrs is counted as night time.

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

**Environmental, Health, and Safety (EHS) Guidelines: General EHS Guidelines: Environmental

Ambient daytime noise level (**Leq_{day}**) during May to June 2018 was recorded in the range of 60.1 to 73.18 dB (A). Whereas, ambient night time noise level (**Leq_{night}**) in the study area varied in the ranged of 61.25 to 65.71 dB (A). Maximum noise levels (**L_{max}**) at the monitoring locations were recorded in the range of 75.9 to 94.6 dB(A) and the minimum noise levels (**Leq_{min}**) at the monitoring locations were recorded in the range of 48.2 to 52.5 dB(A).

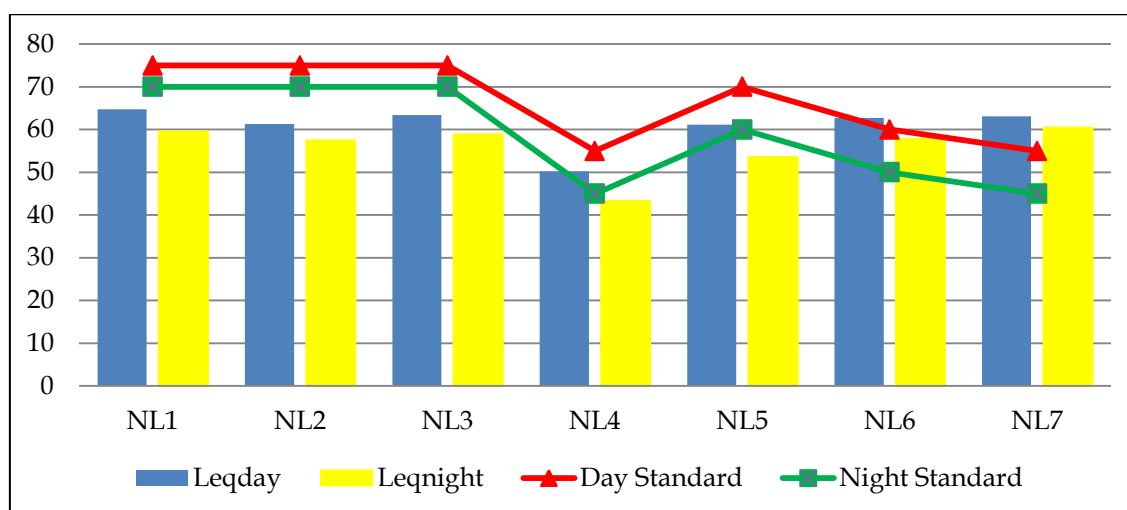


Figure 4-26: Noise Levels Recorded in the Study Area during May 2018-June 2018

Conclusion

The project area falls into industrial area zone according to Bangladesh Environmental Quality Standard ECR'97 categorization. The background noise level during August 2016 at the project area is below under the national standard value. Table 4-14 summarizes the measured ambient noise levels at each monitoring location. Average noise level at day and night time in some locations (NL2, NL4, NL5, NL6, and NL7) were slightly higher than national noise level standard due to construction work and running of other power plant near the monitoring locations whereas rest of the locations were well within the standard limit of ECR'97 (subsequent amendment in 2006).

From the above it can be concluded that ambient noise levels in the rural and village setting of the Project AOI between May 2018- June 2018 were within the prescribed limits for

Industrial landuse, which is 75dB(A) for day time and 70 dB(A) for night time at most of the locations for both Bangladesh and IFC standards. At that point of time, only NL-4 (In front of Mosque) and NL-5 (In front of Moynu bibi house, Moynulpur) a mixed and residential landuse location was found to exceed the both day and night time limit because of power plant operation. The noise level of both NL4 and NL5 were also exceed the standard during the August 2016. Present (May 2018-June 2018) noise level of these locations are increased than the previous noise level due to the operation of the 163 MW combined cycle power plant. Incremental noise level of the both locations is presented in the Table 4-15.

Table 4-15: Incremental Noise Level between August 2016 and May 2018

Location	Noise Level (August 2016)		Noise Level (May-June 2018)		Incremental Noise Level dB (A)	
	Leq _{day}	Leq _{night}	Leq _{day}	Leq _{night}	Day	Night
In front of Mosque	62.71	57.82	64.72	65.71	2.01	7.89
In front of Moynu bibi house, Moynulpur	63.11	60.45	71.89	62.1	8.78	1.65

4.15 Water Quality

Ambient surface water quality is represented by some selected parameters, which are crucial for drinking purpose, industrial use and to maintain optimum aquatic environment.

4.15.1 Surface Water Quality

The river water quality of the Kushiara River is subject to pollution from untreated industrial effluents and municipal wastewater, runoff from chemical fertilizers and pesticides used in crop fields, and oil and lube spillage of different industries. Surface water quality sampling location has been shown in Table 4-16 and Figure 4-27.

Table 4-16: Details of Surface water sampling Locations

Sl.	Code	Location	Geographic location
1.	SW1	Kushiara River (Upstream)	24°41'56.54"N, 91°56'7.77"E
2.	SW2	Kushiara River (Near Project Site)	24°41'24.87"N, 91°54'59.12"E
3.	SW3	Kushiara River (towards downstream)	24°40'46.25"N, 91°54'57.16"E
4.	SW4	Kushiara River (Downstream)	24°40'30.23"N, 91°54'47.32"E

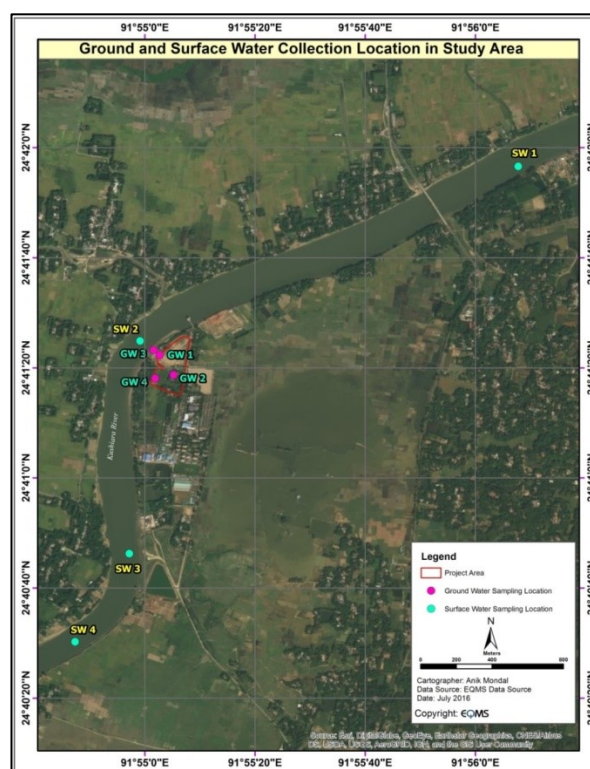


Figure 4-27: Ground water and Surface water quality sampling Location

According to the water quality investigation data of the Kushiara River provided by EQMS laboratory the physico-chemical variables, namely temperature, total dissolve solids, electrical conductivity, pH, dissolve oxygen, were within the standard value of ECR'1997 (Table 4-17).

Table 4-17: Surface Water Quality at Kushiara river

Characteristics	Unit	Sampling Location				Bangladesh Standard*					
		SW1	SW2	SW3	SW4	Source of drinking water for supply only after disinfecting	Water useable for recreational activity	Source of drinking water for supply after conventional treatment	Water useable by fisheries	Water useable by various process and cooling industries	Water useable for irrigation
pH	-	7.2	7.3	7.2	6.9	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
EC	µmhos/cm	88	92	90	87						
DO	mg/l	8.1	7.8	8.4	7.9	6 or above	5 or more	6 or more	5 or more	5 or more	5 or more
Temperature	°C	32.3	31.5	31	32.1	-	-	-	-	-	-
TDS	mg/l	69	66	68	74	-	-	-	-	-	-
Salinity	ppt	0	0	0	0	-	-	-	-	-	-
Nitrate	mg/l	0.61	0.73	0.66	0.71	-	-	-	-	-	-
Nitrite	mg/l	<0.05	0.1	<0.05	<0.05	-	-	-	-	-	-
BOD 5	mg/l	4.2	4.9	4.6	4.7	2 or less	3 or less	6 or less	6 or less	10 or less	10 or less
COD	mg/l	25.7	28.4	24.5	26.8	-	-	-	-	-	-
Salinity	(ppt)	0	0	0	0	-	-	-	-	-	-
Manganese	mg/l	BDL	BDL	BDL	BDL	-	-	-	-	-	-
Phosphate	mg/l	0.66	0.71	0.64	0.58	-	-	-	-	-	-
Iron	mg/l	0.44	0.47	0.53	0.39	-	-	-	-	-	-
Turbidity	(NTU)	253	218	205	260	-	-	-	-	-	-
Oil and Grease	mg/l	BDL	BDL	BDL	BDL	-	-	-	-	-	-
Lead	mg/l	BDL	BDL	BDL	BDL	-	-	-	-	-	-
Mercury	mg/l	BDL	BDL	BDL	BDL	-	-	-	-	-	-
Chromium	mg/l	BDL	BDL	BDL	BDL	-	-	-	-	-	-
Fecal Coliform	n/100 ml	360	580	460	300	-	-	-	-	-	-
Total Coliform	n/100 ml	1500	1800	1700	1600	50 or less	200 or less	5000 or less	-	5000 or less	1000 or less

Source: EQMS Survey (August 2016)

Environmental Conservation Rules 1997; SCHEDULE – 3; Standards for Water; (A) Standards for inland surface Water

4.15.2 Ground Water Quality

The results of four groundwater samples collected from the two tube well and three drinking water supplies in and around project site are shown in Table 4-18 and depicted in Figure 4-27.

In August 2016, Groundwater samples were collected by EQMS from shallow tube wells in the project area. The result of the groundwater field samples and the GoB standards for potable water (ECR, 1997) are shown in Table 4-19. The concentration levels of pH, As, Fe, Chloride for tube well were found within the acceptable limit set by the DOE, GoB for drinking water. According to the overall water quality data, practically moderate quality and quantity of ground water is available in and around the project site.

Table 4-18: Details of Ground water sampling Locations

Sl.	Code	Location	Geographic location
1.	GW1	Deep tubewell supply inside the project area	24°41'22.3"N, 91°55'2.7"E
2.	GW2	Tubewell beside the project site	24°41'18.7"N, 91°55'5.2"E
3.	GW3	Deep tubewell supply inside the project area	24°41'23.2"N, 91°55'1.6"E
4.	GW4	Tubewell from residential area	24°41'17.8"N, 91°55'1.9"E

Table 4-19: Ground Water Quality Analysis Result

Sl.	Parameters	Unit	Sampling code				Bangladesh Standard
			GW1	GW2	GW3	GW4	
1.	pH	-	6.8	7.0	7.1	7.0	6.5-8.5
2.	Temperature	°C	27	28.6	26.3	27.2	20-30 °C
3.	Salinity	ppt	Nil	Nil	Nil	Nil	-
4.	Arsenic (As)	mg/l	<0.05	<0.05	<0.05	<0.05	0.05 mg/l
5.	Chloride (Cl ⁻)	mg/l	163.68	145.37	151.72	141.7	150-600 mg/l
6.	Iron (Fe)	mg/l	0.55	0.48	0.33	0.74	0.3-1.0 mg/l
7.	Total Dissolved Solids	mg/l	80	70	70	80	1000 mg/l
8.	EC	µmhos/cm	120	127	132	122	-
9.	DO	mg/l	6.1	5.9	6.0	6.5	5 or more
10.	Nitrate	mg/l	0.6	0.4	0.3	0.5	10
11.	Nitrite	mg/l	BDL	BDL	BDL	BDL	<1
12.	Lead	mg/l	BDL	BDL	BDL	BDL	0.05
13.	Mercury	mg/l	BDL	BDL	BDL	BDL	0.001
14.	Chromium	mg/l	BDL	BDL	BDL	BDL	0.05
15.	Cadmium	mg/l	BDL	BDL	BDL	BDL	0.005
16.	Total Hardness (as CaCO ₃)	mg/l	214	306	316	268	200-500
17.	Fecal Coliform	n/100 ml	0	0	0	0	0
18.	Total Coliform	n/100 ml	0	0	0	0	0

Source: Laboratory Analysis

Environmental Conservation Rules 1997; SCHEDULE – 3; Standards for Water; (B) Standards for drinking water

pH

The pH of the samples varies in the range of 6.8 to 7.1 which is well within the standard range of 6.5 to 8.5.

Chloride

The chloride content in the samples is 141.7 to 163.68 mg/l and is well within the permissible standards of 150-600 mg/l.

Iron and Arsenic

The iron content of the groundwater samples is 0.33 to 0.74mg/l which is well within the standard range of 0.3 to 1 mg/l.

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

4.16 Soil Quality

4.16.1 Sampling Methodology and Locations

The soil sampling strategy was designed to assess the existing soil quality over the study area. Samples were collected from two locations near the study area. The detail of the sampling locations is presented in Table 4-20 and Figure 4-28. A composite sampling technique was used for soil sampling from each location.

Soil samples were collected using tools from a depth of 45 cm from the top soil surface. Soil sample was collected from one spot and homogenized.

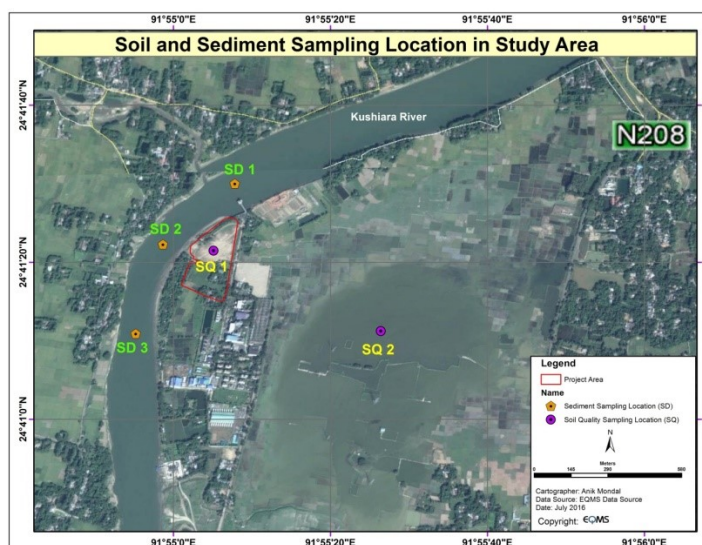


Figure 4-28: Soil & Sediment sampling location

Table 4-20: Location of Soil Samples

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1.	Inside Project Site	SQ1	24°41'22.672"N, 91°55'5.513"E	Project Site
2.	Near Project site	SQ2	24°41'18.672"N, 91°55'16.679"E	Agricultural field

The homogenized sample was collecting following quartering technique and then packed in polythene plastic jars and sealed. The sealed sample was sent to the laboratory for analysis.

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

4.16.2 Analysis Results and discussions

The analysis results of physico-chemical parameters of samples are presented in Table 4-21.

Table 4-21: Soil Quality Results

Parameters	Soil Quality		Methods of Analysis
Particle size distribution	Sand-33% Silt-37% Clay-30%	Sand-30% Silt-43% Clay-27%	USDA Textural Triangle
Texture	Clayey loam	Clayey loam	USDA Textural Triangle
Bulk Density (g/cm ³)	1.33	1.34	-
pH	5.7	5.5	pH meter
Organic Content (%)	2.1	2.8	ASTM D 2974
Calcium (mg/kg)	11.2	13.3	Atomic Absorption Spectrometry (AAS)
Magnesium (mg/kg)	3.7	5.1	AAS
Potassium (mg/kg)	4.8	3.24	Near Infrared Reflectance Spectroscopy (1000-2500 nm)
Sodium (mg/kg)	78	84	PFP7 Flame Photometer
Copper (mg/kg)	3.7	3.6	AAS
Iron (mg/kg)	240	230	AAS
Zinc (mg/kg)	1.37	1.95	AAS
Lead (mg/kg)	11.02	10.4	AAS
Cadmium (mg/kg)	BDL	BDL	AAS
Arsenic (mg/kg)	0.26	0.87	AAS
Mercury (mg/kg)	BDL	BDL	SW-846 method

BDL-Below Detection Limit

(Source: Laboratory Analysis, Soil Research Development Institute (SRDI, Sampling Date: 29/8/16)

Physical characteristics of soil

The particle size distribution of the soil samples shows major percentage of silt, followed by sand and clay in most of the samples. The texture shows soil samples of the study area are of Clayey loam type.

pH level of soil: The pH of the soil sample from the site was found to be neutral as per the standard soil classification.

Organic content in soil: The organic content of soil greatly influences the plant, animal and microorganism populations in that soil. The soil of the sampling area was found to have an loworganic content which indicates a low agricultural value of the soils.

Soil minerals and nutrients: Nitrogen, Phosphorus and Potassium (NPK) are the main nutrients, which defines the soil fertility. The Potassium content was 4.8 mg/kg for the respective sample.

Metals in soil: Iron, Manganese, Zinc, Lead, Cadmium, Arsenic and Mercury were analyzed in the soil sample. All metals were detected in the soil sample.

4.17 Sediment Quality

4.17.1 Sampling Methodology and Locations

The sediment sampling strategy was designed to assess the existing sediment quality over the study area. Samples were collected from three locations within the study area. The detail of the sampling locations is presented in Table and Figure 4-28 . A composite sampling technique was used for soil sampling from each location.

Table 4-22: Location of Sediment Samples

Sl.	Sampling Station	Station Code	Geographic Location
3.	200 m Upstream of the jetty area	SD1	24°41'29.929"N, 91°55'7.892"E
4.	Near to Jetty Area	SD2	24°41'22.222"N, 91°54'58.565"E
5.	200 m downstream of the jetty area	SD3	24°41'10.981"N, 91°54'55.129"E

4.17.2 Analysis Results and discussions

The analysis results of physico-chemical parameters of samples are presented in **Table 4-23**.

Table 4-23: Sediment Quality Results of the Kushiara River

Characteristics	Unit	Sediment Quality		
		SD1	SD2	SD3
Grain Size Distribution				
Sand	%	30	27	36
Silt		54	50	48
Clay		16	23	21
Texture	-	Silt loam	Silt loam	Silt loam
Organic content	%	0.30	0.28	0.29
pH	-	6.5	6.8	6.75
EC	dS/m	0.50	0.48	0.49
Bulk Density	g/cm³	1.40	1.39	1.38
Calcium (Ca)	mg/kg	6.8	6.3	6.2
Manganese (Mn)	mg/kg	117.4	134.5	120.7
Zinc (Zn)	mg/kg	23.5	26.7	24.1
Lead (Pb)	mg/kg	27.3	23.6	22.5
Cadmium (Cd)	mg/kg	BDL	BDL	BDL
Arsenic (As)	mg/kg	0.65	0.72	0.66
Mercury (Hg)	mg/kg	BDL	BDL	BDL

BDL-Below Detection Limit

(Source: Laboratory Analysis, Soil Research Development Institute (SRDI, Sampling Date: 29/8/16)

Biodiversity is the variation of taxonomic life forms within a given ecosystem, biome or for the entire Earth and is often used as a measure of the health of biological systems. The study discussed on ecosystem and species level biodiversity of the study area (10 km radius of the proposed power plant). The survey was conducted with following objectives:

-

4.18.1 The Bio-ecological Zone

4.18.2 Biodiversity of the flora

- Terrestrial Flora;
- Aquatic Flora

In the proposed Power Plant site and its adjoining area's (study area) major terrestrial ecosystems are:

- Agricultural Land or Crop Field
- Homesteads/settlement

i) Agricultural Land or Crop Field

Crop field vegetation is a major type of the study area. A big portion of crop fields is inundated in rainy season. The area is mostly used for paddy Cultivation. Lower part of the cropfields is used for aman cultivation and comparatively higher portion are used for Boro and Aus crops along economical crop. Local inhabitant plant Dhaincha (*Sesbania rostrata*) at the end of Boro harvesting and this species is commonly found in all area. *Amaranthus spinosus* , *Cotula hemisphaerica* etc. are common species.

Plant Species diversity: The common crop field's species are listed in Annex D. The crop field vegetation is less diverse but is important because it is the source of food and shelter for wildlife.

High land diversity is large dominated by two economical crops (*Hevea brasiliensis* & *Camellia sinensis*). Among the recorded 09 families, which are comprised of 12 Species where we found 3 family of Amaranthaceae, 1 family of Chenopodiaceae, Compositae, Convolvulaceae, Leguminosae, Rubiaceae, Theaceae & Cruciferae and 2 family of Euphorbiaceae. Herbs dominate shrubs in crop field vegetation.

ii) Homesteads/settlement

A total of 60 homestead species of 44 Families were listed. Out of 60 species 38 are tree, 16 are shrub, 4 species are herb and 02 are vines. Common planted tree species are Aam (*Mangifera indica*), Supari (*Areca catechu*), Mehogani (*Swietenia mahagoni*), Lichi (*Litchi chinensis*) Kola (*Musa sp*), Guava (*Psidium guajava*) etc. Raintree (*Samanea saman*), Narikel (*Cocos nucifera*) and Supari (*Areca catechu*) occupied the top canopy. Homesteads are commonly founds near the plain land which favor good growth of like Teak (*Tectona grandis*), Arjun (*Tectona grandis*) etc. Among the shrubs Dumur (*Ficus hispida*) is the most common of all species. Homestead flora consists of both native and exotic species and some of them are naturalized *Albizia richrdiana*, *Psidium guajava*, Hairy Fig (*Ficus hispida*).

Biodiversity Indices

The above table shows that the plot surveyed in the north part (Plot 2 & Plot 3) of study area represents highest diversity followed by south part (Plot 4) (Table 4-24).

Shannon Weiner Diversity: The highest H' value was recorded in Plot 1 (2.8), which possesses moderate diversity on the H' scale.

Simpson's Index (D): The highest Simpson's diversity (0.1) was recorded at Plot 2.

Simpson's Index of Diversity (1-D): The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species. The highest diversity (0.9) among the sampled plots was recorded at Plot 1.

Simpson's Reciprocal Index (1/D): The value of this index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. Higher value than 1 shall represent higher diversity on the similar scale. Accordingly, Plot 1 recorded maximum diversity represented by 12.

Species Richness: Plot 1 & 2 recorded the highest number of species, i.e., 30 & 23, and thus showed higher species richness with respect to other sampled plots. Plot 3 shows lower diversity represented by presence of only 2 species.

Total Abundance: Total abundance represents the highest number of individuals recorded per sample which was recorded highest in Plot 2 (220) in the study area.

Evenness (J'): Evenness is constrained between 0 and 1. The higher value of J' represents less variation in communities between the species. Accordingly, J' is recorded highest in Plot 5 and indicated the dominance of similar species with less variation.

Table 4-24: Biodiversity Indices of different Plots

Parameter	Plot 1 Kathalpur	Plot 2 Kutubpur	Plot 3 Monipur Tea State	Plot 4 Sadekpur	Plot 5 Uttarbug
Shannon-Wiener Diversity Index	2.883739	2.6228771	0.4101163	2.4602017	2.6172576
Species Richness (S)	30.0	23.0	2.0	17.0	19.0
Total Abundance	205	220	21	132	116
Simpson Diversity Index	D: 0.08335514 1-D: 0.9166449 1/D: 11.99686	D: 0.11772727 1-D: 0.8822727 1/D: 8.494208	D: 0.75510204 1-D: 0.24489796 1/D: 1.3243244	D: 0.10961892 1-D: 0.8903811 1/D: 9.122513	D: 0.09512485 1-D: 0.90487516 1/D: 10.5125
Evenness	0.8478599	0.83651155	0.5916728	0.86834323	0.8888816

4.18.2.2 Aquatic Flora

Wetland is a one of the feature in the study area. (Wetlands govern necessary nutrients and other elements for whole ecosystems as it is an important type.

There are two types of wetland in the project site.

- A. Permanent wetland and
- B. Seasonal wetlands.

Rivers, canals, perennial water bodies and fishponds are the permanent wetland. Seasonal wetland is mainly floodplains which inundates in the monsoon. Most of the study area supports permanent wetland. Wetland are abounded by different types aquatic flora such as free floating, rooted floating, submerged, sedges and meadows and marginal plants. Free floating plants are commonly observed throughout the project area. During the survey 13 families comprising of 22 species have been found where Lemnaceae & Polygonaceae families are dominating. Among the other species *Colocasia esculenta*, *Cyperus sp.*, *Eichhornia crassipes*, *Enhydra fluctuans*, *Ipomoea aquatica*, *Nymphaea nouchali* and *Phragmites karka* were largely seen.

The area consists of some evergreen wetland trees forming a closed canopy in wooded areas or freshwater swamp. The trees are 10 to 12 m high at maturity. Pitali (*Trewia nudiflora*), Hizal (*Barringtonia acutangula*), Biash (*Salix tetrasperma*) and Barun (*Crataeva nurvala*) are the tree species. A detail species list of wetlands flora is provided in Annex D.

4.18.3 Biodiversity of Fauna

During the fauna survey of the study area mainly covers –

- Fish
- Birds
- Amphibians and Reptiles
- Mammals
- Butterflies, Dragonflies and Damselflies

4.18.3.1 Fish

The projected area has somewhat importance for both endemic and exotic type of fish which was found in the open and closed water area. Some of the species has conservational significance and listed as threatened according to the IUCN Red list vol.3,2015. According to the Upazilla officer, some parts of the Kushiara River in upstream which is near to the project area were declared as sanctuary.

There are 40 species of fishes including endemic and exotic were observed in the projected area. Among of them 6 species are endangered and 3 species were found vulnerable. Rui, Catla, Mrigal, Grass carp, Sarpunti, Common carp etc. are the common scenario in the closed water culture. Rui, ayre, kachki, Baim, taki, tilapia, silver carp along with chingri are most abundant in the inland water resources. A detail about the endemic and exotic checklist of fish species is given in the Annex E.

In addition, 8 types of Gear, 2 types of Trap & 2 types of Craft were reported during the fisheries survey. The details of the fishing Gears & Nets are provided in the Annex E.

4.18.3.2 Birds (Avifauna)

The project area is a no so important bird area except homestead forest area. The surroundings of the proposed Kushiara Power Plant site are ecologically good condition for resident birds; no migratory birds come in this area ever recorded. Huge number of stagnant water bodies and channels, rivers and tributaries support a habitat of rich biodiversity. Homestead, aquatic vegetation and reeds land have supported the wild birds feeding and roosting. Major groups of the oriental birds are represented in this zone by many species.

A total of about 13 bird species were observed within the project area. A detail about the terrestrial and aquatic birds' species checklist is presented in Annex D.

4.18.3.3 Amphibians & Reptiles

The geographical location of Bangladesh is such that there is a high possibility of occurrence of animals and plants. It supports a wide range of floral and faunal community throughout the country. The Project area supports many important aquatic and terrestrial wildlife species. Like all over Bangladesh, this area also inhabits a unique and highly biota. During field investigation, a total species of 16 species found under 11 families. Among those most

of Colubridae species are natural and usually not seen in day light. FDG and secondary data confirmed their presence at the project area. These species IUCN status are LC. Other families Ranidae, Hecophoridae, Scincidae, Varanidae species also found during visit both land and aquatic area followed by their habitat. Calotes versicolor family also commonly had seen the project area. Among the 16 species, species few also take place in CITES list. Special attention required those species habitat conservation. A detail species list of Amphibians and Reptiles is provided in Annex D.

4.18.3.4 Mammals

Among the mammals, 7 species were recorded under 05 families. Almost all large mammals are facing habitat predicament due to human pressure. Common mammals that were found within the study area are Mus booduga, Mus musculus and Rattus rattus,. A detail species list of mammals is provided in Annex D.

4.18.3.5 Butterflies, Dragonflies and Damselflies

Diversity of Butterfly

Butterfly carries a symbol of climate condition. The survey area prevail a good number of butterflies. A total of 20 species has been identified during the survey tenure where Nymphalidae family dominated mostly. A detail species list of butterfly is provided in Annex D.

Diversity of Dragonflies and Damselflies

During the survey, the presence of Dragonfly and Damselflies are rich which indicates a sound aquatic biodiversity. Among the 13 species, mostly dominated by Libellulidae family. Gomphidae & Coenagrionidae families' presence also found. A detail species list of dragonflies and damselflies is provided in Annex D.

4.19 Socio-economic Environment

4.19.1 Administrative Profile of Fenchuganj

Sylhet district located at the north-east part of Bangladesh and the Project area is located at Fenchuganj Upazila. Total area of Fenchuganj Upazila is 28193 acre and total population is 1,04,741. Population density is 918 per km². The proposed site is located at Majigaon Union of Fenchuganj Upazila under Sylhet district. The project area located approximately 28 km far from Fenchuganj Upazila.

4.19.2 Demography of Project Area

In the 5 km study area, there are 32,122 households (HHs) including squatters with a total population of 182952 that will be affected in different scale depending on project activities by the implementation of the Project. The average sex ratio is 94 and the average household size is 5.7. Table 4-25 shows the Demography of the project area.

Table 4-25: Demographic Profile of the Project Area

District	Upazila	Union	Total population	Total HHs	Average HH size	Sex Ratio	Literacy (%)
Sylhet	Balaganj	Dewan Bazar	32135	5560	5.7	96	46.3

District	Upazila	Union	Total population	Total HHs	Average HH size	Sex Ratio	Literacy (%)
		Paschim Gauripur	13913	2240	6.1	95	50.1
		Purba Gauripur	16140	2586	6.2	91	54.5
	Fenchuganj	Fenchuganj	21020	3400	5.4	89	43.6
		Gilachhara	32139	5798	5.6	92	44.8
		Maijgaon**	29741	5672	5.2	99	64.4
Maulvibazar	Raznagar	Uttarbhag	37864	6866	5.5	96	46.8
	Project Study Area		182952	32122	5.7	94	50.1

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

** Project area is located in this union

4.19.3 Ethnic Composition

According to population census (2011), among the selected Unions 1100 ethnic households are found in Gilachhara, Maijgaon and Uttarbhag Union (Table 4-26).

Table 4-26: Ethnic composition of Project Area

District	Upazila	Union	Total population	Total HHs
Sylhet	Balaganj	Dewan Bazar	0	0
		Paschim Gauripur	0	0
		Purba Gauripur	0	0
	Fenchuganj	Fenchuganj	0	0
		Gilachhara	859	165
		Maijgaon**	13	3
Maulvibazar	Raznagar	Uttarbhag	228	47
	Project Study Area		1100	215

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

** Project area is located in this union

4.19.4 Religion

As per the 2011 census, the population of the project study area primarily consists of Muslims constituting almost 88.63% of the total population. The remaining 11.37% is primarily constituted by Hindus with Christians, Buddhists and others comprising an insignificant percentage. The following Table 4-27 indicates the various religious profile of the project study area.

Table 4-27: Religion Profile of Project Area

District	Upazila	Union	Total Pop.	Muslim		Hindu		Christian		Buddhist		Others	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Sylhet	Balaganj	Dewan Bazar	32135	31269	97.31	866	2.69	0	0.00	0	0	0	0.00
		Paschim Gauripur	13913	12474	89.66	1422	10.22	0	0.00	0	0	17	0.12

District	Upazila	Union	Total Pop.	Muslim		Hindu		Christian		Buddhist		Others	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
		Purba Gauripur	16140	14824	91.85	1316	8.15	0	0.00	0	0	0	0.00
	Fenchuganj	Fenchuganj	21020	19664	93.55	1355	6.45	1	0.00	0	0	0	0.00
		Gilachhara	32139	27646	86.02	4493	13.98	0	0.00	0	0	0	0.00
		Maijgaon	29741	26088	87.72	3640	12.24	5	0.02	0	0	8	0.03
Maulvibazar	Raznagar	Uttarbhag	37864	28142	74.32	9660	25.51	56	0.15	1	0.00264	5	0.01
	Project Study Area		182952	160107	88.63	22752	11.32	62	0.02	1	0.0004	30	0.02

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

** Project area is located in this union

4.19.5 Education

Table 4-25 shows the Literacy (%) of the project area. It shows the concentration of literate people in seven unions of selected Upazilas. The literacy rate in the Project areas is 50.1% which is higher than the national average of 42.1%.

4.19.6 Settlement and Housing

According to population census (2011), total household of the project study area is 32,122. Predominant structure of this study area is kacha (51.77) followed by Semi-pucka (24.57%), Pucka (22.17%) and Jhupri (1.46%). Housing tenancy of the study area is owned by 86.83%, rented (4.66%) and Rent free (8.51%).

