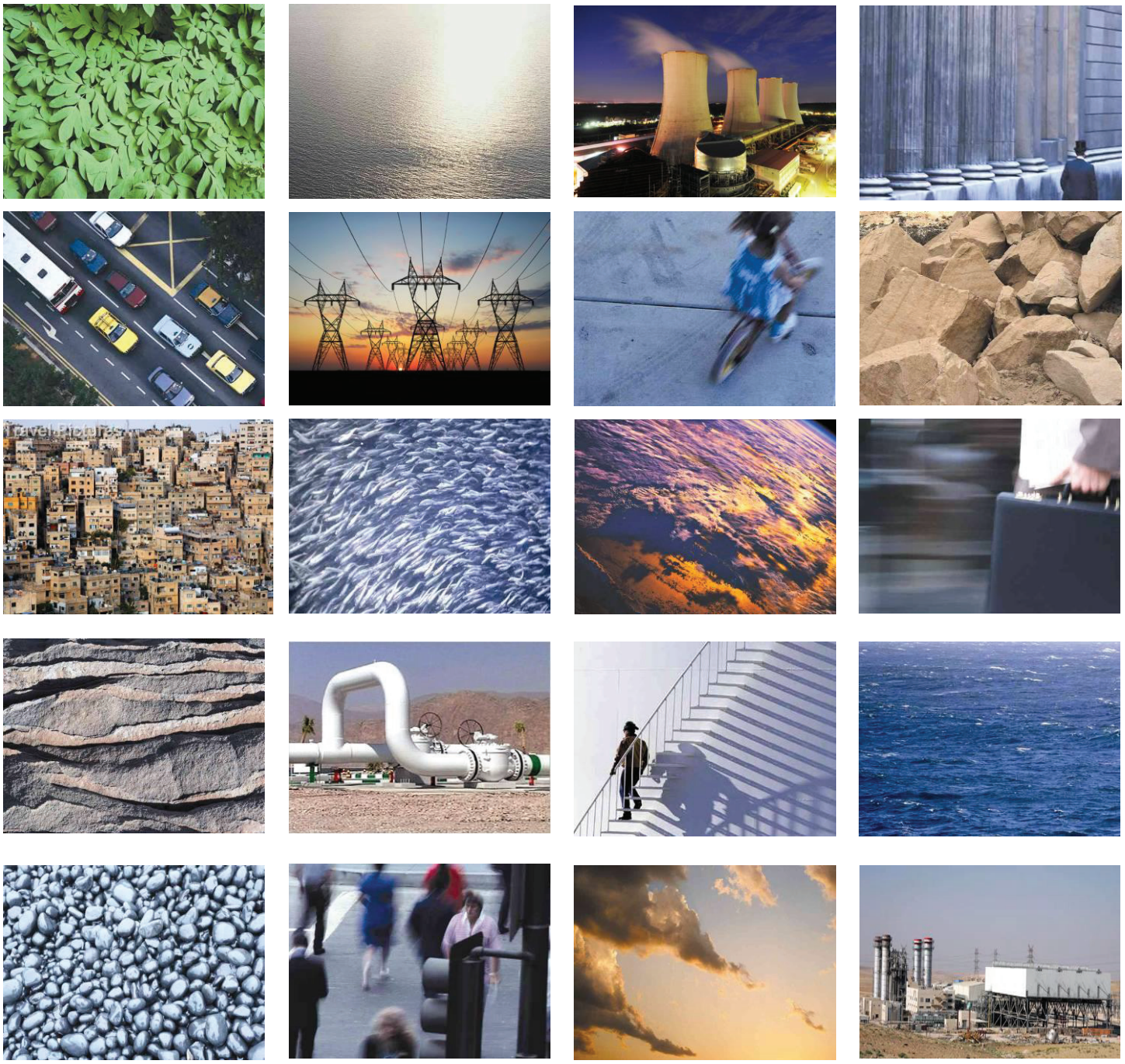

Environmental and Social Impact Assessment of 400 MW ± 10% Combined Cycle Power Plant (Sirajganj-4): *Sirajganj, Bangladesh*

Final Report

August 2016

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Sembcorp North West Power Company Limited (SNWPCL)

The Business of Sustainability

ERM

Environmental and Social Impact Assessment of 400 MW ± 10% Combined Cycle Power Plant (Sirajganj-4): *Sirajganj, Bangladesh*

Environmental Resources Management (S) Pte Ltd

120 Robinson Road
#10-01
Singapore 068913
Telephone (65) 6324 9636
Facsimile (65) 6226 1636
Email ermsg@erm.com
Website: www.erm.com

Environmental and Social Impact Assessment Report

Client	Project No
Sembcorp Industries Ltd	0276008
Project Summary Sembcorp Utilities Pte Ltd, a wholly owned subsidiary of Sembcorp Industries Ltd, is proposing to set up a **400 MW ± 10%** combined cycle power project in Sirajganj District of Rajshahi Division in Bangladesh. Sembcorp has therefore initiated the environmental and social impact assessment study to comply with the environmental impact assessment guidelines of the Government of The People's Republic of Bangladesh; the Performance Standards of the IFC and the Safeguard Policy Statement of the ADB. This report presents the outcome of ESIA Study.	Date 21 August 2016 Approved by **Alastair Scott** *Managing Partner* *ERM (S) Pte Ltd*

Revision	Description	By	Technical Review (social)	Technical Review (Ecology)	Technical Review (Env) and Approved	Date
2	Final Report	NC	NS	AV	AS	21.08.16
1	Draft Final Report	NC	NS	AV	AS	23.07.16
0	Draft Report	NC	NS	AV	AS	30.06.16

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ABBREVIATIONS

ACF	Activated Carbon Filters
AERMOD	AMS/EPA Regulatory Model
AOI	Area of Influence
ARIPO	Acquisition and Requisition of Immovable Property Ordinance
ASTM	American Society for Testing and Materials
BBA	Bangladesh Bridge Authority
BFIDC	Bangladesh Forest Industries Development Corporation;
BFRI	Bangladesh Forest Research Institute
BMD	Bangladesh Meteorological Department
BNH	Bangladesh National Herbarium
BOO	Build, Own and Operate
BOP	Balance of Plant
BPC	Bangladesh Petroleum Corporation
BPDB	Bangladesh Power Development Board
BPEO	Best PracticableEnvironmental Option
BTU	British thermal units
BWDB	Bangladesh Water Development Board
CC	Clifford Capital
CCO	Chief Compliance Officer
CCPP	Combined Cycle Power Plant
CCW	Closed Circuit Water
CEM	Continuous Emission Monitoring
CITES	Convention on International Trade in Endangered Species of
CLAC	Central Land Allocation Committee
COC	Cycle of Concentration
COD	Commercial Operation Date
CW	Cooling Water
DC	Deputy Commissioner
DCS	Distributed Control System
DEM	Digital Elevation Model
DFID	Department for International Development
DFIs	Development
DG	Diesel Generator
DLACs	District Land Allocation Committees
DMF	Dual Media Filters
DoE	Department of Environment
DPHE	Department of Public Health Engineering
ECAs	Ecologically Critical Areas
ECC	Environmental Clearance Certificate
ECR	Environment Conservation Rules
EERT	External Emergency Response Team
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EMF	Electric and Magnetic Field
EMP	Environmental Management Plan
EOI	Expression of Interest
EPC	Engineering Procurement Construction
EPRI	Electric Power Research Institute
EQS	Environmental Quality Standards
ERDMP	Emergency Response and Disaster Management Plan

ERM	Environmental Resources Management
ERP	Emergency Response Plan
ERT	Emergency Response Team
ES	Executive Summary
EIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ETP	Effluent Treatment Plant
FD	Forest Department;
FDS	Fire Detection System
FGD	Focused Group Discussions
FPIC	Free, Prior, and Informed Consent
FSA	Fuel Supply Agreement
GDS	Gas Detection System
GHG	Green House Gases
GIIP	Good International Industry Practice
GRC	Grievance Redress Cell
GRM	Grievance Redress Mechanism
GSA	Gas Supply Agreement
GT	Gas Turbine
GTG	Gas Turbine Generator
HFL	Highest Flood Level
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HSD	High Speed Diesel
IA	Implementation Agreement
ICP	Informed Consultation and Participation
IEC	International Electrotechnical Commission
IECs	Important Environmental Components
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Organisation
IMCI	Integrated Management of Child Illness
IP	Intermediate Pressure / Indigenous People
IPCC	Intergovernmental Panel on Climate Change
IPP	Indigenous Peoples Plan
IPPF	Indigenous Peoples Planning Framework
IUCN	International Union of Conservation for Nature
KJ	Kilojoules
LCC	Location Clearance Certificate
LGED	Local Government Engineering Department
LLA	Land Lease Agreement
LTSA	Long Term Service Agreement
MB	Mixed Bed
MCR	Minimum Continuous Rating
MM	Million
MMS	Manab Mukti Sangstha
MoEF	Ministry of Environment & Forest
MP	Management Plan
MPEMR	Ministry of Power, Energy and Mineral Resources
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standard
NEMAP	National Environmental Management Action Plan
NFPA	National Fire Protection Association, United States of America

NGO	Non-Governmental Organization
NNE	North North East
NNW	North North West
NOC	No objection Certificate
NQ	Noise Quality
NWPGCL	North West Power Generation Company Ltd
O & M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PCO	Project Company
PGCB	Power Grid Company of Bangladesh
PGCL	Pashchimanchal Gas Company Ltd
PLC	Programmable Logic Controller
PM	Particulate Matter
PP	Project Proponent
PPA	Power Purchase Agreement
PPMP	Pollution Prevention Management Plan
PPP	Public Private Partnership
PS	Performance Standards
PSMP	Power System Master Plan
PT	Pre-Treatment
PVC	Project Village Committee
R & R	Resettlement and Rehabilitation
RCC	Reinforced Cement Concrete
RET	Rare, Endangered and Threatened
RF	Resettlement Framework
RFP	Request for Proposal
RMS	Regulating and Metering Station
ROW	Right of Way
RP	Resettlement Plan
SAC	Strongly Acidic Cation
SBA	Strong Base Anion
SCI	Sembcorp Industries Limited
SCPP	Simple Cycle Power Plant
SCU	Sembcorp Utilities Pte Ltd
SEP	Stakeholder Engagement Plan
SGX	Singapore Exchange
SHG	Self Help Groups
SPA	Share Purchase Agreement
SPL	Sound Power Levels
SPM	Suspended Particulate Matter
SPS	Safeguard Policy Statement
SSE	South South East
ST	Steam Turbine
STG	Steam Turbine Generator
STP	Sewage Treatment Plant
TMP	Traffic Management Plan
TSA	Technical Service Agreement
UNO	Upazilla Nirbahi Officer
VBI	Village Based Institutions
VOCs	Volatile Organic Chemicals
WB	World Bank
WCP	Waste Collection Point
WFP	World Food Program
WHO	World Health Organization

WMP	Waste Management Plan
WSA	Waste Storage Area
WSP	World Sanitation Program
WTP	Water Treatment Plant

0 EXECUTIVE SUMMARY

0.1 INTRODUCTION

The Government of Bangladesh (GOB) has given highest priority to power sector development in the country and has committed to making electricity available to all citizens by 2021[1]. The GOB has further extended its vision for power supply out to 2030 and prepared the Power System Master Plan (PSMP), 2010. The plan forecasts a supply surplus scenario by 2030 with power demand expected to be approximately 34,000 MW against a generation capacity of 40,000 MW (Power Division 2015). To realize these targets, the GOB since 2011 has undertaken the implementation of reforms in the power sector, including significant development programs for participation of the private sector of which this Project constitutes one of the important parts.

The GOB has adopted a strategy for the development of the power sector which envisages private participation in the sector. As part of that strategy, the GOB decided for part of the new generation capacity to be installed and operated by the private sector.

0.2 PROJECT BACKGROUND

BPDB has plans to develop the Sirajganj site as a major power generation complex and currently has a 225 MW Combined Cycle Power Plant (CCPP) referred as "Sirajganj 1" or "S1" operated by NWPGCL. NWPGCL is in the process of tendering for two additional 225MW CCPPs, namely "Sirajganj 2" or "S2" and "Sirajganj 3" or "S3", which will be developed in between Sirajganj 1 and Sirajganj 4 projects by NWPGCL. A 230 kV substation connects the complex to the national transmission system of the Power Grid Company of Bangladesh (PGCB) Ltd. A 30" East-West gas pipeline crossing the Bangabandhu Bridge (also called the Jamuna Multi-purpose Bridge) and Gas pipeline valve station is about 1.5 km away from the Project site.

In line with this strategy, the GOB decided to (a) implement a new greenfield 400 MW±10% Combined Cycle Power Plant on Build, Own and Operate ("BOO") basis under the GOB's Public Private Partnership (PPP) program at Sirajganj, Bangladesh (the "Project"); (b) to execute the Implementation Agreement ("IA"), the Power Purchase Agreement ("PPA"), the Gas Supply Agreement ("GSA"), the Fuel Supply Agreement ("FSA"), the Land Lease Agreements ("LLA"), Share Purchase Agreement ("SPA") (together, the IA, PPA, GSA, LLA, FSA and SPA are hereinafter referred to as the "Project Agreements") and other contracts required for the financing, construction, operation and maintenance of the Facility; (c) implement the Project, and (d) upon Commissioning (in both simple cycle and combined-cycle modes),

[1] Vision; Power Cell, Ministry of Power, Energy and Mineral Resources, GoB

operate and maintain the Facility for an initial period of 22 years (plus the 6 month period during which the Facility is operated in simple cycle mode). In the past, the MPEMR has made several attempts to tender for a gas based IPP in Sirajganj, under the Public-Private Partnership scheme, however none of these processed could be successfully completed largely due to the inexperience of bid participants who submitted unsustainable low tariffs.

The last of such processes was conducted in 2012 by the Power Division, MPEMR and the selected Project Sponsor was issued a Letter of Intent ("LOI") to undertake the development and implementation of a 367MW power plant in Sirajganj. Subsequently, the project failed to take off due to the inability of the Project Sponsor to comply with the conditions of the awarded bid which led to a termination of the award by the Power Division in September 2012.