4.19.7 Traffic and Transport

In the project area; constituted Balaganj, Fenchuganj and Raznagar, total Metalled, Semi metalled, Unmetalled (kacha) road is 1315Kilometer. Total Railway (all broad gage, meter gage and duel gage)is 14 kilometer, though Balaganj and Raznagar have no Railway connection. Water way in monsoon (river + canal) is 113 Kilometer where Raznagar has no waterway. Water way round the year (river + canal) is only5 Kilometer. Embankment road, Canal, Others are 56.5kilometer where 54 kilometer covered by Raznagar. (Source: District Statistics 2011, Bangladesh Bureau of Statistics (BBS)).

Table 4-28: Type of Structure in the Project Area

District	Upazila	Union	No. of HH	Type of Structure (%)			
				Pucka	Semi-pucka	Kutcha	Jhupri
Sylhet	Balaganj	Dewan Bazar	5560	23.6	19.0	55.2	2.2
		Paschim Gauripur	2240	18.5	17.5	61.3	2.7
		Purba Gauripur	2586	35.8	19.3	43.9	0.9
	Fenchuganj	Fenchuganj	3400	13.5	32.0	53.9	0.6
		Gilachhara	5798	12.6	30.7	54.9	1.8
		Maijgaon**	5672	38.0	32.0	29.7	0.3
Maulvibazar	Raznagar	Uttarbhag	6866	13.2	21.5	63.5	1.7
Project Study Area			32122	22.17	24.57	51.77	1.46

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

** Project area is located in this union

Table 4-29: Housing tenancy in the project area

District	Upazila	Union	Number of Households	Housing Tenancy (%)		
				Owned	Rented	Rent free
Sylhet	Balaganj	Dewan Bazar	5560	93.5	2.3	4.2
		Paschim Gauripur	2240	94.8	0.3	5.0
		Purba Gauripur	2586	95.7	0.6	3.7
	Fenchuganj	Fenchuganj	3400	94.7	1.3	4.0
		Gilachhara	5798	83.0	0.4	16.5
		Maijgaon**	5672	70.2	27.0	2.8
Maulvibazar	Raznagar	Uttarbhag	6866	75.9	0.7	23.4
Project Study Area			32122	86.83	4.66	8.51

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

** Project area is located in this union

4.19.8 Public Utilities

4.19.8.1 Water supply

At the project study area, the major source of drinking water is tube-well where about 75.67% population use tube-wells water. About 5.67% people have access to tap-water. Other 18.66% people have access neither tube-well nor tap water. An overview is depicted in Table 4-30 below.

Table 4-30: Sources of Drinking Water and Electricity Facility of the Project Area

District	Upazila	Union	Number of Households	Source of Drinking Water (%)			Electricity Connection (%)
				Tap	Tube-well	Other	
Sylhet	Balaganj	Dewan Bazar	5560	2.1	62.0	35.9	53.7
		Paschim Gauripur	2240	0.3	60.1	39.6	24.1
		Purba Gauripur	2586	1.2	82.6	16.2	58.7
	Fenchuganj	Fenchuganj	3400	1.2	82.2	16.6	67.0
		Gilachhara	5798	3.0	91.3	5.7	48.9
		Maijgaon**	5672	29.0	68.9	2.1	81.3
Maulvibazar	Raznagar	Uttarbhag	6866	2.9	82.6	14.5	42.1
Project Study Area			32122	5.67	75.67	18.66	53.69

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

** Project area is located in this union

4.19.8.2 Electricity

Electricity is an important indicator for measuring the quality of life in the Project area. In the project area, only 53.69% of the households have grid electricity connection. However, households mostly use the electricity for lighting and fanning purposes. Electricity connection of the project area shows Table 4-30.

4.19.8.3 Sanitation

In the Project area, only about 25.94% and 41.74% of households use respectively water sealed and non-water-sealed sanitary latrine facility which represents the 67.68% households of the study area. 27.83% households use non-sanitary facilities. Significant numbers of households, 4.46%, defecate in open places with no access to hygienic latrine facilities. Table 4-31 shows sanitation facility of the project area.

Table 4-31: Sanitation Facility of the Project Area

District	Upazila	Union	No. of HH	Type of Toilet Facility (%)			
				Sanitary (water-sealed)	Sanitary (non water-sealed)	Non-sanitary	None
Sylhet	Balaganj	Dewan Bazar	5560	26.6	40.4	28.9	4.0
		Paschim Gauripur	2240	12.8	44.1	38.7	4.4
		Purba Gauripur	2586	36.9	42.6	14.0	6.5
	Fenchuganj	Fenchuganj	3400	34.3	45.2	17.8	2.7
		Gilachhara	5798	23.9	37.2	35.6	3.3
		Maijgaon**	5672	29.4	51.8	18.3	0.5
Maulvibazar	Raznagar	Uttarbhag	6866	17.7	30.9	41.5	9.8
Project Study Area			32122	25.94	41.74	27.83	4.46

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

** Project area is located in this union; HH- Household

4.19.8.4 Healthcare Facility

Three Upazilas; Balaganj, Fenchuganj and Raznagar, lie under the project area. Within these Upazilas Number of MBBS and FCPS are 53 persons. In the study area both in Fenchuganj and Raznagar Upazila, there is no private hospital/clinic and related health personnel. Moreover, eight numbers of diagnostic center and related health personnel have established in project area. (Source: District Statistical 2011, BBS).

4.19.8.5 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 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.

4.19.9 Economy and Employment

In accordance to the Census of Bangladesh (2011), Agriculture including direct farming, sharecropping, agricultural laborers etc. is the dominant source of employment in the project area. Approximately, 74.91% and 50.29% male and female involve in Agricultural activities. Moreover, significant numbers of the population; 17.87% male and 37.56% female, of the project area are employed in services. According to census 2011 in these Upazilas, agriculture (including livestock and agricultural labor) is the primary source for income. In the project area 14454 male and 2326 female are employed. Table 4-32 shows employment status in agriculture sector of the project area.

Table 4-32: Employment status in agriculture sector of the study area

District	Upazila	Union	Population Aged 7+, not attending school		Field of Activity			
			Male	Female	Agriculture			
					Male		Female	
					Pop.	%	Pop.	%
Sylhet	Balaganj	Dewan Bazar	2907	117	2454	84.42	66	56.41
		Paschim Gauripur	1307	91	997	76.28	25	27.47
		Purba Gauripur	1021	22	872	85.41	15	68.18
	Fenchuganj	Fenchuganj	1592	54	1108	69.60	23	42.59
		Gilachhara	2795	657	1970	70.48	280	42.62
		Maijgaon	1543	196	1009	65.39	66	33.67
Maulvibazar	Raznagar	Uttarbhag	3289	1189	2394	72.79	964	81.08
Project Study Area			14454	2326	10804	74.91	1439	50.29

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

** Project area is located in this union

Table 4-33: Employment Status in Agriculture Sector of the Study Area

District	Upazila	Union	Population Aged 7+, not attending school and employed		Field of Activity							
					Industry				Service			
					Male		Female		Male		Female	
			Male	Female	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Sylhet	Balaganj	Dewan Bazar	2907	117	168	5.78	2	1.71	285	9.80	49	41.88
		Paschim Gauripur	1307	91	53	4.06	4	4.40	257	19.66	62	68.13
		Purba Gauripur	1021	22	38	3.72	0	0.00	111	10.87	7	31.82
	Fenchuganj	Fenchuganj	1592	54	23	1.44	1	1.85	461	28.96	30	55.56
		Gilachhara	2795	657	392	14.03	309	47.03	433	15.49	68	10.35
		Maijgaon	1543	196	209	13.55	39	19.90	325	21.06	91	46.43
Maulvibazar	Raznagar	Uttarbhag	3289	1189	262	7.97	121	10.18	633	19.25	104	8.75
Project Study Area			14454	2326	1145	7.22	476	12.15	2505	17.87	411	37.56

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

4.19.10 Fisheries

Fenchuganj Upazila has potential of inland open water fisheries resources that consist of the seasonal water bodies, haor, rivers, natural depressions or beels and reservoir. There are about 6,570 beneficiaries involved in fisheries activities of the upazila. Present field survey shows that annual flooding in the rainy season inundates up to 18% of the total land surface. Despite the existence of huge resources the inland capture fisheries have been replaced as top fish producing sources over the years by aquaculture due to decline and degradation of

resources. But, over a few years aquatic biodiversity especially fish species and other aquatic organism in inland open water have been declined due to natural and anthropological causes.

Table 4-34: Fish Culture in the study area

District	Upazila	Union	Union Area (ha)	Culture Fisheries		Total Culture	Total Capture (In dry season)	Total Wetland
				Pond Culture	Other Culture			
Sylhet	Balaganj	Dewan Bazar	4493.52	23.66	108.11	131.77	809.73	941.50 (20.95%)
		Paschim Gauripur	2505.66	26.15	68.42	94.57	817.09	911.66 (36.38%)
		Purba Gauripur	2061.53	42.15	14.70	56.85	317.26	374.11 (18.14%)
	Fenchuganj	Fenchuganj	5382.60	55.39	203.70	259.09	1211.08	1470.17 (27.31%)
		Gilachhara	4310.93	57.22	102.75	159.97	1588.14	1748.11 (40.55%)
		Maijgaon	1720.64	112.08	440.96	553.04	348.94	901.98 (52.42%)
Maulvibazar	Raznagar	Uttarbhag	5885.83	76.58	-	76.58	922.89	999.47 (16.98%)
Project Study Area			26360.71	393.23	938.64	1331.87	6015.13	7347 (27.96)

Source: www.landzoning.gov.bd (accessed in August 2016)

4.20 Analysis of the Socio-economic Survey

The baseline assessment comprised a socio-economic survey which was conducted within 2 km of the project area and data collected from randomly selected 180 households in order to gain first-hand information about the key households' socio-economic indicators. The data was collected primarily from the following unions located within 2 km of the project study area.

- Purba Gauripur
- Maijgaon

The household distribution from each union is presented in the following Table 4-35. It also indicates the total respondents from these unions to whom the survey was subjected.

Table 4-35: Sample Distribution Statistics

Sl#	Union	Total HH	Total Male Respondents	Total Female Respondents
1.	Purba Gauripur	30	12	18
2.	Maijgaon	150	73	77
Total HH		180	85	95

Source: Social Survey, 2016

The socio-economic data was collected on the following main indicators:

- Demographic Characters

- Education and Literacy
- Occupational Profile
- Property Types and Ownership
- Access to Public Amenities and Infrastructure
- Access to Utilities and Resources
- HH Income
- Overall awareness and opinion about the project

The following sections provide results from the analysis of the data collected as per the above indicators.

4.20.1 Demographic Characters of the Community

According to the survey shows that 57.2% of the total surveyed populations, 980 in total, are male and the rest (42.8%) are female. Most family type is Nuclear and rest is Joint; 80% of the total households are Nuclear. 44.3% populations are currently married. Percentage of unmarried and widow are 53.3% and 2.4% respectively. Among the total surveyed population 96.3% are physically healthy. Only 3.5% people are handicapped and .2% people have chronic health disease. Among the total population 26.8% (263 number) people are currently working. Demographic scenario of the surveyed community is shown in the following Table 4-36.

Table 4-36: Demographic Trend of the Surveyed Community

		Frequency	Percent (%)
Gender Distribution	Female	419	42.8
	Male	561	57.2
	Total	980	100.0
Family Type	Nuclear	144	80.0
	Joint	36	20.0
	Total	180	100.0
Marital Status	Married	434	44.3
	Unmarried	522	53.3
	Widow/Widower	24	2.4
	Total	980	100.0
Health Status	No Disease	944	96.3
	Handicap by Birth/Other	2	0.2
	Chronic Health Problem	34	3.5
	Total	980	100.0
Employment Status	Yes	263	26.8
	No	717	73.2
	Total	980	100.0

Source: Social Survey, 2016

4.20.2 Age Distribution of the Community

Average age of the surveyed community is 25.91. 63.88% population of the surveyed community lies in 15-65 years category. Less than 4 years, 5-14 years and More than 65 years represent 6.22, 26.94 and 2.94 percent of the total population. Age distribution of the community is presented in Table 4-37.

Table 4-37: Age Distribution of the Community

Age	Frequency	Percent (%)
Less Than 4 Years	61	6.22
5-14 Years	264	26.94
15-65 Years	626	63.88
+65 Years	29	2.96
Total	980	100
Average Age		25.91

Source: Social Survey, 2016

4.20.3 Education and Literacy

Within the total population 21.6% are illiterate. Primary and secondary level education status are most significant; 32.9% and 34.1% respectively. Moreover, 8.7% intermediate and 2.8% graduate level education status are also found. Education and literacy rate of the surveyed community is presented in the following Table 4-38.

Table 4-38: Education and Literacy Profile of the Community

Educational Status	Frequency	Percent	Valid Percent	Cumulative Percent
Illiterate	212	21.6	21.6	21.6
Primary (Class 5)	322	32.9	32.9	54.5
Secondary (Class 6-10)	334	34.1	34.1	88.6
Intermediate	85	8.7	8.7	97.2
Graduate	27	2.8	2.8	100.0
Total	980	100.0	100.0	

Source: Social Survey, 2016

4.20.4 Occupational Profile

Among the 263 number of people's workforce most popular occupations are Agriculture, Agriculture Labor, Non Agri Labor, Business/Trade, Govt. Service and Others. 36.12% population involve in business/trade as well as 23.95% and 14.07% people involve in agriculture and agriculture labor. Occupation profile of the community is shown in the following Table 4-39.

Table 4-39: Occupation Profile of the Community

Occupation Types	Frequency	Percent (%)
Agriculture	63	23.95
Agriculture Labor	37	14.07
Non Agri Labor	20	7.60
Business/Trade	95	36.12
Govt. Service	12	4.56
Others	36	13.69
Total	263	100(%)

Source: Social Survey, 2016

4.20.5 Agricultural Land Type

Average land holding by households is 57.96 Decimal. 50.6% of these are irrigated. Rests are non-irrigated. Agricultural land type owned by the community is shown in the Table 4-40.

Table 4-40: Agricultural Land Type Own by the Community

Land Type	Frequency	Percent	Valid Percent	Cumulative Percent
Non- Irrigated	89	49.4	49.4	49.4
Irrigated	91	50.6	50.6	50.6
Total	180	100.0	100.0	100.0
Average Land Holding by HH (Decimal)				57.96

Source: Social Survey, 2016

4.20.6 Types of Business in the Locality

Within the surveyed households 9.4% population engage in Grocery/General Store business. Pan (betel)/Cigarette shop is the second popular business in this community. Tea stall is also popular in this community; 5% of the total community engagement. Karbari Shop, Educational Institution, Furniture and Medicine Shop are also available in this locality. Types of business involved by the community people are presented in the Table 4-41.

Table 4-41: Types of Business involved by the Surveyed Community

Business Types	Frequency	Percent (%)
Tea Stall	9	5.0
Grocery/ General Store	17	9.4
Pan/Cigarette Shop	16	8.9
Kabari Shop	1	0.6
Educational Institution	1	0.6
Furniture	1	0.6
Medicine Shop	1	0.6

Source: Social Survey, 2016

4.20.7 Property Types and Ownership

Survey result shows that 92.8% properties within the surveyed households are private. Government and community based properties are 6.7% and 0.6% respectively. Moreover, 91.7% households own the property themselves. Squatter ownership has also found. 8.3% households' ownership type is Squatter. Property types and ownership status of the surveyed community is shown in the following Table 4-42 and Table 4-43.

Table 4-42: Property Types Status of the Surveyed Community

Property Types	Frequency	Percent	Valid Percent	Cumulative Percent
Private	167	92.8	92.8	92.8
Government	12	6.7	6.7	99.4
Community	1	0.6	0.6	100.0
Total	180	100.0	100.0	

Source: Social Survey, 2016

Table 4-43: Property Ownership Status of the Surveyed Community

Property Ownership	Frequency	Percent	Valid Percent	Cumulative Percent
Owner	165	91.7	91.7	91.7
Squatter	15	8.3	8.3	100.0
Total	180	100.0	100.0	

Source: Social Survey, 2016

4.20.8 Number of Floors for Residential/ Commercial Code

Survey result has found that 96.1% residential and commercial structures are one stored. 3.3% and 0.6% structures are two and three stored respectively. Number of floor of the structure in the surveyed household is presented in Table 4-44.

Table 4-44: Number of Floor of the Structure in the Surveyed Household

No. of Floor of Structure	Frequency	Percent	Valid Percent	Cumulative Percent
One Stored	173	96.1	96.1	96.1
Two Stored	6	3.3	3.3	99.4
Three Stored	1	.6	.6	100.0
Total	180	100.0	100.0	

Source: Social Survey, 2016

4.20.9 Typology of the Main Structure

RCC, Thatched and GI type roof are used in the surveyed community. 68.3% roofs of structures are GI type. RCC type and Thatched type are 31.1% and .6%. Common walls types are Brick, Mud and GI; 67.2%, 11.7% and 21.1% respectively. Moreover, 55.6% floors are concrete and the rests (44.4%) are Mud. In addition, 71.1% structures have no boundary. Brick, Tin and Barbed wire boundary are found 18.3%, 7.2% and 3.3% respectively. Type of main structure is shown in Table 4-45.

Table 4-45: Type of Main Structure

Characteristics of Structure	Type	Frequency	Percent (%)
Roof	RCC	56	31.1
	Thatched	1	.6
	GI/Asbestos	123	68.3
	Total	180	100.0
Wall	Brick	121	67.2
	Mud	21	11.7
	GI/Asbestos	38	21.1
	Total	180	100.0
Floor	Concrete	100	55.6
	Mud	80	44.4
	Total	180	100.0
Boundary	Brick	33	18.3
	Barbed Wire	6	3.3
	Tin	13	7.2
	No Boundary	128	71.1
	Total	180	100.0

Source: Social Survey, 2016

4.20.10 Land/Structure Impact in Project Site/Transmission Corridor

Within the surveyed households only 2.8% households have found who suffer land/structure losses as the impact of project site construction. On the other hand, no land and structure losses have been found in the case of transmission corridor setup. Land/structure impacted due to the proposed power plant and transmission line corridor within the surveyed household in presented in following Table 4-46.

Table 4-46: Property Impact due to the Proposed Power Plant and Transmission Line Corridor

Project site Impact	Frequency	Percent	Valid Percent	Cumulative Percent
No	175	97.2	97.2	97.2
Yes	5	2.8	2.8	100.0
Total	180	100.0	100.0	
Transmission Corridor	Frequency	Percent	Valid Percent	Cumulative Percent
No	180	100.0	100.0	100.0
Total	180	100.0	100.0	

Source: Social Survey, 2016

4.21 Socio-Economic of the Closest Receptor Villages

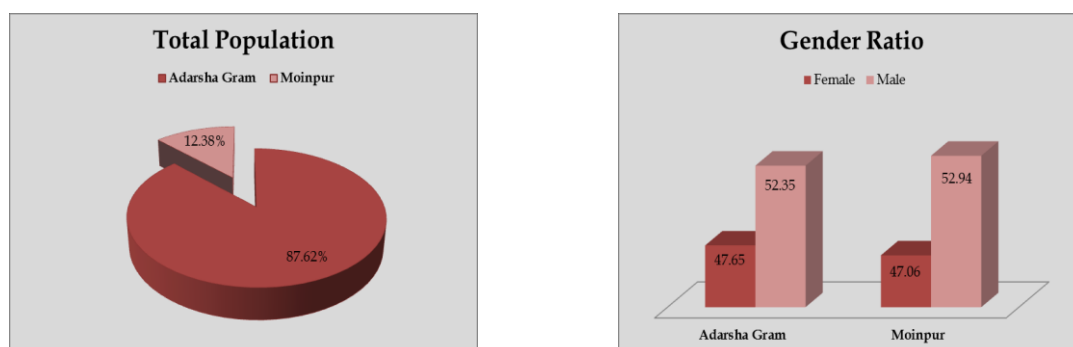
Adarsha Gram and Moinpur villages are the closest receptors, situated within 300 meters radius, of the proposed power plant. For being the closest proximity EQMS has conducted 100% census within these villages. A total amount of 61 households consisting 412 populations are residing in these two villages. Adarsha Gram is situated in the West and Southern West side from the proposed power plant. Adarsha Gram was established in Govt. Khash Land and people are living there since more than 25 years. A total of 54 households consisting 361 populations are currently residing in this village. On the other hand, Moinpur is situated in the Northern east side from the project site. Only a total of 7 households consisting 51 populations are currently living in Moinpur village. Table 4-47 shows the details population scenario of two villages.

Table 4-47: Population Distribution of the Closest Receptor Villages

Village Name	Households	Numbers of Female	Numbers of Male	Total Population
Adarsha Gram	54	172	189	361
Moinpur	7	24	27	51
Total	61	196	216	412

Source: Social Survey, 2017

Among the total of 412 populations, 87.62% people reside in Adarsha Gram and rest 12.38% people live in Moinpur. Gender ratio is similar in these two villages. In Adarsha Gram and Moinpur, male ratio is 52.35% and 52.94 and female ratio is 47.65% and 47.06% respectively. Figure 4-30 shows the population and gender ratio of two villages.



Source: Social Survey, 2017

Figure 4-30: Population Distribution and Gender Ratio of the Surveyed Villages

4.21.1 Demographic Characteristics

Basic demographic characteristics include age, marital status, education and health status. Table 4-48 illustrates the demographical characteristics of the households. In Survey, 1-105 age range among the population of Adarsha Gram has been found. On the other hand, 1-84 age range has been found in Moinpur village. Importantly, 84.5% population of Adarsha Gram and 86.3% that of Moinpur belongs to 1-42 age range which signifies that most of the populations are eligible or will be eligible for being active in economic activities. Additionally, in Adarsha Gram and Moinpur 46.3% and 41.2% population are married respectively. Unmarried population are in Adarsha Gram 48.8% and Moinpur 58.8%. Higher education is absent in both villages. Only 3% population has intermediate or higher education. All over health status among the households has been found quite well. Around 93.4% in Adarsha Gram and 98.9% in Moinpur are found healthy. On average 1.4% and 2.9% population are handicapped and having chronic disease.

Table 4-48: Demographic Characteristics of the Surveyed Household

Items	Categories	Adarsha Gram		Moinpur	
		Frequency	Percent	Frequency	Percent
Age	1-21	183	50.7	30	58.8
	22-42	122	33.8	14	27.5
	43-63	41	11.4	5	9.8
	64-84	14	3.9	2	3.9
	85-105	1	.3	0	0
	Total	361	100.0	51	100.0
Marital Status	Married	167	46.3	21	41.2
	Unmarried	176	48.8	30	58.8
	Widow/Widower	18	5.0	0	0
	Total	361	100.0	51	100.0
Education	Illiterate	100	27.7	16	31.4
	Primary	149	41.3	22	43.1
	Secondary	101	28.0	13	25.5
	Intermediate	7	1.9	0	0
	Graduate	4	1.1	0	0
	Total	361	100.0	51	100.0
Health	No Disease	337	93.4	50	98.0
	Handicapped by Birth	3	.8	1	2.0
	Chronic Health Problem	21	5.8	0	0
	Total	361	100.0	51	100.0

Source: Social Survey, 2017

4.21.2 Occupational Engagement and Income

Survey result shows that among the 412 population about 27.7% in Adarsha Gram and 15.7% in Moinpur are economically active. Thus it can infer that, dependency level is higher in Moinpur than Adarsha Gram. Private Service is the dominating occupation in those two villages 17.7% in Adarsha Gram and 9.8% in Moinpur. Agriculture, agri and non agri labor and business are also common occupations in these two villages. Average 73.79% population of two villages is not economically engaged. Among them 30.92% population are still students. Moreover, 28.95% and 22.57% are Old/Young and engage in domestic work respectively. About 65.74% of the economically active populations earn BDT 6-10 thousand.

Among the all earners about 8.33% only earn more than BDT 15 thousands. Table 4-49 shows the occupational engagement and income of the designated villages.

Table 4-49: Occupational Profile and Income Source of the Surveyed Household

Items	Categories	Adarsha Gram		Moinpur		Total	Total %
		Frequency	Percent	Frequency	Percent		
Employment Status	Yes	100	27.7	8	15.7	108	26.21
	No	261	72.3	43	84.3	304	73.79
	Total	361	100.0	51	100.0	412	100
Occupations	Agriculture	2	.6	1	2.0	3	2.78
	Agri Labor	1	.3	-	-	1	0.93
	Non Agri Labor	17	4.7	1	2.0	18	16.67
	Business/Trade	11	3.0	0	0	11	10.19
	Govt. Service	1	.3	0	0	1	0.93
	Private Service	64	17.7	5	9.8	69	63.89
	Others	4	1.1	1	2.0	5	4.63
	Total	100	27.7	8	15.7	108	100
Reasons for not Working	Domestic Work	89	24.7	10	19.6	99	22.57
	Old/Young	74	20.5	14	27.5	88	28.95
	Handicapped	2	.6	0	0	2	0.66
	Student	80	22.2	14	27.5	94	30.92
	Others	16	4.4	5	9.8	21	6.91
	Total	261	72.3	43	84.3	304	100.00
Monthly Income	Less Than Tk. 5000	14	3.9	0	0	14	12.96
	Tk. 6000-10000	66	18.3	5	9.8	71	65.74
	Tk. 11000-15000	11	3.0	3	5.9	14	12.96
	Above Tk. 15000	9	2.5	0	0	9	8.33
	Total	100	27.7	8	15.7	108	100.00

Source: Social Survey, 2017

4.21.3 Gender Analysis

When setting up a project, an essential first step for ensuring that it meets gender equality requirements is to conduct a gender analysis of the issue being addressed by the project. Gender analysis helps gain an understanding of the different patterns of participation, involvement, behavior and activities that women and men in their diversity have in economic, social and legal structures and the implications of these differences. Table 4-50 shows the Gender analysis of the selected population on specific indicators.

Table 4-50: Gender Analysis of the Selected Population on Specific Indicators

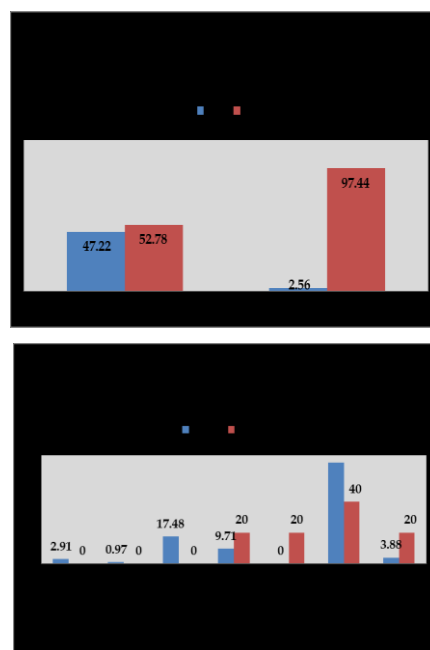
Items	Categories	Gender Analysis			
		Male	Percent	Female	Percent
Employment Status	Yes	102	47.22	5	2.56
	No	114	52.78	190	97.44
	Total	216	100.00	195	100.00
Occupations	Agriculture	3	2.91	0	0.00
	Agri Labor	1	0.97	0	0.00
	Non Agri Labor	18	17.48	0	0.00
	Business/Trade	10	9.71	1	20.00
	Govt. Service	0	0.00	1	20.00
	Private Service	67	65.05	2	40.00
	Others	4	3.88	1	20.00

Items	Categories	Gender Analysis			
		Male	Percent	Female	Percent
	Total	103	100.00	5	100.00
Education	Illiterate	55	25.46	61	31.12
	Primary	103	47.69	68	34.69
	Secondary	51	23.61	63	32.14
	Intermediate	3	1.39	4	2.04
	Graduate	4	1.85	0	0.00
	Total	216	100.00	196	100.00
Health Status	No Disease	203	93.98	184	93.88
	Handicapped by Birth	3	1.39	1	0.51
	Chronic Health Problem	10	4.63	11	5.61
	Total	216	100.00	196	100.00
Reasons for not Working	Domestic Work	0	0.00	99	51.83
	Old/Young	47	41.59	41	21.47
	Handicapped	1	0.88	1	0.52
	Student	48	42.48	46	24.08
	Others	17	15.04	4	2.09
	Total	113	100.00	191	100.00

Source: Social Survey, 2017

4.21.3.1 Gender Based Employment Status and Occupations

In designated two villages, Adarshas Gram and Moinpur, this study has found that the male ratio is 52.35% and 52.94 and female ratio is 47.65% and 47.06% respectively. Although there is no much difference between male female ratio but it is found that there is a remarkable difference between male and female in employment status. Whereas 47.22% male of the total male populations are economically active by engaging different level of occupation, in the case of women this ratio is very negligible and it is 2.56% only. Moreover, men are engaged in different types of occupations where women are engaged in only four types of occupations. Figure 4-31 shows the employment status and occupational engagement by gender.



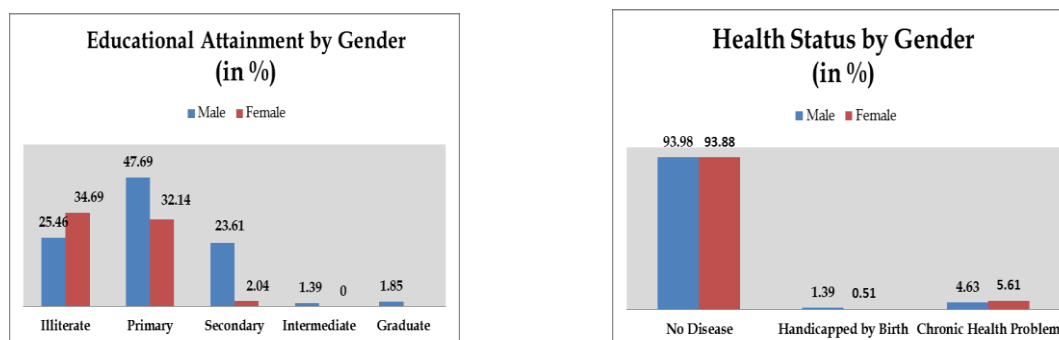
Source: Social Survey, 2017

Figure 4-31: Employment Status and Occupational Engagement by Gender

4.21.3.2 Gender Based Educational Attainment and Health Status

This study has found that women are comparatively less educated than men. There was no woman found who completed intermediate or graduation degree. This signifies that less education may hinder women participating or engaging economic activities. Health status between men and women are almost same. This signifies that health status may not hinder

women engaging economic activities. Educational attainment and health status by gender is shown in the Figure 4-32.

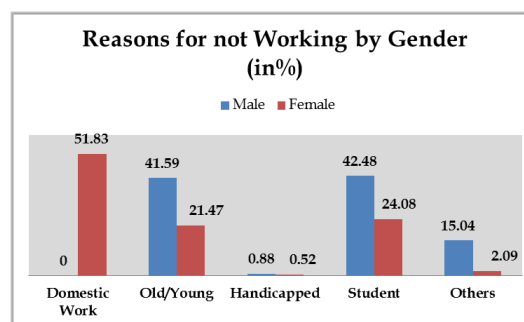


Source: Social Survey, 2017

Figure 4-32: Educational Attainment and Health Status by Gender

4.21.3.3 Factors for non-Engagement

In this section reasons behind not engaging in economic activities based on gender is described. Study result has found that among the all women population who are not working about 51.83% women are not working for involving in domestic work. This signifies that women are usually engage in domestic work rather than engaging in economic activities. Conversely, 42.48% and 41.59% men of total men population who are not working currently are not working for being student and old/young respectively.



Source: Social Survey, 2017

Figure 4-33: Reasons for Not Working by Gender

This signifies that among these portions significant male will turn into mature and get involved in economic activities. Figure 4-33 shows the reasons for not working by gender.

4.21.4 Local Workforce Assessment

Assessing labor market suitability for a new or expanding operation involves more than just researching the area population size and unemployment rate. Other considerations should account for an understanding of competitive wage positioning to better attract talent, an assessment of the depth and concentration of targeted skills, an understanding of evolving demographic attributes, as well as measuring the level of competitive labor demand and capitalizing on local workforce-training resources.

A comprehensive approach addresses these and other labor-market considerations through analysis of published statistics, and field-based research (employer interviews with firms employing similar skills). The goal is to uncover potential near- and long-term operating risks and to find the location that best supports the broader location decision and commitment. Table 4-51 shows local workforce assessment on some specific indicators.