With tariff discovery having being competitively undertaken as recently as in 2012 and relying on the provisions of the *Power and Energy Fast Supply Enhancement (Special Provision) Act, 2010 (Board of Investment 2010)* which allow for bilateral solicitation of proposals for IPP development, the MPEMR invited Sembcorp Utilities Pte Ltd. (SCU), in October 2014, to submit a comprehensive proposal for development for a 400MW (±10%) IPP in Sirajganj, while keeping tariff the same as that derived under the competitively bid process of 2012.

SCU submitted an RFP compliant proposal to the MPEMR on Dec 7, 2014 and received the notification of acceptance of proposal from MPEMR on Apr 02, 2015. The Letter of Intent (LOI) for the development of project was issued by NWPGCL vide letter no. 537/NWPGCL/Siraj 400MW/(Unit-4)/2015 dated 22 September 2015

Sembcorp North-West Power Company Ltd("SNWPCL") has been duly formed and registered under the Laws of the People's Republic of Bangladesh on 26 November 2015 as a private limited company to develop, design, finance, build, own, operate and maintain the Plant. The Company has been set up for the sole purpose of developing, owning and operating the Project. The Company will be 71% owned by SCU, and 29% by NWPGCL. SNWPCL is proposing to set up a 400 MW±10% combined cycle power project (*hereinafter referred as the "Project" or the "Plant" or the "Facility" or "Sirajganj 4"*) with net generation capacity of 413.8 MW[1] in Sirajganj District of Rajshahi Division in Bangladesh. The project site is located approximately 135 km north-west of Dhaka on the western bank of the River Jamuna. As per the Request For Proposal issued by North West Power Generation Company Limited (*"NWPGCL"*) on 28 October 2014 the power plant will operate on natural gas as its primary fuel and is designed to operate on High Speed Diesel ("HSD") for short periods of time as the back-up fuel in case of interruptions in gas supply.

[1] As per the RFP of the Project, project generation capacity is 400 MW ± 10%. Based on the Sembcorp's assessment of power generation from the facility, which will be supplied to the national grid, net generation capacity of the Plant will be 413.8 MW. This excludes auxiliary consumption of the Plant.

The total project cost is estimated at USD 384 MM and will be financed 75:25 through debt and equity. The lending consortium comprises of the International Finance Corporation ("*IFC*"), the UK development finance institution CDC Group plc (CDC) and Clifford Capital ("*CC*"), with each lender expected to fund one-third of the total debt.

0.3 THE PROJECT – SIRAJGANJ 4

The Project will be sited at the Saidabad power generation complex owned by NWPGCL and situated along the banks of the Jamuna River in the north-west region of Bangladesh. The Project site falls under the Saidabad Union of Sirajganj Sadar Upazilla (Sub-district) of Sirajganj District. 16 acres of land (excluding land to be provided for utilities) has been earmarked within the Sirajganj power generation complex for the Project which will be jointly owned by SNWPCL and NWPGCL. Within the Saidabad power generation complex, NWPGCL currently owns and operates a 225 MW dual fuel Combined Cycle Power Plant ("CCPP") (Sirajganj 1) and is in the process of tendering for two additional 225MW dual fuel CCPP plant (Sirajganj 2 and Sirajganj 3), that will be developed in between Sirajganj 1 and Sirajganj 4 projects.

A 230 kV substation connects the complex to the national transmission system of the Power Grid Company of Bangladesh ("PGCB") and the 30" East-West gas pipeline crossing the Bangabandhu Bridge (also called the Jamuna Multi-purpose Bridge) is located about 1.5 km away from the Project site.

The proposed CCPP (Sirajganj 4) will be located in district Sirajganj of Rajshahi division in north-western region of Bangladesh. The Project will be implemented build, own and operate (BOO) basis under the GOB's PPP program. The land required for the project will be provided by BPDB pursuant to a Land Lease Agreement ("LLA"). The Project is supported by a 22 year Implementation Agreement ("IA") with the GOB, acting through the Ministry of Power, Energy and Mineral Resources (MPEMR), and the PGCB. The electrical capacity and electricity generated will be sold under a 22 year Power Purchase Agreement ("PPA") with the Bangladesh Power Development Board (BPDB). SNWPCL will enter into a Gas Supply Agreement ("GSA") with Pashchimanchal Gas Company Ltd. ("PGCL"), a subsidiary of state-owned Petrobangla and a Fuel Supply Agreement ("FSA") with state-owned Bangladesh Petroleum Corporation ("BPC").

The Project has been designated by the GOB as a "Public, Private Partnership" project, and as such, twenty nine percent (29%) of the equity interest in the Company will be subscribed, purchased and owned by NWPGCL pursuant to the Share Purchase Agreement ("SPA") to be entered into by and among SNWPCL and the Project Sponsors (SCU and NWPGCL).

0.3.1 Size and Magnitude of Operations

The main power block of the Plant will consist of one gas turbine (GT), one steam turbine (ST), one heat recovery steam generator (HRSG) and bypass and exhaust stacks. Black start and emergency diesel generators will be provided to provide black start and safe shutdown capabilities.

The plant will be constructed to have a minimum continuous rating (MCR) capacity of 413.8 MW (net) output of combined cycle with natural gas as fuel, at the high voltage side of the outgoing terminals of the 230 kV transformer, corrected to the Reference Conditions at 0.85 power factor (lag). However with HSD as fuel, the net capacity of combined cycle will be 333.0 MW. The simple cycle output capacity with natural gas will be 282.0 MW (net) at the high voltage side of the outgoing terminals of the 230 kV transformer corrected to the Reference Conditions at 0.85 power factor (lag), whereas with HSD as fuel will be 236.8 MW.

The Project components include:

- Gas Turbine;
- Heat Recovery Steam Generator;
- Steam Turbine;
- Steam Turbine Condenser;
- Fuel Gas Compression and Conditioning System;
- HSD Storage;
- Water System including cooling water system;
- Electrical System
- Connection from S4 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 GTCL Valve Station to the RMS of S4 Project
- New water pipeline of about 4.0 km from River Jamuna, water intake structure and water pump house
- HSD pipeline from the tapping point provided in HSD pipeline within Saidabad Power Generation Complex.
- Potable water treatment Plant
- Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP) with 4 m3/hr capacity each

0.3.2 Land

The total power generation complex is 69.69 acres out of which the land requirement for the Project S4 is estimated to be approximately 23.6 acres. In addition to this approximately 19.3 acres of land will be required temporarily for construction laydown area and construction workers accommodation. The proposed S4 plant will be built beside the existing S1 and proposed S2 and S3 plants within the power complex. The land required is currently owned by institutions including equity partner BPDB/NWPGCL and Khas Land under

possession of the GOB. The land will be obtained by Land Lease Agreements with respective entities in consideration of a lease rent as per the market price. Break-up of land requirement for the project is as follows:

- Power Plant : 16 acres
- Gas RMS : 0.9 acres
- HSD Pipeline (within complex) : 0.16 acres
- Gas Pipeline (outside complex) : 3.95 acres
- Water Pipelines (outside complex) : 2.57 acres
- Lay down area (construction phase) : 10.95 acres
- Worker camp (construction phase) : 8.37 acres

0.3.3 Natural Gas (Primary Fuel)

The high-pressure gas transmission system for the supply of Gas to the Facility will be comprised of approximately 1.5 km considering the source point of 20"ND pipeline and as per design to be operated at an average of 600 psi with maximum operating pressure of 1000 psig and at worst condition operating pressure will be 200 psig. This pipeline will be connected with source at one end at the Connection Point and the other end will terminate at the inlet of the RMS. The pipeline will be constructed on a strip of land of 8 m width (which is being used by NWPGCL as well for its gas pipeline) and is marked as required by the Gas Safety Rules, 1991, as amended up to 2003.

0.3.4 HSD (Secondary Fuel)

Use of HSD as fuel for power generation in the project will be only in case of interruption in natural gas supply. This will be a back-up fuel for the project. As per the fuel supply agreement (draft), three days of HSD supply will be stored in two tanks with capacity equivalent to 15 days operation at 80% output on HSD, while the plant is running on Gas. The tanks will be installed on a bund of adequate size per environmental and safety requirements. Total storage capacity at site will be 19,000 m^3. HSD will be delivered via rail from BPC Depot in Chittagong/Daulatpur/ Khulna up to the nearest rail head at Saidabad (i.e. Bangabandhu Bridge West Railway Station), which is located approximately 3 km from the Project site. NWPGCL has constructed an HSD unloading and pumping station at the railway station and an HSD supply pipeline has been constructed up to the Saidabad Power Generation Complex by NWPGCL. The unloading facility that has 30 rail car connections for unloading purposes and screw type, electric motor driven, carbon steel pumps rated for 100m^3/hr at 70m head, capable of pulling suction, have been provided. The unloading facility has been designed to unload 3 complete trains (consists of 30 nos. oil tanker wagon having capacity of 42 ton each wagon) per day. The available unloading oil tanker wagons having capacity of 42 tons are available for use by BPC. BPC will use the same system for HSD supply as per the common agreement; however the exact location of the HSD receiving point is yet to be confirmed by SNWPCL. It is also to be noted that the HSD pipeline will have HSD on it only during transfer of fuel from railway siding to the storage facility within the site and after completion of

transfer, the pipeline will be cleaned. This will avoid any risk during non-operation of the HSD pipeline.

0.3.5 Water

Raw water will be drawn from the Jamuna River for cooling tower make up and water pre-treatment plant requirements. The raw water system will consist of an intake structure on the River Jamuna near the Bangabandhu Bridge and vertical raw water pumps. The water supply system will be designed to maximum gross demand of water in all modes of operation. Water requirement during operation phase of the Project will be approximately 600 m^3/hr, which will be drawn from the Jamuna River by a 4.0 km long pipeline (the pipeline from water intake point to the pump house will be downstream of the west guide bund and will be overground, whereas after pump house, same will be underground). Cooling water and other treated effluent discharge from the Project will be about 74.4 m^3/hr. This will be discharged on land outside the southern boundary of the project. In addition to that treated effluent generated from sewage treatment plant (~ 3 m^3/hr) will be used within the site for greenbelt development. No untreated sewage will be directly discharged into Jamuna River/Channel or disposed of on land through the project life cycle. As back up of water supply, ground water may be considered, which is subject to the local authority approval. Drinking water supply during construction will be provided by the EPC and during operations will be provided through ground water treated through a potable water treatment plant.

0.4 DESCRIPTION OF THE ENVIRONMENT

The extent of the EIA study covered the Area of Influence (AOI) of the Project, which was defined based on the scoping study. The AOI of the Project, comprising of the Project Site and the surrounding areas, where influence of the Project activities is anticipated, was defined. Based on the anticipated impacts on physical, ecological and social resources due to the Project, AOI has been considered as 5 km radial zone from the Project site, which also consists of existing S1 and proposed S2 and S3 plants along with the proposed S4 plant.

The baseline studies were carried over a period of five months from December 2012 to February 2013 and from February to March 2015.

0.4.1 Landuse/ Land Cover

The maximum percentage of land use/land cover of the Project AOI falls under agriculture (38.08%), followed by water bodies (28.34%) and waste land (19.25%). Plantation (homestead and others) covers an area of 9.33% of the total area of AOI. Built-up area is limited to 2.46%. Industrial activity zone is currently limited to the Power Generation Complex. Land use of the fuel pipelines (Gas and HSD) RoW with 100 m buffer consists of 36.65 % built up area, followed by 30.71% waste land, 14.55% agricultural land and rest under

plantations (homestead and agriculture+ roadside+ Jamuna Ecopark). Landuse of the water pipeline RoW with 100 m buffer consists of 31.36 5 waste land followed by 14.16% built up, 12.69% agriculture, 9.18% water bodies and rest under plantations. The laydown area and worker's accommodation area identified are scrub land currently under possession of BBA.

0.4.2 Topography

The area under Jamuna Eco Park and Saidabad Power Generation Complex is in the elevation range of 12-18 m above MSL (as per DEM map) and the complex has 2.5 -3 m height embankment developed in 2006-2007. The area has no considerable slope variations. More than 80 % of the area falls in the gradient range of 0-5 % and some places have 5-10 % slope. Very few areas fall in the 20-27% gradient range, i.e. near Saidabad, near river bank of Jamuna Eco Park and at the edges of few char areas on the Jamuna River. The entire river bank can be seen to have a slope range of 10-15% variation because of the difference in the land embankment and the river level.

0.4.3 Geology

Sirajganj lies in the Rajshahi Division of Bangladesh which falls under a stable Precambrian platform and is characterised by limited to moderate thickness of sedimentary rocks above a Precambrian igneous and metamorphic basement. This unit is geologically stable in relative terms and has not been affected by fold movement. The AOI lies in the active delta region of the Brahmaputra-Jamuna floodplain and the surface geology consists of alluvial deposits of alluvial silt and sand.

0.4.4 Hydrology

The water level data for the Sirajganj Hardpoint was collected from the Bangladesh Water Development Board (BWDB) office for last 65 years (1950-2014). The danger level is 13.35 m and from the data it was observed that almost every year during rains between July to September, the River crosses the danger level mark. The recorded highest water level till date at Sirajganj is 15.11 m on 30.8.1988. The last reported major flood in the area was in 2007 when the maximum level of Jamuna reached 14.95 m on 1st August. In 2014 the maximum level reached was 13.51 m on 29th September. The Project site along with the Saidabad Power Generation Complex is situated at an elevation of 15.75 m which is 0.64 m above the level reached in 65 years of recorded data (maximum level ever reached was 15.11 m in 1988).
Water discharge and maximum velocity data for 2000-2014 was also collected from BWDB for Station SW46.9L (Bahadurabad-Transit) the nearest upstream data collection location[1] from Sirajganj.

(1) BWDB at [1]Sirajganj Hardpoint maintains water level data only. Discharge, cross section and velocity data is collected at Bahadurabad transit.

0.4.5 Water Quantity and Quality

Based on the last 15 years data of water flow in the River Jamuna as recorded by BWDB, minimum flow of the River was measured as 2,036.82 m^3/s on 5th March 2013. Whereas the proposed water requirement of the Sirajganj 4 project is about 0.17 m^3/s. This amount is only 0.008% of the lean season flow of the Jamuna River in Sirajganj. Furthermore, a study conducted by IWM also revealed that the minimum discharge of the channel near the West Guide Bund (WGB) is about 745 m^3/s and the maximum char extent between the channel and WGB is around 910 m at intake location and 1040 m after 250 m downstream. Considering the lean season flow of the channel near intake location, the water intake is of the order of 0.02%. Considering the lean season water availability in the River Jamuna as well as the channel near WGB, it is evident that the amount of water intake is negligible in the context of water availability in the River/ Channel.