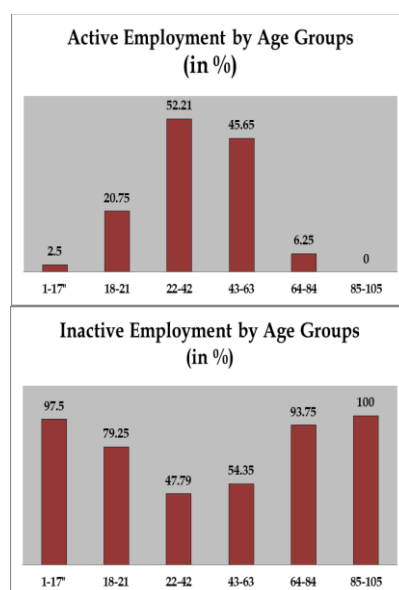
Table 4-51: Local Workforce Assessment on Some Indicators

Items	Categories	Age Category					
		1-17	18-21	22-42	43-63	64-84	85-105
Employment Status	Yes	4	11	71	21	1	0
	No	156	42	65	25	15	1
	Total	160	53	136	46	16	1
Occupations	Agriculture	0	0	0	3	0	0
	Agri Labor	0	0	1	0	0	0
	Non Agri Labor	1	1	13	3	0	0
	Business/Trade	0	1	6	4	0	0
	Govt. Service	0	0	0	1	0	0
	Private Service	3	10	48	8	1	0
	Others	0	0	3	2	0	0
	Unemployed	156	41	65	25	15	1
	Total	160	53	136	46	16	1
Gender	Male	86	21	72	29	8	0
	Female	74	32	64	17	8	1
	Total	160	53	136	46	16	1
Education	Illiterate	52	3	26	23	11	1
	Primary	66	26	59	17	3	0
	Secondary	42	20	45	5	2	0
	Intermediate	0	3	3	1	0	0
	Graduate	0	1	3	0	0	0
	Total	160	53	136	46	16	1
Health	No Disease	159	52	132	38	5	1
	Handicapped by Birth	1	0		1	2	0
	Chronic Health Problem	0	1	4	7	9	0
	Total	160	53	136	46	16	1

Source: Social Survey, 2017

4.21.4.1 Employment Status by Age Groups

Age based employment engagement analysis is very common to identify whether all workable age (18-63) groups are working or not. This study has found that, 2.5% of the total population of the 1-17 age group are currently active. As the existing government law does not permit working of this age group, this percentage is acceptable. In 18-21 age groups, only 20.75% of the total populations of this group are currently working. Remarkable issue is about 79.25% of this group are still unemployed. Additionally, in 22-42 age group 52.21% of total populations of this group are currently working and rest 47.79% are not working. Moreover, 45.65% of the total population of the 43-63 age group is engaged in economic activities. After this group, percent of non-engagement in economic activities becomes higher as 93.75% for 64-84 and 100% in 85-



Source: Social Survey, 2017

Figure 4-34: Employment Status by

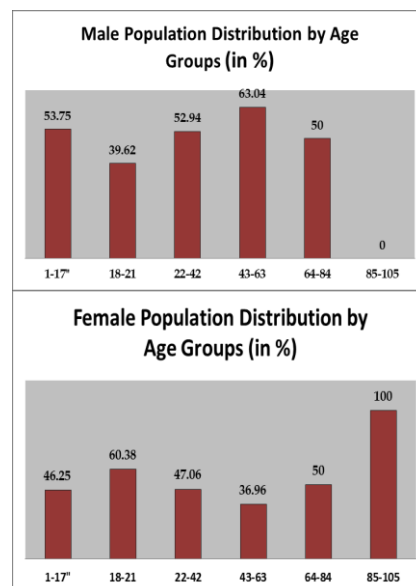
105 age groups respectively.

Age Group

In the age groups between 64-105, less engagement in economic activities is common phenomena. People in this age group are physically vulnerable and become depended on the other family members. Employment status by age group is shown in the Figure 4-34.

4.21.4.2 Gender Analysis by Age Groups

Age groups by gender may provide some more insights. Study result shows that in 1-17 age group, male percentage is little bit higher than that of women. Unlike the first age group, woman percentage is higher than that of man in 18-21 age group. In 22-42 and 43-63 age groups male percentage is higher than that of female; 52.94, 63.04 percent and 47.06, 36.96 percent respectively. In 64-84 age group male female portion are same. Lastly, in 85-105 age group there is no male population has been found in Figure 4-35. Result depicts that where female proportion is higher there economic engagement is lower. Therefore, if female are encouraged or given opportunity to work, then percentage of all over economic engagement in different age groups will be increased.

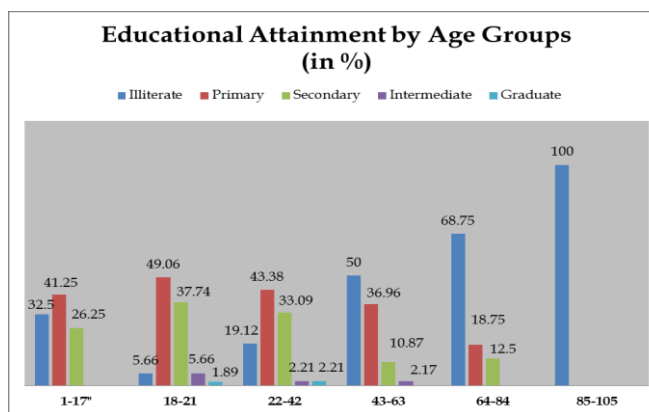


Source: Social Survey, 2017

Figure 4-35: Population Distribution by Age Group

4.21.4.3 Educational Attainment by Age Groups

Educational attainment by age groups presents more insights of the selected age groups. In age group 18-63, workable population, primary and secondary level educations are most common. Intermediate and graduation level education are very low in these population. Primary and secondary level educational attainment is not enough for engaging in higher or prestigious occupations. Moreover, less educational attainment may hinder involving in economic activities. Educational attainment by age group is shown in Figure 4-36.

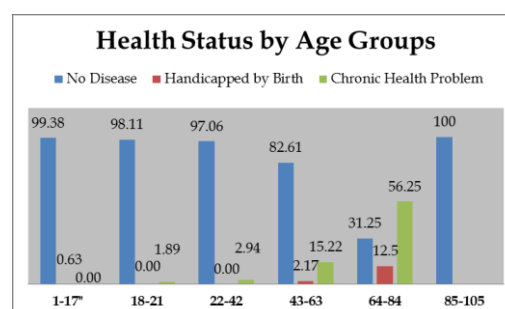


Source: Social Survey, 2017

Figure 4-36: Educational Attainment by Age Group

4.21.4.4 Health Status by Age Groups

Health status of the designated population shows that with age percentage of no disease is decreasing. But in 18-63 age groups, percentage of no disease is acceptable. Result suggests that health condition is not affecting the population engaging in economic activities. Health status by age group is shown in Figure 4-37.



Source: Social Survey, 2017

Figure 4-37: Health Status by Age Groups

4.21.5 Major Findings

- ❖ Male percentage is higher than female percentage of total population.
- ❖ Percentage of higher educational attainment is very low.
- ❖ Female's educational attainment is lower than that of male.
- ❖ Only 26.21% of total populations are engaged in economic activities.
- ❖ Populations, who are engaged in economic activities, among them most of the populations have BDT 6000 to 10000 monthly income.
- ❖ Female's engagement in economic activities is very low compared to male's engagement.
- ❖ Engaging in domestic work is the main reason for female for not engaging in economic activities.
- ❖ Only 20.75% of 18-21 age group is currently active in economic activities. Higher female percentage belongs to this group.
- ❖ In all workable age groups, where female percentage is higher there economic engagement is lower.

4.21.6 Recommendation

- ❖ As higher education attainment is very low, awareness, scholarship programs for students may enhance the percentage of higher educational attainment.
- ❖ Female students should get extra privileges for enhancing female's attainment in higher education.
- ❖ Awareness program, for enhancing female's engagement in economic activities, should be carried out. Specific job opportunity for female should be created also.
- ❖ Less educated/illiterate female group may be unionized in any kind of handicraft groups and given financial assistance. Thus engagement in economic activities will be enhanced.

4.22 Land Details and Procurement Process

4.22.1 Purchased Land Ownership

Project Company bought required land from the seven landowners. Study team identified these households and interviewed individually. Interview questionnaire was developed considering to capture Project Affected Persons' (PAP) socio-economic status and degree of losses. Though the required land was purchased based on the willingness of the sellers,

however, the purpose of the interview with the PAPs were to know the socio-economic status of the land sellers, degree of losses and satisfaction on the contract amount. Table 4-52 shows the land ownership details of the land sellers.

Table 4-52: Land Ownership Details

Sl#	Land Owner's Name	Father's Name	Land Amount (Decimal)
1.	Harun or Rashid	Sultan Ahmad	20.7
2.	Masum or Rashid	Sultan Ahmad	20.7
3.	Roshna Begum	Sultan Ahmad	20.7
4.	Rahman Ali	Hashmat Ali	21
5.	Jaynal Mia	Hashmat Ali	21
6.	Shekh Anu Mia	Hazi Sundar Ali	360
7.	Mahmud Us Samad Chowdhury	Late Delwar Hossain Chowdhury	457.9
Total			922

Source: KPCL

4.22.2 Land and Other Assets

A total of 7 households have been identified who owned 922 decimal land. Among the total 922 decimal around total 2.90 acres was brickfield area and 0.05 was acre fallow land area. The brickfield area was abandoned and no production activity was undertaken during the land purchase period. Moreover, 1.81 acre area was covered by Homestead (1.14 acre) and homestead premises (0.67 acre). Besides these, 4.37 acres and 0.05 acre were Agricultural and pond area respectively. Agriculture area was single cropped in nature and comparatively low productive.

Table 4-53: Land Types

Types of land	Land Amount	Percentage
Brick Field Area	2.90	31.5
Agricultural Land	4.37	47.5
Homestead Premises	0.67	7.3
Homestead	1.14	12.4
Fallow land	0.05	0.5
Pond	0.05	0.5
Total	9.2	100.0

Source: Field survey, October 2016

Study also found that two households were residing within the 1.81 decimal homestead land consisting 1200 Sft Pucca (building), 2100 Sft Semi- Pucca (semi building) and 450 Sft Tin Made structures.

Table 4-54: Affected Structures Types

Sl.#	Structure Type of construction materials	Total	
		Sft.	%
01	Pucca	1200	32
02	Semi Pucca	2100	56
03	Tin Made	450	12
Total		3750	100

Source: Field Survey, October 2016

Along with the living structures it was known that 2 Pucca Latrine, Dip Tube-well and Motor / Water Pump were available within the 142 decimal homestead land area.

Table 4-55: Other Structures

Category of structure	Unit	Total (Number)
Pucca Latrine	No.	2
Dip Tube-well	No.	2
Motor / Water Pump	No.	2
Safety Tang / dyeing House/Water Storage	cft	1

Source: Field Survey, October 2016

4.22.3 Socio-Economic Status of the PAPs

Study revealed seven landowners who constitute seven individual households consisting 46 populations. Average household size of these households is 6.6.

Table 4-56: General/Demographic Profile of Affected Population

Profile	Number
Number of total affected Households	7
Number of total Population	46
Average AHs Size	6.6

Source: Field survey, October 2016

Among the total population of the seven households, 43.5% belong to dependent group followed by 8.7% age group 0-4, 28.3% age group 5-14 and 6.5% age group 65+. Rest 56.5% belong to age category 15-65 who are physically capable to be engaged with economic activities.

Table 4-57: Age and Sex Distribution of Affected Populations

Age Group	Total	
	N	%
0-4	4	8.7
5-14	13	28.3
15-65	26	56.5
65+	3	6.5
TOTAL	46	100.0

Source: EQMS survey, October 2016

Among the total population, 10.9% are illiterate. Besides this, 23.9% have minimum literacy and 26.1% have primary education. Only 30.4% have at least S.S.C education.

Table 4-58: Level of Education of Affected Household Head

Education	Total	
	Nos.	%
Primary	12	26.1
S.S.C	7	15.2
H.S.C	2	4.3
B.A or Equivalent	4	8.7
M.A or Equivalent	1	2.2
Infant	4	8.7
Literate	11	23.9
Illiterate	5	10.9
Total	46	100.0

Source: Field Survey, October 2016

Among the seven household, five household heads are engaged with business and rest two heads are engaged with private job which signifies the less dependency on the land they sold.

Table 4-59: Occupation Distribution of the Affected HHs

Occupations	Total	
	N	%
Business	5	71.4
Private Job	2	28.6
Total	7	100.0

Source: Field survey, October 2016

According to the HIES 2010, the minimum BDT 144000 (considered 2014) yearly income is the bar line for lower poverty line. Study found that no household falls below to poverty line.

Table 4-60: Annual Income of Affected HHs

Level of Income (BDT)	Number	Percentage (%)
250000-300000	0	0
300000-350000	1	14.3
350000-400000	3	42.9
400000-450000	1	14.3
Above 450000	2	28.6
Total	7	100

Source: Field survey, October 2016

4.22.4 Land Purchase Contract and Land owners' Satisfaction

It was revealed that the land purchase agreement was done between the project company and the landowners. In the interview with the landowners, it was confirmed that land and structures rates were finalized after the negotiation between the representative of Project Company and the landowners. Land and structure rates were considered and confirmed separately. Agreed rates were higher than the compensation rate of the Government followed by the ordinance "*THE ACQUISITION AND REQUISITION OF IMMOVABLE PROPERTY ORDINANCE, 1982*". Landowners also confirmed that the agreed rates were not lower than the current market price that time. All owners expressed their high level of satisfaction with the agreed rates.

Besides these, landowners were given priority by the project company to get work or business opportunity. During the interview, it was found that among the seven households, two household heads were engaged in private service and one household head was engaged with subcontractor business with the project company.

4.22.5 Conclusion

Land sellers sold their land based on their self-will. Land and other assets rates were confirmed after the negotiation between the land sellers and the project company. Socio-economic status of the land sellers suggests that all households lie above the poverty line. Additionally, no female headed or physically handicapped household heads identified. Two households, who sold their homestead land, already have shifted and reconstructed their homestead structures. Moreover, landowners were also privileged by getting work and business opportunity during the project construction activities. At last, along with the local community these land owners are also satisfied and they believe that this proposed power plant project will facilitate to enhance social, economic and infrastructural development of the local area.

CHAPTER 5: IMPACT ASSESSMENT AND MITIGATION/ENHANCEMENT MEASURES

5. IMPACT ASSESSMENT AND MITIGATION/ENHANCEMENT MEASURES

5.1 Introduction

This section analyses the potential environmental and social impacts due to the Project. The Project activities will occur in two distinct stages of the Project life cycle: (a) construction of the Plant (Construction Phase) and (b) operation and maintenance of the Plant (Operation Phase). The Project does not envisage any major environmental impact in the preconstruction phase as it is located in the mixed used zone with industrial surroundings.

5.2 Scope of the Assessment

The scope of the assessment captures the understanding of the envisaged risks and impacts assessed during the scoping exercise of this impact assessment study as well as the risks identified during subsequent physical baseline assessment and impact evaluation process. The key environmental and social issues and risks identified are further elaborated in the following sections.

5.3 Impact Assessment Methodology and Approach

The methodology for the impact assessment will follow the international Guidelines including the General EHS Guidelines and those for Development Project. It will involve the prediction, evaluation and mitigation of impacts, and will report on impacts including residual impacts (impacts remaining after all possible mitigation has been incorporated) and cumulative impacts.

The impacts will be identified and quantified for the intensity using modeling and/ or matrix techniques and evaluated as Very Low, Low, Medium-Low, Medium-High and High impacts on the environment and communities in the study area as per the prescribed Format of the ECR, 1997. The anticipated changes enhancing the baseline conditions, with respect to air, noise, water, ecosystem and land environments or potential deterioration of human health, ecosystem and cultural baseline conditions of the study area will be assessed and predicted using prediction tools as per the following description:

- **Impact prediction:** to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- **Impact evaluation:** to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and enhancement:** to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts;
- **Residual impact evaluation:** to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement.

The key issues that will be identified during the scoping phase will be analyzed upon the baseline information. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative, from the project onto the environment or from the environment onto the project. In the ESIA study the significance of the potential impacts will be considered before and after identified mitigation is implemented, for direct, indirect and cumulative impacts, in the short and long term.

The following criteria will be used to evaluate **significance**:

- **Nature:** This is an assessment of the type of effect the activity is likely to have on the surrounding affected environment. The description includes what is being affected and its magnitude. The nature of the impact will be classified as positive or negative, and direct or indirect.

Direct	Potential/ possible Impacts will be generated directly from the project activities and its associated facilities which is directly linked with the project. (e.g. loss of land due to project development or air emission from a power plant)
Indirect	Potential/ possible Impacts will be generated from secondary sources which are induced by the project activities. (e.g. loss of any species habitat due to the project activities)
Induced	Potential/ possible Impacts will be generated (which are not part of the Project) due to effect /consequence/ outcome of the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).

- **Extent and location:** This indicates the spatial area that may be affected by the project activities or its associated facilities (Table A).

Table A: Geographical extent of impact

Rating	Extent	Description
1	Project Site	Potential/ possible Impacts' area only at or within the project site/ project boundary
2	Local	Potential/ possible Impacts' area is not only limited to the site but also its immediate surrounding areas/ receptors.
3	Regional	Potential/ possible Impacts' area extends to the immediate surrounding areas along with adjacent areas
4	National	Potential/ possible Impacts' area considered of national level.
5	Trans boundary	• Impact considered of not only within national level but also neighbouring country. • Impact considered global level.

- **Duration:** this measures the lifetime/ existence/ continuation of the impact (Table B).

Table B: Duration of Impact

Rating	Duration	Description
1	Short term	Potential/ possible Impact duration is very limited time

Rating	Duration	Description
		or length of construction / decommissioning period
2	Medium term	Potential/ possible Impact duration will continue after construction period but stop/ discontinue/cease within a tenure of 10 years
3	Long term	Potential/ possible Impact duration will continue more than 10 years, or entire operational life of project.
4	Permanent – Mitigated	Potential/ possible Impact will remain after operational life of project but appropriate mitigation measures reduce the impact
5	Permanent – no mitigation	• Potential/ possible Impact will remain after operational life of project. • No mitigation measures will reduce impact after implementation.

- **Intensity/severity:** This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (Table C).

Table C: Intensity of Impact

Rating	Intensity	Description
1	Insignificant	Changes due to Potential/ possible impact are minor, not visible/ noticeable, natural functioning of environment not affected.
2	Low	• Natural functioning of environment is minimally affected. • Natural, cultural and social functions and processes can be reversed to their original state if mitigation measure taken.
3	Medium	• Environment remarkably distorted/ disturbed/ impacted, still functions, if in modified way. • Negative impacts cannot be fully reversed.
4	High	• Cultural and social functions and processes distorted/ disturbed/ impacted. • Potentially ceasing to Environmental function temporarily. • Negative impacts cannot be fully reversed.
5	Very high	• Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. • Negative impacts cannot be reversed.

- **Potential for irreplaceable loss of resources:** This is the degree to which the project will cause loss of resources that are irreplaceable (Table D).

Table D: Potential for irreplaceable loss of resources

Rating	Potential for irreplaceable loss of resources	Description
1	Low	No Irreplaceable/ unique resources will be impacted.
3	Medium	Irreplaceable/ unique resources can be replaced, with

		mitigation measure/ effort and will be replaced after certain period of time.
5	High	Potential/ possible Impact replaces a particular/ vulnerable resource.

- **Probability:** This is the likelihood or the chances that the impact will occur (Table E).

Table E: Probability of Impact

Rating	Probability	Description
1	Unlikely	Under normal conditions, no Potential/ possible Impact expected.
2	Low	The probability of the impact to occur is low due to its design or historic experience.
3	Medium	There is a distinct probability of the impact occurring.
4	High	It is most likely that the impact will occur
5	Definite	The impact will occur regardless of any prevention measures.

- **Magnitude:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

Magnitude essentially describes the intensity of the change that has the potential to occur in the resource/receptor as a result of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are:

- Positive
- Insignificant
- Low
- Medium-low
- Medium - high
- High
- Very High

In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the EIA to indicate that the Project has the potential to result in a potential positive impact, without characterizing the exact degree of positive change that may occur.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. Magnitude x probability = significance).

		Probability of Impact				
		Unlikely	Low	Medium	High	Definite
Magnitude of Impact	Insignificant	Very Low	Very Low	Very Low	Low	Low
	Low	Very Low	Very Low	Low	Low	Medium-Low
	Medium - Low	Very Low	Low	Low	Medium-Low	Medium-high
	Medium - High	Very Low	Low	Medium-Low	Medium-high	High
	High	Low	Medium	Medium-high	High	High
	Very High	Low	Medium	High	High	Very High

5.4 Identification of Potential Impacts during Construction Phase

Construction of the power plant will be carried out by the construction contractor appointed by KPCL. The summary of the construction activities with the potential to cause impacts to the surrounding environment and human receptors is presented below.

- Site preparation, including raising using the dredged sand from a nearby river.
- Transportation of construction materials, construction machinery and equipment for the power plant by barge along the Kushiara River;
- Construction of a temporary jetty to receive construction equipment, materials and power plant components at the site;
- Carpeting the existing road from the connecting point of BPDB access road to the project site by using the brick;
- Excavation of equipment foundations and installation of power plant components. The excavated soil will mainly be used to backfill the foundations, with some going towards raising the ground level;
- Construction of a 200 m long gas pipeline;
- Storage and handling of hazardous materials, waste and wastewater;
- Accommodation and transportation for the construction work force and KPCL personnel. All personnel will travel to the site by road using local vehicles (cars, autos); and
- Use of diesel generator sets to provide electricity for construction activities.

The potential impacts have been identified through a systematic process whereby the activities (both planned and unplanned) associated with the Project construction have been considered with respect to their potential to interact with environmental and social resources or receptors. The interaction matrix enables a methodical identification of the potential interactions each Project activity may have on the range of resources/ receptors within the Area of Influence i.e. the study area for the Project. An activity-impact interaction matrix for the construction phase of the project is presented in Table 5-1.

Table 5-1: Activity-Impact Interaction Matrix for Construction Phase of the Project

Activity	Potential Impact/Risks													
	Surface Water Quality/Quantity	Ground Water Quality/Quantity	Soil / Sediment Quality	Air Quality	Climate Change	Noise & Vibration	Drainage Pattern	Transportation	Occupational Health & safety	Community Health & Safety	Infrastructure & Services	Terrestrial Ecology	Aquatic Ecology	Socio-economic
Construction Phase														
Site Clearing & Leveling	√		√	√		√	√		√			√		
Building of structures including temporary structures and laying of pipelines	√		√	√		√			√			√		
Heavy equipment operations	√			√		√			√		√	√		
Storage, handling and disposal of waste	√		√						√	√				
Generation of sewage	√								√					
Influx of construction workers	√	√						√		√				√
Transportation of power plant equipment over water	√			√		√		√	√				√	
Transportation of personnel & material by road				√		√		√		√	√			√
Storage and handling of chemicals (unplanned release)			√						√				√	
Maintenance of vehicles and equipment	√													
Concreting works			√	√		√			√					

5.4.1 Impact on Soil Environment

A. Impact on Soil due to Compaction

- **Sources of impact**

- Soil will be compacted during the establishment of laydown areas, internal roads, gas pipelines and installation of equipment to ensure stability
- Movement of heavy vehicles and heavy construction machinery will also cause soil compaction

- **Impact Significance**

The project site is almost developed and raised by the dredged sand. Now small quantity dredged sand will be required to labeling the project site. Hence the soil compaction will be carried out in limited scale. Soil compaction and possible damage to the soil structure due to heavy vehicular movement will only be limited to the vicinity project site. Based on the impact assessment matrix given below the impact was assessed as *very low*.

Impact	Impact on soil due to compaction						
Impact Nature	Direct	Indirect			Induced		
Impact Scale	Within the project site						
Frequency	Limited to construction Phase						
Extent and location	Project Site	Local	Regional	National	Trans boundary		
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation		
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High		
Potential for irreplaceable loss of resources	Low		Medium		High		
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High	
Probability of Impact	Unlikely	Low	Medium		High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high		High	Very High
	Significance of impact is considered as <i>Very Low</i>						

- **Mitigation Measure**

The following measures will be implemented to mitigate potential soil compaction:

- Establishing the project boundary prior to sand filling;
- Demarcating routes for movement of heavy vehicles;
- Stripping and placing soils when dry, and not when wet;
- Restricting the height of topsoil stockpiles to minimize erosion and compaction during gas pipeline RoW excavations

B. Impact on Soil due to Contamination from Spillage and Leakage

- **Sources of impact**

- Soil contamination during the construction phase may result from leakage and spillage of oil, lubricants, fuel from heavy equipment or leakage from chemical/fuel storage;
- Sediment contamination may take place during the construction of temporary jetty and unloading of heavy equipment

- **Impact Significance**

Contamination from spillage and leakage can have a long-term impact on soil, but are expected to be localized in nature. While the risk of accidental spillage potentially hazardous substances is low, proper handling and disposal of contaminated materials will further reduce the risk if such event does take place. Soil samples analysis indicate that the soil/fill material at the Project site is not contaminated. Spill control measures such as storage and handling of chemicals and fuels on impervious areas (such as concrete surfaces) will be implemented to minimize impacts in case of spills. Liquid effluents arising from construction activities will be treated to the standards specified in Schedule 9 and 10 of ECR, 1997 of the GOB and the applicable World Bank/IFC guidelines prior to discharge. Therefore, the likelihood of unplanned events (i.e. spills and leaks) leading to soil and sediment contamination is possible but low. Based on the matrix below the impact has been considered as *low*.

Impact	Impact on soil due to compaction					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Within the project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Very Low</i>					

- **Mitigation Measure**

The following prevention and mitigation measures will be proposed in the Specification Manual for EPC Contractors:

- The Contractor will prepare unloading and loading protocols and train staff to prevent spills and leaks
- The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oils, fuels or chemicals;
- A site-specific Emergency Response Plan will be prepared by the Contractor for soil clean-up and decontamination
- Fuel tanks and chemical storage areas will be provided with locks and be sited on sealed areas;
- Use of spill or drip trays to contain spills and leaks;
- Use of spill control kits to contain and clean small spills and leaks;
- The storage areas of oil, fuel and chemicals will be surrounded by bunds or other containment device to prevent spilled oil, fuel and chemicals from reaching the receiving waters;

- The construction contractor will implement a training program to familiarise staff with emergency procedures and practices related to contamination events.

C. Impact on Soil due to Contamination from Waste

- **Source of impact**

Contamination of the soil may occur from improper handling of waste. The major sources are as follows:

- General construction waste will comprise of surplus or off-specification materials such as concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, plastic pipes, metals etc.
- Domestic-type wastes consisting of food waste, plastic, glass, aluminium cans and waste paper will also be generated by the construction workforce.
- A small proportion of the waste generated during construction will be hazardous and may include:
 - Used paint, engine oils, hydraulic fluids and waste fuel;
 - Spent mineral oils and cleaning fluids from mechanical machinery; and
 - Spent solvents from equipment cleaning activities
 - Concrete and bitumen will be generated and may be reused if possible
 - Spent batteries or spent acid/alkali from the maintenance of machinery on site.

- **Impact Significance**

The majority of the generated wastes will be non-hazardous. If improperly managed, hazardous waste could create impacts not only to land but also to local air quality, water quality, and human health. With reference to similar projects, it is anticipated that the quantity of hazardous waste (mainly waste lubricant oil and waste paints/solvents) will be less than 80 litres per month. The construction contractor will handle, store and dispose of all waste in accordance with applicable GOB guidelines. Concrete and bitumen waste will be stored in a laydown area near the concrete batching plant and will be reused under floors or internal roads. Improper waste handling may cause direct, long-term negative impacts to soil quality. Based on the matrix below the impact has been considered as *very low*.

Impact	Impact on soil due to contamination from Waste Handling					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>very low</i>					

- **Mitigation Measure**

The following mitigation measures should be taken to minimize impact on soil due to contamination from waste handling.

- Design processes to prevent/minimize quantities of wastes generated and hazards associated with the waste generated;
- Training laborers for waste disposal in designated areas and use of sanitation facilities;
- Proper storage of the construction materials and wastes to minimize the potential damage or contamination of the materials; and
- Implementation of construction materials inventory management system to minimize over-supply of the construction materials, which may lead to disposal of the surplus materials at the end of the construction period;
- Segregation of hazardous and non-hazardous waste and provision of appropriate containers for the type of waste type (e.g. enclosed bins for putrescible materials to avoid attracting pests and vermin and to minimize odor nuisance);
- Storage of wastes in closed containers away from direct sunlight, wind and rain;
- Storage of waste systematically to allow inspection between containers to monitor leaks or spills;
- Ensuring that storage areas have impermeable floors and containment, of capacity to accommodate 110% of the volume of the largest waste container; and
- Disposal of waste by licensed contractors.

5.4.2 Impact on Water Resources

A. Impact on Surface Water

- **Source of impact**

Potential impact on surface water could arise from:

- Earthworks in the Project area may increase the erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources. Similar impacts are possible from construction of the floating jetty at Kushiara River for receiving construction materials and equipment;
- Inappropriate storage of waste leading to water quality impacts from runoff entering the Kusiara canal.
- Wastewater generated from washing of equipment and machinery on site.
- Surface water runoff from construction site
- Generation and disposal of domestic waste water from construction camp
- Pilling activities

- **Impact Significance**

The wastewater may contain suspended solids and traces of hydrocarbon. The contractor will be responsible for ensuring that any wastewater discharged meets the standards stipulated in Schedule 10 of ECR, 1997 and the applicable World Bank/IFC General EHS Guidelines prior to discharge of such wastewater. Sanitary facilities including toilets will be provided for the use of the construction workforce both on-site and at the workers'

accommodation. Such sewage streams are likely to be high in organic matter, suspended solids, coliform and other Pollutants. Septic tanks will be provided to treat sanitary wastewater. Potential impacts are expected to be short-term and localized in nature. Therefore, the impact to surface water from wastewater discharges during construction is assessed to be *low*.

Impact	Impact on surface water					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Impact on Kushiara river					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Low</i>					

- **Mitigation Measure**

- Restrict the earth work activities during monsoon season;
- Channelize all surface runoff from the construction site through storm water drainage system and provide adequate size double chambered sedimentation tank;
- Prevent & mitigate spill of paint/fuel within the construction site;
- Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal;
- Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce;
- All liquids effluent will be treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997 and IFC EHS Guidelines prior to discharge to Kushiara River.
- Stockpiles will be protected by plastic sheets and suitably secured against the wind, at the end of each working day if rain is forecasted;
- Temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge will be adequately designed for the controlled release of storm flows; and
- The temporary diverted drainage will be reinstated to the original condition when the construction work has finished or when the temporary diversion is no longer required.

B. Impact on Ground Water

- **Source of impact**

Potential impact on ground water could arise from:

- The spillage and seepage of chemical, oil and lubricants from storage area, waste handling area and generation of domestic waste/wastewater from construction labour camp area may adversely affect ground water quality in the area.

- Liquid effluents will be generated from washing of construction equipment and vehicles

- **Impact Significance**

The existing groundwater quality analysis around project does not reveal any existing contamination or pollution. Groundwater contamination during the construction phase may occur from unplanned events such as leaks and spills of oil, lubricants, fuel from heavy equipment, improper handling of sewage or chemical/fuel storage. Mitigation measures such as storage of chemicals at concreted/lay down areas will be implemented to minimize contamination in the event of a spill. Septic tanks will be provided to treat sanitary wastewater. As stated above, all wastewater discharges will meet the standards stipulated in Schedule 9 and 10 of ECR, 1997 and the applicable World Bank/IFC General EHS Guidelines prior to discharge. While there is a potential for long-term direct impacts to groundwater quality from construction, with the implementation of mitigation measures for proper handling of chemicals, waste and liquid effluents, the impact to groundwater from spills and leaks is assessed to be *very low*.

Impact	Impact on ground water						
Impact Nature	Direct		Indirect			Induced	
Impact Scale	Within the project site						
Frequency	Limited to construction Phase						
Extent and location	Project Site	Local		Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term		Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low		Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium			High	
Magnitude	Insignificant	Low	Medium-low		Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite	
Impact Significance	Very low	Low	Medium-Low		Medium-high	High	Very High
	Significance of impact is considered as <i>very low</i>						

- **Mitigation Measure**

The following measures can be taken to minimize impact on ground water during construction phase.

- Ensure proper spill control and management at site;
- Ensure storage of hazardous material and waste in proper manner and disposed the waste in hazardous waste landfill site;
- The surface runoff or extracted ground water contaminated by silt and suspended solids will be collected by the on-site drainage system and discharged into storm drains after the removal of silt in silt removal facilities;

5.4.3 Impact on Air quality

A. Impact on Air Quality due to Dust Generation

- **Sources of impact**

The possible sources of dust generation activities during pre-construction and construction phases are as follows:

- Site preparation and leveling
- Excavation of soil to construct building and equipment foundations;
- Pile driving for the equipment foundation;
- Movement of construction equipment by vehicle and barge;
- Loading and unloading of materials;
- Installation of gas pipeline;
- Dust generated from stockpiles of materials, waste, loose earth, handling and moving excavated material and transporting wastes on vehicles.
- Concreting works, including operation of concrete batching plant;

• Impact Significance

Dust generated from many of these activities will increase the particulate matter levels in ambient air. Most of the construction activities mentioned above have the Potential to generate dust. The extent of impacts from dust will depend on the exact location of these activities and on the weather conditions; stronger winds and dry conditions will enhance the transfer of dust, while damp or wet condition will reduce this impact. Construction dust dispersion is expected to be localized due to the relatively high mass of the dust particles which will tend to confine the most significant dust impacts to the area within 200 m of the source. The potential for dust emissions during the wet season will be small, due to the moistening of any dust by rainfall.

During the dry season, dust suppression techniques will be used and stockpiles will be covered to minimise fugitive dust emissions from spoil storage. As the dust is expected to settle within 100 m and dust suppression techniques Practiced, the main receptors would be workers on site and neighboring settlement.

On the basis of the above factors, the magnitude of the impact associated with the emission of dust during construction activities is predicted to be medium and the significance of the impacts is assessed to be *Medium Low*.

Impact	Impact on air quality due to dust generation					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium low</i>					

• Mitigation Measure

The proposed mitigation measures are as follows

- Implementation of a regular watering and sprinkling dust suppression regime, during the dry season;
- Concrete batching plant will be located within the protected site to keep it away from sensitive receptor/s;
- Stockpiles will be maintained at site only, which is a fenced area. No stockpiles will be maintained outside, and maximum possible distance between the stockpiles and receptors will be maintained;
- During construction, the approach road will be kept clean, free from mud and slurry;
- Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site; and
- Waste from construction will not be burned.

B. Impact on Air Quality due to Exhaust Emission

• Sources of impact

The potential sources of gaseous emission are as follows:

- Exhaust emission from movement of heavy equipment by barge, heavy loaders, trucks;
- Operation of diesel generators and other diesel based construction machinery;

• Impact Significance

Heavy equipment such as excavators, cranes, and compactors will be used onsite. Emissions from these equipment and diesel generator sets used to generate Power will cause impacts to ambient air quality. Transportation of construction material using heavy trucks will also contribute to exhaust emissions. Impacts from vehicle emissions decrease rapidly with increasing distance from the source and are not likely to be significant at distances of more than 200 m from the source; they are usually minor at a distance of more than 50 m with limited no. of vehicles plying the access road. The distance between the Project site boundary and the closest residential dwelling is approximately 200-220 m. However, there are a few settlements located along the access road.

The implementation of the good site practices, such as the regular maintenance of vehicles and equipment, using cleaner fuels and switching off vehicles when not in use will reduce exhaust emissions from the operation of the diesel-powered construction equipment and therefore minimize adverse air quality impacts. The air quality impacts associated with the vehicular and equipment emissions during construction activities are assessed as *Low*.

Impact	Impact on air quality due to exhaust emission					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	in and around project site					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	

Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation Measures**

Exhaust emissions will be minimized as follows:

- The movement of construction vehicles will be minimized and a 20 km/hr speed limit will be enforced around the construction site,
- All diesel-powered equipment will be regularly maintained and idling time reduced to minimize emissions;
- Vehicle / equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use); and
- Vehicle / equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced.

5.4.4 Impact on Noise

- **Sources of Impact**

The potential sources of noise during the construction phase of the Project include equipment, machinery and transportation used for the construction activities. The heavy equipment used for the construction activities will be the major sources of noise. This will include piling and preparing concrete foundations for plant and buildings. The traffic volume will be increased during the construction phase due to transportation of equipment, construction materials and workers on the access road which will be the source of noise to the closest receptor along the road. To minimize these impacts, only those vehicles meeting the standards stipulated in Schedule 5 of the Environmental Conservation Rules, 1997 will be used. Construction works are expected to last for approximately 24 months. The noise impact assessment was conducted with reference to Bangladesh Environmental Conservation Rules, 1997 and the IFC EHS Guidelines.

Baseline noise monitoring was carried out at 7 (seven) locations, including two within the Project site. The results of baseline monitoring indicated that ambient noise levels inside the project location are under the national standard (*Schedule 4 of the ECR, 1997*).

- **Impact Significance**

The nearest settlement is located adjacent to the western and north-eastern boundary. The sensitive receptor is also located adjacent to the western boundary. The household is located within the 50 m of the access road as a result they will be affected due to the movement of vehicle.

A significance source of noise during construction phase is additional traffic to and from the project site as well as traffic on the site. The concrete batching plant will significantly reduce heavy traffic vehicle movement to and from the site. Construction traffic is expected to be generated throughout the entire construction period; however the volume and type of traffic generated will depend on construction activities being conducted which will vary during the construction period. There is potential for disturbance to habitations in proximity of construction site. Movement of traffic during night hours can also disturb the local community. Approximately 90-92dB (A) of noise is expected to be generated from

construction activity which will attenuate to less than 45dB (A) i.e. night time prescribed noise level at about 100 m. The receptors are present close to the project area and along the approach road therefore peoples will feel discomfort due to the construction activities as well as movement of vehicles on access road. So the impact on ambient noise due to the project activities during the construction phase has been assessed as **Medium-Low**.

Impact	Impact on ambient noise					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	in and around project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Medium-Low</i>					

The following mitigation has been prescribed for reduction of noise impact on the closest receptor as a result the impact will reduce from medium-low to low.

- **Mitigation Measures**

The following mitigation measures will be implemented to minimise potential noise impacts during the construction phase in all periods:

- Normal working hours of the contractor will be between 06:00 and 21:00 hours from Saturday to Thursday. If work needs to be undertaken outside these hours, it should be limited to activities that do not exceed the noise criteria at nearby noise sensitive receptors;
- Only well-maintained equipment will be operated on-site;
- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machinery and construction plant that may be in intermittent use (e.g. trucks) shall be shut down or throttled down during non-work periods;
- Low noise equipment shall be used as far as practicable;
- The number of equipment operating simultaneously shall be reduced as far as practicable;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable;
- Noisy plant (such as breakers and rollers) shall be located as far away from receptors as practicable.
- The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work (this is a requirement of OSHA 2007);
- The contractor should undertake additional post development noise monitoring in

accordance with National and International noise standards.

- Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum disturbance to receptors;
- Developer shall instruct their Safety Officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum;
- Only limited construction activities shall be carried out during night-time;
- Restrict the night time vehicle movement through the access road;
- Adopt the vehicle speed (20 km/hr) limit in the access road
- All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary;
- Rubber padding/noise isolators will be used for construction equipment.
- Temporary noise barriers shall be provided surrounding the high noise generating construction equipment;
- The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels;
- Construction vehicles and machinery will be well maintained and not kept idling when not in use;

5.4.5 Impact on Eco-system

A. Impact on Terrestrial Ecosystem

- **Sources of Impact**

The potential sources of impact on terrestrial ecosystem during the construction phase of the project are as follows.

- Site development activities by sand filling
- Vegetation clearance;
- Fugitive emission and deposition on vegetation;
- Noise and vibration;
- Construction activities at site;
- Influx of labor force; and
- Transportation of man and material by road and River.

- **Impact Significance**

The project site is at present build up area which was previously fallow land and brick kiln. A total of 128 homestead species were listed inside the project site. Out of 128 species 19 were sapling, small (27), medium (43) and large (39) respectively. All trees need to cut down prior to start the construction. The construction workers will be primarily residing in the nearby habitation or near to the project site in construction camp. There is a likelihood of impact the construction camps on nearby vegetation due to requirement of fuel and timber from the vegetation.

Noise during construction activities may create communication problem among fauna. Construction activities will also disturb amphibians, reptiles, avi-fauna and mammals observed in and around the project site. Four common bird species only found in the project site. The species richness at the project site and associated infrastructure area with respect to

the study area is low. Based on the above observations the impact for the construction phase on terrestrial ecosystem has been assessed to be *very low*.

Impact	Impact on Terrestrial ecosystem					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as very low					

- **Mitigation Measures**

To minimize impact on terrestrial eco-system the following activities can be implemented.

- The noise generating activities should be scheduled during daytime only.
- Movement of construction and transport vehicles should be restricted to dedicated paths to minimise any harm to small mammals near to proposed site.
- Construction activities should be planned and undertaken in a phased manner
- Project related activities should be avoided during the night time;
- Damage to the natural topography and landscape should be minimized;
- Strict prohibition should be implemented on trapping, hunting or injuring wildlife within the subcontractors and should bring a penalty clause under contractual agreements;
- A minimum possible number of routes should be authorized for use during construction by the labourers and staff, speed limit of the vehicles plying in these routes should be kept 20-25 km/hr to avoid road kill;
- Tree species which are present edge of the project boundary should keep remain alive;
- Plantation of local species for stabilization of the filled in material and plantation in surrounding areas;

B. Impact on Aquatic Ecosystem

- **Sources of Impact**

- Surface runoff from construction site, discharge of hydro-testing water,
- spillage & leakage of oil and lubricate, from construction site;
- Spillage from River Transportation;

- **Impact Significance**

The Kushiara River is located about 60 m western side from the plant boundary. This River will be used as a means of transport for equipment for the power plant which may disturb the aquatic habitat. Transportation will be undertaken with the help of barges/trawlers. There is a likelihood of accidental spillage of oil and other chemicals during transportation/unloading, which may impact on the flora and fauna of Kushiara River. The

spillage may affect the fish habitat hence due care should be exercised to avoid spill incidences. Based on the matrix below the impact has been considered as **Low**.

Impact	Impact on aquatic ecosystem					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In the Kushiara River					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as Low					

- **Mitigation Measures**

The mitigation measures are as follows:

- Avoidance of any leakage of fuels and other contaminants from barges/trawlers to Kushiara River;
- Trawlers/barges with valid requisite licenses and emergency handling capacity or tie-ups shall only be engaged; and
- Standard codes and practices to be followed during unloading of fuels and construction material.
- Proper maintenance for avoidance of any leakage of fuels and other contaminants from barges/trawlers to Kushiara River;

5.4.6 Traffic and Transport

- **Source of impact**

The construction phase will involve the transportation of the following over water.

- Vehicles carrying equipment, construction material in project site
- Vehicles carrying workers in the project site

- **Impact Significance**

A. Impact on Road Traffic

During the construction, the heavy equipment will be carried out through river way. Some construction materials and approximately 50 KPCL personnel will move to the project site using the Moulovibazar-Sylhet road via approach road. Approximately 2 km approach road is good condition and 0.90 km road is narrow and unpaved which need to be strengthened by KPCL. The approach road is not so busy. Additional road traffic will increase the congestion on the Moulovibazar-Sylhet highway in a limited scale as the road is wide enough. So the additional traffic contributes by KPCL personnel is not expected to be significant. Therefore, the impact to the traffic on the approach road is assessed to be **very low**.

Impact	Impact on Road Network						
Impact Nature	Direct	Indirect				Induced	
Impact Scale	Moullovibazar-Sylhet and Access Road						
Frequency	Limited to construction Phase						
Extent and location	Project Site	Local	Regional		National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term		Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/severity	Insignificant	Low	Medium		High	Very High	
Potential for irreplaceable loss of resources	Low		Medium			High	
Magnitude	Insignificant	Low	Medium-low	Medium - high		High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high		High	Very High
	Significance of impact is considered as <i>Very Low</i>						

B. Impact on Waterway Traffic

Equipment and power plant components will be delivered to the site by barge. Mainly country boat and trawler is playing in the Kushiara River but not frequently. Hence the equipment carrying through the Kushiara River will not cause significant impact on waterway traffic. Therefore, the impact due to the barge movement for equipment carrying on River traffic has been assessed as *very low*.

Impact	Increase River traffic in Kushiara River					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Kushiara River					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Very Low</i>					

• Mitigation Measures

The following mitigation measures will be put in place to reduce impacts on road networks in vicinity of the Project site to as low as reasonably practicable:

- Construction materials and equipment will be transported over water to avoid impacts from heavy vehicles to traffic on the Moullovibazar - Sylhet highway and access road;
- The construction workforce involved in construction will be provided accommodation in the vicinity of the Project site to minimise the distance travelled;
- Avoiding peak hours for heavy vehicles movement where possible;
- Regular maintenance of vehicles to avoid break downs leading to congestions;
- Training and awareness amongst driver's to encourage systematic parking,

- following traffic rules, preventing unnecessary stoppages and overtaking;
- Collaboration with local communities and responsible authorities to improve signage, visibility and awareness of traffic and pedestrian safety; and
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents.

5.4.7 Occupational Health and Safety

- **Sources of Impact**

The sources of impact to the health and safety of the Project's construction workforce are listed below.

- Accidents and injuries associated with the operation of heavy machinery and other construction activities; and
- Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions to air, water, land and noise emissions from construction activities as well as from storage and handling of waste, particularly hazardous waste.

- **Impact Assessment**

A. Accidents and Injuries from General Construction Activities

The construction workforce of 100 skilled and 500 unskilled workers as well as up to 70 KPCL personnel will be exposed to occupational health and safety impacts arising from construction activities.

Over-exertion, ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries on construction sites. Loose construction materials, liquid spills, and uncontrolled use of electrical cords and ropes on the ground, are also among the most frequent causes of lost time accidents at construction sites. Falls from elevation associated with working with ladders, scaffolding, and partially built structures are also among the most common causes of fatal or permanent disabling injury at construction sites.

Construction activities may pose significant hazards related to the potential for dropping materials or tools, as well as ejection of solid particles from abrasive or other types of power tools which can result in injury to the head, eyes, and extremities.

Vehicle traffic, use of lifting equipment and the movement of machinery and materials on a construction site may pose temporary hazards, such as physical contact, spills, dust, emissions, and noise. Heavy equipment operators have limited fields of view close to their equipment and may not see pedestrians close to the vehicle. Center-articulated vehicles create a significant impact or crush hazard zone on the outboard side of a turn while moving.

Construction sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms. Access to construction areas and the access road, will be restricted to reduce risks to public health and safety. These risks could create long-term impacts to the health and safety of the

construction workforce and therefore the impact severity is assessed to be medium. Measures will be implemented to ensure that these risks are considered prior to the commencement of construction, and that all risks are communicated to the workforce. Appropriate PPE will be provided and equipment maintained and inspected regularly. Taking this into account, the impact to the health and safety of workers is assessed to be *medium-low*.

Impact	Occupational health and safety during construction phase					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	600 construction workers and 70 KPCL personnel					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Medium Low</i>					

B. Health Impact associated with Environmental Conditions

Changes in the environmental quality of air, surface water, groundwater and soil quality may occur as a result of construction activities. High noise levels are also expected from the operation of heavy machinery.

An increase in dust and noise during the construction period has the potential to lead to health impacts associated with eye irritation and general disturbance to daily activities. The dust and noise impacts during the construction phase are assessed and discussed in Section 5.4.3 and Section 5.4.4.

Waste will be generated during the construction including excavated material, construction waste, hazardous waste, sewage sludge and general refuse. The impacts from waste are presented in detail in Section 5.4.1 and Section 5.4.2.

Further, it is noted that potable water will be provided to the construction workers through bore wells. As discussed in Section 4.15.2, groundwater in the project area shows the quality of ground water is good.

The discharge of domestic waste effluent from construction workers may have the potential to cause contamination of surface water and groundwater in this area. A detailed assessment of this is presented in Section 5.4.2.

There is a potential for long term impacts to worker's health from changes in environmental quality, as workers will be exposed to higher levels of emissions than off-site receptors. The health and safety impact associated with changes in environmental quality is considered to have *medium-low* significance.

Impact	Health impact associated with environmental condition		
Impact Nature	Direct	Indirect	Induced
Impact Scale	600 construction workers and 70 KPCL personnel		

Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Medium Low</i>					

- **Mitigation Measures**

The measures will be in place to minimise the health and safety impacts to personnel from general construction activities include:

- The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements;
- Measures will be implemented to reduce the likelihood and consequence of the hazards due to falling from height, falling into water, entanglement with machinery, tripping over permanent obstacles or temporary obstructions, slipping on greasy or icy walkways, falling objects, asphyxiation, explosion, contact with dangerous substances, electric shock, mistakes in operation, variable weather conditions, lifting excessive weights; and traffic operations.
- A permit to enter system will be established to ensure that only authorized persons gain entry to the site;
- Competent and adequately resources sub-contractors will be used where construction activities are to be sub-contracted;
- All workers will be properly informed, consulted and trained on health and safety issues;
- Personal Protective Equipment (PPE) shall be worn at all times on the Site. This shall include appropriate safety shoes, safety eyewear, and hard hats. Non-slip or studded boots will be worn to minimize the risk of slips;
- All lifting equipment and cranes will be tested and inspected regularly. All hoist ways will be guarded;
- All scaffolds will be erected and inspected in conformity with the Factories Act and the appropriate records maintained by the Contractor;
- Safety hoops or cages will be provided for ladders with a height in excess of two meters;
- All breathing apparatus, safety harnesses, life-lines, reviving apparatus and any other equipment provided for use in, or in connection with, entry into Confined Spaces, and for use in emergencies, will be properly maintained and thoroughly examined at least once a month, and after every occasion on which it has been used;
- Where sound levels cannot be reduced at the source, suitable hearing protection will be provided when noise levels indicate an Leq of more than 90 dB(A). When hearing protection is used, arrangements will be made to ensure the wearers can be warned

of other hazards; and

- The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work is in progress.

5.4.8 Impact on Community Health and Safety

- **Source of Impact**

Possible sources of impacts on community health and safety during the construction phase are:

- Changes in environmental quality due to construction activities;
- Increased prevalence of disease arising from the influx of construction workers;
- Heavy traffic movement.

- **Impact Significance**

Project site workers, settlements in close Proximity to the Project site (within 100 m) and along the access road (with 50 m) are Potential receptors of health impacts from construction related activities.

A. Impact on Community health due to Environmental Changes

Health Impact associated with environmental conditions changes in the environmental quality of air, surface water, groundwater and soil quality may occur as a result of construction activities. High noise levels are also expected from the operation of heavy machinery.

An increase in dust and noise during the construction Period has the Potential to lead to health impacts associated with eye irritation and general disturbance to daily activities. The dust and noise impacts during the construction phase are assessed and discussed in Section 5.4.3 and Section 5.4.4.

Waste will be generated during the construction including excavated material, construction waste, hazardous waste, sewage sludge and general refuse. The impacts from waste are presented in detail in Section 5.4.1 and Section 5.4.2.

The discharge of domestic waste effluent from sanitary facilities for construction workers may have the potential to cause contamination of surface water and ground water in this area. A detailed assessment of this is presented in Section 5.4.2.

The impacts to the workers on site and involved in transportation activities have been covered under Labor Welfare. There is a potential for short term impacts to community health from changes in environmental quality. The health and safety impact associated with changes in environmental quality is considered to have low impact significance when assessed against the receptors location and the various mitigation measures in place.

Impact	Impact on community health due to environmental changes				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Surrounding inhabitant area				
Frequency	Limited to construction Phase				
Extent and location	Project Site	Local	Regional	National	Trans boundary
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation

Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>low</i>					

- **Mitigation measures**

The following mitigation measures will be put in place to reduce impacts on community receptors:

- Barriers will be provided to prevent entrance of Persons into the construction site and also to protect public exposure to hazards associated with construction activities;
- Avoiding formation of stagnant water pools in and around the site;
- Implementation of a vector control programme in labor camps and surrounding areas; and
- Educating area residents and workers on risks, prevention, and available treatment for vector-borne diseases.
- Regular water spying in the high dust generating area;
- Put the noise barrier/wall in the high noise generating area

B. Impact on health due to increasing prevalence of diseases

A total of 670 workers will be employed in the construction phase. This influx of workers to the community may cause impacts to public health, especially an increase in prevalence of diseases.

Baseline surveys revealed that the most common diseases in the Project AOI are Pneumonia, peptic ulcers and Diarrhoea. The greatest incidence is of food and water borne diseases, arising from contamination by faecal elements, pests and vectors and due to lack of sanitation facilities. Furthermore, the construction and industrial installation work will produce certain amount of debris. Potential for this waste being dumped improperly and coming into contact with any community resource or surrounding is possible. All such waste if left on site would have potential for breeding of vectors and pests in turn causing vector borne diseases. There is also the Possibility of increase in sexually transmitted diseases such as HIV/ AIDS as a result of the expected influx of workers into the area.

Measures such as proper collection, storage and disposal of wastes, construction of septic tanks to prevent contamination of water resources from sanitary effluents generated from plant site will be implemented. Taking these measures into account, the impact to public health and safety is evaluated to be of very *Low* significance.

Impact	Impact on health due to increasing prevalence of diseases				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Communities close to the project footprint area				
Frequency	Limited to construction Phase				
Extent and location	Project Site	Local	Regional	National	Trans boundary
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation

Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation measures**

The following mitigation measures will be put in place to further reduce prevalence of diseases:

- Screening, surveillance and treatment of workers, through the provision of medical facilities and, where required, immunization programmes;
- Undertaking health awareness and education initiatives among workers;
- Implementation of a vector control programme;
- Avoiding formation of stagnant water pools; and
- Educating project personnel and area residents on risks, prevention, and available treatment for vector-borne diseases.

C. Impact on Community due to Traffic Movement

During pick construction period, Heavy or light trucks will be move for transportation of construction materials. Construction workers and official people will stay in rented buildings outside the site. So, transportation is needed for construction staffs. An increase in local traffic is expected as a result of the construction activities which may create public safety issues for local accidents, especially along the access road.

Potential impacts include blocking access, congestion and traffic accidents along the access road. The probability of pedestrian traffic accidents is low given that the road is not a busy road. With the implementation of speed controls (20 km/hr), the potential impact to communities from heavy vehicular movement is assessed as *medium low* during the construction phase.

Impact	Impact on community due to heavy traffic movement					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	in and around the project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium-low</i>					

- **Mitigation Measures**

The following mitigation measures should be taken to minimize the impacts on community due to heavy traffic movement:

- Emphasizing safety aspects among drivers, particularly with regard to the speed limit of 20 km/hr that will be enforced;
- Ensuring that only licensed drivers are employed by the Project;
- Avoiding peak hours for heavy vehicles movement where possible;
- Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure;
- Collaboration with local communities and responsible authorities to improve signage (e.g. pedestrian crossings, speed limits etc), visibility and awareness of traffic and pedestrian safety; and
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents.

D. Stress on Water Resources

Most of the household depend on the ground water for their drinking and other domestic purposes. The proposed power plant will use underground water for drinking as well as construction purposes which strain on the ground water sources and therefore water conservation measures will be implemented.

Kushiara river water could meet the construction water demand. Water will be reused where possible. The impact on water resources is expected as short term but medium sensitivity of the receptor, the impact during the construction phase is evaluated to be of *medium-low* significant.

Impact	Stress on water resources					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Community close to the project footprint area					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium-low</i>					

- **Mitigation Measures**

Following mitigation measures will be implemented to mitigate the impact on water resources.

- Use the surface water as much as possible;
- Aware the construction worker to avoid the misuse of water;

- Reuse the water where possible.

5.4.9 Social Impacts

- **Sources of Impact**

The area affected by the proposed project during construction and area occupied for the construction equipment, the pipeline trenches, area for storage facilities, pumping station, labour camps areas etc. Based on the assessment of above activities and in consultation with the different stakeholders, the following impacts are being envisaged for the construction phase of the project.

- **Impact Significance**

A. Impact on Employment

Employment generation will be a significant contribution of the project, especially considering that the employment scenario in project area. The project is expected to maximum employee 600 un-skilled and semi-skilled labors during the construction phase. The civil works will be done through experienced sub-contractors. Hence, most of the employment will be provided through sub-contractors.

The construction phase activities will facilitate intermixing of local workforce (mostly unskilled) with the migrant workforce (mostly skilled). Also, in addition to that, on the job skill enhancement associated with technical detailing and designing, health and safety, work based skills, etc. will also enhance the skills of the local workforce. The transfer of knowledge will not only be limited at the level of the workforce but also at the level of the contractors and sub-contractors who would benefit from it. Considering the potential for employment generation and skill enhancement, the significance of the employment generation is summarized below.

Impact	Employment Opportunity					
Impact Nature	Cumulative					
Impact Scale	Fenchuganj and extent to Sylhet					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium-high</i>					

B. Impact on Local Enterprises

Local enterprises, particularly those involved in the production and sale of construction materials, material suppliers are potential benefactors of the civil works involved in the project. Local market, business man and shop owners will also be benefited from the construction activity as a considerable number of man power will engage this project.

C. Impact due to Labor Influx

The total labor requirement has been estimated approximately 670, it is expected that 30-40% would be sourced from other parts of Bangladesh. The migrating labor population will primarily consist of more skilled labor workforce while unskilled workforce would be mostly procured locally through local contractors. The labor influx will be for short term and they would return back to their home provinces at the end of construction period. Some construction labor will stay inside the plant area and maximum number will stay at rented building with proper sanitation facility and security which is walkway distance from the plant site. Though the location of the labor camp will significantly reduce the interaction of the migrant labor force with local community, improper management of labor and human relations, competition for sharing resources and facilities with the local laborers, disregard for local customs and traditions may cause conflict situations. The influx of labor also raises other challenges such as health related issues (including sexually transmitted and communicable diseases), unhygienic conditions in constructed labor camps, strain on local food produce available in the local markets etc. However, considering the fact that proper accommodation facilities are provided as part of the project design and also the fact that the total migrant labor will account for only 30 to 40% of the total workforce of 670 and the severity of the impacts raised above is expected to be *Medium-Low*.

Impact	Impact due to labour influx					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Surrounding community will be impacted due to the labour influx					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium-low</i>					

• Mitigation Measures

The following mitigation measures are proposed to avoid impact due to labor influx:

- Preventing stress on local infrastructure by providing labor related infrastructure such as camps, sanitation facility, drinking water facility, etc. in accordance with local regulations as well as IFC handbook for labor accommodation;
- Ensure proper administrative channel to manage labor related statutory compliance, such as payment of wages, provident fund, insurance etc. as well as labor issues arising during the construction phase activities;
- Manage illegal labor practices such as child labor, bounded labor or forced labor through internal vigilance mechanisms and surveillance; and
- Awareness shall be generated amongst migrant laborers in maintaining congenial relations with local laborers as well as community.
- Engage as many locally available unskilled, semi-skilled and skilled human resource

- as practically possible to avoid large scale in migration of labour force;
- Provision of infrastructure and amenities for migrant labour in construction camp to avoid dependence on limited local resources;
 - Adequate sanitation facility at labour camps to maintain hygiene and minimise spread of diseases;
 - Creating awareness about local tradition and culture among outside migrant and encouraging respect for same;
 - Providing awareness training regarding sexually transmitted diseases among the migrant population;
 - Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area;
 - Avoid unnecessary movement of vehicles through settlement areas to avoid disturbance and traffic safety related issues.

5.5 Identification of Potential Impacts during Operation and Maintenance Phase

The assessment of operational phase impacts includes those arising both from routine operations and maintenance of the KPCL power plant. An activity impact interaction matrix for the operation phase of the project is presented in **Table 5-2**.

Table 5-2: Activity-Impact Interaction Matrix for Operation Phase of the Project

Activity \ Potential Impact/Risks	Surface Water Quality/Quantity	Ground Water Quality/Quantity	Soil / Sediment Quality	Air Quality	Climate Change	Noise & Vibration	Drainage Pattern	Transportation	Occupational Health & safety	Community Health & Safety	Infrastructure & Services	Terrestrial Ecology	Aquatic Ecology	Socio-economic
	Operation Phase													
Air emissions from stacks of the plant				√					√	√		√		
GHG emission					√									
Noise generation due to operation of plant and auxiliaries						√			√	√		√		
Water demand for plant operations		√												√
Wastewater discharge/disposal	√	√	√										√	
Wastes - domestic waste and other non-hazardous wastes handling, storage	√		√									√	√	
Hazardous material and waste storages	√	√	√						√	√				√
Natural gas transportation by pipeline										√				√
Transportation of personnel, raw material/s and disposal of wastes				√		√		√		√				
Employment														√

5.5.1 Impact on Soil

- **Sources of Impact**

The potential sources of wastes during operation of the power plant are as follows:

- Office and kitchen,
- Dewatered sludge from the WTP, ETP and STP sludge and
- Air filters from the gas turbines
- Chemical waste generated,
- Chemical Cleaning waste from the CT compressor,
- Waste/used oil from the power house and workshop,
- Oil/dust contaminated cloths and rags from the lube oil system and spill kit waste,
- Power house and workshop area.

- **Impact Significance**

Land in and around the Project site are mostly industrial, agricultural and water body. Kushiara River is located adjacent to the west side of the project area. Improper storage, handling and disposal of solid and hazardous waste may lead to contamination of the land and water bodies nearby. In addition, waste can generate odor and cause health hazards to employees and communities nearby.

The unplanned storage and disposal of these wastes may have a direct impact on land and water resources. The solid and non-hazardous wastes generated from the various areas during operations will be collected and segregated at the point of generation and stored in proper designated areas and disposed of through waste disposal contractors or authorized recyclers. These hazardous wastes, if haphazardly stored, may be incompatible in nature and can result in ignition, generation of toxic fumes etc. In addition, improper handling, storage and disposal can cause spillage or leachate generation, which in turn can contaminate the land and ground water.

It is planned that hazardous wastes generated from the proposed Project will be collected and stored in designated roofed-areas and/or barrels with concrete flooring and secondary containment and disposed of/ sold through contractors or treated prior to discharge.

Given the controls in place, i.e. segregation measures, collection and disposal by licensed waste collectors, dedicated storage areas with secondary containment, the impacts during operation as a result of solid and hazardous waste generation is assessed as *Low*.

Impact	Impact on soil quality due to waste generation					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	in and around the project site					
Frequency	Limited to operation phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	

Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation Measures**

In addition to the proper collection, storage and disposal options the following steps will be taken further to manage hazardous wastes:

- Wastes will be stored in a manner that will prevent contact between incompatible wastes i.e. post compatibility checks,
- Proper labelling of hazardous wastes;
- Special care will be taken in the storage areas to prevent any spillage of hazardous wastes and restrict access (except for trained staff) to such areas;
- Periodic audits will be carried out for such areas and containers; also on the segregation and collection systems and the findings will be documented and appropriate action taken against irregularities;
- A spill response plan and emergency plan will be prepared to address accidental spillages or release of hazardous wastes; and
- A proper manifest record will be maintained of waste travelling/ removed from the site.

5.5.2 Impact on Water Resources

- **Sources of Impact**

The potential sources of impact on surface and ground water resources during the operational phase are:

- The discharge of effluent and sewage from the operational plant that may have an impact on the quality of surface water; and
- The abstraction of ground water for plant operation and drinking purposes for the employees of the power plant.

- **Impact Significance**

A. Impact on Surface Water due to Wastewater Discharge

Approximately 47.5 m³/hr of effluent will be generated during the power plant operation of which some water will be used for gardening and discharged from the plant to the Kushiara River after treatment. The sources of liquid effluent generation in the Plant include:

- Oily effluents from Steam turbine building, Combustion turbine building, Transformer yard of CTG and STG, Compressor and CCW pump house, Emergency DG set area, HSD Storage Tank Farm;
- HRSG blow down;
- Sampling rack waste;
- CTG auxiliary CTBD;
- CTG washing;
- HRSG washing;
- Filters (service water filtration plant) back wash; and
- CW side stream filter backwash.