A high level of iron was found in the groundwater of study area. This is a common occurrence in many parts of Bangladesh and can be attributed to predominance of reducing conditions in the aquifers of Bangladesh[1]. Apart from iron, other parameters fall within the standard permissible limits for drinking water. Arsenic contamination is also found in the Project AOI though both the groundwater samples analysed for this study were within limits. Arsenic contamination of geological origin is reported in many districts of Bangladesh[2] and Sirajganj District is also affected by it.

0.4.6 Climate

Bangladesh is located in the tropical monsoon region and its climate is characterised by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. From the climatic point of view, three distinct seasons can be recognised 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. Most rains occur during the monsoon (June-September) and little in winter (November-February). Moderate rains are also reported in the months of March, April and October.

Wind direction and speed keeps changing due to seasonal variations. Winds are generally moderate during non-monsoon season, whereas during the monsoon season, these are moderate to strong. The wind speed varies from 1.02 m/s to 7.71 m/s, with wind speed varying in between 2.31 to 3.34 m/s

(2) [1] Groundwater studies of Arsenic contamination in Bangladesh, DPHE/BGS/DFID, 2000

(3) [1] Groundwater studies of Arsenic contamination in Bangladesh, DPHE/BGS/DFID, 2000

most of the times, which indicates good dispersion conditions for air pollutants dispersion.

The annual windrose shows the predominant wind direction to be SSE to NNW. During the months of May to October the predominant wind direction is SSE to NNW and during November to April it is NNE to SSW. Predominant wind direction is most of the time not towards the major settlement area of Saidabad, which is located in the west and north-west direction.

Due to heavy rainfall and proximity to Bay of Bengal, the humidity levels in the Bangladesh remains high. Relative humidity in Project AOI is generally above 80% during June to December. The month of March is the driest with relative humidity around 69%. Monthly normal relative humidity varies in the range of 69-85% throughout the year.

0.4.7 Natural Hazards

The Project site falls in the Zone-II area with a basic seismic coefficient of 0.05g and at moderate risks from earthquakes. The Project site does not fall under cyclone affected area; however, there are reports of a Tornado in 1991, wind storm in 2001 and tropical storm in 2002 in the district, though no data on any effect in the Project AOI is available.

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. The project AOI also gets inundated with flood water of Jamuna River every year during rainy season and is highly prone to river bank erosion. The Project site also used to get affected by flood waters prior to its raising and embankment construction. However, with the construction of the -225 MW CCPP of NWPGCL plant, the entire Power hub including the site has been raised by 2.5 m – 3m and embankment constructed all around the power hub. Currently, the Project site lies at an elevation level of 15.75 m as against the danger level of 13.35 m. The GoB through BWDB is actively involved in flood prevention, monitoring and protection measures in the Sirajganj District. It has taken up projects to dredge about 20 km portion of Jamuna to keep the flow of water in the river smooth and protect Sirajganj district town.

0.4.8 Soil and Sediment Quality

The entire Project site has been filled with Jamuna river sand depositions to raise it above flood level initially during site preparation in 2006-2007. The soil and sediment quality in the AOI varies from sandy loam to silty clay loam type. The soil inside the Project site was found to have low organic content of 0.43% whereas of Punorbason village (750 m, NE) of 1.05 % respectively. Metals analysed in baseline quality of both soil and sediment was observed to

be well below the threshold limits for Intervention as per the Dutch Standards[1].

0.4.9 Ambient Air Quality

The ambient air quality of the project AOI is good with respect to the gaseous pollutants and fine particulate matter ($PM_{2.5}$). However, SPM and PM_{10} are slightly higher with respect to the National Ambient Air Quality Standard (NAAQS) of Bangladesh due to the site conditions and large open and agricultural areas, with scattered anthropogenic activities and traffic movement. Industrial activity in the area is currently limited to the operational 225 MW CCPP of NWPGCL and small scale handlooms at household level at almost all villages especially villages as Khas Bara Shimul (0.5 km), Radhunibari (3 km), Makimpur (3 km) in the Project AOI. Further the comparison of the ambient air quality monitoring carried out in 2012-13 and 2015 in the same area indicated that the levels in 2015 were much lower than previous monitoring results and that clearly indicates that the AOI is not a degraded airshed.

0.4.10 Ambient Noise Levels

Ambient noise levels in the rural and village setting of the Project AOI between Dec 2012- Feb 2013 (monitored at 6 locations) were within the prescribed limits for residential landuse, which is 55dB(A) for day time and 45 dB(A) for night time at most of the locations for both Bangladesh standards and IFC guideline values. At that point of time, only NQ-4 (starting point of access road near National Highway) a mixed landuse location was found to exceed the night time limit of 50 dB(A) for mixed area mainly because of increased heavy vehicular movement at night time.

In the current scenario with the 225 MW operational plant (monitoring carried out during February 2015 in 14 locations), the noise levels around the power complex boundary when compared to the prescribed limits for industrial landuse was well within the limits. However at noise monitoring location NL-9, location in Bara Shimul Village (220 m, NW), monitoring results marginally exceed both day and night time limits for residential land use. Detailed analysis of the monitoring data indicated that the noise levels on the day of monitoring at this location were in the range of 58.5 to 60.9 dB(A) between 15:00 to 18:00 hrs. This has resulted into higher daytime noise levels. Since NQ2 and NL9 are the same locations of noise monitoring and the comparison of the results indicated that the noise results of February 2015 are not a regular phenomenon and it is being contributed due to the anthropogenic activities on the day of monitoring. When the results at NL9 are compared with NL1 to NL8 results (monitoring locations within and around the Saidabad Power Generation Complex), which provide the baseline due to the operation of

[1] There is no Bangladesh soil or groundwater regulation/standard. In the absence of local country standards, it is ERM's practice to use 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines.

existing NWPGCL power plant, it is evident that the noise levels at NL9 are higher than these monitoring results. This clearly indicates that majority of noise at NL9 is not being contributed by the existing S1 power plant operations.

0.4.11 Traffic

The access road connecting the Project site from the National Highway is about 6 m in RoW. This road was built with the sole purpose of providing access to the Saidabad Power Hub i.e. the existing NWPGCL's 225 MW power plant, proposed power plant and related facilities as the grid station, however, local villages of Punorbason, Boro Simul and Panchosona also started using this road (mostly non-motorized or motorcycles) for connectivity as this is accessible even in the monsoon season. The traffic level on this road reaches a maximum of 12.25% during the peak hour. The maximum number of heavy vehicles on this access road is due to the NWPGCL power plant.

0.4.12 Ecology

The project AOI is situated at the right bank of Jamuna (Brahmaputra) River at a distance of 1.5 km from the Jamuna Multipurpose Bridge. An ecological assessment of fauna and flora in various habitats was undertaken. This covered terrestrial and aquatic ecosystems. The entire study area does not include any protected area[1] earmarked by the GOB.

Ecopark: The study area includes an eco-park, named Jamuna Eco-Park[2], which was developed by the BBA on the west-guide bund constructed for the protection of the Bangabandhu Multi-purpose Bridge from erosion. The plantation in this eco-park was developed and is being maintained by the Forest Department and the eco-park is used for eco-tourism and recreational purposes. However, Jamuna Eco-Park is neither a classified forest nor notified by the Government of Bangladesh as a Protected Area[3]. The nearest protected area from the project site is Madhupur National Park, which is located in Tangail and Mymensingh districts of Bangladesh and is about 42 km in north-east direction from the project site.

A survey of the plantation in the ecopark enumerated a total of 18 species of trees belonging to 15 genera of 10 families. Plantation areas within the project area of influence are present within the Jamuna Eco park area on the north and south of west end of Bangabandhu Multipurpose Bridge. Major plant

[1] "Protected Area" means all sanctuaries, national parks, community conservation areas, safari parks, eco-parks, botanical gardens notified under the provisions of sections 13, 17, 18 and 19 under Chapter IV and special biodiversity conservation area established under the provisions of section 22 under Chapter V and traditional heritage and kunjaban declared under section 23

[2] The Jamuna Eco Park is having a total area of about 600 acres and out of that only 124 acres area is fenced and is being used for recreational and eco-tourism activities.

[3] In Bangladesh, there are a total of eight (8) eco-parks are covered under the conservation sites. (http://www.bforest.gov.bd/index.php/protected-areas). However, Jamuna Eco-park is not covered in that list as well.

species planted by the Forest department are *Terminalia arjuna*, *Dalbergia sisso, Eucalyptus citiodora*, *Albizia lebbeck.* Among these species *Dipterocarpus turbinatus* is identified as critically endangered and *Hopea odorata* as vulnerable species as per IUCN.

Agricultural Land in the villages of the AOI bears general weeds and herbs. A total of 21 species belonging to 19 genera of 12 families were enumerated from the agricultural lands. None of them had conservational significance. Fallow land bears a total of 22 species belonging to 22 genera of 15 families. None of them had conservational significance. Grassland bears a total of 29 species belonging to 25 genera of 13 families. None of them had conservational significance.

Homestead Plantation survey in the villages in the AOI enumerated a total of 33 species belonging to 32 genera of 21 families. *Swietenia mahagoni* tree species was reported to be endangered as per IUCN classification. *Cocos nucifera, Eucalyptus citriodora, Mangifera indica, Psidium guajava, Ricinus cummunis, Lichi chinensis, Ziziphus mauritiana, Carica papaya, Lannea coramandelica, Moringa oleifera, Citrus aurantifolia, Sweitenia mahagoni, Musa sapientum, Musa paradisiac, Atrocarpus heterophyllus, Ficus hispida* and *Syzygium cumunii* were recorded as most commonly occurring trees.

Among the plantation species *Dipterocarpus turbinatus* is identified as critically endangered and *Hopea odorata* as vulnerable species as per IUCN and amongst homestead *Swietenia mahagoni* tree species was reported to be endangered as per IUCN classification. None of these species were observed in Temporary Jetty route survey and water intake pipeline route survey undertaken in May – June 2015. Based on the recent survey in May-June 2015, a total of 45 individuals of newly raised (4-5 years old) ornamental trees (*Ficus benjamina*-41 individuals, *Bahunia varigata*-2 individuals, *Aphanamixis polystachya*-2 individuals) with girth size 10 cm to 40 cm were identified to be removed/replanted from the road inside Ecopark near Jetty area and along the fence area of Jamuna Eco Park. Along with these tree species certain shrub species which were planted along the fence also need to be removed. The majority of these ornamental shrubs are *Thuja standishii.* None of the species falling within the transportation route were identified as species of conservational significance as per IUCN Red Data List (2015. Ver 2). This will be compensated by undertaking adequate compensatory afforestation within the BBA land.

Terrestrial faunal components were recorded for mammals, avifauna and aquatic birds, herpetofauna in the project AOI. Habitat specific surveys were conducted for the same. Study enumerated 10 species of mammals, 40 species of avifauna and aquatic birds, 9 species of reptiles and 5 species of amphibians. None of the mammal and avifaunal and aquatic bird species recorded is listed in IUCN for conservational significance. Among the 9 reptile species, Grey Indian Monitor (*Varanus benghalensis*) and Ganges Soft Shell Turtle (*Nilssonia gangetica*) are reported to be listed in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing

and capturing. Two turtles and one terrapin are listed as RED category fauna namely Ganges Soft Shell Turtle (*Nilssonia gangetica*) as Vulnerable, River Terrapin (*Batagur baska*) as Critically Endangered and Striped Roof Turtle (*Kachuga dhongoka*) as Endangered as per IUCN category. During a recent survey (May-June 2015) habitat mapping for the above mentioned endangered species was undertaken in order to understand the sensitivities related to their nesting/egg laying sites near the Temporary Jetty area and Water Intake location. None of the species were observed during field assessments. Further consultation with IUCN Bangladesh and a recent study conducted by IUCN (EIA of the River Management Improvement Programme (Bangladesh Water Board, Ministry of Water Resources, May 2015) revealed that major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore despite a report by fishermen, it is unlikely that these species are found here. Fishermen reports tend to be through memory and therefore reports of the species may have been due to sightings further north. Turtle and terrapin species presence in this area is very unlikely. Pre-construction surveys will also look for any nesting/egg laying/basking sites of the herpetofaunal species by a qualified ecologist. Amphibian species encountered doesn't bear protection status and are common in the project AOI.

Faunal species were recorded from the project AOI were also verified for protection status as per national legislation. Among mammals Indian Gray Mongoose (*Herpestes edwardsi),* Three Striped Squirrel (*Funambulus palmaram),* Jungle Cat (*Felis chaus)* and Asian House Shrew (*Suncus murinus)* are reported to be listed in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capturing.

Among avifaunal and aquatic bird species Red Vented Bulbul (*Pycnonotus cafer),* Black Drongo (*Dicrurus macrocercus),* Oriental Magpie Robin (*Copsychus saularis),* Long Tailed Shrike (*Lanius schach),* Spotted Dove (*Streptopelia chinensis),* Black Kite (*Milvus migrans),* Large Billed Crow (*Corvus macrorhynchos),* Rufous Treepie (*Dendrocitta vagabunda),* Indian Roller (*Coracias benghalensis),* Common Hoopee (*Upupa epops),* Black Rumped Flameback *(Dinopium benghalense),* White Throated Kingfisher (*Halcyon smyrnensis),* Pied Kingfisher (*Ceryle rudis),* Fulvus breasted Woodpecker (*Dendrocopos macei),* Shikra (*Accipiter badius*), White Wagtail (*Motacilla flava),* Red Wattled Lapwing (*Vanellus indicus),* Asian Koel (*Eudynamys scolopacea),* Rock Pigeon (*Columba livia),* Common Stonechat (*Saxicola torquate)* Common Myna (*Acridotheres tristis),* Jungle Myna (*Acridotheres grandis)* and Green Beeeater (*Merops orientalis)* are reported to be listed in Sch-III.

Jamuna River is identified as an Important Bird Area (IBA) as category (A1, A4i[1]:). No such species were encountered in and surrounding water bodies of

[1] A1: Threatened Species) and A4i: Site known or thought to hold, on a regular basis, ≥ 1% of a biogeographic population of a congregatory waterbird species. for the thresholds of this criterion, relevant flyway populations are combined to produce biogeographic population estimates).