These discharges may have a direct impact on the water quality which in turn would have ecological implications. All the wastewater generated at various areas of the project will be segregated at the source of generation according to their type. Similar wastewater types will be collected at one point before treatment and then treated to meet the requirements for disposal or reuse as per the GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements.

In addition, instrumentation will be used to monitor the Plant's compliance with discharge limits. In the event that effluent discharge is detected above the effluent discharge limit criteria, isolation valves will automatically close and stop the discharge. The overall impact to the surface water quality with the treatment prior to disposal on land and water body is assessed as *Low*.

Impact	Wastewater Discharge in Surface Water					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Surface water quality of the Kushiara River					
Frequency	Throughout the operation phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

B. Impacts on Aquatic Flora and Fauna due to discharge of Water in Kushiara River

Water is mainly required for cooling purposes in the project which will be sourced from underground and discharged after treatment. The discharged effluent characteristic shall be in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements and World Bank/IFC guidelines. The project has a raw water requirement of about 243.3 m³/hr, whereas the outfall is expected to be 47.5 m³/hr. The cooling tower blow down and other treated effluent generated from boiler blow down, effluent treatment plant and DM plant will be used in gardening and rest water will be discharged on Kushiara River. Dispersants and algacides will have to be added in the cooling water to prevent fouling of the heat exchangers and piping. It is proposed to use non-toxic and heavy metal base free dispersants and algacides in the project. The Kushiara River has sufficient water for dilution therefore the impact of the discharge on aquatic flora and fauna is considered as *low*.

Impact	Discharge of cooling water				
Impact Nature	Direct	Indirect			Induced
Impact Scale	Surface water quality of the Kushiara River				
Frequency	Throughout lifecycle of the power plant				
Extent and location	Project Site	Local	Regional	National	Trans boundary

Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation Measures**

The following mitigation measures are suggested to minimize the impact on Kushiara river water quality;

- Monitoring of temperature at the discharge point at a frequency of every 15 days;
- Discharge system shutdown in event that discharge temperature of effluent exceeds standard;
- Efforts to be made to increase the cycle of concentration to reduce the volume of blow down and consequently the volume of make-up water required by the cooling tower.
- Storm water drainage and waste water of similar nature from different units will be treated in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements and World Bank/IFC guidelines.

C. Impact due to Groundwater Abstraction

The safe operation of the plant requires 234.3 m³/h of water for cooling purposes which will be fulfilled through pumping of multiple wells at the site. This added stress to the underlying aquifer will result in a lowering of water table through continuous abstraction during its operational cycle and will consequently affect well yield.

Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes. As the ground water abstraction is 234.3 m³/h and the aquifer is replenished fully by the Kushiara River during the monsoon. Whatever minimal permanent lowering of water table does occur, will ultimately be contained within the vicinity of the plant area thus having little to no impact on the regional subsurface flow system.

A license for groundwater abstraction good installation will be sought from the Fenchuganj Upazila Parishad prior to installation. The quantity of groundwater abstracted and associated draw down will be monitored. This will enable early identification and control (e.g. stop abstraction) in the event that any adverse observation to the groundwater table is made. Any impact would be short term, reversible and localized in nature.

Water requirement for the proposed power plant is 234.3m³/hr and source of the water will be ground water. A ground water modeling and aquifer test for the power plant was conducted on July 2016. Detail ground water modeling report has been attached in Annex F. The study was conducted on the basis of historical water level data of Kushiara River as well

as three test borehole in the project site and surroundings. Also consider the existing borehole data of the nearest BPDB power plant.

Analysis of river stage data from 1948 to 2015 indicated that the water level reaches to the highest elevation of about 11m in the month of August or September. From the end of September or from the beginning of October the water level starts to decline. Minimum elevation of water level is about 3m above PWD datum which occurs mostly in March. Generally, the water level in the river starts to rise in April. By June the river water level rises to about 9 to 10m above PWD datum.

The study area is underlain by a good aquifer system. Four exploratory bore holes were drilled to find out the aquifers with substantial vertical and horizontal extents. Two bore log data of pre-existing test wells were also used to depict the geometry of aquifers. **Figure 5-1** gives the location of bore holes in the project area.

For conducting pumping test DTW-1 of 153.3 m (503 feet) depth was constructed. Calculated maximum depths to water level (**D_{max}**) in DTW-1 for pumping at the rate of 100m³/hour, 150m³/hour and 200m³/hour for one year are: 27.4m, 33.1m and 38.8m respectively.

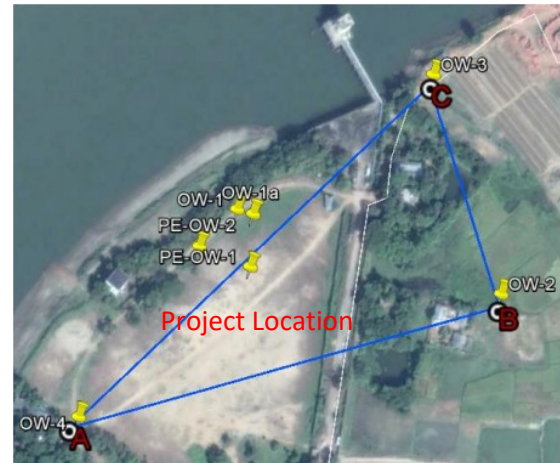


Figure 5-1: Location map of test bore holes

It is recommended that the safe depth for installing submersible pump is **180 feet** (54.8m) below the top of well casing of the well. Discharge rate of **150m³/hour** has been suggested the maximum long-term safe yield for this well based upon the analysis of the step drawdown test data. A pump of this discharge capacity is selected in this study.

Taking into consideration of the model predictions it has been recommended from this study that three pumping wells of cumulative discharge of 234.3m³/hour can be set up within the Kushiara 163 MW Combined Cycle Power Plant area. However, locating all the pumping wells within KPCL Project site will cause well interference. But supply of desired volume of water will not be hindered if DTW-2 and DTW-3 abstract water from deeper aquifers. Two new production wells (DTW-2 and DTW-3) should be drilled up to 850 feet below ground level to tap the deeper aquifers. Site specific well design for each well will be required.

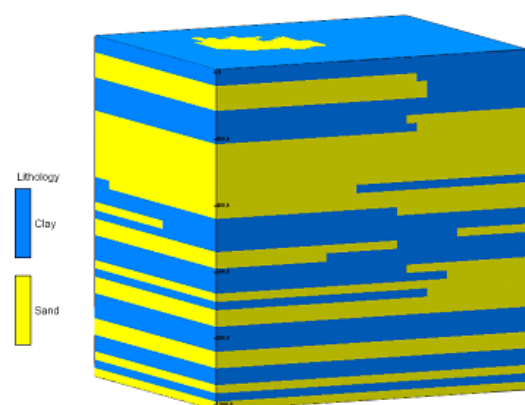


Figure 5-2: 3D Model of the Aquifer System of the Project Area

As the ground well groundwater aquifer is available after 100 ft in the project area and the project will pumping one well at 503 ft depth and other two wells at 850 ft depth. Local community will get water at 100 ft depth. So, 234.3 m³/hr water withdrawals for the proposed power plant will not cause any impact to local community for getting ground water even during dry period. The overall significance is therefore assessed as **Low**.

Impact	Impact due to ground water abstraction						
Impact Nature	Direct	Indirect			Induced		
Impact Scale	Surrounding community of the project site						
Frequency	Throughout the project lifecycle						
Extent and location	Project Site	Local	Regional	National	Trans boundary		
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation		
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High		
Potential for irreplaceable loss of resources	Low		Medium		High		
Magnitude	Insignificant	Low	Medium-low	Medium - high		High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite		
Impact Significance	Very low	Low	Medium-Low	Medium-high		High	Very High
	Significance of impact is considered as <i>low</i>						

D. Groundwater contamination

There is a risk of impacts to groundwater quality from the storage and handling of hazardous materials in the Project AOI. The hazardous materials to be stored at the site will include acids, ammonia, diesel fuel, maintenance oils and lubricants, hydrazine hydrate etc. for the water treatment plant, process plant operation, and the laboratory. The hazardous materials will be stored in a dedicated room at the water treatment plant area. The storage arrangements will include secondary containment measures and spill kits for spillage control. Given the control measures which will be implemented during operations, and adequate training of operational staff in spill response measures, the impact to groundwater from the plant operations is assessed as **very low**.

Impact	Impact on ground water quality due to contamination					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	In and around the project area					
Frequency	Throughout the project lifecycle					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>very low</i>					

- **Mitigation Measures**

The following mitigation measures will be followed to minimize the impact on ground water resources.

- Periodic Monitor the ground water level;
- If the local community do not get water during the dry period KPCL need to be install a deep tube well for the local people to serve the water for community peoples;
- For minimising use of antifouling and corrosion inhibiting chemicals appropriate depth of water intake will be maintained and use of screens will be ensured;
- Waste storage areas will be equipped with secondary containment and spill control measures (similar to the hazardous material storage areas) to limit impact to ground;
- Liquid wastes such as waste oil, etc. will be collected and stored for recycling in cemented areas; and
- All drainage/tanks, etc. will be positioned on concrete hard standing to prevent any seepage into ground.

5.5.3 Impact on Air Quality

• Sources of Impact

The Project includes one CCGT, consisting of 1 gas turbine (GT) in simple cycle, 1 HRSG and 1 Steam Turbine. The SCGT is already in operation the CCGT will be operational by the end of December 2017.

The gas turbine will be equipped with a set of dampers which will allow the turbine to operate in simple-cycle or combined-cycle mode. The bypass damper will control the flow through the bypass or simple-cycle stack, and the isolation damper will control flow through the HRSG. During start-up operations as well as during simple cycle operation, the isolation damper will be closed; preventing flue gas flow through the HRSG, and the bypass damper will be open, allowing flue gas to exit through the bypass stack. Once the turbine has completed start-up procedures the isolation damper will be opened and the bypass damper will be closed redirecting flue gas flow through the HRSG. The hot flue gas will heat boiler feed water to produce steam, which will be used to drive a steam turbine to produce more electricity in combined cycle operation. In the combined cycle operations, the flue gas will be allowed to exit through the main stack. Considering the plant running in combined cycle (during normal operations after commission of combined cycle system), one scenarios was modelled as part of the impact assessment on air quality due to the Project.

The operation of the plant in combined cycle will generate flue gas emissions containing NO_x and CO. Emissions of SO₂ are likely to be negligible, as natural gas typically has a low sulphur level (as per the gas specification). Particulate emissions are likely to be negligible; as natural gas is a gaseous fuel (there is no supplementary fuel to be used in the GT). It is noted however that particulate emissions (<1 µm diameter) in the form of unburnt hydrocarbons and Volatile Organic Chemicals (VOCs) such as benzene and formaldehyde, can be released if poor air/fuel mixing and the incomplete combustion of the fuel source occurs.

Summary of Emission Sources and Emission Rate

The emission source during the operation of the Plant will be either the bypass stack (simple cycle operation) or main stack (combined cycle operation). The emissions from each stack based on the simple/ combined cycle operation along with stack parameters are presented in Table 5-3.

Table 5-3: Emission Parameter for the Proposed Power Plant

Stack	UTM Coordinate		Stack Height (m)	Stack Inside Diameter (m)	Flue Gas Exit Velocity (m/s)	Flue Gas Temperature	Emission Concentration				Emission Rate	
	Easting	Northing					NOx		CO		NOx	CO
							ppm	mg/N m ³	ppm	mg/N m ³	g/s	g/s
Bypass Stack (S1)	390562.79	2730963.90	40	5.694	40	560	25	51	9.5	11.7	40.04	9.18
Main Stack (S2)	390557.30	2730946.98	60	5.18	25	100	25	51	9.5	11.7	36.03	8.27

* UTM Zone- 46

Prediction of Impacts

Impacts due to the operation of plant were assessed by modelling projected emission rate (Table 5-3) of the plant operation by modelling in the AMS/EPA Regulatory Model (AERMOD). 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 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 receptors, 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

Household are present south-western side of the project site as well as four power plant are located within the 1 km area at south-east direction. No urban area is located within 5 km whereas semi urban area located around 2.3 km away from the project site. A fertilizer factory is located around 3.70 km away from the project site. Based on this, the Project site and its surroundings have been considered as 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, 8-hourly, daily and annual average pollutant concentrations around the Project site.

Terrain Data: Terrain data for the AERMAP model were taken from the 90 m SRTM database, while land cover data was sourced from satellite imagery of the Project site and its surroundings.

Receptors: The receptor grid or network, defines the locations of predicted air concentrations used to assess compliance with the relevant standards or guidelines. The following comprehensive fine and coarse receptor network was used for this analysis:

- 250 m spaced receptors along the project boundary up to 3.0 km; and
- Cartesian receptors located within the study area, where baseline monitoring was carried out during the study period.

This network used Cartesian (X, Y) receptors with UTM coordinates. Base elevation of all the receptors were found using terrain elevations interpolated from SRTM (~90 m) Digital Elevation Model (DEM) data. The discrete Cartesian receptor locations have been presented in Table 5-4.

Table 5-4: Receptor Location with Respect to the Project

Sl.	Receptor Name	Station Code	Geographic Location*	Elevation (m)	Distance from Project Boundary (m)	Direction from the project area
1.	Adjacent to the project site	AQ1	390640.75 E 2731118.16 N	19.0	30	N
2.	In front of Adarsha Gram Primary School	AQ2	390364.41 E 2730646.60 N	17.25	250	SW
3.	In front of Abdul's House	AQ3	390174.05 E 2731376.79 N	15.74	500	W
4.	In front of Abdus samad house	AQ4	392147.99 E 2731220.18 N	19.46	1500	E

*UTM Zone 46

Modeling Results

Predicted maximum pollutant concentrations due to the project in the study area have been presented in Table 5-5.

Table 5-5: Summary of Air Quality Dispersion Modeling Results

Scenario	Pollutant	Averaging Period	Predicted Concentration ($\mu\text{g}/\text{m}^3$)					Max. Background Concentration*					Total Concentration (Predicted+Background) ($\mu\text{g}/\text{m}^3$)					Bangladesh Standard ($\mu\text{g}/\text{m}^3$)	WHO Standard ($\mu\text{g}/\text{m}^3$)
			Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4		
KPCL (CCGT)	NO _x	1-hourly	29.34	21.90	22.13	23.57	17.66	-	-	-	-	-	-	-	-	-	-	-	200
		24-hourly	9.14	5.16	4.55	6.37	5.42	43.8	43.8	42.3	35.8	18.7	52.94	48.96	46.85	42.17	24.12	-	-
		Annual	1.58	1.21	1.05	1.18	0.90	-	-	-	-	-	-	-	-	-	-	100	40
	CO	1-hourly	7.08	5.46	5.37	5.74	4.34	-	-	-	-	-	-	-	-	-	-	40000	-
		8-hourly	5.60	3.19	3.13	4.03	2.84	2350	2350	2200	1850	1230	2355.6	2353.19	2203.13	1854.03	1232.84	10000	10000

*baseline concentrations refer to Table 4.1

It is evident from the above table that the maximum ground level concentration in the study area will be well within the applicable national as well as international standards (WHO) for air quality in the CCGT scenario. The concentration isopleths of NO_x and CO for different averaging periods without baseline concentrations have been presented from Annex G. On this basis, the potential air quality impacts due to the operation of the Plant are predicted to be *low*.

Impact	Ambient Ai Quality					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Maximum impact zone would be confined to 3km from Project Site					
Frequency	Throughout the project lifecycle					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>low</i>					

- **Mitigation Measures**

To ensure compliance with the air emission criteria for flue gas stacks the following measures will be implemented during operations:

- Periodically monitor the ambient air quality and stack emission

5.5.4 Impact on climate due to Green House Gas Emissions

The Kyoto Protocol – United Nations Framework Convention on Climate Change nominates the following GHGs:

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Nitrous Oxide (N₂O);
- Hydrofluorocarbons (HFCs); and
- Perfluorocarbons (PFCs).

Inventories of GHG emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO₂e). Gases are converted to CO₂e by multiplying by the gas global warming potential (GWP). The GWP of gases are as follows²:

- GWP for CO₂ = 1
- GWP for CH₄ = 21
- GWP for N₂O = 310

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred in terms of CO₂-equivalent (CO₂e) emissions.

GHG Estimation and Impact

The combustion of natural gas produces GHGs. The amount of GHGs emitted by a power plant is a measure of its contribution to global warming and can be estimated based on fuel

²Source: Intergovernmental Panel on Climate Change (IPCC) (1995), Second Assessment Report

consumption. In order to estimate GHG emissions, the IFC recommended Carbon Emission Estimation Tool (CEET model – Version February 2014)³ has been used as set out below.

Table 5-6: Estimated GHG Emissions from the Plant SN Particular Value Unit

Sl.	Particular	Value	Unit
A*	Net Heat Rate (Natural Gas Turbine)	9521	KJ/KWH
B*	Gross Generation Capacity (Turbine)	115430	KW
C	Operating Days	330	days
D	Daily Operating Hours	24	Hours/day
E	Total Annual Output(= B x C x D)	914205600	KWH
F	Annual Fuel Consumption (= E x A)	8.70415 x 10 ¹²	KJ
		8704.151518	TJ
G*	Annual GHG Emission in Gas Turbine	491,732	tCO ₂ e/year

* Based on natural gas specification provided by KPCL

It is evident from Table 5-6 that the estimated GHG emissions from the Plant while using natural gas as primary fuel will exceed the threshold of ADB SPS (100,000 tons CO₂e per year) and of IFC PS3 (25,000 tons CO₂e per year) that define them as significant GHG emission sources. Therefore, the Project is required to report annual GHG emissions.

As per the latest report (26 December 2012) of GHG emission submitted by Bangladesh to the United Nations Framework Convention on Climate Change (UNFCCC)⁴, electricity generation sector contribution to GHG emission in year 2005 was 1.192 x 10⁷ tons CO₂e and projection of aggregate GHG emissions using LEAP modelling program indicates that the annual GHG emissions from this sector in year 2020 and 2030 will be 2.752 x 10⁷ tons CO₂e and 5.9168 x 10⁷ tons CO₂e, respectively. Taking this into consideration, GHG emission contribution of the proposed Project in the year 2020 will be 1.7% of the electricity generation sector in Bangladesh. Considering this fact, the GHG emission impact will be *medium low*.

Impact	Impact on climate due to greenhouse gas emissions					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	impact zone will be regional/national					
Frequency	operation phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>medium low</i>					

- Mitigation Measures**

The following mitigation measures will minimize GHG emissions to ALARP levels:

³http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/CB_Home/Measuring+Reporting/

⁴<http://unfccc.int/resource/docs/natc/bgdnc2.pdf>

- Ensure that all equipment and machinery is maintained in accordance with manufacturer's specifications;
- Higher efficiency steam turbine blade design and
- Improved efficiency of auxiliary drives.

5.5.5 Impact on Ambient Noise Level

- **Sources of Impact**

For gas based power plant, the major noise sources during base load operation are the air-cooled condenser (ACC) or cooling tower, steam turbine generator (STG), combustion inlet filter house, and the exhaust stack or heat recovery steam generator (HRSG). During start-up or other transient conditions in combined cycle configurations, the high-pressure steam piping and condenser is a major noise producer, with steam bypassing the STG. The combustion turbine and generator (CTG) are typically housed in acoustical enclosures, thereby dropping their respective noise source ranking. Other balance-of-plant (BOP) equipment also generates noise. The cumulative effects of fuel gas compressors, air compressor skids, boiler feed water pumps, lube oil coolers, and other equipment may affect far-field noise levels.

- **Prediction of Impact**

The nearest noise receptor is located within 50m from the project boundary in the western and north-east side. In addition, the nearest noise sensitive receptor (mosque) is located adjacent to the western boundary. It is planned that the project will meet the noise emission criteria specified in the GoB ECR, 1997 and WB/IFC EHS Guidelines, as presented in Table 2-15 and Table 2-16.

Methodology:

The environmental noise prediction model SoundPLAN 7.4 was used for modeling noise emissions from the power plant operation. The major noise sources are GTG, STG, Heat recovery steam generators, cooling tower. We have taken two types of noise area in the modeling calculation. Major noise generating sources GTG, STG, HRSG etc are considered as area source with a standard noise generating level 85 dB(A) and cooling tower as separate noise area sources of noise level 70 dB(A). Operation of equipment with 100% usage scenario was modeled to cover the operation phase of the Project. As a conservative approach to the assessment, atmospheric absorption during sound transmission was not included in the assessment. In addition, to represent a worst-case scenario for the assessment, all equipment was assumed to be operating simultaneously. In order to assess the impact on noise reflection/ barrier due to the structures, buildings within the power plant complex and boundary wall have been taken into consideration.

Predicted Noise Levels at Receptors

The predicted noise levels around the power plant are shown in Table 5-7. Predicted noise levels at 7 receptors (where baseline noise levels were also monitored) have been presented in Table 5-7.

Table 5-7: Predicted Noise Levels at Noise Receptors during Operation Phase of KPCL

Recept or Code	Location Setting	Distance from plant center point (m)	Baseline Sound Pressure Levels at Receptors, Leq (dBA) ¹		Predicted Sound Pressure Levels at Receptors, Leq (dBA)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard, dB(A) ² as per Zone		Applicable Standard, dB(A) ³ Zone	
			Leq _d	Leq _n	Leq _d	Leq _n	Leq _d	Leq _n	Day	Nig	Day	Nig
NL1	Industrial	105	64.77	59.62	68.1	68.1	69.76	68.68	75	70	70	70
NL2	Industrial	92	61.31	57.5	66.9	66.9	67.96	67.37	75	70	70	70
NL3	Industrial	56	63.42	58.94	77.8	77.8	77.96	77.86	75	70	70	70
NL4	Residential	1630	50.23	43.3	42.9	42.9	50.97	46.11	55	45	55	45
NL5	Commercial	2600	61.17	53.6	36.7	36.7	61.19	53.69	70	60	-	-
NL6	Mixed	73	62.71	57.82	63.5	63.5	66.13	64.54	60	50	-	-
NL7	Residential	330	63.11	60.45	57.2	57.2	64.10	62.13	55	45	55	45

¹⁾ Ambient noise levels as monitored during the baseline survey

²⁾ Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

³⁾ IFC/WB EHS Guidelines: Noise Management dated April 30, 2007, Noise level guidelines for Residential; institutional and educational receptors in daytime (07:22:00) and night time (22:00-7:00) as 55 and 45 one hour Leq dBA respectively. For industrial and commercial receptors it is 70 one hour Leq dBA for both night and day time.

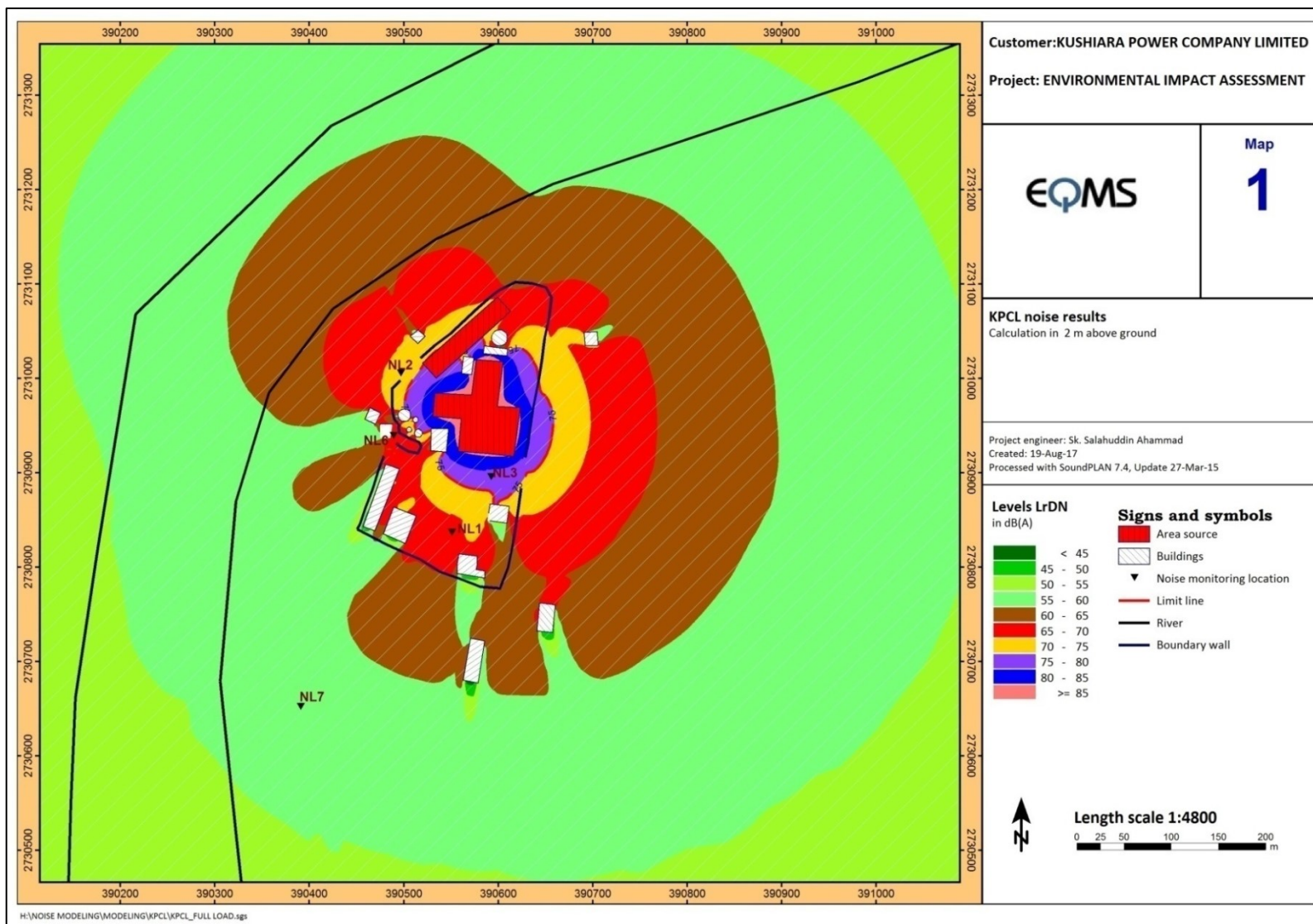


Figure 5-3: Predicted Operation Phase Noise Levels of KPCL project

The noise level at NL1 is within the standard of DOE/IFC for industrial area. Although receptor point at NL1 is within the plant boundary predicted noise level is also less than permissible limit. However, NL3 located close to the noise sources has cross the permissible limit. The predicted noise level at NL4 residential receptor is slightly high due to the traffic movement as well as power plant has little contribution. At NL5 noise level is high due to excessive traffic movement in the road crossing. Receptors may receive excessive noise due to operation of the existing heavy power plants near KPCL. Boundary fence are already in place to reflect noise and the building structures will provide barrier to the noise and further noise will also be attenuated with distance. Therefore, the impact has been estimated as *medium low*.

Impact	Impact on ambient noise level due to Power plant operation					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around project site					
Frequency	Limited to operational phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Medium Low</i>					

- **Mitigation Measures**

Noise level in operational phase of the power plant can be controlled if the following measures will be taken:

- Selection of equipment with lower sound power levels (< 85 dB);
- Installation of mufflers on engine exhausts and compressor components;
- Installation of acoustic enclosures for equipment (e.g. gas turbine, compressor) casing radiating noise;
- Buildings will be designed with improved acoustic performance and sound insulation will be provided;
- Installation of acoustic barriers without gaps and with a continuous minimum surface density in order to minimize the transmission of sound through the barriers;
- Barriers will be located as close to the source, as far as practicable, to be effective;
- Periodic ambient noise monitoring is suggested as part of the EMP to monitor the noise levels and
- A noise analysis of all major plant components will be carried out during commissioning of the plant to ensure compliance with the specification and guaranteed performance.

5.5.6 Impact on Ecosystem

- **Sources of Impact**

The following activities will be impacted on the flora and fauna during the operation of the project.

- Operational noise of the power plant
- Disposal of cooling water discharge on land and water

- **Impact Significance**

A. Impact on Terrestrial Flora and Fauna

The assessment of the potential impacts to the flora and fauna has considered the Sch. I-III of Bangladesh Wildlife Prevention Order, 1973. The impact will be mainly on the terrestrial flora and fauna within the project site and its surrounding. The impact on terrestrial flora and fauna will negligible as the project will be running on natural gas. The avifauna will be impacted due to the noise generation from the power plant operation. There is no significant avifauna in the project site according to the IUCN red list. Noise levels due to the operation of power plant will be in the range of 85 dB (A) at a distance of 1 m from the source however it may further attenuated to 70 dB (A) at plant boundary and further 50 dB (A) at the nearest habitation. The background noise level of the project site is high as there are another four power plants are in operation. Incremental noise may have significant impact on avifauna around the project site and force them to avoid power plant area and migrate to other part of the project AOI. There is no ecological sensitive are like national park, reserve forest, Eco Park, wildlife sanctuary in and around the project site therefore the impact on terrestrial flora and fauna has been assessed as *low*.

Impact	Incremental noise levels due to the operation of power plant					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Limited to project site and immediate surroundings					
Frequency	Operational phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation Measures**

The following mitigation measures are suggested to minimize the impacts:

- Noise levels must be attenuated to the extent possible by proper lubrication of machinery and equipment and installation of noise barriers/acoustic enclosures at source/s of higher noise (i.e. > 85 dB);
- Habitat improvement in form of dense plantation with native species along the boundary and the vacant land in the power plant area. This shall improve the habitat conditions for the avifauna and mammalian fauna in the project AOI; and
- Minimizing the secondary sources of noise generation such as vehicle noise and other operation and maintenance.

B. Impact on Aquatic Flora and Fauna

Water is mainly required for cooling purposes in the project which will be sourced from underground and discharged after primary treatment. The discharged effluent characteristic shall be in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements and World Bank/IFC guidelines. The project has a raw water requirement of 234.3

m³/hr, whereas the outfall is expected to be 47.5 m³/hr. The cooling tower blow down and other treated effluent generated from boiler blow down, effluent treatment plant and DM plant will be used for gardening and discharged on Kushiara River after treatment. This discharge will be having about <3°C of intake water temperature at the outlet of condenser. Dispersants and algaecides will have to be added in the cooling water to prevent fouling of the heat exchangers and piping. It is proposed to use non-toxic and heavy metal base free dispersants and algaecides in the project.

Elevated temperature typically decreases the level of dissolved oxygen (DO) in water. The decrease in levels of DO can harm aquatic animals such as fish, amphibians and planktons. Temperature increase may also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time. An increased metabolic rate may result in food source shortages, causing a sharp decrease in a population. Changes in the environment may also result in a migration of organisms to another, more suitable environment and to in-migration of fishes that normally only live in warmer waters elsewhere.

Increased temperature may lead to the replacement of species with warm water species. The indirect detrimental impact on the fishes and other life forms due to elevated temperature levels is decrease level of dissolved oxygen in the aquatic ecosystem. Impact of elevated temperature due to discharge cooling water is also reported to be lethal to the larval stages. The discharge of cooling water will be into the adjoining Kushiara River which has sufficient water for dilution therefore the impact on aquatic life has been assessed as low.

Impact	Discharge of cooling water in the Kushiara River					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	Outfall point					
Frequency	Operational phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>Low</i>					

- **Mitigation measures:**

The following mitigation measures are suggested to minimize the impacts:

- Monitoring of temperature at the discharge point at a frequency of 15 days;
- Efforts to be made to increase the cycle of concentration to reduce the volume of blow down and consequently the volume of make-up water required by the cooling tower.
- Storm water drainage and waste water of similar nature from different units will be treated in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements and World Bank/IFC guidelines.

5.5.7 Community Health and Safety

- **Sources of Impact**

The following sources may impact on the community health and safety.

- Vehicle movement during the plant operation and maintenance;
- Natural gas pipeline leakage;
- Leakage of fuel Diesel, Hydrochloric acid, Sulphuric acid storage tank;
- Accident during the operation and maintenance activities

- **Impact Significance**

During the operation phase of the Project, the regular traffic and transportation will be limited to the movement of plant personnel and contracted workers during their working shifts. As the total manpower, will be limited to 50-60 who will work in shifts, their transportation will not lead to any impact on road safety of the nearby communities using the access road. Considering these facts, impact due to traffic movement during operation phase will be *very low*. The impact due to the leakage of the gas pipeline and chemical storage tank will be significant if proper management would not be taken place. Adjacent community is the vulnerable group of the accidental event. Proper maintenance and regular inspection will be taken for minimize such event as a result the impact has been assessed as very low.