Jamuna River. The secondary data for Jamuna EcoPark and surrounding areas also does not support the presence of any such species. The boundary of the IBA passes through the AOI and the AOI represents very small part (~3%) of the total area of the Jamuna-Bramhaputra River IBA. During the recent survey (May-June 2015) 3 individuals of Tufted Duck (*Aythya fuligula*) as late migrant were recorded near the Temporary Jetty area. As the IBA is covering a large area, maigratory species are likely to be observed within and around the AOI during the entire migratory season.

Planktonic studies were undertaken in the assessment of aquatic ecosystem, from the River Jamuna falling in the AOI. The phytoplankton enumerated from the 4 duplicate samples include different species of Diatoms (5 species), cyanobacteria (3 species), green algae (8 species) and protozoa (1 species).

The zooplankton enumerated from the 4 duplicate samples include different species of rotifers (4 species), crustaceans (2 species), Copepods (2 species) and ostacods & cladoceras with single species.

The plant species usually submerged or partially submerged/floating in the water recorded from the project AOI are *Azolla* sp, *Eichornia crassipes, Ipomea alba, Hydrilla verticillata, Calocasia esculenta, Rorippa indica, Oxalis corniculata, Marselia sp, Chenopodium album, Sphenoclea zeylanica* and *Ceratophyllum* sp.

Microinvertibrate surveys were conducted in May-June 2015 survey. Macro invertebrate species such as water spiders (*Argyroneta aquatic*), Common Apple snail (*Pila globosa),* Disk Snail (*Macrochlamys sequax*), River Snail (*Bellamya begalensis*), Brotia Snail (*Brotia costula*), Lymneid Snail (*Lymnaea luteola*), Fresh water Mussels species such as (*Lamellidens corrianus*), (*Lamellidens marginalis*), (*Lamellidens jenkinsianus)* were observed in the study area.

Fish survey was conducted in the project AOI, enumerated 20 species of fishes. No species listed as Endangered and Threatened fish species as per IUCN were recorded from the project influence area. Most of the fish species were found in the rainy season while some major fish species like Hilsha (Ilish) were found in the early winter and also in the early monsoon. Small indigenous fish species were available especially in the post monsoon season. Fishing takes place in entire Jamuna River within the AOI and not limited to only the temporary jetty and Water Intake Point locations. Infact, fishing related activities are not allowed under the Bangbandhu Bridge due to security reasons related to the bridge. Boats were observed to be occasionally parked near the proposed temporary jetty area in a small water channel which is used by the local people for fishing when the water level of the river is high. When the river level is low the fisherman fish in the main river. These boats are also used by the people from the neighbouring villages for connectivity to the char lands, which are used for cultivation during non-flooding period. Some fishermen populations were surveyed in villages however these populations were not solely dependent on fishing for their livelihood as mentioned during surveys.

During the recent survey (May-June 2015), the Jamuna River within the AOI was surveyed twice for the South Asian River Dolphin and a total of three sightings occurred at two locations. The species is commonly spotted by the fishermen in the area during the pre-monsoon and monsoon period when the water level is high.

0.4.13 Socio-Economic Profile

The Area of Influence covers a 5km radius and is largely spread within Saidabad and Kalia Haripur Unions of Sirajganj Sadar Upazilla. Only a small fraction (south of the plant location) falls under Rajapur Union in Belkuchi Upazilla. As part of the socio-economic baseline study, the area of influence was identified as covering 55 villages. The total households considered within the area of influence 15, 681 comprising of 73,721 people as per the 2011 census. The average household size has been estimated at 4.7 individuals.

The land usage pattern within the study area is dominantly agricultural and cultivable land with the remaining utilized for urban settlement. Associated agricultural activities like rearing of livestock and fishing are comparatively low within area of influence. Industrialization is comparatively very low and the only major industrial unit is the existing gas power plant within the project site complex. The industrial geography of the area is primarily dotted with household level handlooms and textile mills in most of the villages in the AOI especially in Khas Bara Shimul, Makhimpur and Radhunibari. The whole sale and retail trade and manufacturing (textile and agro products) are the two mainstays for livelihood generation.

The study area is poor in terms of infrastructural facilities for electricity supply and health. The electricity overage in the area of influence is limited to only about 31.67%. The access to power within Sirajganj Sadar and Belkuchi were observed to be 65.9% and 55.7% of households respectively.

The healthcare services within the district with respect to infrastructure and access is limited. Based on available statistics for 2007, there is only one clinic or hospital bed for every 7,375 persons in context of the entire district. The situation is better within Sirajganj Sadar with one bed for every 3,101 persons. However, it is worse for Belkuchi with one bed for every 11,382 persons.

More than 95% of the people are dependent on deep water tube wells for drinking water. The primary health risk associated with ground water is the high content of arsenic which can cause skin problems when consumed over very long durations. The sanitation facilities within the area of influence comprises mostly of pit latrines with dry disposal without any sanitary hardware. The facility was observed to be prevalent in more than 50% of the households. Proper sanitation facilities with water sealed latrines were observed only in 11% of the households, and mostly persisting within urban clusters and municipalities. Open defecation or absence of any form of sanitation facilities was observed in 9% of the households.

The area of influence as such, does not have any key cultural heritage or resource of national or regional value. The Bangbandhu Bridge located at about 1.75 km aerial distance from the Project site is considered as a strategic and important infrastructure. The cultural sites in the AOI are local mosques and graveyards which are located mostly in respective villages or cluster of villages sharing common boundaries. The project footprint is devoid of any cultural sites or heritage sites and project's impact on cultural heritage is insignificant.

0.5 ALTERNATIVES

As part of the alternative analysis, the no project scenario and with project scenario were compared along with alternatives on site location, design options (plant site, fuel supply arrangement and material transportation) and technology options.

The electricity produced from the power plants are supplied to the distribution grid and GoB decides on the areas to which the power generated is to be supplied. So, though the power plant will be at Sirajganj, the local community in the Project AOI may or may not benefit from the power generated. Therefore another perspective of the 'No Project Scenario' is whilst the country as a whole will benefit from power; the local area may be subject to disproportioned impact vs the benefit to the whole nation.

The site location has advantages in terms of technical, geological, environmental and social aspects. The land for the Project was already identified and acquired by BPDB; therefore no alternative site was available for analysis. In terms of design, NWPGCL has designed the plant layout in such a way to allow for common facilities to be shared with a future Sirajganj 2 project at the site, such as the RMS and Sub-station. In addition, both Sirajganj 1, 2 and 3 plants of NWPGCL and Sirajganj 4 plant of SNWPCL will be able to share a common access road, gas pipeline ROW and HSD unloading, pumping and supply system.

The technology selected for the Project is based on the technology specified in the BPDB "Request for Proposal". No alternative technology option has therefore been considered. However a comparison of the Simple cycle power plant (SCPP) and Combined cycle power plant (CCPP) reveals the CCPP to be better suited technology option. The project design has considered embedded pollution control systems, which include NOx control, stack height for dispersion of pollutants, use of cleaner primary fuel (natural gas), use of Jamuna River water for the Project as opposed to ground water, induced draft cooling tower for reducing water requirement and limited warm water discharge from the Project. Best suited technological options have been considered by BPDB to provide more reliability of power generation.

Construction camp and laydown area: For the location of the construction camp and laydown area, three locations were considered, (a) within the power generation complex, (b) area between the national highway and railway line near the Bangabandhu memorial (C1), and (c) the area available between the national highway and Punorbason Village fence line (C3). However, as the Sirajganj 2 project is expected to begin construction activities around the same time as the Sirajganj 4 project, the location within the power complex is presently not available for the construction camp and laydown area. Of the other two possible locations identified by Sembcorp, C1 and C3, C1 has been identified for laydown area, whereas C3 has been identified for the construction phase labour camp. The reasons for C1 being identified for laydown area and C3 for construction camp are as follows:

- The area C1 is located on the opposite side of the highway from the project, thus, which would increase the risk of road accidents of labourers, if the labour camp is constructed there, as the traffic flow in the area is of a speed of more than 60 km/hr.
- Due to the presence of the Main Gas Pipeline Corridor in the C3 area, only an approx. 10 m wide corridor is available for the laydown in the elevated stretch.
- Due to the proximity of the Punorbason Village (less than 10 m), C3 cannot be used for material storage, and the only option is to use the area for a construction camp.

Water intake source and location: The required water withdrawal amount is about 600 m3/hr. The existing Sirajganj 1 project is extracting ground water for their cooling purpose and other requirements. Sirajganj 2 project is also planning to use ground water, whereas at present there is no information about the source of water for Sirajganj 3 project and it is assumed that this plant will also be dependent on ground water. Considering this fact and to receive mineral free water, Sirajganj 4 project has decided to install a surface water intake facility for Sirajganj 4 project.

Probable Intake Locations: Two intake locations were considered, one at downstream part of West Guide Bund (Location–1) and the other just opposite to the proposed power plant (Location–2). The following four factors were mainly considered for selecting suitable intake point.

- Presence of near bank channel
- Near bank erosion/scour,
- Extent of char, and
- Suction pipe length

The IWM study on selection of the intake location indicates that Location 1 has been selected to be located at the downstream end of the WGB. The last 10 years satellite images show that there is possibility of temporary char formation in this location. Maximum extent of char was found to be 910m in year 2011. This extent of char is the lowest comparing other locations in the vicinity of power plant and significant char at this location formed in only three years out of the last 12 years. In addition, pilot dredging has been accomplished along the right channel of Jamuna River at Bangabandhu Bridge

site. According to cross-section survey carried out as part of the study, the extent of char is negligible along this location. Along location 2 the suction pipe line will need to cross a small channel besides the Power Plant and also char formation along this route is significantly higher. Hence, abstraction of water from Location 1 was found to be feasible.

Water Intake/abstraction mechanism: Three alternatives were considered. Alternative 1 considers pump house coupled with intake chamber (suction sump) will be located onshore and mouth of intake will be located below the lowest water level to guarantee water supply in lean flow periods and will be ahead of maximum extent of char to overcome possibilities of getting silted up. Alternative 2 considers the pump house will be installed at the near bank. The intake of suction pipe will be located below lowest water level to guarantee water supply in lean flow period and will be ahead of maximum possible extent of char to overcome possibilities of getting silted up. Alternative 3 considers surface water can directly be extracted from near bank channel during high flow period. However, during lean flow period channel is expected to be away from bank line. In that period, ground water will be extracted through pump instead of surface water abstraction. For groundwater abstraction, submersible pump may be installed. In addition another centrifugal pump will need to be installed at pump house for pumping surface water. Considering economy, navigability and safety in terms of siltation at the intake mouth the decision matrix suggested Alternative 3 is the most promising. However, considering the all-weather availability of surface water from the river and no withdrawal of ground water, Alternative 2 has been considered as the preferred option for water abstraction.

Pump House: Initially pump house installation over the bank of West Guide Bund was considered. But as the pipe and intake chamber cannot be laid out through guide bund slope protection measures, this location was ruled out. The pump house location was selected to be immediately downstream of the WGB. Due to presence of WGB, the location was considered safe with no significant threat of bank shifting present here. Moreover, the pump station will be constructed sufficiently inside the bank line. Hence protection against erosion and scour is not necessary.

0.6 KEY ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

All 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.

0.6.1 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;
- transportation of construction material and machinery for the power plant by road/ rail and heavy machinery/ equipment by barges upto temporary jetty location;
- dredging of water channel up to the temporary jetty depending on available water depth during the heavy lift transportation;
- construction of a temporary jetty, water pipelines and gas pipeline;
- excavation of equipment foundations and installation of power plant components;
- laydown areas for temporary use during construction phase;
- storage and handling of hazardous materials, waste and wastewater; and
- accommodation and transportation for the construction workforce and SNWPCL 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. Also soil compaction and erosion may take place during civil works at project site, laying of pipelines, temporary jetty and laydown areas.

Construction of the power plant will be carried out by the construction contractor appointed by SNWPCL. The construction contractor will handle, store and dispose of all waste in accordance with applicable GOB guidelines to prevent soil, sediment 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 and 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 to the soil and sediment quality; 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. A few (3-4) scattered huts are located on the west side about 200-220 m from the Project site boundary

and few settlements are located along the access road. The main village settlements (Panchosona and Khas Bara Shimul) start at about 400 m away from the Project site boundary on the west and north-west side. As the dust is expected to settle within 100 m and dust suppression techniques will be practiced, the main receptors would be workers on site and neighbouring plant and people living near the access road. The laydown area has also been selected away from the settlements of Khas Bara Shimul and Punorbason village. 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 nearest receptor is located at 220 m from the Project boundary at Panchosona Village, which will be exposed to noise from construction activities. Apart from this the receptors located close to the access road of Khas Bara Shimul and Punorbason villages will also be affected due to the movement of vehicles. It is evident from the predicted results that in the worst case scenario, the nearest receptor – Khas Bara Shimul (220 m from the western boundary of the Project site) will have a daytime noise level of 53.4 dB(A) during the construction phase. Ambient noise levels due to construction activities will be well within the applicable standard during day time at 18 receptors and night time at 14 receptors, out of total 20 receptors considered in the study. The noise impact from construction activity during day time is expected to be negligible to minor and during night time is expected to be minor to moderate. The construction contractor will need to 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 be minor. Further mitigation measures as regular maintenance of construction equipment, noise barriers/enclosures etc. are proposed to further reduce noise.

In terms of terrestrial ecology, clearance of vegetation at the project site, jetty location, transportation route near jetty, RoW for intake and outfall and intake structure and excavation of gas pipeline laying will have negligible to minor impact. A total of 45 individuals of newly raised (4-5 years old) ornamental trees such as *Ficus benjamina*- 41 individuals, *Bahunia varigata*-2 individuals, *Aphanamixis polystachya*-2 individuals with girth size 10 cm to 40 cm were identified to be removed/ replanted from the road inside Ecopark near Jetty area and along the fence area of Jamuna Eco Park. Along with these tree species certain shrub species which were planted along the fence also need to be removed. The majority of these ornamental shrubs are *Thuja standishii*. Clearance of vegetation was assessed to have negligible impact for the identified areas as project site, near jetty, Row water pipeline and intake.

The requirement for a temporary jetty is primarily for receiving the heavy equipment (GT, ST, HRSG, Transformer, etc.), which could not be able to transport by road/ rail. The requirement of the temporary jetty will be for a

period of about 6 to 9 months, depending upon the receipt of shipment and will be required after 15 months from receipt of the limited notice to proceed (LNTP) from the BPDB. The temporary jetty will be constructed by using layers of sand and sand bags and these will be arranged so as to provide compaction and strength. Small compaction units will be used throughout the erection process to ensure that the ground is solid and suitable for the off-loading of the heavy lifts. Impact on aquatic flora and fauna is predicted as moderate from spillage from transportation vessels since the spillage may affect their habitat and egg laying sites. Due care should be exercised to avoid any leakages and ballast water discharge near the temporary jetty area.

Dredging may be required near the temporary jetty in order to provide sufficient draft for the incoming barges carrying heavy lifts. However, the magnitude of dredging will depend on the bathymetry of the channel connecting with the main river and the water level at the time of heavy lifts transportation. However, it has been observed during the survey of the temporary jetty location that dredging on the River Jamuna is being carried out by the BWDB in order to remove silt from the main channel as well as for river bank erosion control. Considering the on-going dredging activities near to the temporary jetty location as well as construction of closures in the upstream of the temporary jetty, the impact magnitude of limited dredging during the transportation of heavy lifts was considered as not significant. However taking into consideration the sensitivity of the receptors, i.e. South Asian River Dolphin (*Platistina gangeticus*) IUCN 2015.2 EN, the impact significance was assessed to be moderate.

Project site workers, settlements in the close proximity of the Project site (within 500 m) and along the access road (within 100 m) are the receptors, which will be exposed to health impacts associated with environmental conditions from construction activities 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.

The community health and safety impacts, including those associated with changes in environmental conditions, increased prevalence of diseases and heavy traffic movement are assessed as minor. Impacts due to construction workers camp, laydown areas and logistics on the community health and safety will be temporary and can be considered as minor to moderate depending upon the finalised locations for these facilities and their distance from the local community.

In terms of social impact, 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. There is a likelihood of overlapping in the construction schedule of Sirajganj 4 and Sirajganj 2 projects within the power generation complex and this will lead to unavailability of land within the complex for construction workers camp.

Therefore, the labour camp will be located outside the power generation complex. The area identified for the construction workers camp is located between the main highway and Punorbason village fence line. Available land area for this purpose is about 8.37 acres.

The influx of labour also raises other challenges such as health related issues (including sexually transmitted and communicable diseases), unhygienic conditions in constructed labour 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 labour will account for about 25% of the total workforce of about 1,500 (which is an insignificant number as compared to the existing population within the AOI), the severity of the impacts raised above is expected to be Moderate.

The project benefits will either reduce or disappear at the end of construction phase, creating some residual impacts. Mitigation measures include maximising local procurement and employment to reduce and manage influx, labour management measures, ensuring no local resources are indiscriminately used by the project, health interventions etc.

0.6.2 Operation Phase

The contamination of soil and sediment contamination from generation of hazardous and non-hazardous wastes are assessed as negligible. 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; compressors; lube oil systems; DG sets; and power house and workshop area. These 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 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 will be from the discharge of treated effluent from the operational plant to the adjoining channel and abstraction of ground water for drinking purposes for the employees of the power plant. The On-site water quality test results of S1 discharge were monitored for Temperature, pH and TDS. At discharge point the temperature was in the range of 32.0 to 34.8°C, pH 8.73 to 8.87 and TDS 470-490 mg/l. At the mixing zone, the temperature varied in the range of 30.9 to 34.2°C, pH 8.70 to 8.83 and TDS 480-490 mg/l. This All the wastewater generated at various areas of the plant will be segregated at the source of generation and treated at a waste water treatment

plant (ETP and STP of about 4m^3/hr capacity each), 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. Furthermore, the Jamuna River is the fifth largest river in the world in terms of volumetric discharge. Jamuna River water discharge quantity for the nearest upstream point of the Project site i.e. Bahdurabad Transit, the minimum discharge in last 15 years has been 2036.82 m^3/s in cross section of 14, 301.38 m^2 at velocity 0.65 m/s. The cooling tower blow down and other treated effluent generated from boiler blow down, effluent treatment plant and DM plant will be discharged on land in the southern boundary of the project site, which is having high permeability coefficient and the soil type is in general silty sand and fine sand. This discharge will be <3°C of intake water temperature at the outlet of the 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. Groundwater abstraction at the Plant will be undertaken for drinking water purposes only. The quantity of groundwater abstraction will be 4-5 m^3/day.

The operation of the plant with natural gas as fuel in simple/ combined cycle will generate flue gas emissions containing NOx and CO. Emissions of SO_2 are likely to be negligible, as natural gas typically has a very low sulphur level (as per the natural gas specifications for the Project). Particulate emissions are likely to be negligible; as natural gas is a gaseous fuel (there is no supplementary fuel to be used in the CT). However, operation of the plant with HSD as fuel in simple/ combined cycle will generate flue gas emissions containing NOx, SO2, PM and CO.

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 standards for air quality for natural gas and the impact on air quality was predicted to be negligible. While using HSD as fuel, the maximum ground level concentrations (maximum baseline concentration + predicted maximum concentration) of $PM_{2.5}$, NOx, SO_2 and CO will be within the applicable standard. It shall be noted that the Project will be using natural gas as primary fuel and HSD will only be used in case of non-availability of natural gas from GTCL. Further to ensure compliance with the air emission criteria for flue gas stacks continuous emission monitoring (CEM) equipment for the measurement of air emission levels in the exhaust stack of HRSG will be installed.

The cumulative impact on ambient air quality due to the Sirajganj 4 project (gas/HSD), proposed Sirajganj 2, Sirajganj 3 projects and existing Sirajganj 1 project were also evaluated by using air dispersion modelling. The modelling

outcome revealed that maximum ground level concentration in the project AOI with natural gas as well as HSD as fuel will be well within the applicable standards. The cumulative impact on ambient air quality with natural gas and HSD were predicted as minor.

With respect to GHGs emissions, the Project will emit 1,404,790 tons (CO_2 equivalent) per year. The estimated GHG emissions from the Plant while using natural gas as primary fuel will exceed the threshold of IFC PS3 (25,000 tons CO_2e per year) that define them as significant GHG emission sources. The cumulative assessment of GHG emissions based on overall capacity of the four power plants has been estimated as 3,624,541 tons of CO_2 equivalent per year. Considering the significance of GHG emissions, it is recommended to reduce consumption of primary resources and emissions of pollutants by applying adequate control measures and to enhance operating performance and efficiency. Additionally all the four power plants need to monitor GHG emission continuously and to ensure annual reporting of the emissions.

Climate change could have a variety of impacts on operation of the Sirajganj 4 project, particularly with regards to increased flood risk. The high level climate change risk assessment study has recommended that risks identified as high (i.e. flooding of the facility causing business interruption and damage to infrastructure as well as flooding of surrounding areas) be investigated in further detail to fully understand the implications for operation of the plant in the future. Given that these both relate to the increased risk of flooding in the future, which will also apply to the Saidabad Power Generation Complex as a whole and its surrounding communities, options to work closely with local authorities and NWPGCL on this issue should be investigated as a combined response is likely to be more cost-effective.

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 noise receptor is located at 200-220 m from the Project boundary in the western side, whereas other settlements are located about 400 m away from the Project boundary. The predicted noise levels through model Sound Plan 7.2 that in the worst case scenario, the nearest receptor (200 m from the western boundary of the Project site) will have a daytime noise level of 42.1 dB(A) and night time 42.1 dB(A) during the operation phase, whereas overall impact has been predicted at the location as 55.8 dB(A) and 46.9 dB(A) respectively due to the higher background levels recorded during the baseline monitoring. Among mitigation measures acoustic barriers, enclosures and mufflers are proposed where required.

The cumulative impact assessment for S1, S2, S3 and S4 project along with vehicular movement in access road was also carried out through Sound Plan 7.2 model. During operation phase minor impacts were predicted on the fauna present at AOI. Use of cooling towers along with no direct discharge into the

Jamuna River or Channel means that there will be no impacts on aquatic flora and fauna during operation. The discharge will be mostly in the form of seepage to the ground during the non-monsoon season, which has also been noticed in case of S1 discharge.

During the operation phase of the Project, Community health and safety issues as hazardous material handling and storage and traffic movement was considered for impact. A Consequence Analysis in case of Loss of Containment of hazardous materials from the respective storage facility and pipeline was carried out. The pool fire effect zone for full bore rupture of natural gas pipeline, HSD pipeline near unloading zone and storage tanks, leakage in storage tank, and hydrochloric acid tank was captured and impact was assessed as minor and risk reduction measures suggested. Impact on traffic in the operational phase of the project is assessed as negligible as the total manpower will be limited to 70 who will work in shifts, their transportation will not lead to any impact on road safety of the nearby communities using the access road.

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.

0.6.3 Cumulative Impact Assessment

Cumulative Impact due to Groundwater Abstraction

The EIA study report of NWPGCL's Sirajganj 2 (proposed 225 MW CCPP) concluded that the natural aquifer condition in the Project area would be suitable for supplying 30000 m^3/day of water continuously without any permanent lowering of groundwater table or environmental degradation. Jamuna River invariably fully recharges the aquifer in the wet season of each year preventing any adverse effect on the natural condition of the project area. Since, there is another project Sirajganj 3 (225 MW) is proposed within the Saidabad Power Generation Complex and due to similar capacity as that of Sirajganj 1 and 2 project, it has been assumed that the water requirement for this project will also be of the order of 600 m^3/hr. Source of this water demand is currently unknown (i.e. ground water or surface water from River Jamuna) and it has been assumed that the project will follow same source as that of Sirajganj 1 and 2 projects, i.e. ground water abstraction from project site. This will lead to daily water abstraction from ground water within the power generation complex of the order of 43,500 m^3.

The above clearly indicates that overall ground water abstraction from the Saidabad Power Generation Complex after commissioning of all the four projects will be higher than safe water supply potential of the aquifer of the

order to 30,000 m^3/day. This will create some stress on the ground water aquifer and quality due to higher abstraction in comparison of recharge. However, it was further been observed that the Sirajganj 1 project is currently discharging the cooling tower blowdown and other effluent after treatment on land in the eastern boundary of the complex (which is about 200 m away from the adjoin channel) and the other 3 projects will also be doing the discharge in the similar manner, which will lead to a total discharge of the order of 6,700 m^3/day, which do not flow towards the adjoin channel during non-monsoon season and will help in recharging the ground water aquifer. Review of geo-technical data collected for Sirajganj 2 Project also reveals that (a) The soil is mostly silty sand and fine sand in all the bore logs with some small layers of silty and clayey sand in a couple bore logs, which indicates that the soil profile is porous in nature and is good for water percolation, (b) Soil permeability coefficient is in the range of 10 to 15 m/day, which is as per soil permeability classes represent "very rapid" soil permeability class (i.e. > 6 m/day). Further it was also mentioned in the ground water modelling study that, recent studies indicate that the rainfall in Bangladesh and surrounding areas is increasing due to climate change (UK Met Office 2011) which would contribute to enhanced recharge to the aquifer in the projected period. Therefore, the overall cumulative impact of ground water abstraction is assessed as minor.

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, alkalis, diesel fuel, maintenance oils and lubricants, hydrazine hydrate etc. for the water treatment plant, process plant operation, and the laboratory. The maximum volume stored will be 2 tonnes each of hydrochloric acid, caustic lye. The hazardous materials will be stored in a dedicated room at the water treatment plant area in each project. HSD to be used as secondary fuel for power generation will be stored in two tanks with capacity equivalent to 15 days operation at 80% output on HSD. Diesel for emergency DG sets will be stored in above ground oil tanks located in the vicinity of the Black Start DGs and Emergency DG set. 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 negligible.

Water Pollution from Wastewater Discharge

Since the water requirement of all the four power plants is same (i.e. about 600 m^3/hr) and hence it has been assumed that the discharge from all the plants will be same as that of S4 project (i.e. about 75 m^3/hr). Based on this assumption, the total treated wastewater discharge from the complex will be about 300 m^3/hr, which will be discharged from the respective plant to the eastern/ southern boundary of the complex in the upstream of adjacent

Channel (which is about 200 – 400 m away from the discharge points during non-flooding season) after treatment.

Considering the on-site monitoring results of the discharge from Sirajganj 1 project, it is assumed that the treated wastewater from all the plants will also follow similar discharge quality and as the discharge points will be different and will have a minimum distance of about 100 – 150 m between the two discharge points, the cumulative impact of wastewater discharge on land will not affect the quality of surface/ ground water or the condition of soil in that area.

In addition, instrumentation will be used to monitor the Plants' 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 based on the results of the Sirajganj 1 project is assessed as negligible.

Cumulative Impacts on Air Quality – Operation of Sirajganj 1, 2, 3 and 4 Projects

Impact on ambient air quality due to the Sirajganj 1 project (gas/HSD), proposed gas based Sirajganj 2 project (gas/HSD), Sirajganj 3 (gas/HSD) and Sirajganj 4 project (gas/HSD) were also evaluated by using air dispersion modelling. It was evident from the results of modelling that the maximum ground level concentration (maximum baseline concentration + predicted maximum concentration) in the project AOI with natural gas as fuel will be well within the applicable national standards. It shall be noted that HSD is secondary fuel for in all the four projects. Considering this fact, the cumulative impact of these projects on air quality will be minor.

GHG Emissions

It is evident from the modelling results that the estimated GHG emissions from the four plants while using natural gas as primary fuel will exceed the threshold of IFC PS3 (25,000 tons CO_2e per year) that define them as significant GHG emission sources. Therefore, the Projects are required to report annual GHG emissions.

Noise

Impact on ambient noise levels due to the operation of Sirajganj 1, Sirajganj 2 and Sirajganj 4 projects were also evaluated by using noise prediction model. It is evident from the predicted results that in the worst case scenario, the nearest receptor (220 m from the western boundary of the Project site) will have a daytime noise level of 47.0 dB(A) during the operation phase, whereas the overall noise level will be about 56.2 dB(A) due to the background noise level of 55.6 dB(A) recorded during the baseline monitoring. Ambient noise levels due to operation of the three projects will be well within the applicable standards with respect to daytime standards except the nearest noise sensitive

receptor, whereas during night time it would be more than the landuse specific standard at five locations. However, it is also to be noted that the contribution of noise due to the project much lesser than the ambient noise levels recorded at these locations. Furthermore, the noise levels at the boundary of the power generation complex will be well within the applicable standards for industrial area land use. Therefore, the impact has been estimated as minor.