Impact	Accidental event due to the gas pipeline leakage and chemical storage tank					
Impact Nature	Direct	Indirect			Induced	
Impact Scale	In and around the project site					
Frequency	Operational phase					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent - Mitigated	Permanent - no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium - high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact is considered as <i>very Low</i>					

- **Mitigation Measures**

In order to minimize the risk of industrial accidents and fatalities to workers during operations, the following mitigation measures are proposed:

- On job training for the workers shall be carried out;
- Work permit system shall be followed;
- PPE shall be provided and use of PPEs shall be enforced;
- The Project will adopt a total safety control system, which aims to prevent the probable accidents such as fire accidents or chemical spills;
- Firefighting systems, such as sprinklers, portable extinguishers (appropriate to the flammable hazard in the area) and automated fire extinguishers will be provided at strategic locations with clear labelling of the extinguisher type. A main hydrant will also be available around the buildings. An automated fire detection system will be in place on all

floors;

- The site operations manager will take steps to train all emergency team members and will draw up an action plan and identify members. The appointed emergency controller role will be in-charge at the site in the event of incident control;
- The staff will be trained for first-aid and firefighting procedures. The rescue team will support the first-aid and firefighting team;
- A first-aid centre with the trained personnel;
- Training and rehearsal of the emergency response procedures by the emergency team members and personnel on site will be completed periodically;
- A safe assembly area will be identified and evacuation of the premises will be practiced regularly through mock drills;
- A safety manual for storage and handling of Hazardous chemicals will be prepared and implemented;
- All the personnel at the site will be made aware about the hazardous substance stored and risk associated with them.
- Personnel engaged in the handling of hazardous chemicals will be trained to respond in the unlikely event of an emergency;
- A written process safety information document will be compiled for general use;
- Material Safety Data Sheet (MSDS) will be made available and displayed at prominent places throughout the Plant, e.g. Process areas and hazardous material storage areas;
- Safe work practices will be developed to provide for the control of hazards during operation and maintenance;
- In the material storage area, hazardous materials will be stored based on their compatibility characteristics;
- Safety measures in the form of DO and Don't Do will be displayed at strategic locations;
- Firefighting system will be tested periodically ; and
- All hydrants, monitors and valves will be visually inspected every month.

5.5.8 Social Impact

The operation phase impacts are associated with the operation and maintenance of the power plant. Hence, they may occur frequently for a fairly long time. The possible range of social impacts is discussed in sub-sections below.

A. Employment Generation and In-Migration of Skilled workforce

The workforce requirement in operation phase requires approximately 50-60 un-skilled skilled, technical, professional and executive staff and 10-15 un-skilled person. The nature of employment also changes from temporary contract workers to long-term workers or permanent staff members. This includes technical or executive staff that can be sourced from different parts of the country or can even be experts. Some of them would be residing nearby the plant location or in Fenchuganj Upazila. Although the employment generated during this phase would be small in number, it will still account for a positive impact on the local employment scenario. Further, this development is going to attract more industries due to reliable power availability which will increase the demand for employment in and around Fenchuganj Upazila.

B. Demand for lodging, housing and civic services

The in-migration of long term or permanent staff will induce demand for permanent housing and other civic services for them. This will create an increase in demand on housing and supply of other civic services. Considering the limited number of staff in operation stage, the projects contribution to the cumulative impact of demand for lodging, housing and civic services is not substantial. Therefore, the impact significance for this is expected to be as low.

C. Industrial Development and Growth

The key positive impact associated with the project is Industrial development and growth in the region due to the establishment of this project. It would enable development of power infrastructure which will support newer essential industries that are necessitated for Sylhet's economic development. This in lieu will create a significant scope for large scale employment and bring about socio-economic benefits to the community.

This project will also go a long way in significantly contributing to the power requirements of the country as a whole.

CHAPTER 6: ANALYSIS OF ALTERNATIVES

6. ANALYSIS OF ALTERNATIVES

6.1 Introduction

The purpose of the analysis of alternatives as part of the ESIA process is to select best among all possible project options. The assessments and recommendations made by the ESIA team are presented below:

6.2 Site Selection

The critical and attentive issues for selection of power plant site are taken care of is listed below:

- Avoiding the following twelve (12) Critical Areas: Human Settlements, Forest Sanctuaries, National Parks, Game Reserves, Mangroves, Forest Areas, Wetlands, Wildlife Habitats, Archaeological Sites, Ancient Monument Sites, Biodiversity Areas and Similar Other Areas.
- Preference of Non-productive Land: The non-productive land as an alternative just near the proposed agriculture land is preferable for environmental soundness.
- The power plant land is a privately-owned land and has no dispute with the locality. More on the land is out of the DOE identified twelve critically areas.

The site is well located considering the following:

- Easy access
- Inside the industrial area
- Close proximity to the already existing national electric transmission lines
- Close proximity to the already existing natural gas transmission lines

6.3 Technology Options

Combined cycle power plants are self-contained, light weight and they do not require bulk water. They can be quickly installed at a lower cost than other types of power plants. These units require less space, have lower installation and maintenance cost and have simple lubrication and ignition system. Specific fuel consumption does not increase with time in gas turbine plants as rapidly as other IC engine based power plants. Also, poor quality of fuel can be readily used in gas turbines. Their disadvantages are poor part load efficiency, special metal requirements, special cooling methods and short life. Gas turbine power plants are the most suitable plants that can be installed at selected load centers with fewer auxiliaries. Gas turbines can be brought on load quickly and surely.

Table 6-1: Summary of Site Assessment

Sl#	Issues	Justification for the Selected Site
1	Land Availability	Proposed site of the power plant
2	Land Acquisition	No land acquisition is required
3	Land Development	Minor improvements required
4	Logistics Support (Technical and nontechnical)	No logistic support available. New logistic network is required to be developed.
5	Proximity to Load Center	Fairly close the main load center
6	Mode of Communication	• Good connectivity by roadway • Excellent water transport connectivity

Sl#	Issues	Justification for the Selected Site
7	Transmission Line	Relatively closer distance from existing transmission lines
8	Gas Line	Relatively closer to the source and can be developed with marginal investment
9	Environmental Impact	Given modern technologies for control of noise, vibration and air pollution, environmental impact is expected to marginally increase
10	Time for implementation	New power generation facilities can be established and made operational within a possible short time

6.4 No Project Scenario

Bangladesh is facing a major electrical power shortage for the last one decade. The shortfall aggravated during the last 2-3 three years and the total power scenario is very complex one. The supply demand situation in this sector will drastically hamper the development in all sectors of life including those in agricultural, industrial, commercial and domestic sectors. Particularly, the agricultural sector and the industrial sector productivity stoppage may lead to catastrophic disaster in the country in future. There is no alternative than to add more power generating units to the existing power system of Bangladesh within a shortest possible time frame. This is due not only to the increase in demand, but also due to aging of the existing power generating units most of which will near their life cycle very shortly. Both, base load and peaking plants are necessary to be added to the system, so that the whole system can run economically and efficiently. Technically a gas fired power plant is necessary to have more energy efficient power generation systems with higher output. Considering the nature of the peaking demand the proposed gas fired power plant seems to be the most suitable option.

CHAPTER 7: INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

7. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

7.1 Introduction

Participation is a process, through which stakeholders influence and share control over development initiatives, the decisions and the resources, which affects them. The effectiveness of environment and social management plan is directly related to the degree of continuing involvement of stakeholders in the project development process. Participation of stakeholders in the projects is also a primary requirement in developing an appropriate EMP that addresses project's requirement and suited to the needs of the stakeholders. Stakeholder's involvement is also vastly increases the probability of successful implementation of management plan. In order to make consultation and disclosure process effective and fruitful, comprehensive planning is required to assure that local government, host population and project staff interacts regularly and purposefully, throughout all stages of the project and contribute toward a common goal.

7.2 Approach and Methodology for Consultation

The approach undertaken for information disclosure and consultation involved the following key processes.

- Mapping and Identification of key stakeholders such as primary (direct project influence) and secondary (indirect project influence) stakeholders;
- Undertaking expert consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Undertaking structured on field consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Assessing the influence and impact of the project on these stakeholder groups;
- Summarizing of key findings and observations from the consultations; and
- Preparing a future stakeholder engagement strategy consultation plan for a more detailed assessment at a microscopic level taking into account the various project lifecycle phases and their implications on the stakeholder.

7.3 Stakeholder Assessment

A stakeholder is defined as “a person, group, or organization that has direct or indirect stake in a project/organization because it can affect or be affected by the Project or its Proponent's actions, objectives, and policies”. Stakeholders vary in terms of degree of interest, influence and control they have over the Project or the proponent. In the present study, all the stakeholders have been primarily categorized into two categories that have been identified as:

- Primary Stakeholders: include people, groups, institutions that either have a direct influence on the project or are directly impacted (positively or adversely) by the project and its activities; and

- Secondary stakeholders: are those that have a bearing on the project and its activities by the virtue of their being closely linked or associated with the primary stakeholders and due to the influence they have on the primary stakeholder groups.
- Apart from categorization, the stakeholders have also been classified in accordance with the level of influence they have over the project as well as their priority to the project proponent in terms of importance.
- The influence and priority have both been primarily rates as:
 - High Influence/Priority (Manage Closely): People who have high power and interest are grouped in this category. They always must be managed closely. This implies a high degree of influence of the stakeholder on the project in terms of participation and decision making or high priority for project proponent to engage that stakeholder.
 - Medium Influence/Priority (Keep Satisfied/ keep informed): People who have high power but low interest as well as who have high interest but low power should be kept satisfied or informed. This implies a moderate level of influence and participation of the stakeholder in the project as well as a priority level for project proponent to engage the stakeholder who are neither highly critical nor are insignificant in terms of influence.
 - Low Influence/Priority (Monitor with minimum effort): This implies a low degree of influence or interest of the stakeholder on the project in terms of participation and decision making or low priority for project proponent to engage that stakeholder.

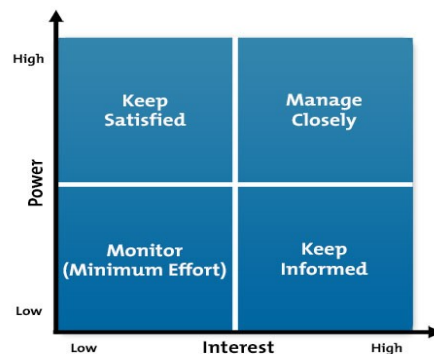


Figure 7-1: Power/Interest Grid for Stakeholder Prioritization

How they are likely to feel about and react to the project, how best to engage them in the project and how best to communicate with them, are measured by getting answers of following questions;

- What financial or emotional interest do they have in the outcome of your work? Is it positive or negative?
- What motivates them most of all?
- What information do they want from the project?
- How do they want to receive information? What is the best way of communicating?
- What is their current opinion? Is it based on good information?
- Who influences their opinions generally?
- If they are not likely to be positive, what will win them around to support the project?
- What should be done to manage stakeholders' opposition?
- Who else might be influenced by stakeholders' opinions?

Stakeholders were talked directly and asked their opinions in building a successful relationship with them.

Table 7-1: Stakeholder Mapping for the Project

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Project Management				
Kushiara Power Company Limited (KPCL)	Primary	KPCL is the primary project proponent own a controlling stake of 100% in the project	Highest	- Are the primary project proponents - Responsible for establishment and operation of this project - Primary financial beneficiaries - Responsible for all the project related risks and impact liabilities
Community				
Vulnerable Groups (poor, old aged, and destitute)	Primary	The marginal groups within the project area primarily comprises of landless households as a result of acquisition, households below poverty threshold, women headed households, old aged & destitute	Low	- Employment opportunity during construction. - Job prospect for their children - Compensation paid to male member of family - Little control over compensation amount - Employment opportunities
Fisherman	Secondary	Fisherman in the area are primarily engaging in small scale fishing in the river		Low scale for self-consumption
Local Community	Primary	- Primarily includes adjacent community to the project site - Also include community within 2 km radial radius of the project site	High	- Project will bring development to the area - Increase in employment opportunities and preference in job - Improvement in infrastructure in the area
Regulatory/Administrative Authorities & Agencies				
Dept. of Environment, Bangladesh	Primary	The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh.	High	- Government Regulatory agency to provide Environmental Clearance (EC) to the project based on evaluation and approval of Environmental Impact Assessment (EIA) study - Responsible for monitoring project's Environmental compliance throughout the project lifecycle

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Dept. of Social Welfare (DSW)	Secondary	Local governmental agency responsible for implementation of governmental social welfare schemes and activities in Fenchuganj.	Low	- No major influence on project related activities - However, participation level and influence may increase in case community welfare activities proposed by the project proponent are implemented in coordination with this agency
Other Regulatory & Permitting Authorities	Primary		High	- Agencies required for obtaining permits and licenses for establishment and operation of the project - Primary involvement during pre-construction and operation phases
Political Administration				
Upazila (sub District Level) Political Administration	Secondary	Elected representative of people at sub-district level for a fixed tenure	Medium	Key linkage between the community and the project proponent
Ward leaders& local representatives	Secondary	Elected representative at ward level i.e. village level for a fixed tenure	Medium	- Plays important role in providing public opinion and sentiment on the project - Empowered to provide consent and authorization for establishment of project on behalf of the community
Other Institutional Stakeholders Groups				
Local NGOs and Community & Social Welfare Groups (CSWG)	Secondary	Microfinance agencies, social welfare groups and charitable organizations working in the area	Low	- No major involvement in the project as per today - Possible inclusion during future stages of the project with respect to project related community welfare activities

7.4 Information disclosure and consultation

Number of consultation exercises was conducted during this phase of ESIA preparation. The stakeholders consulted include local People, community in the vicinity of project area, local elected representatives and other external stakeholders such as relevant government officials. The details of consultations held with issues raised or discussed and suggestions provided by the respective stakeholders are presented in Table 7-2 of this chapter.

A combination of mixed methods of information disclosure and consultation process was adopted at this stage of ESIA preparation. The method selected for consultation was basically designed keeping in mind the profile of the stakeholders, type of information desired and level of engagement required. In each consultation session, the consultant introduced themselves, introduced the project and the purpose of engagement with the respective stakeholder. The primary methods followed in the consultation process are:

- Individual level consultation/discussion;
- Key Informant Interview
- Focus group discussion; and
- Public Consultation

Table 7-2: Details of Consultations held for the Project

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Response/Suggestions made	Mitigation measures
23/08/2016	Department of Agriculture	Chandan Kumar Mohapatro, Agriculture Officer, Fenchuganj	• Understanding and Broad overview of the agricultural sector in Fenchuganj • Information on the crops grown in the area and agricultural practices • Information the agricultural schemes under implementation from the local government • Sharecropping practices in the project area • Proper mitigation measures as well as waste management should be in place during the project	• Agriculture is the primary mainstay of the district with almost 70% households involved in this • Main crops include rice, and vegetables. Rice production is the highest amongst crops. Vegetables are also grown in significant quantity and used for export to other parts of Bangladesh. • The agricultural practices in the region are a mix of both cultivating one's own land as well as sharecropping. • Impacts from the project related activities are envisaged to be less on the neighboring area.	• Project area has an existing Power Plant. So, there is less impact on agriculture. • Improve drainage system beside agricultural land otherwise in rainy season land will be under water • Ecofriendly Power Plant should be constructed considering the agricultural opportunity of the local people.
23/08/2016	Department of Fisheries	Ummul Fara Begum Tazkira, Fisheries Officer, Fenchuganj	• Primary fishing Point/ports Located in and around in Fenchuganj • Fish production in Fenchuganj in quality & monetary value. • Fish export status from Fenchuganj to other areas • Understanding on the Fishermen community Status of fishing at the canal	• Effluent should not discharge to the river/ water body. • This power plant development may cause harm to natural habitat of fish breeding. • The nutrient elements of water may be deteriorate • The temperature, Salinity may be fluctuated. • Some toxic gas may be	Considering the threats upon the fisheries sufficient measures should be taken.

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Response/Suggestions made	Mitigation measures
				formed. • Mortality of fish may be increased. • Loss of biodiversity due to loss of breeding ground.	
23/08/2016	Department of Public Health and Engineering	Azad Kazi, DPHE, Fenchuganj	• Responsibility of DPHE • Key issues in the upazila regarding water supply and sanitation	• DPHE provide tube-wells and sanitary latrine in the rural and urban areas. • Water quality is well in the Fenchuganj upazila. • Arsenic contamination is 3-4% in the Fenchuganj Upazila. • More than 70% household under sanitation facility	• Should develop proper sanitation and drainage facilities during the construction work as well as operation phase. • Ensure fresh water for everyone
23/08/2016	Union Chairman	Md. Nurul Islam, Maijgaon Union	• Negative and Positive site of a Power plant • Noise Problem • Health and safety • Drainage System	• Improve Safety management for power plant • Noise Pollution is very harmful for human • Drainage System Should be improved • Ensure job facilities for local People	• Should be interconnected with Government • Improve drainage System • Buy safety equipment • Employ local people as much as possible
23/08/2016	Department of Education	Education Officer, Fenchuganj	• Appreciated consultation and Project information • Discussed critical issues those might hamper students safe schooling and study.	• Road and transportation system may hamper by heavy vehicles. • Sounds may create problem when students study at night.	• Try to not hamper in communication system so that students face problem going schools and college • Reduce noise Pollution

7.5 Public Consultation Meeting

The Public discussion meeting was held on 23th August 2016 at Moinpur, adjacent the Mashjid, Fenchuganj, Sylhet. Both sides of people were participated in this Public Consultation Meeting. The proceedings commenced at 4:30 pm. The meeting was attended by a total of 34 people, which represent the Govt. employee, local people and senior citizen. The list of participants from these groups has been presented and attendance sheet has been provided as **Annex H**. Public Consultation meeting minutes has been given in **Table 7-3**.

Table 7-3: Brief overview of the Public Consultation Meeting

Sl	Name	Occupation	Comment/Question
1.	Omar Faruk	Deputy Project Manager, KPCL	- We have been working here along with the help of the local community since last year. Though this plant starts its commissioning from next year but we already are trying to improve road-transportation and drainage system. - Since the beginning of the construction phase dramatic change of the standards of living of the local community is being observed. Business and work opportunities have been created. So many people are currently working as labors. - We also improve the facilities of the adjacent Mashjid (Mosque). - We have a plan to develop a well-constructed road connecting Palbari to power plant end. We hope, if people of this vicinity help us, we will change this village as a model village.
2.	Luku Mia	Farmer, Adarsha Gram	- People of this locality are quite concerned about the sound emission of the power plant. Three power plants excluding the proposed power plant are running right now and people's daily life activities are hampered due to the excessive sound emission. As Omar Faruk, deputy project manager, confirms us that no such sound emissions will be created by this proposed power plant, we have no question about the environment problem issue. - We, the people of the community, expect from this company to give us priority for employing workers. - We also expect that this company will enhance it's helping hand as a part of social responsibility for developing this locality by contributing in development of schools and roads etc.
3.	Alauddin	Driver, Adarsha Garm	Drainage system adjacent to the proposed power plant is not available. Consequently, local community face waterlogging problem in the rainy season. Company should contribute developing proper drainage system and we the common people are ready to support them.

Sl	Name	Occupation	Comment/Question
			- Connecting road Palbari to power plant area is now at vulnerable situation for the company's heavy vehicles running. So, company should contribute to develop a well-constructed road. - People of this locality face obstacle in accessing health services. As KPCL has medical facilities for its workers, we expect that they may make this facility available for this local people with minimum service charge. Thus, we can access to health services easily.
4.	Monir	Safety Assistant, Moinpur	- Work opportunity has been created as the result of this power plant but very few people in this locality get this opportunity. We want us to be given more priority. If company arrange any training program for the locality, so many young students may train up them and can meet the company's labor force requirements. - We the people of this locality always welcome any kind of development activities. It's true that such power plant establishment enhances the development possibility, but we want to consider environment issue. We hope this power plant will not emit intolerable sounds and pollute adjacent river water.
5.	Alek Mia	Mason, Adarsha Gram	We welcome this proposed power plant and hope this power plant will start it's commissioning as soon as possible.

7.6 Focus Group Discussion

Discussion was held with the local people at 5 places surrounding the project area; Kochuwa Bohor, Bidyut Bazar, Bhoraut, Adarsha Gram and Moinpur of Fenchuganj. Date, location and the number of participants of each discussion is listed in **Table 7-4**. The local people attended the focused group discussion meeting include Shop owners, Businessmen, Drivers, Farmers etc. The summary of focused group meeting (FGD) is shown in **Table 7-5**. Attendances of Focus Group Discussion meeting are provided in **Annex I**.

Table 7-4: Details of FGD Meetings

Sl#	Date	Location of the meeting	Participants	Category of participants
1.	24/08/16	Kochuwa Bohor	7	Shop owners, Businessmen, Farmers etc.
2.	26/08/16	Bidyut Bazar	7	Businessmen, Job holders
3.	26/08/16	Bhoraut	11	Drivers, Masons, Banker and Private service holder etc.
4.	25/08/16	Adarsha Gram	9	Daily Labors, Masons and Drivers etc.
5.	24/08/16	Moinpur	9	Businessmen, Students, Farmers etc.

Table 7-5: Summary of Focus Group Meeting

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception about the project and the awareness about the proposed project.	Most of the participants are in favor of the project and have been made aware of the proposed project through the various surveys and Public consultations that have taken place	Acceptance of the project
Support of local people for the proposed project?	Everybody said that they will support the project and advised the Consultants to take precautions in the environmental mitigation to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project and to ensure protection of the natural water bodies of the areas.	The Consultants informed that during the study, the design and layout of all infrastructures have been considered the anticipated adverse impacts.
How people will be benefited from the proposed project?	Most people; most among all participants of five FGDs, believe that employment opportunity will be created. Some of the participants believe that road and transportation will be developed. Few participants believe that multi-dimensional development may also be incurred as the result of this power plant construction.	People are eagerly waiting for the power plant to be constructed as soon as possible.
Does the proposed Project create any problem with ambient air, noise quality or water quality?	People of the project area site were not aware of this problem.	Impact of the project upon ambient air, noise quality, water quality has been assessed during draft ESIA report.
Land Acquisition and Resettlement	Land acquisition and resettlement will not be the major issue. According to the participants, they are concerned this issue and this can be mitigated through proper compensation and assistance to the affected persons.	The type of land acquisition is voluntary in nature. Land acquisition has been also completed from public land for construction of the proposed power plant and proper compensation has been given. Overall impact on the community will be minimized accordingly.
Any critical issue or concern by the local people regarding the project? Or Any criteria	Respondents urged that environmental hotspots (like school, hospital, graveyard etc.) won't be affected. Additionally,	Dust suppression measures and noise mitigation will be considered.

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
you would like to see considered during project design, construction and operation stage?	They added that dust suppression, noise mitigation and proper drainage system must be considered.	
Is the proposed project going to provide better traffic system?	All the participants felt that the proposed project will facilitate a better traffic system.	Some concerns over safety, supporting design measures such as increased number of sign board, road mark, bump etc.
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. Plant is designed to avoid most of those structures.
Employment Status: Percentage of employment/unemployment/underemployment	Employment is expected in the project area.	Job chance and employment will be enhanced and promoted once the construction is started.
If this power plant is constructed, there may be large groups of workers living temporarily in the area, and construction operations that generate noise and dust. Are there any other issues about construction, including noise and dust that might worry you?	The participants strongly welcome the construction activities. Many observed that the measures are temporary and besides there will be more chances for local communities to be employed during construction, providing both skilled and unskilled labor. Participants did not mention any other problems which might bother them other than following basic safety rules.	Residents understand that construction impacts can be expected and do not have an issue with these, provided safety measures are taken.

CHAPTER 8: GRIEVANCE REDRESS MECHANISM

8. GRIEVANCE REDRESS MECHANISM

8.1 Introduction

The implementation of an infrastructural project is a complex time and labor intensive process involving multitude of lifecycle phases and processes. Over the duration of the project, it encounters numerous instances of conflicts, allegation and dissatisfaction within the working and as associated human capital and their interactions. Some of these issues could be related to compensation payment, improper estimation of affected assets, failure to fulfil commitments, poor management of construction activities, accidents due to inappropriate planning of vehicle movement, and cultural conflicts between migrant workers and local communities etc. amongst others. Most of the conflicts and allegations may not appear to be of serious nature but if not managed appropriately from the beginning may snowball into a bigger issue. In order to manage these risks, an internal mechanism is required to be in place where the aggrieved party/s can lodge their complaints and get it amicably settled prior to approaching the formal mode of solution available to them i.e. access to legal system through courts. In order to provide a formal forum to the aggrieved parties to deal with issues arising out of project, it is proposed that a joint grievance redress mechanism be instituted for both environmental and social related issues.

The proposed Grievance Redress Mechanism (GRM) will be developed for the Project in order to settle as many disputes as possible through consultations, negotiation and mutual settlement. Such a mechanism is important as it is expected that most cases, if not all, would be resolved amicably; and the process, as a whole, will promote dispute settlement through mediation to reduce litigation. However, the options of legal recourse will not be restricted in any way by the project proponent.

8.2 Objectives of Grievance Redress Mechanism

The basic objective of the GRM shall be provide an accessible mechanism to the affected people, community or any stakeholder(s) having stake in the project to raise their issues and grievances as well as concerns. The Grievance non- judicial will seek to resolve non-judicial disputes arising out of various matters related to the implementation of the ESMP, as well as other aspects of the project, as may deemed fit to be raised before the GRC.

The fundamental objective of GRM is to resolve any social (including labor, contractor, community amongst others) and environmental related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of project related work activities. The other important objective is to democratize the development process at the local level and to establish accountability towards the stakeholders.

8.3 Composition of GRC

Keeping into context that the project is mostly void of any significant impact, it is suggested to have only one single level of grievance redress mechanism or agency for the project. This agency shall be called as the Grievance Redress Cell (GRC).

The GRC will be driven internally by KPCL and shall have the following representation to ensure fair and timely solution to the grievances:

- Site personnel serving as the EHS/Community relations officer shall also serve as the Grievance Officer. The KPCL EHS Officer can take this role and responsibility;
- Senior Representative on behalf of KPCL and part of the site level project management team. In most cases, this individual shall be of an authority Site Manager is not available, this role may be deputed to his immediate deputy or any individual with that level of authority;
- Any other concerned person with decision making authority in relevance to the grievance or aggrieved party. For Senior contractor personnel as a part of the GRC in case of a contractor labor dispute or issue;

A grieved party shall register their grievances with the GRC. The GRC shall be empowered to take a decision which is to be considered final and binding on Lance. However, the decision of the GRC is not binding on the aggrieved person and he or she may take the grievance to the administrative setup in case any grievance channel is available at that level or take a legal course, in case not satisfied with the outcome of GRC decision.

8.4 Functional Premises of GRC for Grievance Redress

The GRC meetings will be held in Lance project office at site and the same will be widely publicized in project area for the knowledge of general public. The key responsibilities of GRC are as follows:

- Review, consider and resolve grievances related to social and environmental aspects received by the Lance Field Office having the GRC; Entertain grievances of indirectly affected persons and/or persons affected during project implementation;
- Resolve grievances within a period of two weeks at the GRC level and communication of the resolution to the aggrieved party;
- The GRC shall not engage in any review of the legal standing of an “awardee” nor shall deal with any matters pending in the court of law;
- Arrive at decisions through consensus, failing which resolution will be based on majority vote. Any decision made by the GRC must be within the purview of Environmental Management Plan, Corporate EHS and Social Policies or any such documents of relevance of that matter;
- In case the grievance relates to environmental monitoring results or engineering matters, the GRC will validate the information available to it, as provided by Lance Project management team/ environmental monitoring team. However, GRC will not be in a position to question the validity of the data provided to it. The GRC team shall meet at least twice a month for review of grievances registered and the resolution vetted out to the concerned parties. The frequency of meeting may increase or decrease depending on the number grievances received.
- If needed, may undertake field visits to verify and review the issues, dispute or other relevant matters.

8.5 Disclosure of the Grievance Redress Mechanism

Some of the important points regarding disclosure of the grievance e redress mechanism are:

- The grievance redress process shall be disclosed and the procedures mentioned therein shall be properly disseminated to the identified stakeholders.
- KPCL shall integrate it as a part of the training programmed especially those conducted for self-employees and those of the contractors. For the rest of the stakeholders including the community, it can be displayed at important places such as town centers, at site gates and on the website.
- The disclosure and the display shall clearly mention the name and designation of the grievance redress officials, office location and their respective contact numbers.
- GRM procedures and operational rules will be publicized widely through community meetings and pamphlets in the local language (Bangle) so that people are aware of their rights and obligations, and procedure of grievance redress.

8.6 Grievance Reporting Procedure under GRM

An aggrieved person, a group of persons or a community will be able to file grievances without any fear and intimidation. The grievances can be submitted in either in writing or may be submitted orally/ telephonically to the GRC; the whole purpose is to make the GRM easily accessible to the affected population. Once the complaint is received, acknowledgement of the same will be made to the complainant, and tentative date of hearing may be communicated to him/her in advance. The complainant may be represented by him/her or appointed agent for hearing of grievance. The decision made by GRC will be communicated to the concerned person/group/community in writing. If dissatisfied, with the decision of the GRC, the person/ group/ community may either register the grievance at the administrative level in case there are necessary channels for the same or take a legal course.

8.7 Grievance Redress Process of GRC

The grievance redress procedure will include the stepwise procedure, to deal with any grievance that comes for redress before the GRC. A schematic representation of the grievance redresses procedure to be followed by KPCL is being shown below in Figure 8-1.

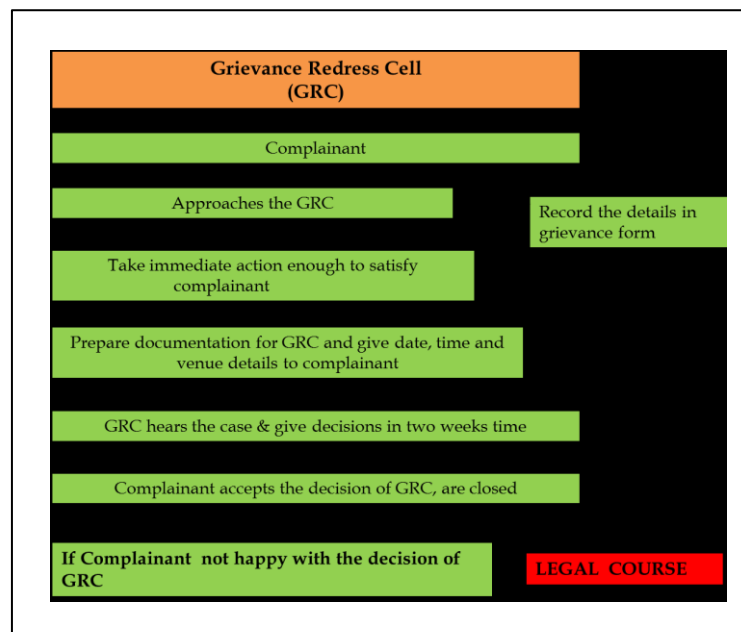


Figure 8-1: Grievance Redress Process for the Project

Grievances primarily related to any serious event such as accidents involving g the community, labor related major disputes such as non-payment of wages or work related injuries or fatalities, major intrusion of project on any community resource, and other issues for which the aggrieved party in his or her free will wants to register a grievance or complaint.

The process followed will follow the following steps:

- On receipt of complaint the GRC shall give an acknowledgement to the complainant with date, time and venue of hearing of his/her grievance.
- The GRC shall prepare a brief note on the grievance for discussion on scheduled date. On the given date, the GRC shall hear the complainant and give its decision. A written copy of decision shall be provided to the complainant. If the complainant is satisfied with the decision, an acknowledgement of same shall be obtained from him on the decision copy and the case shall be closed.
- If the complainant is not satisfied with the outcome of GRC's decision, he or she can opt for any grievance redress forum available at the administrative level or undertake the course of law available to him/her. However, every effort shall be made to resolve the case amicably without resorting to legal course of action. While the process continues, a proper documentation of the records shall be maintained by KPCL, pertaining to each of the grievance in a proper grievance register or record.

8.8 Monitoring and Evaluation

Like the other project components, GRM shall be monitored to ensure that the stakeholders are having no or limited issues with the project and in case there are concerns, they are being adequately addressed as per the mandate. In order to keep track on the effectiveness of GRM, it is the responsibility of KPCL Environment and Social team to compile and maintain database on grievances for periodic review. The mechanism shall be based on two components, internal monitoring and reporting and external monitoring and reporting which shall run simultaneously. Mostly this shall be aligned with simultaneous process monitoring rather than doing it separately all the time.