0.6.4 Residual Impacts

Table 0.1 present the outcomes of the comprehensive assessment of identified impacts as a result of various phase of the project and present significance of residual impacts before mitigation (with embedded controls) and with suggested mitigation measures.

Table 0.1 Summary of Impact Assessment and Residual Impacts

Project Activities/ Impacts	Nature of Impact	Significance of Residual Impacts	
		Before Mitigation	With Mitigation
Construction Phase (Sirajganj 4 Project)			
Soil compaction	Negative	Negligible	Negligible
Soil erosion	Negative	Negligible	Negligible
Soil and sediment contamination	Negative	Minor	Negligible
Soil contamination from waste handling	Negative	Negligible	Negligible
Waste water discharge	Negative	Negligible	Negligible
Ground water contamination	Negative	Minor	Negligible
Air quality degradation due to dust generation	Negative	Moderate	Minor
Air quality degradation due to exhaust emissions	Negative	Minor	Negligible
Noise from Construction Activities and transportation of man/ material (Day-time)	Negative	Negligible to Minor	Negligible
Noise from Construction Activities and transportation of man/ material (Night-time)	Negative	Minor to Moderate	Negligible to Minor
Clearance of vegetation at the Project Site	Negative	Negligible	Negligible
Clearance of vegetation at the Right of way of Water Pipeline Route & Water Intake Structure	Negative	Negligible	Negligible
Clearance of vegetation at the Jetty Location and Transportation Route	Negative	Negligible	Negligible
Excavation for laying fuel pipelines	Negative	Negligible	Negligible
Spillage from transportation vessels	Negative	Moderate	Minor
Habitat Disturbance due to construction of Temporary Jetty and Dredging	Negative	Moderate	Minor
Impact on endangered species (based on critical habitat assessment)	Negative	Minor to Moderate	Negligible to Minor
Traffic impact on road network	Negative	Minor	Negligible
Community health from changes in environmental conditions	Negative	Moderate	Minor
Increased Prevalence of Diseases	Negative	Moderate	Minor
Traffic safety due to heavy traffic movement	Negative	Moderate	Minor
Employment generation	Positive		
Benefit to local enterprises	Positive		
Impact on fishing households	Negative	Minor	Negligible
Labour influx and construction workers accommodation	Negative	Moderate	Minor
Community expectations	Neutral		

Project Activities/ Impacts	Nature of Impact	Significance of Residual Impacts	
		Before Mitigation	With Mitigation
Operation Phase (Sirajganj 4 Project)			
Contamination of soil and sediment from wastes	Negative	Negligible	Negligible
Surface water abstraction	Negative	Negligible	Negligible
Water pollution from wastewater discharge	Negative	Negligible	Negligible
Discharge of Cooling water due to operation of Power Plant	Negative	Negligible	Negligible
Ground water abstraction	Negative	Negligible	Negligible
Ground water contamination	Negative	Minor	Negligible
Ambient Air Quality (by use of natural gas as fuel for power generation)	Negative	Negligible	Negligible
Ambient Air Quality (by use of HSD as fuel for power generation)	Negative	Negligible	Negligible
GHG Emission due to Sirajganj 4 project	Negative	Moderate	Moderate
Noise from Operation of Plant and vehicular movement in Access Road (Day-time)	Negative	Negligible	Negligible
Noise from Operation of Plant and vehicular movement in Access Road (Night-time)	Negative	Minor	Negligible to Minor
Electric and magnetic field	Negative	Minor	Negligible
Impact on terrestrial flora and fauna due to incremental air emissions	Negative	Negligible	Negligible
Impact on fauna due to incremental noise levels	Negative	Negligible	Negligible
Discharge of cooling water to Jamuna River due to operation on aquatic flora and fauna	Negative	Negligible	Negligible
Risks due to hazardous materials handling and storage	Negative	Minor	Negligible
Community health and safety due to project induced traffic	Negative	Negligible	Negligible
Risks of industrial accidents and fatalities to workers	Negative	Minor	Negligible
Health associated risks from air emissions and waste water release	Negative	Negligible	Negligible
Employment generation and in-migration of skilled workforce	Positive		
Demand for lodging, housing and civic services	Positive		
Increments in cost of living	Neutral	Negligible	Negligible
Opportunity for local transporters	Positive		
Competing demand on natural gas	Negative	Negligible	Negligible
Demand for power amongst locals in AOI	Neutral		
In-migration of skilled workforce	Neutral	Negligible	Negligible
Cumulative Impacts due to Operation of Sirajganj 1, 2, 3 and 4 Projects)			
Cumulative Impact due to Groundwater Abstraction	Negative	Moderate	Minor
Water Pollution from Wastewater Discharge	Negative	Negligible	Negligible
Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with natural gas as fuel	Negative	Negligible	Negligible
Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with HSD as fuel	Negative	Negligible	Negligible
GHG emissions due to Operation of Sirajganj 1, 2, 3 and 4 Projects	Negative	Moderate	Moderate
Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Day time)	Negative	Minor	Negligible
Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Night time)	Negative	Minor to Moderate	Negligible to Minor
Cumulative Impact from Labour Influx due to Sirajganj 2 and Sirajganj 4 projects simultaneous construction	Negative	Moderate	Minor

0.7 ENVIRONMENTAL AND SOCIAL 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 SNWPCL for the Engineering, Procurement and Construction (EPC). Mitigation measures for the operation phase (such as those for air emissions and noise generation) of the Project are part of the design and incorporated into the Project design specifications submitted to the BPDB as a Guarantee for the Project.

The construction phase of the Project is anticipated to last three years, whereas the operation phase of the Project is 22 years, as per the Power Purchase Agreement (to be signed between SNWPCL and the BPDB). A summary of mitigation measures identified for the construction and operation phases of the Project is presented in the Environmental and Social Management Plan. This also identifies lead responsibility for implementing of the mitigation measures and its verification along with reporting requirements and sources of funds for such implementation.

The design life of the Project is about 30 years and SNWPCL 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 (SNWPCL and NWPGCL) and EPC contractor have been defined for implementation and monitoring of environmental and social impacts. 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 SNWPCL 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 semi-annual during construction phase and annual during operation phase and the reports will be submitted to the DOE and the Lenders.

Sembcorp has a Group HSE Management System in place which is enforced across the Group, following ISO and OHSAS standards. The GHSE Management System with its associated Guidance Documents is mandatory for all entities under the management control of Sembcorp Group of Companies. Business units have the authority to meet the requirements of the elements with their existing processes, programs and systems (e.g. ISO 14001, OHSAS 18001) as long as conformance to the HSE Guidelines is demonstrated.

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 SNWPCL 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 SNWPCL to develop and deliver a training program on operation phase environmental monitoring and reporting.

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 semi-annual and the reports will be submitted to the DOE and the Lenders.

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. An detailed Emergency Response plan will also need to be prepared containing three categories of emergencies.
Level 1: This is an emergency or an accident, which:

- can be effectively and safely managed, and contained within the site, location or installation by the available resources; and
- has no impact outside the site, location or installation.

Level 2: This is an emergency or an accident, which:

- cannot be effectively and safely managed or contained at the location or installation by available resource and additional support is alerted or required;
- is having or has the potential to have an effect beyond the site, location or installation and where external support of mutual aid partner may be involved; and
- is likely to be danger to life, the environment or to industrial assets or reputation.

Level 3: This is an emergency or an incident with off-site impact which could be catastrophic and is likely to affect the population, property and environment inside and outside the installation, and management and control is done by district administration. Although the Level-III emergency falls under the purview of District Authority but till they step in, it should be responsibility of the unit to manage the emergency.

Roles and Responsibilities in emergency incident response should be identified as per entity Emergency Response Team, EPC Contractor Resources, External emergency response team etc. The ERT will be led by the senior EPC Contractor Engineer (designated ERT-Lead) on-site with a suitably trained site supervisor or junior engineer as deputy. Trained first-aiders and security personnel will be the core members of the ERT. The EPC contractor will ensure that ERT members are physically, technically and psychologically fit for their emergency response roles and responsibilities
Evacuation Procedures and response procedures in case of medical emergency, fire etc. should be clearly defined.

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. The ERDMP needs to be based on the outcome of the consequence analysis as well as detailed quantitative risk assessment of the Project after finalisation of project design, an emergency response and disaster management plan. 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.

0.8 PUBLIC CONSULTATION AND DISCLOSURE AND GRIEVANCE REDRESS

Public consultation & disclosure process is conducted for any project to intimate the community about the project, its activities and associated benefits, impacts, risks etc. so that people can participate in the project activities in an informed manner and can raise their concerns to be addressed. A good consultation process effectively manages public apprehensions, identifies control measures for these apprehensions in association with the public stakeholder and also facilitates in implementation of the identified measures.

0.8.1 Approach to Consultation and Disclosure

The public consultation and disclosure process takes place at different project stages and have varying needs and objectives. The approach undertaken for information disclosure and consultation at the draft EIA stage involved the following key processes.

- Mapping and Identification of key stakeholders such as primary and secondary and prioritising them according to their influence;
- Conducting expert consultations, interviews and focussed group discussions (FGD);
- Assessing the influence and impact of the project on these stakeholder groups and vice versa;
- Summing up of key findings and observations from the consultations; and
- Preparing a future disclosure and consultation plan taking into account the project lifecycle phases and their implications on the stakeholder.

0.8.2 Disclosure and Consultation

A number of consultation exercises were conducted during preparation of this EIA. The stakeholders consulted include the community in the direct vicinity of the Project area, local elected representative such as the district commissioner of Sirajganj and the Union Chairman of Saidabad Union, and other external stakeholders such as relevant government departments and NGOs. Every consultation meeting has been recorded and the minutes from every meeting have been compiled in the respective stakeholder consultation sheets.
In addition to the above, a public consultation meeting was held on 21st March 2015 at the Hall Room of Manab Mukti Sangstha (MMS) Head Office located at Khas Boro Shimul, which is located about 0.5 km away from the Project site. The meeting was presided by the Honourable Deputy Commissioner of the Sirajganj District Mr. Billal Hosen. This public consultation meeting was convened to discuss the project features of Sirajganj 4 project, findings of the EIA study as well as to get an opinion of the key stakeholders (including government officials, elected representatives, NGOs, village people including women). Overall the stakeholders had welcomed the project in the area.

0.8.3 Continuation of Future Consultation & Disclosure Strategy

The effectiveness of the EIA is directly related to the degree of continuing involvement of those affected directly or indirectly by the Project. During the preparatory stage, consultations were held at local, sub district and district level. Several additional rounds of consultations with stakeholders are planned in EIA finalisation, construction and operation phase of the Project. A public consultation meeting with key stakeholders was completed in March 2015 during the EIA preparation stage. Another public consultation meeting was held in April 2015 to disclose the findings of the EIA study. Continued information disclosure and consultation process can either be done internally by the Project proponent or through engaging some outside agency on behalf of them. This will help them in developing internal capacity and maintaining continued consultation process through the Project life cycle.

Further consultations will also be done as part of the IEE and EIA for regulatory environmental clearance certificate from DOE. The purpose of consultation at this phase would focus on sharing the mitigation measures proposed in the study for identified impacts. The Project Developer

(SNWPCL) will organise a number of meetings and disclosure sessions with stakeholders by giving them prior intimation about the date, time and venue of consultation. The details of such meeting and consultation would be captured and made part of the regulatory EIA document.

0.8.4 Grievance Redressal

The project is currently in the process of finalising the key contracts including those for engineering procurement and construction with the selected contractor. SNWPCL will be formed in due course and any grievances related to the project, upto commencement of construction, can be directly addressed to the Commercial Head, of SNWPCL. After the commencement of construction, SNWPCL will duly form a Grievance Redress Cell (GRC). The possibility of including an external member nominated by the local District Administration to be part of the GRC will also be explored. The nominated member may be an elected member from the Union Parishad or a senior administrative officer of the district. In the interim period, any grievances may be addressed to:

Nazmul Ahsan
House no.: 1, Road: 9C
Nikunja-1, Airport Road,
Dhaka-1229, Bangladesh
Email: Nazmul.ahsan@sembcorp.com
Mobile: +880 1819226635

0.9 CONCLUSIONS

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. Cumulative impact assessment of noise levels however indicated major impact during functioning of all four power plants planned in the Sirajganj complex. It was observed that the cumulative impact on air quality, water quality, water resources and ambient noise during daytime will be minor in nature, whereas GHG emissions resulting from the four power plants and ambient noise levels particularly during night time at the nearest receptor will be moderate in nature and will require specific attention in order to reduce the impacts.

The social assessment of the Project ascertains that the Project is unlikely to cause any significant social impacts. The Project will have both positive and negative impact on the social environment. The Project received favourable support from local people and other stakeholders, including elected representatives, villagers, businessmen, NGOs and women. Stakeholders appreciated that in addition to providing a reliable power supply to the

region, the Project will have several other benefits such as supporting economic growth in the region by opening avenues for further development.

1 INTRODUCTION

1.1 INTRODUCTION

Sembcorp North- West Power Company Ltd, (*hereinafter referred as "SNWPCL"*), a wholly owned subsidiary of Sembcorp Industries Limited (*"SCI"*), is proposing to set up a duel fuel combined cycle power project (*hereinafter referred as the "Project" or the "Plant" or the "Facility" or "Sirajganj 4" or "S4"*) with net generation capacity of 413.792 MW (Gas)/333.02 MW(HSD) in Sirajganj District of Rajshahi Division in Bangladesh. The project site is located approximately 135 km north-west of Dhaka on the western bank of the River Jamuna. As per the Request For Proposal issued by North West Power Generation Company Limited (*"NWPGCL"*) on 28 October 2014 the power plant will operate on natural gas as its primary fuel and is designed to operate on High Speed Diesel ("HSD") for short periods of time as the back-up fuel in case of interruptions in gas supply.

According to the Bangladesh Environment Conservation Rules 1997 (ECR), power plants come under Red category and requires Initial Environemental Examination (IEE) and environmental impact assessment (*"EIA"*). With respect to the same, SNWPCL had applied to Department of Environment (DoE), Bangladesh through letter dated 15th Februray 2016 for exemption from IEE and approval of Terms of Reference (ToR) for EIA study. DoE in its letter No: DoE/Clearance/5572/2016/122 dated 10th March 2016 issued the exemption of IEE and approval of ToR for the EIA study of the project. SNWPCL has commissioned Environmental Resources Management (*hereinafter referred as "ERM"*) to conduct this EIA study.

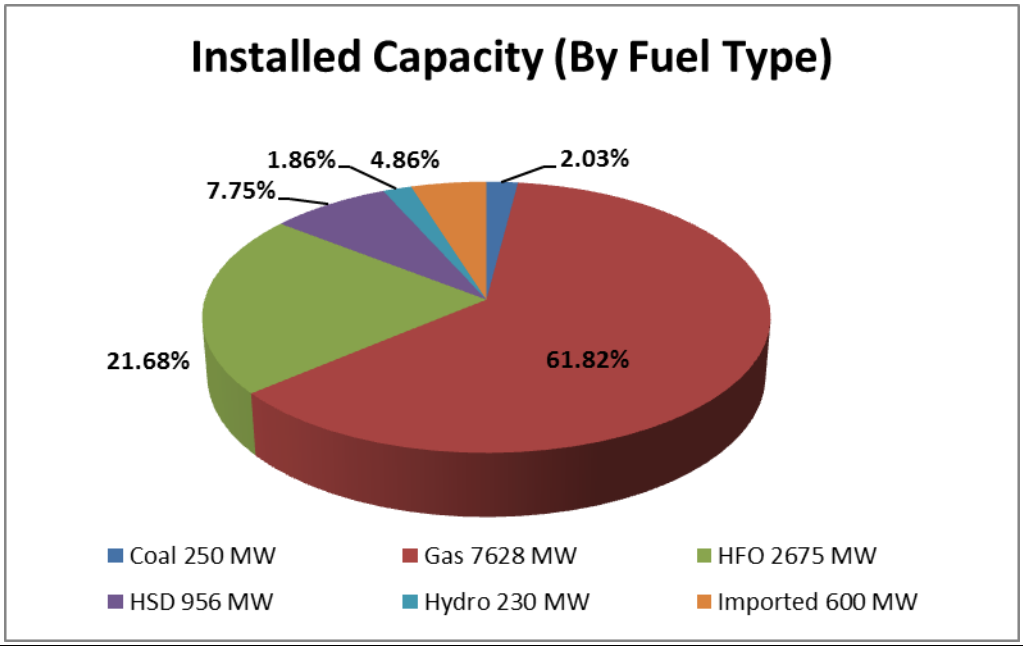
This report has been prepared for SNWPCL by ERM and presents the objectives, methodology and outcomes of the EIA study in line with the applicable reference framework and approved ToR for EIA study by the DoE.

1.2 OVERVIEW OF THE PROJECT

1.2.1 Need for the Project

The supply of electricity has a great impact on the national economy of any country. Bangladesh, with its 152 million people in a land mass of 147,570 sq. km, has shown tremendous growth in recent years. A booming economic growth, rapid urbanization and increased industrialisation and development have increased the country's demand for electricity. Presently, 68% of the total population has access to electricity and per capita generation is 348 kWh, which is significantly lower when compared to other developing countries (Power Division 2015). The present installed generation capacity as on May 2016 is 12,339 MW. Installed capacity as of May 2016 in Bangladesh (by fuel type) is presented in ***Box 1.1***.

Box 1.1 *Installed Capacity by Fuel type and Plant type in Bangladesh (May 2016)*



Source: (BPDB 2016)

The GOB has given highest priority to power sector development in the country and has committed to making electricity available to all citizens by 2021 (Power Division 2015). The GOB has further extended its vision for power supply out to 2030 and prepared the Power System Master Plan (PSMP), 2010. The plan forecasts a supply surplus scenario by 2030 with power demand expected to be approximately 34,000 MW against a generation capacity of 40,000 MW (Power Division 2015). To realize these targets, the GOB since 2011 has undertaken the implementation of reforms in the power sector, including significant development programs for participation of the private sector of which this Project constitutes one of the important parts.

1.2.2 Project Background

The GOB has adopted a strategy for the development of the power sector which envisages private participation in the sector. As part of that strategy, the GOB decided that some new generation capacity will be installed and operated by the private sector.

In line with this strategy, the GOB decided to (a) implement a new greenfield 400 MW±10% Combined Cycle Power Plant on Build, Own and Operate ("BOO") basis under the GOB's Public Private Partnership (PPP) program at Sirajganj, Bangladesh (the "Project"); (b) to execute the Implementation Agreement ("IA"), the Power Purchase Agreement ("PPA"), the Gas Supply Agreement ("GSA"), the Fuel Supply Agreement ("FSA"), the Land Lease Agreements ("LLA"), Share Purchase Agreement ("SPA") (together, the IA, PPA, GSA, LLA, FSA and SPA are hereinafter referred to as the "Project Agreements") and other contracts required for the financing, construction, operation and maintenance of the Facility; (c) implement the Project, and (d) upon Commissioning (in both simple cycle and combined-cycle modes),

operate and maintain the Facility for an initial period of 22 years (plus the 6 month period during which the Facility is operated in simple cycle mode). In the past, the MPEMR has made several attempts to tender for a gas based IPP in Sirajganj, under the Public-Private Partnership scheme, however none of these processed could be successfully completed largely due to the inexperience of bid participants who submitted unviable low tariffs.

The last of such processes was conducted in 2012 by the Power Division, MPEMR and the selected Project Sponsor was issued a LOI to undertake the development and implementation of a 367MW power plant in Sirajganj. Subsequently, the project failed to take off due to the inability of the Project Sponsor to comply with the conditions of the awarded bid which led to a termination of the award by the Power Division.

With tariff discovery having being competitively undertaken as recently as in 2012 and relying on the provisions of the Power and Energy Fast Supply Enhancement (Special Provision) Act, 2010 (Board of Investment 2010) which allow for bilateral solicitation of proposals for IPP development, the MPEMR invited SNWPCL, in October 2014, to submit a comprehensive proposal for development for a 400MW (±10%) IPP in Sirajganj, while keeping tariff the same as last discovered under the competitively bid process of 2012.

SNWPCL submitted an RFP compliant proposal to the MPEMR on Dec 7, 2014 and received the notification of acceptance of proposal from MPEMR on Apr 02, 2015. The Letter of Intent (LOI) for the development of project was issued by NWPGCL vide letter no. 537/NWPGCL/Siraj 400MW/(Unit-4)/2015 dated 22 September 2015 (refer to ***Annex A***).

1.2.3 The Project – Sirajganj 4

The Project will be sited at the Saidabad Power Generation Complex owned by NWPGCL and situated along the shores of the Jamuna River in the north-west region of Bangladesh. The Project site falls under the Saidabad Union of Sirajganj Sadar Upazilla (Sub-district) of Sirajganj District. The location of the Project site is shown in ***Figure 1.1***. 16 acres of land has been earmarked within the Sirajganj Power Generation Complex for the Project which will be jointly owned by SNWPCL and NWPGCL. Within the Saidabad power generation complex, NWPGCL currently owns and operates a 225 MW dual fuel Combined Cycle Power Plant ("CCPP") (*herein after referred to as "Sirajganj 1" or "S1")* and is in the process of tendering for two additional 225MW CCPPs, namely "*Sirajganj 2*" or "*S2*" and "*Sirajganj 3*" or "*S3*", which will be developed in between Sirajganj 1 and Sirajganj 4 projects by NWPGCL[1].

A 230 kV substation connects the complex to the national transmission system of the Power Grid Company of Bangladesh ("PGCB") and the 30" East-West

[1] Sirajganj 2 project has also completed the environmental impact assessment study and the financial close for the project is currently under progress. Sirajganj 3 project has received the site clearance certificate from the DOE, however details of project including the stutus of EIA study and financing progress currently unknown.

gas pipeline crossing the Bangabandhu Bridge (also called the Jamuna Multi-purpose Bridge) is located about 1.5 km away from the Project site.

The land required for the project will be provided by BPDB pursuant to a Land Lease Agreement ("LLA"). The Project is supported by a 22 year Implementation Agreement ("IA") with the GOB, acting through the Ministry of Power, Energy and Mineral Resources (MPEMR), and the PGCB. The electrical capacity and electricity generated will be sold under a 22 year Power Purchase Agreement ("PPA") with the Bangladesh Power Development Board (BPDB). SNWPCL will enter into a Gas Supply Agreement ("GSA") with Pashchimanchal Gas Company Ltd. ("PGCL"), a subsidiary of state-owned Petrobangla and a Fuel Supply Agreement ("FSA") with state-owned Bangladesh Petroleum Corporation ("BPC").

The Project has been designated by the GOB as a "Public, Private Partnership" project, and as such, twenty nine percent (29%) of the equity interest in the Company will be subscribed, purchased and owned by NWPGCL pursuant to the Share Purchase Agreement ("SPA") to be entered into by and among the Project Company (SNWPCL) and the Project Sponsors.

The Request for Proposal (RFP) issued to Sembcorp on October 28, 2014 stipulates that the remaining 71% of the equity will be held by the Project Sponsor that will be selected through a bilateral negotiation process that is allowed per the Power and Energy Fast Supply Enhancement (Special Provision) Act, 2010 (Board of Investment 2010).

1.3 ABOUT THE PROJECT COMPANY AND SHAREHOLDERS

1.3.1 The Project Company – Sembcorp North-West Power Company Limited

Sembcorp North-West Power Company Ltd("SNWPCL") has been duly formed and registered under the Laws of the People's Republic of Bangladesh on 26 November 2015 as a private limited company to develop, design, finance, build, own, operate and maintain the Plant. The Company has been set up for the sole purpose of developing, owning and operating the Project. The Company will be 71% owned by SCU, and 29% by NWPGCL. Trade license of SNWPCL is included as ***Annex B***.

1.3.2 Shareholders

Sembcorp Industries Limited (SCI)

Sembcorp Industries Ltd ("SCI") is a leading energy, water and marine group with operations across six continents worldwide. With facilities of over 10,600 megawatts of gross power capacity and over nine million cubic metres of water per day in operation and under development, SCI is a trusted provider of essential energy and water solutions to both industrial and municipal customers.

It is also a world leader in marine and offshore engineering, as well as an established brand name in urban development. SCI is listed on the Singapore stock exchange with a current market capitalization of about US$3.9 billion (S$5.5 billion) as at 31 December 2015. SCI is 49.5% (as at 31 December 2014) owned by Temasek holdings, the investment holding arm of the government of Singapore and is listed on the main board of the Singapore stock exchange.

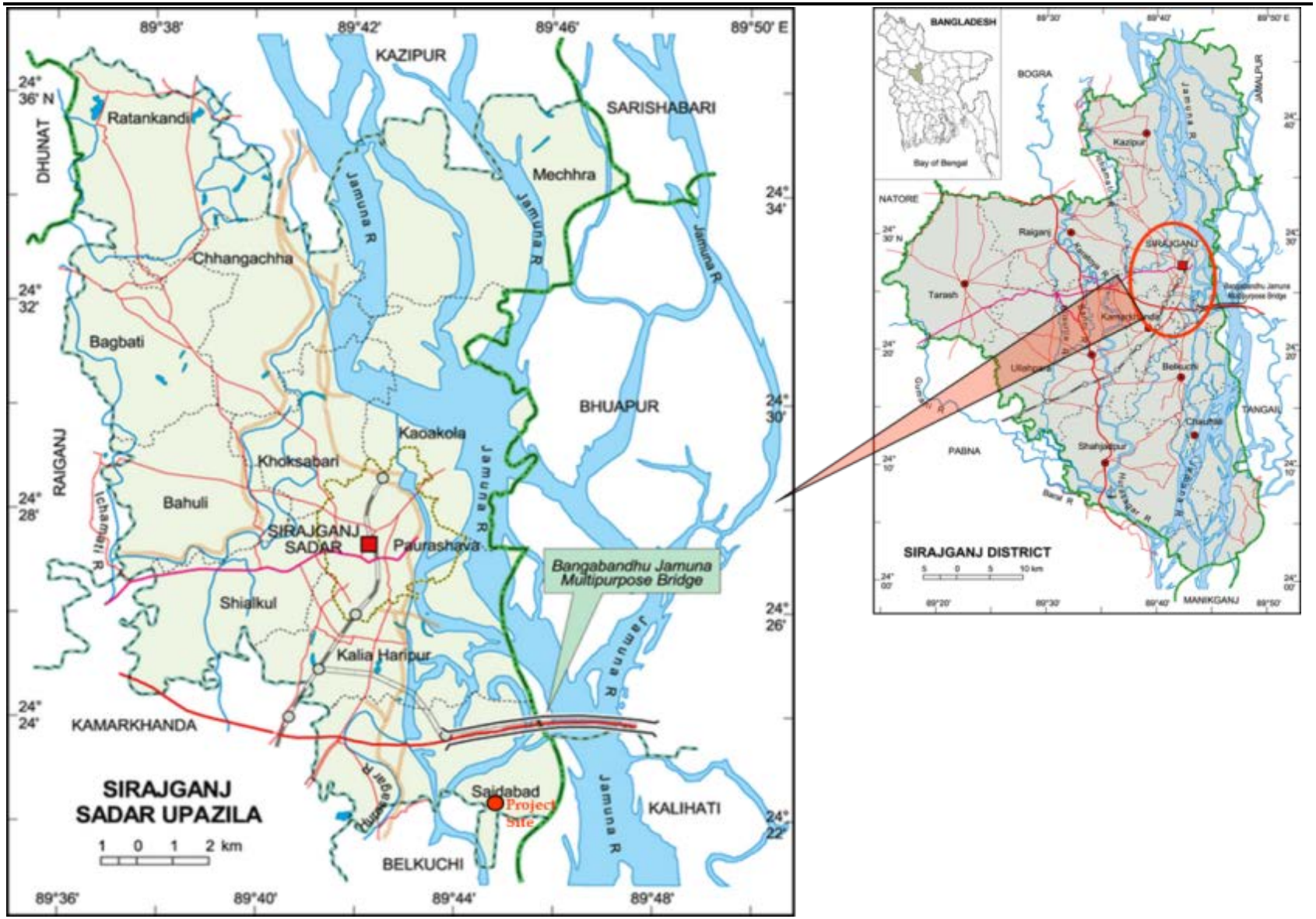
The Group has total assets of over S$17.2 billion and employs more than 8,000 employees. Listed on the main board of the Singapore Exchange, it is a component stock of the Straits Times Index and several MSCI and FTSE indices.