8.9 Budgeting

The KPCL administration shall ensure adequate budgeting and resource allocation for implementing the grievance redress mechanism.

Sample Grievance Form

Reference No.:		Date:	
Full Name:			
Father's Name:			
Mother's Name:			
Address			
Phone No.			
Date, time & Venue of GRC meeting			
Description of Incitement or Grievance			
Date of incident			
What is you like to see happen to resolve the problem			
Signature of Complaint/ Thump impression of Complaints		Signature of person filling the form (KPCL Representative)	

CHAPTER 9: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1 Introduction

The Environment and Social Management Plan (ESMP) for the Project has been developed with an aim to avoid, reduce, mitigate, or compensate for adverse environmental and social impacts/risks and to propose enhancement measures. This includes:

- mitigation of potentially adverse impacts;
- monitoring of impacts and mitigation measures during different Project phases of implementation and operation;
- integration of the ESMP with Project planning, design, construction and operation;
- institutional capacity building and training; and
- compliance to statutory requirements;

The ESMP for the project will also align with the IFC Performance standard and Equator Principle Guideline.

9.2 Mitigation Measures

Key environmental and social impacts have been identified and reported in Chapter 5 along with mitigation measures. A summary of mitigation measures identified for the construction and operation phases of the project is presented in Chapter 5. This also identifies lead responsibility for implementing the mitigation measures and sources of funds for such implementation. Many of the mitigation measures suggested during the construction phase of the Project are associated with good construction and housekeeping practices and are also included within the “Specification Manual for Construction Contractor” prepared by KPCL for the EPC Contractor. Most of the mitigation measures for the operation phase (such as those for air emissions and noise generation) of the Project are already incorporated into the project design specifications.

The construction phase of the Project is anticipated to last approximately 732 days. However, the design life of the Project is 22 years and KPCL will be responsible for ensuring that the mitigation measures in the ESMP are implemented throughout the life span of the Project. The management plan for construction and operation phase of the project is presented in the following **Table 9-1** and **Table 9-2** respectively.

Table 9-1: Environmental and Social Management Plan (ESMP) for Construction Phase of the Project

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
A Environmental Issue Associated with site Preparation and Construction								
1.1	Soil Quality	Site clearing and preparation, laying of gas pipeline, use of heavy loaders	Soil compaction	- Establishing the project boundary prior to sand filling; - Demarcating routes for movement of heavy vehicles; - Stripping and placing soils when dry, and not when wet; - Restricting the height of topsoil stockpiles to minimize erosion and compaction	EPC Contractor	On site project management team of project developer	Route plans and top soil management inventory submitted to HSE and Project Management team of KPCL	EPC Contractor Cost
1.2	Soil and sediment Quality	Fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities	Soil and sediment contamination through spills and leaks	- Preparation of guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals; - Development of a site-specific Emergency Response Plan for soil clean-up and decontamination; - Storage areas for oil, fuel and chemicals to be surrounded by bunds or other containment devices to prevent any spilled oil, fuel or chemicals from contaminating soils, sediment, water or groundwater; - Fuel tanks and chemical storage areas to be provided with locks to prevent unauthorized access; - Use of spill or drip trays to contain spills and leaks, and use of spill control kits to clean small spills and leaks; and - Installation of oil/water separators to treat surface run-off from banded areas prior to	Appointed EPC Contractor	HSE division of project developer and on site project management team	Plans submitted to HSE division for approval and monthly reports to KPCL	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				discharge to the storm water System. .				
1.3	Soil Quality	Storage, handling and disposal of construction waste	Soil contamination	• Design processes to prevent/minimize quantities of wastes generated and hazards associated with the waste generated; • Implement a construction materials inventory management system to minimize over-supply of which lead the construction materials, may the end of the disposal of the surplus at construction period; • Properly store construction materials to minimize the potential for damage or contamination of the materials; • Segregate hazardous and non-hazardous waste and provide appropriate containers for the waste types generated (e.g. enclosed bins for putrescible materials to avoid attracting pests and vermin and to minimize dour nuisance); • Store wastes in closed containers away from direct sunlight, wind and rain; • Provide enough space to allow for inspection between waste containers so as to identify any leaks or spills; • Ensure storage areas have impermeable floor and containment, of capacity to	Appointed EPC Contractor	HSE division of project developer and on site project management team	Quarterly report by 3 rd party Organization to KPCL	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				accommodate 110% of the volume of the largest waste container; • Storage of concrete and bitumen waste in a lay down area near the concrete batching plant and reuse of these wastes under floors or roads; and • Dispose of waste by licensed contractors.				
2.1	Surface Water Quality	• Leaks and spills of oil, lubricants, fuel • Improper handling of sewage or chemical • Pilling activities	Surface water contamination	• Restrict the earth work activities during monsoon season; • Channelize all surface runoff from the construction site through storm water drainage system and provide adequate size double chambered sedimentation tank; • Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal; • Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce; • All liquids effluent will be treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997 and IFC EHS Guidelines prior to discharge to Kushiara River. • Stockpiles will be protected by plastic sheets and suitably secured against the wind, at the end of each working day if rain is forecasted;	Appointed EPC Contractor	On site Project Management team and designated HSE team	Quarterly report by 3 rd party Organization to KPCL	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				• Temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge will be adequately designed for the controlled release of storm flows;				
2.2	Ground Water Quality	• Spillage and seepage of chemical, oil and storage area • Construction camp waste • Liquid effluent from washing and construction equipment and vehicles	Ground water contamination	• The spillage and seepage of chemical, oil and lubricants from storage area, waste handling area and generation of domestic waste/wastewater from construction labour camp area may adversely affect ground water quality in the area. • Liquid effluents will be generated from washing of construction equipment and vehicles	Appointed EPC Contractor	On site Project Management team and designated HSE team	Quarterly report by 3 rd party Organization to KPCL	EPC Contractor Cost
3.1	Air Quality	• Site preparation and leveling • Excavation of soil to construct building and equipment foundations; • Pile driving for the equipment foundation; • Movement of construction equipment by	Dust generation	• Implementation of a regular and rigorous watering and sprinkling regime for dust suppression during the dry season; • Maintain the maximum possible distance between stockpiles and receptors; • Cover and/or water spray all stockpiles of dusty materials such as excavated spoils, loose construction material piles to avoid fugitive dust; • During construction, the access road will be regularly maintained to keep it clean, free from mud and slurry.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Quarterly report by 3 rd party Organization to KPCL	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
		vehicle and barge; - Loading and unloading of materials; - Installation of gas pipeline;		- Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site. - No waste will be burnt on or around the Project site.				
3.2	Air Quality	- Operation of heavy machinery and transport vehicles - Operation of DG sets	Exhaust Emissions	- A speed limit of 20 km/hr will be enforced on the construction site/access road; - Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NO_x, PM₁₀ and SO₂; - Where available use low Sulphur diesel (LSD) in diesel powered equipment; - Implement best practice procedures to control vehicle / equipment air emissions (such as turning off equipment when not in use); and - Vehicle / equipment exhausts observed to be emitting significant black smoke from their exhausts will be serviced/ replaced.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Quarterly report by 3 rd party Organization to KPCL	EPC Contractor Cost
4.1	Noise	- Heavy machinery operations for construction works - Transportation related activities	Increase in ambient noise levels	Normal working hours of the contractor will be between 06:00 and 21:00 hours from Saturday to Thursday. If work needs to be undertaken outside these hours, it should be limited to activities that do not lead to exceedance of the noise criteria at nearby NSRs;	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report by 3 rd party Organization to KPCL	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				• Only well-maintained equipment should be operated on-site; • Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted; • Machines and construction plant items (e.g. trucks) that may be in intermittent use should be shut down or throttled down between work periods; • Low noise equipment should be used as far as practicable; • The number of equipment operating simultaneously should be reduced as far as practicable; • Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable; • Noise enclosures should be erected around stationary equipment;				
5.1	Terrestrial Ecosystem	• Site development activities by sand filling • Vegetation clearance; • Fugitive emission and deposition on vegetation	Clearance of shrubs, herbs and weeds	• Construction schedule to be managed such that the foundation work is not done during monsoon season; • Strict instruction shall be given to the construction workers not to cut trees from the nearby areas for their kitchen fuel and timber use; • Use of LPG/ Kerosene for cooking need to be provided/	Project management with the help of hired specialists and appointed EPC Contractor	On site Project HSE Management Team including specialist as required	Quarterly report to KPCL	Project developer cost and EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
		- Noise and vibration. - Construction activities at site; - Influx of labor force; and - Transportation of man and material by road and River.		- encouraged in order to reduce the impacts on vegetation from the vicinity of the Project site; - Construction workers shall be given conservation and awareness training to promote sustainable resource use; - Project related activities should be avoided during the night time; - Damage to the natural topography and landscape should be minimized; - Strict prohibition should be implemented on trapping, hunting or injuring wildlife within the subcontractors and should bring a penalty clause under contractual agreements; - A minimum possible number of routes should be authorized for use during construction by the labourers and staff, speed limit of the vehicles plying in these routes should be kept 20-25 km/hr to avoid road kill; - Tree species which are present edge of the project boundary should keep remain alive; - Plantation of local species for stabilization of the filled in material and plantation in surrounding areas;				
5.2	Terrestrial Ecosystem	Excavation for Gas pipeline lay down	Clearance of plantation, shrubs and herbs	Vegetation clearing will be kept minimum to the extent practicable for the project site & gas pipeline;	Project management and appointed EPC Contractor	On site Project HSE Management Team of KPCL	Visual Inspection by HSE Management of KPCL	Project developer cost and EPC Contractor

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				- Construction schedule to be managed as such that for the foundation work monsoon season is avoided; - Strict instruction should be given to the construction workers not to cut trees from the nearby areas for their fuel and timber use; and - Construction workers will be given conservation and awareness training to promote sustainable resource use.				Cost
6.1	Aquatic Ecosystem	- Surface runoff from construction site, discharge of hydro-testing water, - spillage & leakage of oil and lubricate, from construction site; - Spillage from River Transportation.	Impact on habitat of aquatic fauna due to accidental spillage	- Avoidance of any leakage of fuels and other contaminants from barges/trawlers to Kushiara River; - Trawlers/barges with valid requisite licenses and emergency handling capacity or tie-ups shall only be engaged; and - Standard codes and practices to be followed during unloading of fuels and construction material. - Proper maintenance for avoidance of any leakage of fuels and other contaminants from barges/trawlers to Kushiara River;	Project Management along with hired specialists and Appointed EPC Contractor	On site Project Management Team and designated HSE team on site including specialist as required	Survey report and monthly report to project company	Project Developer Cost and EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
7.1	Traffic and Transport	• Transportation of construction material, and personnel • Vehicles carrying workers in the project site	Disturbance to existing road users through increase in road traffic	• Construction materials and equipment will be transported over water to avoid impacts from heavy vehicles to traffic on the Moulovibazar - Sylhet highway and access road; • The construction workforce involved in construction will be provided accommodation in the vicinity of the Project site to minimise the distance travelled; • Avoiding peak hours for heavy vehicles movement where possible; • Regular maintenance of vehicles to avoid break downs leading to congestions; • Training and awareness amongst driver's to encourage systematic parking, following traffic rules, preventing unnecessary stoppages and overtaking; • Collaboration with local communities and responsible authorities to improve signage, visibility and awareness of traffic and pedestrian safety; and • Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents.	Project company, Appointed EPC Contractor	On site Project Management Team and designated HSE team	Monthly report to project company	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
8.1	Occupational Health and Safety	General construction activities	Health and safety of construction workforce	• The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilization, construction sequence and safety arrangements; • Measures will be implemented to reduce the likelihood and consequence of the different hazards: • A Permit to Enter system will be established to ensure that only authorized persons gain entry to the site; • Competent and adequately resources sub-contractors will be used where construction activities are to be sub-contracted; • The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilization, construction sequence and safety arrangements; • All workers will be properly informed, consulted and trained on health and safety issues; • Personal Protective Equipment (PPE) shall be worn at all times on the Site. This shall include appropriate safety shoes, safety eyewear, and hard hats. Non-slip	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				or studded boots will be worn to minimize the risk of slips; • Women in the region generally wear “sarees”, which is not appropriate while working in hazard prone construction areas. If women will be working in the hazard prone areas, then the contractor needs to ensure proper outfit and PPEs. • All lifting equipment and cranes will be tested and inspected regularly. All hoist ways will be guarded; • All scaffolding will be erected and inspected in conformity with the Factories Act and the appropriate records maintained by the Contractor; • Safety hoops or cages will be provided for ladders with a height in excess of two meters; • Where sound levels cannot be reduced at the source, suitable hearing protection will be provided when noise levels indicate Leq of more than 85 dB (A). When hearing protection is used, arrangements will be made to ensure the wearers can be warned of other hazards; and • The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations.				

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
8.2	Occupational Health and Safety	Labor and working conditions	- Working conditions - Terms of employment - Child/ forced labor	- The EPC contractor will comply with the IFC Performance Standard 2 for labor and working conditions; - No child and/or forced labor will be employed by the EPC contractor and its sub-contractors; and - Working conditions and terms of employment will be fully compliant to the Bangladesh labor laws.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost
9.1	Community Health and Safety	Changes in environmental quality due to construction activities	Impact on community health and safety	- Barriers will be provided to prevent entrance of Persons into the construction site and also to protect public exposure to hazards associated with construction activities; - Avoiding formation of stagnant water pools in and around the site; - Regular water spraying in the high dust generating area; - Put the noise barrier/wall in the high noise generating area	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost
9.2	Community Health and Safety	Increased prevalence of disease arising from the influx of construction workers	Impact on health due to increasing prevalence of diseases	- Screening, surveillance and treatment of workers, through the provision of medical facilities and, where required, immunization programmes; - Undertaking health awareness and education initiatives among workers; - Implementation of a vector control programme;	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
				• Avoiding formation of stagnant water pools; and • Educating project personnel and area residents on risks, prevention, and available treatment for vector-borne diseases.				
9.3	Community Health and Safety	Heavy traffic movement	Increase accident due to traffic movement	• Emphasizing safety aspects among drivers, particularly with regard to the speed limit of 20 km/hr that will be enforced; • Ensuring that only licensed drivers are employed by the Project; • Avoiding peak hours for heavy vehicles movement where possible; • Regular maintenance of vehicles; • Collaboration with local communities and responsible authorities to improve signage (e.g. pedestrian crossings, speed limits etc), visibility and awareness of traffic and pedestrian safety; and	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost
9.4	Community Health and Safety	General construction activities	Stress on existing water resources	• Use the surface water as much as possible; • Aware the construction worker to avoid the misuse of water; • Reuse the water where possible.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to project company	EPC Contractor Cost
B. Social Issues Associated with the Construction Phase								
1.1	Migrant Workers & Labourers	Inflow of Migrant labourers & workers	• Potential conflict with local community;	• Preventing stress on local infrastructure by providing labor related infrastructure such as camps, sanitation facility,	Appointed EPC Contractor	On site Project Management team and designated HSE	Monthly report to project company	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
		expected during construction phase of the project	• Health risks due to spread of communicable diseases and sexually transmitted diseases • Issue of Sanitation and hygiene	drinking water facility, etc. in accordance with local regulations as well as IFC handbook for labor accommodation; • Ensure proper administrative channel to manage labor related statutory compliance, such as payment of wages, provident fund, insurance etc. as well as labor issues arising during the construction phase activities; • Manage illegal labor practices such as child labor, bonded labor or forced labor through internal vigilance mechanisms and surveillance; and • Awareness shall be generated amongst migrant laborers in maintaining congenial relations with local laborers as well as community. • Engage as many locally available unskilled, semi-skilled and skilled human resource as practically possible to avoid large scale in migration of labour force; • Adequate sanitation facility at labour camps to maintain hygiene and minimise spread of diseases; • Creating awareness about local tradition and culture among outside migrant and encouraging respect for same; • Providing awareness training regarding sexually transmitted diseases among the migrant		team		

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Mitigation Cost Source
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population;

Table 9-2: Environmental and Social Management Plan (ESMP) for Operational and Maintenance Phase of the Project

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
A Environmental Issues Associated with the Operation Phase								
1.1	Soil Quality	Waste generated from • Office and kitchen, • Dewatered sludge from the WTP, ETP and STP sludge and • Air filters from the gas turbines • Chemical Cleaning waste from the CT compressor, • Waste/used oil from the power house and workshop,	Contamination of soil	• Wastes will be stored in a manner that will prevent contact between incompatible wastes i.e. post compatibility checks, • Proper labelling of hazardous wastes; • Special care will be taken in the storage areas to prevent any spillage of hazardous wastes and restrict access (except for trained staff) to such areas; • Periodic internal audits will be carried out for such areas and containers; also on the segregation and collection systems and the findings will be documented and appropriate action taken against irregularities; • A spill response plan and emergency plan will be prepared to address accidental spillages or release of hazardous wastes; and • A proper manifest record will be maintained of waste travelling/	Project Developer/Plant Manager/Plant HSE Team	Designated team comprising of representative from relevant department as HSE, Operations, Administration and HR	Monthly internal reports to top management and reporting to regulatory authorities/lenders as required	Plant O & M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
				removed from the site.				
2.1	Water Resources	Wastewater discharge	- Impact on water quality - Impact on aquatic flora and fauna	- Monitoring of temperature at the discharge point at a frequency of every 15 days; - Discharge system shutdown in event that discharge temperature of effluent exceeds standard;	Operations team	Designated team comprising of representative from HSE and operations	Record maintained and monthly internal reports to top management	Plant O & M Cost
2.2	Water Resources	Discharge of cooling water	Impact on aquatic flora and fauna	- Efforts to be made to increase the cycle of concentration to reduce the volume of blow down and consequently the volume of make-up water required by the cooling tower. - Storm water drainage and waste water of similar nature from different units will be treated in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and the applicable World Bank Group environmental requirements and World Bank/IFC guidelines.	Operations and Plant EHS team	Designated team comprising of representative from HSE and operations	Record maintained and monthly internal reports to top management	Plant O & M Cost
2.3	Water Resources	Abstraction of ground water	Impact on ground water availability	- Periodic Monitor the ground water level; - If the local community do not get water during the dry period KPCL need to be install a deep tube well for the local people to serve the water for community peoples;	Operations and Plant EHS team	Designated team comprising of representative from HSE and operations	Record maintained and monthly internal reports to top management	Plant O & M Cost
2.4	Water Resources	Storage and handling of fuel oil and chemicals	Ground water contamination	Minimum required quantities of chlorinated biocides or	Operations and Plant EHS team	Designated team comprising of representative from HSE and	Record maintained and monthly internal reports to top	Plant O & M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
				alternatively intermittent shot dosing of chlorine will be practiced rather than continuous low level feed; - Waste storage areas will be equipped with secondary containment and spill control measures (similar to the hazardous material storage areas) to limit impact to ground; - Liquid wastes such as waste oil, etc. will be collected and stored for recycling in cemented areas; and - All drainage/tanks, etc. will be positioned on concrete hard standing to prevent any seepage into ground.		operations	management	
3.1	Air quality	Stack emissions	- Impact on ambient air quality - GHG emissions	- Periodically monitor the stack emission; - Comply with the Emission guidelines for Combustion engines in the IFC EHS guidelines for Thermal Power Projects. Project will demonstrate compliance to agreed air emission criteria at 100% and 75% plant loads; - Monitor ambient air quality in and around the Project site as per the Environment Monitoring Program formulated for the Project which will comply with National Regulatory requirements.	Plant EHS Team and operations	Designated Team comprising of representation from EHS and Operations of KPCL	Relevant Records maintained. Monthly internal reports to top management and reports to regulatory authorities/lenders as required. Also, quarterly monitoring from the 3 rd party organization	Plant O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
				Ensure that all equipment and machinery is maintained in accordance with manufacturer's specifications;				
4.1	Noise	Plant operations	Increased noise level	- Selection of equipment with lower sound power levels (< 85 dB); - Installation of mufflers on engine exhausts and compressor components; - Installation of acoustic enclosures for equipment (e.g. gas turbine, compressor) casing radiating noise; - Buildings will be designed with improved acoustic performance and sound insulation will be provided; - Installation of acoustic barriers without gaps and with a continuous minimum surface density in order to minimize the transmission of sound through the barriers; - Barriers will be located as close to the source, as far as practicable, to be effective; and - A noise analysis of all major plant components will be carried out during commissioning of the plant to ensure compliance with the specification and guaranteed performance as well as ambient noise levels at the receptors located in the surroundings.	Plant EHS Team and operations	Designated Team comprising of representation from EHS and Operations of KPCL	Record maintained and monthly internal reports to top management Also, Monthly monitoring from the 3 rd party organization	Plant Cost O&M

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
5.1	Terrestrial Habitat	Plant Operation	Incremental noise	- Noise levels must be attenuated to the extent possible by proper lubrication of machineries and equipment and installation of noise barriers/acoustic enclosures at appropriate locations; - Habitat improvement in form of dense plantation with native species along the plant boundary. - Minimizing the secondary sources of noise generation such as vehicle noise and other operation and maintenance.	Plant EHS Team and operations along with specialist required	Designated Team comprising of representation from EHS and Operations of KPCL	Relevant records maintained and internal report to senior management	Plant O&M Cost
5.2	Aquatic ecosystem	Plant Operation	Discharge of cooling water	- Monitoring of temperature at the discharge point at a frequency of 15 days; - Discharge system shutdown in event of effluent temperature exceeding >3°C than intake water; - Efforts to be made to increase the cycle of concentration to reduce the volume of blow down and consequently the volume of make-up water required by the cooling tower. - Storm water drainage and wastewater of similar nature from different units will be treated in accordance to GOB Environment Conservation Rule (1997) Schedule 10 (Standards for Waste from Industrial Units or Project Waste) and World Bank/IFC guidelines. - Undertake a post-operational	Plant EHS Team and operations along with specialist required	Designated Team comprising of representation from EHS and Operations of KPCL	Relevant records maintained and monthly internal report to senior management and report to the regulatory authority as required	Plant O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
				assessment study through independent 3rd party agency/experts with an objective to assess the impact of water discharge in Kushiara River ecological resources and social aspects.				
7.1	Community Health and Safety Management	Plant operations	- Increased vehicular traffic in the region - Exposure to site accidents and incidents - Project security	- Comply with the Community health and safety guidelines preened in Section 3.0 of the General EHS Guidelines published by IFC; - Implement occupational H&S management System certified to OHSAS 1800:1 and periodically reviewed and audited by independent 3rd party agencies / experts to mitigate the onsite accidents and incidents; - PPE shall be provided and use of PPEs shall be enforced; - The Project will adopt a total safety control system, which aims to prevent the probable accidents such as fire accidents or chemical spills; - Firefighting systems, such as sprinklers, portable extinguishers and automated fire extinguishers will be provided at strategic locations with clear labelling of the extinguisher type.; - The site operations manager will take steps to train all emergency team members and will draw up	Plant EHS Team and Administration	Designated Team comprising of representation from EHS/logistics team and GRC	Relevant Records maintained and monthly internal report to senior management	Plant Cost O&M

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
				an action plan and identify members; • The staff will be trained for first-aid and firefighting procedures. The rescue team will support the first-aid and firefighting team; • A first-aid centre with the trained personnel; • A safe assembly area will be identified and evacuation of the premises will be practiced regularly through mock drills; • A safety manual for storage and handling of Hazardous chemicals will be prepared and implemented; • Material Safety Data Sheet (MSDS) will be made available and displayed at prominent places throughout the Plant; • Safe work practices will be developed to provide for the control of hazards during operation and maintenance; • In the material storage area, hazardous materials will be stored based on their compatibility characteristics; • Safety measures in the form of DO and Don't Do will be displayed at strategic locations; and • All hydrants, monitors and valves will be visually inspected every month.				

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting requirements	Mitigation Cost Source
B Social Issues Associated with the operation Phase								
1.1	Stakeholder Engagement, Program (Including Grievance Mechanism)	Project Operation Phase	Different Government and non-government stakeholders	Details in Chapter - 8	Plant Management	Designated Team comprising of representation from EHS and Operations of KPCL	Record maintained and Visual Inspection reports to top management of KPCL	Plant O&M Cost
2.1	Community Development Program	Community Health and safety and Risk of industrial Accidents, Fire related Accidents from gas leakage	- Conflict with community - Management & labor relation	- Developing a Disaster Management Plan (DMP) to charter proper protocol to be followed in the event of a disaster in order to limit the impact on the local community; - Disclose potential disasters and potential risks from the plant to the local community as well as the plan of action on emergency protocol in the event of these accidents. - Disclose and generate awareness on the DMP as well the measures and protocols prescribed by the same; - Train employees and plant personnel on health and safety as well as handling and managing disasters and emergency events; - Maintain harmonious relation with community and create a feedback system;	Plant Management	Designated Team comprising of representation from EHS and Operations of KPCL	Record maintained and Visual Inspection reports to top management of KPCL	Plant O&M Cost

9.3 Environmental Monitoring

The environmental monitoring programme has been planned with the following objectives:

- To identify the need for improvements in the management plans;
- To verify compliance with statutory and community obligations; and
- To allow comparison against baseline conditions and assess the changes in environmental quality in the Project AOI.

9.3.1 Performance Indicators and Monitoring Schedule

Physical, biological and social environmental management components of particular significance have been identified as performance indicators. A comprehensive monitoring plan for each performance indicator has been prepared for all phases of the Project and is presented in Table 9-3.

9.3.2 Reporting Mechanism for Environmental and Social Monitoring Program

A robust reporting system will provide the Project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will ensure regular flow of information from the Project site to the Project headquarters and, as necessary, to regulatory authorities and funding agencies. The reporting system will provide a mechanism to ensure that the measures proposed in the Project's ESMP are implemented.

Before the civil works start, the EHS Division of KPCL will finalize the format for reporting on the status and progress of environmental monitoring. The format will be designed to meet all the compliance conditions associated with the environmental clearance from the Department of Environment and the Government of Bangladesh. The contractor will be required to submit the duly filled up reporting form on a monthly basis to the Project Developer (i.e., KPCL). A further report, detailing the results of pollution monitoring for air, noise, soil, and water will be submitted quarterly as envisaged in the monitoring plan. A health and safety incident/accident report will be prepared and submitted in the event of an incident or accident. Independent verification of the effectiveness of the mitigation measures by the EPC contractor during the construction phase can be done by KPCL EHS team with a periodic third party audit.

During the operation phase of the Project, the Executive, EHS Personnel will monitor the effectiveness of the EMP implementation, monitoring the implementation of social components of the ESMP. He/ she will also responsible for implementation of corporate social responsibility (CSR) activities to be conducted by KPCL. Both Operations Manager and HR Manager will further report to the Station Manager, who will be overall in-charge of the Plant operations and management.

The quarterly reports of the management measures will form an integral part of the Quarterly Progress Reports that can be submitted to the lenders. Additional compliance reports to the Regional Office and Head Office of the DOE required as a part of environmental clearance process shall also be prepared and submitted based on the necessary monitoring and reporting formats.

Table 9-3: Environmental and social Monitoring Plan (Construction and Operation Phase)

Project Stage/ Affected Component	Potential Impact/ Mitigation	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Site Preparation and Construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the ESMP and as specified in EPC Contractor Manual	Project activity areas	Visual inspection of all active work areas	Daily	EHS Team of EPC Contractor	EPC Contractor Cost (1xHSE Manager, 1xDeputy HSE Manager & 1xHSE Executive)
Ambient Air Quality	Dust generation	SPM and PM ₁₀ , PM _{2.5}	Identified ASRs within 500 m from the construction site (4 locations)	24-hour	Quarterly	3 rd Party Environmental Consultant	EPC Contractor Cost (400,000 BDT/annum)
	Vehicle exhaust	PM _{2.5} , NO ₂ , SO ₂ , CO	Identified ASRs within 100 m from the activity (2 locations)	24 hourly monitoring of PM _{2.5} and SO ₂ and 1- hourly monitoring of NO ₂ and CO	Monthly	3 rd Party Environmental Consultant	EPC Contractor Cost (200,000 BDT/annum)
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq day, Leq night and hourly Leq	Identified NSRs within 500m from the activity area/s (6 locations)	24-hour	Monthly	3 rd Party Environmental Consultant	EPC Contractor Cost (200,000 BDT/annum)
Soil	Contamination of soil	pH, salinity, NH ₄ ⁺ , total P, heavy metals, oil & grease	Construction site or lay down area or spill area of hazardous substances, oil, or toxic chemicals	Standard analytical methods	In the event of any leakage or spillage and Half Yearly Monitoring report	3 rd Party Environmental Consultant	EPC Contractor Cost (150,000 BDT/monitoring)

Project Stage/ Affected Component	Potential Impact/ Mitigation	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Water	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	Kushiara River (upstream and downstream)	Standard analytical methods	Quarterly	3 rd Party Environmental Consultant	EPC Contractor Cost (300,000 BDT/annum)
	Ground water quality	Hardness, Cl, F, Iron, Mg, Mn, As, Cl, Fecal Coliform, Total Coliform, Heavy Metal	Ground water wells to be used for drinking water supply during this phase	Standard analytical methods	Monthly	3 rd Party Environmental Consultant	EPC Contractor Cost (600,000 BDT/annum)
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 camp area	As defined in construction phase health & safety plan to be prepared by EPC contractor	As defined in H&S plan	EHS Team of EPC Contractor	EPC Contractor Cost (1xHSE Manager, 1xDeputy HSE Manager & 1xHSE Executive)
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accident, incidents and complaints	Access Road connecting site	Incidents, accidents and community complaints	Based on occurrence	EHS and / or Community Liaison Officer of EPC Contractor	EPC Contractor Cost (1xHSE Manager, 1xDeputy HSE Manager, 1xHSE Executive & 1xLiaison officer)
	Public concerns	Complaints from community	Neighboring communities around the project activity areas	As per the grievance redress mechanism	Continuous	Project Company	Grievance Management Budget of KPCL
Terrestrial Ecology	Impact on species of conservational importance	Tree cutting	Project site	Identification and Enumeration by ecologist	One time prior to start the work	Project company with help of experts	EPC Contractor Cost

Project Stage/ Affected Component	Potential Impact/ Mitigation	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	Impact on habitat of avifauna	Habitat and disturbance to avifauna	Near temporary jetty, transportation route, RoW of gas pipeline	Visual inspection	Continuous	Project company	EPC Contractor Cost (200,000 BDT)
Aquatic ecology	Impact on habitat of aquatic and riverine fauna due to spillage	Habitats and disturbance to aquatic fauna	Near temporary jetty and river transportation route	Identification and Enumeration by ecologist	Prior to start the work and continuous	Project company with help of experts	EPC Contractor Cost (300,000 BDT)
	Impact on mammals due to trawlers and barges	Habitat and disturbance aquatic fauna	Near temporary jetty and river transportation route	Deck monitoring	Continuous	Project company	EPC Contractor Cost
Environmental and Social Issue	Training need	1 – day training for those people of Contractor who involved in environmental and social issues	At project site	As per national and IFC/ WB standard guideline	Before contractor start	Contractor through 3 rd party engagement	EPC Contractor Cost (300,000 BDT)
Operation Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the ESMP and operational manual	Project activity areas	Visual inspection of all active work areas	Daily	EHS Team of KPCL	Included in operation and maintenance (O&M) cost
Air pollution	Stack Emission Concentration	NO _x , CO, PM _{2.5} and O ₂	Main stack and by- pass stack	Stack	Quarterly	KPCL	Installation included in EPC Cost Monitoring and

Project Stage/ Affected Component	Potential Impact/ Mitigation	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
							Maintenance in O&M Cost
	Emission Concentration	Stack emission validation for NO _x , CO and PM _{2.5}	Main stack and by- pass stack	Standard Methods	Annual	3 rd party Environmental Consultant	O&M Cost (150,000 BDT/annum)
	Ambient Air Quality	PM ₁₀ , PM _{2.5} , NO _x , SO ₂ , CO	4 Locations where the samples were collected during baseline monitoring	Standard Methods	Quarterly	3 rd party Environmental Consultant	O&M Cost (500,000 BDT/annum)
Noise	Noise generation from plant Equipment	Sound pressure level	1 m from the noise generation equipment's (for all noise sources greater than 70 dB (A) noise level)	Noise monitor	Monthly	EHS Team of KPCL or 3 rd party Environmental Consultant	O&M Cost
	Ambient Noise	Ambient Noise level	At project boundary and at nearest noise sensitive receptors in all direction from the plant	Noise monitoring with data logger	24- hour observations with hourly noise levels, monthly once at each location	3 rd party Environmental Consultant	O&M Cost (100,000 BDT/annum)
Water	Ground water	Drinking water quality parameters as per schedule 3 of ECR 1997	Bore well water	Standard Methods	Quarterly	3 rd party Environmental Consultant	O&M Cost (100,000 BDT/annum)
		Ground water depletion rate	In and around the project site	Modeling techniques	When complain raise from the neighboring community	3 rd party Consultant	O&M Cost

Project Stage/ Affected Component	Potential Impact/ Mitigation	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	Waste Water	Temperature, pH, Cl, BOD5, COD, oil & grease, heavy metals, FC, TC	Outlet of discharge channel	Standard Methods	Quarterly	3 rd party Environmental Consultant	O&M Cost (100,000 BDT/ annum)
	Surface water quality	Temperature, Conductivity, pH, DO, TDS	Upstream and downstream of Kushiara River	Standard Methods	Quarterly	3 rd party Environmental Consultant	O&M Cost (100,000 BDT/ annum)
Aquatic ecology	Impact on fishes and riverine flora and fauna	Fish count, phytoplankton's, zooplankton's number	Upstream and downstream of Kushiara River	Abundance of aquatic flora and fauna	Once post one year of commissioning of the plant by experts	Plant management	O&M Cost (1,000,000 BDT/ annum)
Community Health and safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complains	Access Road	Accidents, incidents and complains	Based on occurrence	Visual Inspection report by EHS Team of KPCL or community liaison officer	O&M Cost
	Public Concern	Complains from community	Neighboring communities	As per grievance redress mechanism	Continuous	Visual Inspection report by EHS Team of KPCL or community liaison officer	O&M Cost
CSR Activities	Community Development	Activities/ programs and no of beneficiaries	Vulnerable group around the project activities area	No of beneficiaries and outcome of the activities	Periodic and need based	Admin/ HR Manager	CSR Budget

9.4 Institutional Setting and Implementation Arrangements

The ESMP (mitigation plan) will be included in the construction contract and the contractor will be responsible for implementation of the measures associated with design and construction. The Project Developer's staff, specifically the EHS Officer and Site Engineer, will monitor the implementation of these mitigation measures by the contractors at the site. These two officers will be responsible for the field level monitoring of the Project.

The roles and responsibilities of the Project Developer (KPCL) and EPC Contractor for implementation and monitoring have been outlined in Table 9-4. The flow diagram depicting the institutional arrangement for implementation of the ESMP is presented in Figure 9-2.

Table 9-4: Roles and Responsibilities of Project Developer and EPC Contractor

Project Developer (KPCL)	EPC Contractor
Obtaining statutory clearances required during pre-construction stage of the Project	Obtaining permits required during the construction stage
Overall project co-ordination and management through EPC and supported by the third party environmental consultant/s	Joint verification with Project Developer and Third Party Environmental Consultant for review of ESMP implementation
Interaction and reporting to the respective department of GOB	Interaction with Project Developer and appointed supervision consultant, if any
Interaction and reporting to lenders	Filling of reporting formats as per the reporting schedule and submission to Project Developer
Effective implementation of ESMP and monitoring of ESMP implementation	Environmental monitoring through Third Party Environmental Laboratory
Carryout verification/ supervision exercises during the construction phase of the Project for implementation of ESMP	Preparation of various plans for effective implementation of ESMP as detailed out in the "Specification Manual" by the Project Developer
Keeping records of all permits obtained by EPC Contractor	Identification of site for labor camp, batch mix plant, laydown areas
Overall supervision of ESMP implementation	Management of labor camp and to provide drinking water, sanitation facility
Approval of plans prepared by EPC Contractor	
Addressing grievances of local community and information dissemination	
Environmental monitoring through laboratory	

While the contractor or a particular party is responsible for physical implementation of the mitigating measures, the whole implementation process requires supervision, checking,

documentation and verification so that problems are identified and properly addressed before they get out of hand.

In order to ensure proper execution of the ESMP, implementation reviews will be conducted by the project engineer such as the weekly construction meetings, construction log book, monthly and other construction reports etc.

Records of these minutes of the weekly meeting, monthly reports and special reports on implementation of the mitigating measures will also be maintained and available for review by the Project management. It is suggested to identify documents and records that require templates and accordingly suitable templates shall be developed, which shall include but not limited to policies, procedures and work instructions, meeting minutes, monitoring results, training attendance records, emergency contract lists, action plans etc. Further, all these templates shall be communicated to all potential users. All these records will be archived at the Project office and will be maintained by the EHS officer. All documents and records shall be archived with a unique identifier so that they can be distinguished from any other material and can be easily retrieved. KPCL will document the process for creating, allocating and approving unique identifiers and will communicate this to relevant staff.

The contractor shall identify EHS Manager and EHS Officer for implementation ESMP for the project for which the contract has been awarded. The Contractor shall ensure that the ESMP (for the project) is implemented, the performance of which will be evaluated by KPCL time to time. The Contractor shall also be responsible for provisioning adequate arrangements and resources for implementing the corrective action developed as part of the internal and external audit reports developed time to time. Implementation shall be time and responsibility bound in the contractor project organogram.

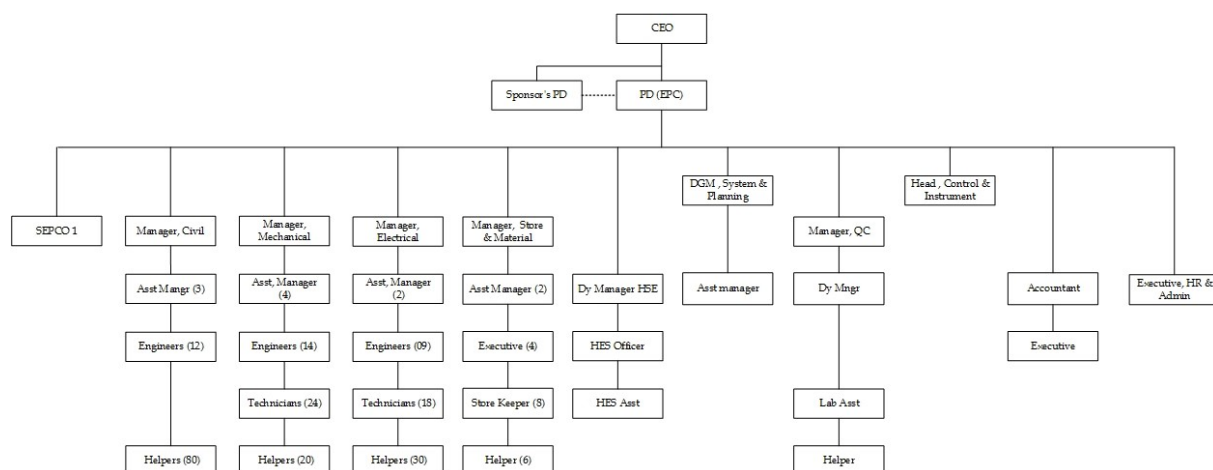


Figure 9-1: Organization Chart of KPCL

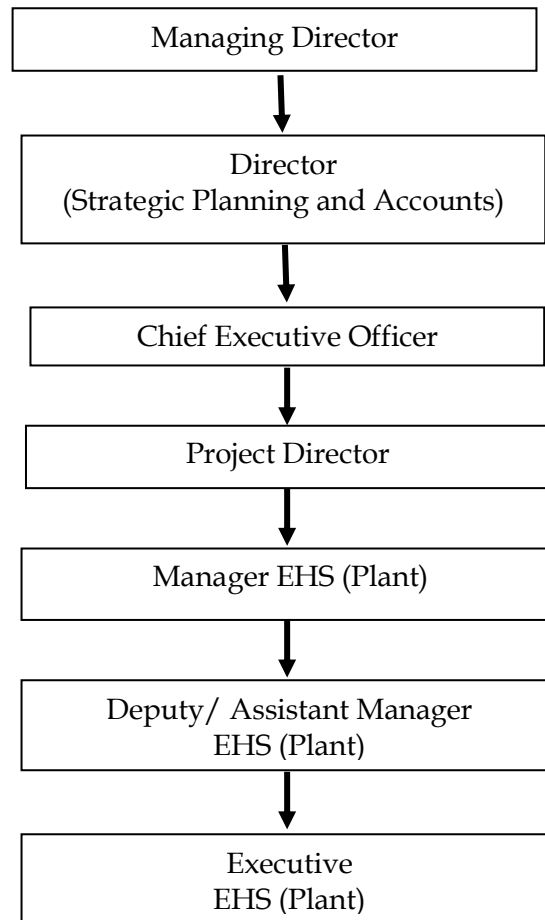


Figure 9-2: Organization Chart for Environmental and Social Management and Reporting Responsibilities during Construction and Operation Phase of the Project

9.5 Training

9.5.1 Construction Phase

Prior to commencement of major civil works at site, a suitably qualified in house/ external expert will be appointed by the EPC contractor in consultation with KPCL to develop and deliver a training program on implementation of the EMP, environmental monitoring and reporting in line with the applicable reference framework for the Project. The training will include the following topics:

- Environment, Health and Safety Policy of the EPC contractor;
- Environment and fundamentals of environmental pollution in relation to the Project;
- EHS management plans prepared by the EPC Contractor;
- Do's and Don'ts for the construction workers;
- Safety procedures and guidelines;
- Internal reporting and response system;
- Hazardous chemicals and waste handling;

In addition, specific training will be provided to the team involved in environmental monitoring and reporting, which will include:

- Applicable environmental guidelines and standards;
- Sampling site selection guidelines in line with environmental monitoring plan;
- Sample collection, storage, transportation and analysis procedures;
- Solid and hazardous waste management;
- Quality assurance and quality control;
- Environmental monitoring report preparation

The training will help in capacity building and implementation of the EMP during the construction phase of the Project. It will also help in ensuring internal and external monitoring and verification of the environmental performance of the Project. The reporting and verification during the construction phase will be quarterly and the reports will be submitted to the DOE and the Lenders.

9.5.2 Operation Phase

Prior to the commencement of the Plant operation, a suitably qualified in-house/ external environmental expert will be engaged by KPCL to develop and deliver a training program on operation phase environmental monitoring and reporting. The topics will be mostly same as that during the construction phase. However, it will also include following modules, which are specific to the operation phase:

- Periodic emission monitoring;
- Wastewater and thermal discharge monitoring;
- Aquatic ecology monitoring;
- Hazardous chemicals and waste management;
- Occupational health and safety programs;

The training will help in capacity building and implementation of the EMP during the operation phase of the Project. It will also help in ensuring internal and external monitoring and verification of the environmental performance of the Project. The reporting and verification during the operation phase will be semi-annual and the reports will be submitted to the DOE and the Lenders.

9.6 Plans for Construction and Operation Phase of the Project

9.6.1 Construction Phase

Prior to the beginning of major land works, the EPC contractor in cooperation with Project Developer will develop the following plans:

Health and Safety Plan

The EPC Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for work activities, plant

utilization, construction sequence and safety arrangements. Measures will be implemented to reduce the likelihood and consequence of the following hazards:

- falling from height;
- falling into water;
- entanglement with machinery;
- tripping over permanent obstacles or temporary obstructions;
- slipping on greasy or oily walkways;
- falling objects;
- asphyxiation;
- explosion;
- contact with dangerous substances;
- electric shock;
- variable weather conditions;
- lifting excessive weights; and
- traffic operations.

Construction Environmental Management Plan

The EPC Contractor will prepare and implement a Construction Environmental Management Plan prior to commencing work to manage the construction related environmental aspects as waste management, sanitation aspects, water conservation etc.

Traffic Management Plan

The EPC Contractor will prepare and implement traffic Management Plan prior to commencing work to manage the construction traffic. This will be required towards prevention of local traffic disruptions, avoid peak hours rush and prevent accidents. Movement of all heavy equipment and vehicles from Jetty to project site needs to be coordinated with the logistics team of project developer. Considering the laydown area on the other side of highway and heavy traffic movement on the national highway (Moulovibazar - Sylhet Highway), specific traffic management planning will be carried out by the EPC contractor and this will include traffic stewards near the highway for smooth traffic movement.

Emergency Response Plan

The EPC contractor must develop a site specific emergency response plan during the construction stage.

9.6.2 Operation Phase

During the operation phase of the Project, the Project Developer will develop the following plan/ management systems for effective operation of the Plant:

HSE and Social Management System

The Project Developer will develop and implement an HSE and Social Management System (HSE&SMS) to international guidelines for the entire Plant premises and its impact zones (project area of influence as defined under IFC PS) within two (2) years of commissioning the Plant.

Waste Management Plan

For effective segregation, handling, storage and disposal of solid and hazardous wastes generated from the Plant operations, a waste management plan will be developed by the Project Developer.

Spill Response and Emergency Plan

The Project Developer will prepare a spill response and emergency plan to address accidental spillages or release of hazardous wastes.

Emergency Response and Disaster Management Plan

Based on the outcome of the consequence analysis, an emergency response and disaster management plan will be developed by the Project Developer. This will define protocols to be followed in the event of emergencies or disasters in order to limit the impact on the employees and the local community. The plan will disclose potential disasters and potential risks from the plant to the local community as well as the plan of action on emergency protocol in the event of any such eventuality. This will also include awareness programs for the Plant personnel, local community and local administration. Details ERP has been depicted Chapter 10.

9.7 Budget

The EPC Contractor and the KPCL will allocate separate budget for environmental and social management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment etc, are already included in the EPC contract cost estimate and/or operating cost estimates. In addition to that separate budget will be allocated for CSR activities, which will be conducted by the Project Developer for community development. The budget estimate for the 3rd party monitoring and verification has been included in **Table 9-3**.

CHAPTER 10: RISK ASSESSMENT AND MANAGEMENT

10. RISK ASSESSMENT AND MANAGEMENT

All types of industries face certain types of hazards which can disrupt normal activities abruptly and lead to disaster like fires, inundations, failure of machinery, explosion to name a few. Gas based power plant also pose fire, electrocution and explosion hazards. Disaster management plan is formulated with an aim of taking precautionary step to control the hazard propagation and avert disaster and also to take such action after the disaster, which limits the damage to the minimum.

10.1 Type of Disaster at Power Plant

Disaster may occur due to following hazards at a gas fired power plant:

- Fire
- Explosion
- Oil spillage
- Electrocution
- Hazardous waste

In any gas based power plant there are various activities or area which pose substantial threat to the workers and hence hazardous in nature. The potential hazardous areas and likely accidents with the concerned areas have been enlisted below Table 10-1.

Table 10-1: Hazardous Area with Concerned Accidents

Sl.	Hazardous Area	Likely Accident
1.	Boiler Area	Explosion
2.	Oil tanks	Fire and Spillage
3.	Turbine Room	Explosion
4.	Electrical Room	Fire and electrocution
5.	Transformer Area	Fire and electrocution
6.	Cable tunnel	Fire and electrocution
7.	Storage facilities for fuel	Fire/Spillage

10.2 Accident Level

If there is any disaster any part of plant / work place due to any reason, the classification of areas which may be affected and nature of accidents can be made as follows:

- | | | |
|---|-----------|-------------------------|
| 1 | Level I | Operator level |
| 2 | Level II | Local community level |
| 3 | Level III | Regional/national level |
| 4 | Level IV | International level |

Out of the above, only level-I and level-II class of accidents can be considered applicable for this type of gas fired power plant.

LEVEL-I ACCIDENTS

Under this level, disaster may happen due to electrocution, fire, explosion, oil spillage and spontaneous ignition of combustible materials.

This level has probability of occurrence affecting persons inside the plant. Various hazardous areas which have been mentioned above in Section 10.1 as potential hazard areas will be affected during this level of accidents.

LEVEL-II ACCIDENTS

Disaster of this level can occur in case of sabotage and complete failure of all automatic control/warning systems and also if the fuel oil stored in tank and covered by tank bunds leaks out. However, probability of occurrence of this is very low due to adequate security, training and education of persons of plant responsible for operating such systems.

10.3 Disaster Preventive Measure

In order to prevent disaster due to fire, explosion, oil spillage electrocution and other accidents following preventive measures shall be adopted:

- i. Design, manufacture and construction of all plant and machineries building will be as per national and international codes as applicable in specific cases and laid down by statutory authorities.
- ii. Provision of adequate access way for movement of equipment and personnel shall be kept.
- iii. Minimum two no. of gates for escape during disaster shall be provided.
- iv. Availability of water spraying facility in oil storage area.
- v. System of fire hydrants comprising electrical motor division and diesel engine driver's fire pumps with electrical motor driver jokey pump for keeping the fire hydrant system properly pressurized and automatic water sprinkling system for all important transformers.
- vi. Fire hydrants with fire hoses in all areas where the fire can break.

10.3.1 Site Emergency Control Room

In order to control the disaster more effectively, a Site Emergency Control Room (SECR) shall be established at the plant site. The facilities proposed to be provided are given in the following sections:

- Plant layout
- Plant layout with inventories and locations of fuel oil/ furnace oil storage tank etc.
- Hazard identification chart, maximum number of people working at a time, assembly points etc.
- Population around the plant
- Internal telephone connections
- External telephone connections

- Hotline connection to district collector, police control room, fire brigade, hospital etc.
- Public address system
- Torch lights
- List of dispensaries and registered medical practitioners around the plant
- Area map of surrounding village
- Nominal roll of employees
- Note pads and ball pens to record message received and instructions to be passed through runners
- The blown up copy of Layout plan showing areas where accident has occurred.

10.3.2 Safety Department

Safety department shall be manned by experienced engineers and other supporting staff who shall bring safety consciousness amongst the work force of plant.

The safety department will conduct regular safety awareness courses by organizing seminars and training of personnel among the various working levels.

10.4 Contingency Plan for Management of Emergency

The emergency organization shall be headed by emergency leader called Site Main Controller (SMC) who will be plant manager. In his absence senior most person available at plant shall be emergency leader till arrival of plant manager.

Besides the top officials described above, rest of the employees shall be divided into three section teams namely A, B, C and a Non-action group D. Action team 'A' will consist of staff of section in which accident has taken place. Action team 'B' will consist of non-affected sections and maintenance department. Action team 'C' will consist of supporting staff i.e. security supervisor, warehouse supervisor, shift supervisor etc. Group 'D' will consist of people not included in those teams like contractor, labor, security men etc.

Team 'A' comprising staff of affected section will be taking up the action in case of an emergency. Team 'B' will help team 'A' by remaining in their respective sections ready to comply with specific instructions of SMC. Team 'C' consisting of supporting staff will help team 'A' as required and directed by team 'B'. Group 'D' will be evacuated to safe region under supervision of team 'C'.

A multichannel communication network shall connect SECR to control rooms of plant, various shops, other departments of plant, fire station and neighboring industrial units and plants. Co-ordination among key personnel and their team has been shown in

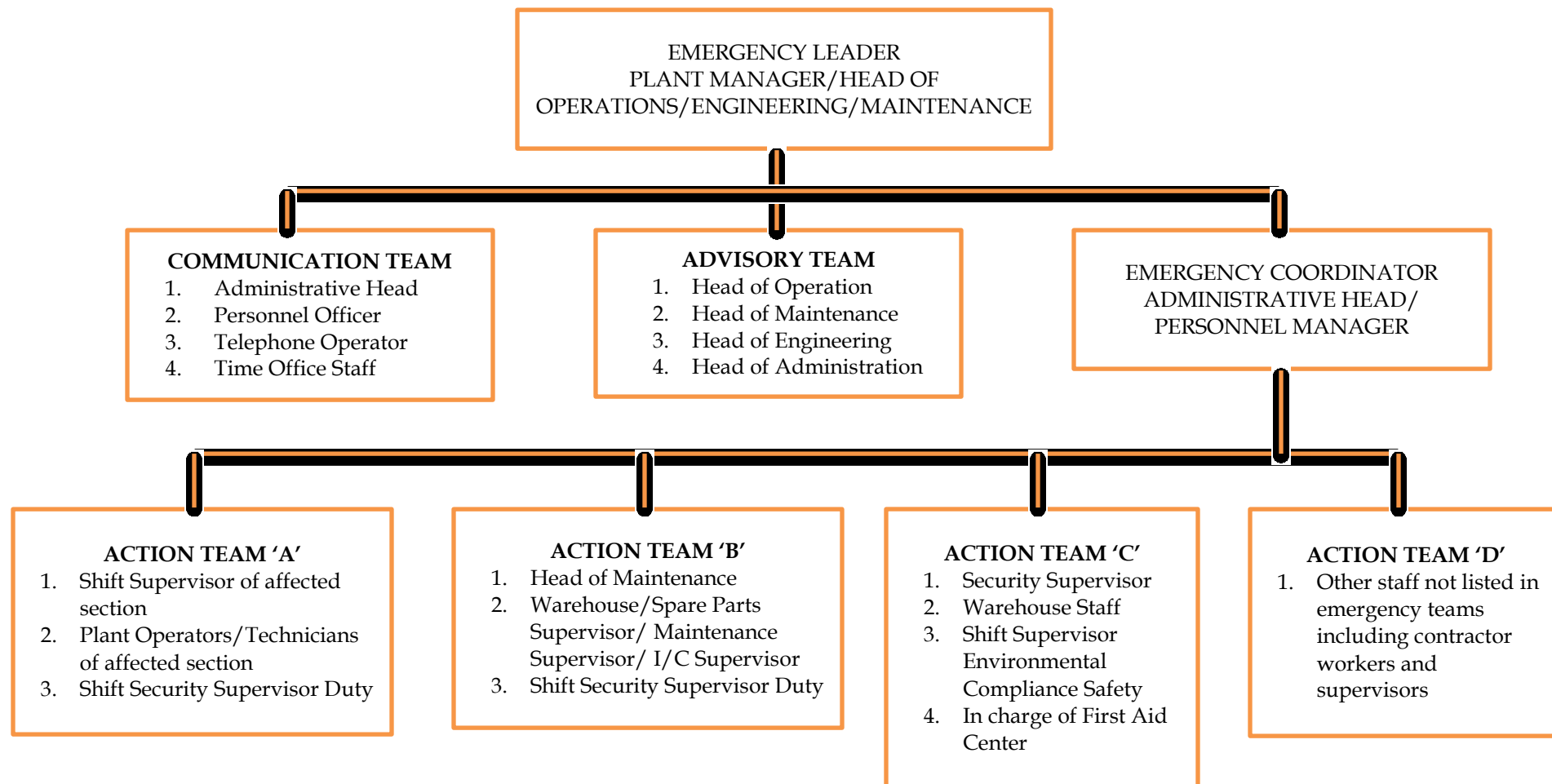


Figure 10-1: General Coordination among on Site Emergency Team Members

10.4.1 Outside Organizations Involved in Control of Disaster

In the event of massive spillage of toxic chemicals, fuel oil or occurrence of fire, population inside and outside plant boundaries, vegetation and animal etc. may be affected. In such circumstances secondary fire may also take place. In such an event help can be taken from outside agencies also. The organizations that shall be involved are as follows:

- (a) State and local authorities: District collector, Revenue divisional officer etc.
- (b) Factory Inspectorate, Chief Inspector of Factories, Joint Chief Inspector of Factories, Inspector of Factories
- (c) Environmental Agencies: Member Secretary of Ministry of Environment and Forests, District Environmental Engineer of Department of Environment (DoE)
- (d) Fire Department: District Fire Officer
- (e) Police Department: District Superintendent of Police, SHOS of nearby Police Stations
- (f) Public Health Department:
 - District Medical Officer
 - Residential medical officers of PHCs in a radius of 3 km around plant site
- (g) Local Community Resources:
 - Regional Transport Officer
 - Divisional Engineer Telephones

The outside organizations shall directly interact with district magistrates who in consultation with SMC shall direct to interact with plant authorities to control the emergencies.

10.4.2 Hazard Emergency Control Procedure

The onset of emergency will in all probability, commence with a major fire or explosion the following activities will immediately take place to interpret and take control of emergency.

1. Staff member on duty will go to nearest fire alarm call point and trigger off the fire alarm.
2. On site fire crew led by fire man will arrive at the site of incident with fire foam tenders and necessary equipment.
3. Site Main Controller will arrive at SECR, from where he will receive information continuously from incident controller and decisions and direction to the incident controller, plant control room, emergency security controllers and to the site medical officer to take care of casualties.

Site Main Controller will be directing and deciding a wide range of following desperate issues. In particular SMC has to decide and direct.

- Whether incident controller require reinforcement of manpower and facilities
- Whether plant is to be shut down or more importantly kept running
- Whether staff of different locations are to remain indoor or to be evacuated and assembled at designated collection center
- Whether missing staff members are to be searched or rescued
- Whether off-site emergency plan to be activated and a message to that effect is to be sent to district headquarter

When the incident has eventually been brought under control as declared by the Incident Controller, the SMC shall send two members of his advisory team as inspectors to incident site for:

- An assessment of total damage and prevailing conditions with particular attention to possibility of re-escalation of emergency which might, for the time being, be under control.
- Inspection of other parts of site which might have been affected by impact of incident.
- Inspection of personnel collection and roll call centers to check if all persons on duty have been accounted for.
- Inspection of all control rooms of plant to assess and record the status of respective plants and any residual action deemed necessary.

Post emergency, the inspectors will return to SECR with their observations and report of finding and will submit the same to SMC.

10.5 Miscellaneous Preventive Measures

10.5.1 Alarm System to be followed during Disaster

On receiving of the message of disaster from Site Main Controller, fire station control room attendant will sound Siren I, wailing type, for 5 minutes. Incident controller will arrange to broadcast disaster message through public address system.

On receiving of the message of "Emergency Over" from Incident Controller, the fire station control room attendant will give all "Clear Signal" by sounding alarm straight for two minutes.

The failures of alarm system will be explained to one and all to avoid panic or misunderstanding during disaster.

10.5.2 Actions to be taken on hearing the warning signal

On receiving the disaster message, following actions will be taken:

- All the members of advisory committee, personnel manager, security controller etc. shall reach the SECR
- The process unit persons will remain ready in their respective units for crash shutdown on the instruction from SECR
- The persons from other sections will report to their respective officer.
- Residents of township will remain alert.

10.5.3 Safety Devices / Equipment's

In order to make the services more effective, the workers and rescue team will be provided with the safety equipment's and items like gas mask respirators, fire entry suits, fire blankets, rubber shoes or industrial shoes, rubber glove, ladders, ropes, petromax lamp torches etc.

10.5.4 Fire Extinguisher

The different type of fire extinguishers have been proposed at strategic locations in the plant and given in Table 10-2.

Table 10-2: Different Fire Extinguishers at Different Sites

Name of sites	Type of fire extinguishers
Generation area	CO ₂ & Foam Type, Dry Chemical Powder
Cable galleries	CO ₂ & Foam Type, Dry Chemical Powder
High voltage panel	CO ₂ & Foam Type, Dry Chemical Powder
Control Rooms	CO ₂ & Foam Type, Dry Chemical Powder
MCC Rooms	CO ₂ & Foam Type, Dry Chemical Powder
Pump Houses	CO ₂ & Foam Type, Dry Chemical Powder
Fuel Tank area	CO ₂ & Foam Type, Dry Chemical Powder and sand basket
Guest Houses and Offices	Dry Chemical Powder, Foam Type
Warehouse	Foam Type
Crusher house	CO ₂ , Dry Chemical Powder, Foam Type

10.5.5 Fire protection and safety Measures

In order to prevent disaster due to fire, explosion, oil spillage, electrocution and other accidents, following preventive measure shall be adopted:

- Design, manufacture and construction of all plant and machineries building will be as per national and international codes as applicable in specific cases and laid down by statutory authorities.
- Minimum 2 no. of gates for escape during disaster shall be provided
- Availability of water spraying facility in oil storage area.
- System of fire hydrants comprising electrical motor division and diesel engine driver's fire pumps with electrical motor driver jokey pump for keeping the fire hydrant system properly pressurized and automatic water sprinkling system for all important transformers.
- Fire hydrants with fire hoses in all areas where the fire can break.

CHAPTER 11: CONCLUSION AND RECOMMENDATION

11. CONCLUSION AND RECOMMENDATION

11.1 Conclusion

Due to the scarcity of electricity, Government of Bangladesh has intended to construct power plant with the requirement of PSMP 2010. The proposed project is a construction of 163 MW gas based CCPP at Fenchuganj, Sylhet under the authorship of the KPCL. The study is carried out following the Environmental Impact Assessment Guideline of DoE and World Bank which include multidisciplinary tools and techniques of Physical, Water resources, Agriculture, Land and soil, Fisheries, Ecology and socio-economic surveys and investigation. The local people participation is ensured through RRA and PRA approach.

The project component includes main plant facility, residential and social facilities, water treatment plant, disposal facilities, and switchyard including substation. The proposed site for construction of Gas Turbine unit, Heat recovery steam generator unit with their auxiliaries, ancillaries and switchyard is about 9.22 acres of KPCL's own land which was abundant brisk field and fallow land. In the scope of ESIA, potential hazards possessed by the proposed thermal power plant are identified with root causes and possible consequences. The risk of potential hazards includes mechanical, electrical, chemical, fire and explosion, and risk of failure mode. Specific safety measures are also suggested which should be considered during design.

The project study area is composed of flat topography with some low lying areas, river system, exposure to earthquake; rural setting with dominating boro paddy cultivation, scattered swamp area. Improved transportation and road network and agriculture farming and fishing the primary occupation are the key socioeconomic characteristics of the study area.

Attempts were made to identify the potential environmental and social impacts with an outline of environmental management plan that have been detailed out in this stage. The significant negative impact may include surface water pollution if due care is not paid in effluent treatment and waste water treatment plant. Negative impacts during construction phase might be air pollution, water quality deterioration, disruption to water resources, disturbance to fisheries habitat and disturbance to society due to increase of noise level. The construction work will create employment opportunity for the local people.

Long term ground level concentration of the NO_x and CO might increase during operational phase of the thermal power plant. This may provoke acid rain in extreme cases of gaseous emission if unchecked of gaseous emission which could have deleterious impacts on human being, crops, vegetation, aquatic wildlife and fishes. For mitigating impacts of NO_x the turbine will be provided with dry low NO_x burner. Normally there is no CO in flue gas. It appears only when there is incomplete combustion which is taken care by the automatic combustion control system. The surface water quality would be changed due to disposal of solid waste and discharge of thermal plume that required adoption of waste management

and treatment of thermal plume. The ground water aquifer loss might be aggravating due to excessive abstraction. The proposed project might have adverse impact on the fish habitat quality indirectly by deteriorating the water quality which could be minimized up to some extent through prescribed mitigation measures. However, proper EMP implementation and public awareness growing and controlling of water pollution may conserve and protect the fishes.

The surrounding terrestrial and aquatic ecosystem are exposed to accidental release of chemical, warm water and fire explosion for which the safety measure prescribed in the hazard and risk analysis section are necessary to adopt. The species composition of the Kushiara River might be changed if the effluent is discharged into the river directly without lowering the temperature to ambient level.

In contrary to negative impacts the proposed project is expected to create enormous scopes of economic and social development of the region. The present electricity crisis and rising of electricity demand require installation of new power plant. The proposed thermal power plant will offer large numbers of job opportunity during its life time where the local people will have the priority. The potential benefits of the project will outweigh the negative impact if the prescribed EMP is implemented.

11.2 Recommendations

Following issues are recommended on the basis of ESIA study:

- Local people should be involved in every stage of the implementation of the power plant;
- Safety measures for potential risk associated with the proposed power plant should be adopted and implemented;
- All activities in pre-construction, construction and post-construction stage should be implemented according to the EMP provided;
- Strong monitoring activities should be carried out for air emission and effluent discharge so as to ensure whether the effluent is harmful for the environment or within the standard limit as defined in ECR, 1997 (amended in 2005);
- Killing any kind of wildlife during construction period and operation stage should be banned;
- Discharge of untreated effluent in the open environment should be restricted;
- Burning of solid waste is prohibited in every stage;
- Periodic ground water monitoring as the local community get sufficient water during lean season;
- Implement the noise controlling measure appropriately;
- Involvement of local people in terms of classified job opportunities should be ensured at each phase of the power plant;
- Special care should be taken for wildlife community protection as per EMP;
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management during preconstruction, construction and operation phases of the project.