Box 1.2 Quick Facts - SCI

Year of Incorporation	:	1998
Listing	:	Singapore Exchange (SGX)
Market Capitalisation	:	S$8.0 billion
Shareholders	:	Temasek Holdings – 49.5% Public – 50.5%
Number of Employees	:	10,000
FY2014 Turnover	:	S$10.9 billion
FY2014 Net Profit	:	S$ 801 million
Key Business	:	Sembcorp Utilities – 100% Sembcorp Marine – 60.7% Sembcorp Development – 100%
Global Presence	:	Singapore, China, India, IndonEIA, Philippines, Vietnam, Myanmar, Australia, Oman, UAE, South Africa, Norway, UK, Panama and the Caribbean, Brazil, Chile

Source: (Sembcorp 2016)

Figure 1.1 *Location of the Project Site*



Source: (Maps of Bangladesh 2015)

Sembcorp Utilities Pte Limited

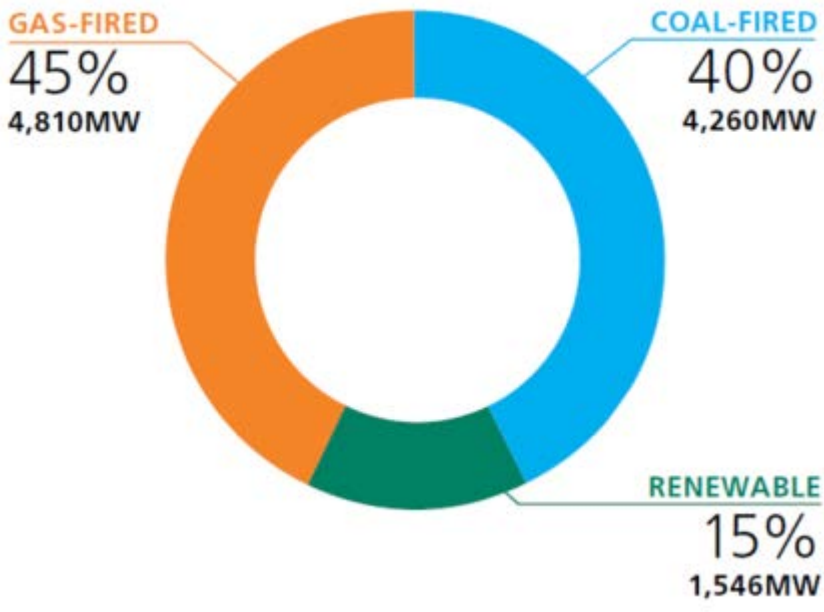
Sembcorp Utilities ("SCU"), a 100% fully owned subsidiary of SCI, is a leading developer, owner and operator of energy and water assets with strong operational and technical capabilities. As a global leader in the provision of energy, water and on-site logistics to multiple industrial customers in energy intensive clusters, SCU has more than 10,600 MW of gross power capacity, 4,500 tonnes/hour of steam production capacity and 8.8 million m^3/day of water capacity in operation and under development worldwide. (Refer ***Figure 1.2***).

North-West Power Generation Company Limited (NWPGCL)

North West Power Generation Company Ltd ("NWPGCL") formed in 2007, is a wholly owned subsidiary of BPDB and is responsible for undertaking power generation projects in the northwest region of Bangladesh. The company presently owns and operates two projects totalling 372 MW and has 2,663 MW under development.

On June 2014, NWPGCL signed the Joint Venture Agreement with CMC, China to implement the Payra 1,320 MW Thermal Power Plant Project. Bangladesh-China Power Company (Pvt.) Limited was constituted and registered in Bangladesh as a Joint Venture Company under the banner of NWPGCL and CMC to implement the project.

Figure 1.2 Power Generation – SCU



Source: (Sembcorp 2016)

Box 1.3 SNWPCL's Energy Business

Power Generation

- Sembcorp is responsible for Singapore's first privately-developed independent power plant, which is also the country's largest cogeneration facility at 815 megawatts. In July 2014, Sembcorp completed its second combined-cycle gas turbine cogeneration plant in Singapore. It has a power capacity of 400 MW and a steam production capacity of 200 tonnes per hour.
- In China, Sembcorp co-owns the largest co-generation plant in Shanghai, the Shanghai Cao Jing Cogeneration Plant, located in the Shanghai Chemical Industrial Park. It has a power capacity of 691 MW and a steam production capacity of 728 tonnes per hour.
- In Vietnam, SNWPCL co-own the 746 MW combined-cycle gas turbine power plant, Phu My 3
- In the UAE, SNWPCL co-own and operate 893 MW power and desalination facility in Fujairah. The plant is one of the world's largest operating hybrid desalination plants.
- In Oman, SNWPCL co-own and operate a 490 MW power and desalination facility in Salalah, the largest and most energy efficient power and water plant in the Dhofar Region in southern Oman.
- In India, SNWPCL co-own and operate two adjacent 1,320-megawatt facilities in Krishnapatnam, SPSR Nellore District, Andhra Pradesh. Both plants will employ efficient supercritical technology.
- In April 2015, SNWPCL received the Notice of Award, after an international bidding process, to develop and operate a 225MW gas fired power plant in central Myanmar
- Sembcorp leads the way in sustainable power generation. Its green facilities include a biomass station and an energy-from-waste facility in the UK, energy-from-waste operations in Singapore and wind power assets in China. It also co-owns and operates wind and solar power assets in India with a total power capacity of 700 MW in operation and under development. With this addition, Sembcorp's renewable energy capacity accounts for approximately 13% of the Group's total power capacity.

Electricity Retail

- SNWPCL retails electricity to contestable customers in Singapore
- SNWPCL offer a variety of electricity packages to meet our customers' operational requirements.

Process Steam Production and Supply

- Sembcorp produces and supplies process steam at different pressure levels for industrial process use in chemical and petrochemical hubs in Singapore, the UK and China.

Natural Gas Import, Supply and Retail

- Sembcorp is Singapore's first commercial importer and retailer of natural gas
- SNWPCL import 431 billion British thermal units (BTU) of natural gas per day from West Natuna in IndonEIA. This gas is supplied to major power generation and petrochemical companies including Tuas Power, PowerSeraya, ExxonMobil and Ellba Eastern.

Source: (Sembcorp 2015)

1.3.3 Sembcorp Group HSE Management System

Sembcorp has a Group HSE Management System in place which is enforced across the Group, following ISO and OHSAS standards. Sembcorp's commitment to environmental protection has been presented in ***Box 1.4***.

Box 1.4 Commitment to Environmental Protection

Sembcorp, as a trusted provider of essential solutions in energy, water and urban developments, recognises that our business activities have varying direct and indirect impacts on the environment. We commit to integrate environmental protection and stewardship into Sembcorp's operations philosophy, believing that sound practice and performance in this area can help mitigate environmental risks while contributing to a sustainable future.

Sembcorp seeks to conduct our businesses in an environmentally responsible manner, and strives to be respected as a company that consistently meets environmental standards in the communities that we operate by:

- Making environmental considerations a priority in the planning for all existing and new operations, products and services.
- Complying with all environmental regulations and other environmental requirements applicable to Sembcorp's businesses.
- Reducing consumption of primary resources and emission of pollutants by applying control measures and technologies to enhance our operating performance and efficiency.
- Taking due diligence in preventing spills, discharge and releases, and providing timely and efficient response if there is an occurrence.
- Verifying the effectiveness of our environmental management practices, and focusing on reduction at source.
- Educating and communicating to employees and contractors to be accountable for environmental protection while working for and on behalf of Sembcorp.
- Establishing and adhering to performance targets for environmental protection and sustainability.
- Promoting sustainability through providing alternative sustainable and economical sources of energy to customers through investments in green technologies.

Source: (Sembcorp 2016)

The Group HSE Management System comprises of sustainability policy and health, safety and environmental policy, which are presented in ***Box 7.1*** and ***Box 7.2***, respectively, and associated GHSE Guidance Documents. Guidance Documents provide operational guidelines for practical application of the principles outlined in the policy document. Updates of the Guidance Documents are being approved by the Senior Management Committee.

The GHSE Management System with its associated Guidance Documents is mandatory for all entities under the management control of Sembcorp Group of Companies. Business units have the authority to meet the requirements of the elements with their existing processes, programs and systems (e.g. ISO 14001, OHSAS 18001) as long as conformance to the HSE Guidelines is demonstrated. The project will also follow these policies and guidelines and will plan specific action to align with them.

1.4 IMPACT ASSESSMENT OBJECTIVES

The objectives of this EIA are to:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be significantly impacted by the Project;

- Identify the aspects of the Project likely to result in significant impacts to resources/receptors;
- Document how stakeholders have been engaged during the EIA Process, and how stakeholder feedback has been considered in the EIA;
- Predict and evaluate the significance of the impacts of the Project;
- Identify the (environmental, social and health) aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, taking into account the implementation of mitigation measures; and
- Generate plans for the management and monitoring of impacts, including plans for ongoing stakeholder engagement.

1.5 SCOPE OF EIA STUDY

1.5.1 *Applicable Reference Framework*

The reference framework for the EIA study will therefore be governed by the following standards/guidelines:

- Applicable Bangladesh national, regional and local regulatory requirements[1];
- International conventions and agreements ratified by Bangladesh[2].
- The IFC Performance Standards for Environmental and Social Sustainability (2012)[6];
- The IFC General EHS Guidelines (2007)[7]; and
- IFC EHS Guidelines for Thermal Power Plant (2008)[8].

1.5.2 *Coverage of EIA Study*

The coverage of EIA includes the 413.792 MW (Gas)/333.02 MW(HSD) dual fuel combined cycle power project and its 5 km radius from centre of the Project site, the gas pipeline from GTCL valve station (about 1.5 km away from Project site), HSD supply pipeline of about 3.0 km from HSD supply system of NWPGCL, transmission line (PGCB Substation in vicinity of Project

[1] Applicable Bangladesh Laws and Regulations are detailed in Chapter 3: Administrative Framework
[2] Applicable Bangladesh Laws and Regulations are detailed in Chapter 3: Administrative Framework
[6] http://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES
[7] http://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final+-+General+EHS+Guidelines.pdf?MOD=AJPERES
[8] http://www.ifc.org/wps/wcm/connect/dfb6a60048855a21852cd76a6515bb18/FINAL_Thermal%2BPower.pdf?MOD=AJPERES&id=1323162579734

site), Project related transportation activities including the temporary jetty North of the Jamuna Multipurpose Bridge.[1]

1.5.3 Scope of Work

The detailed scope of the EIA study is as outlined below:

- Screening of the Project based on applicable reference framework based on reconnaissance survey and desk based review of Project documents;
- Scoping for the EIA study;
- Development of an integrated project description of the Project components including its sub-components, which are under the purview of the Project Proponent (PP);
- Development of a regulatory, policy and administrative framework relevant to the Project;
- Monitoring, analysis and reporting of the environmental and social baseline data of the study area including consultation with local communities and other stakeholders;
- Assessment of the environmental impacts of the Project in the study area;
- Assessment of social impacts on the local community as well as Project affected people and any other stakeholders, which have been identified during the social consultation process;
- Assessment of cumulative impacts of the Saidabad Power Generation Complex based on available information;
- Risk assessment and consequence analysis of the Project;
- Formulation of an Environment and Social Management Plan and associated/specific mitigation plans for identified impacts; and
- Formulation of Public and Stakeholder Consultation and Grievance Redress Mechanism for the Project.

1.6 APPROACH AND METHODOLOGY

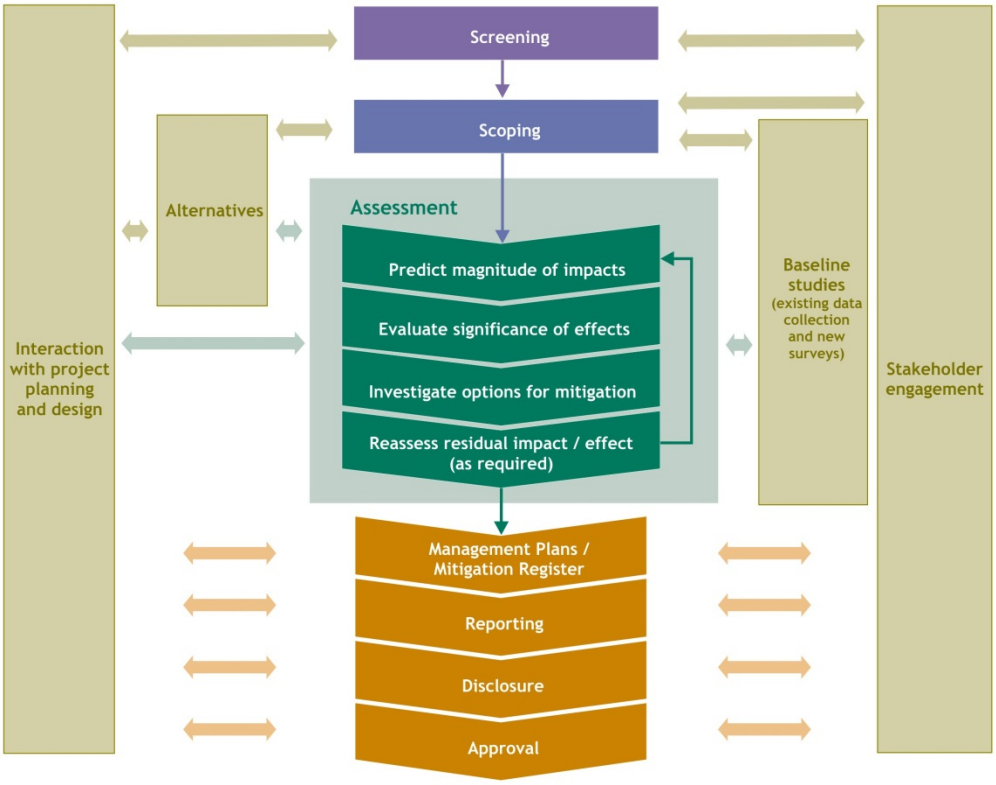
The EIA has been undertaken following a systematic process that predicts and evaluates impacts the Project could have on aspects of the physical, biological, social/socio-economic and cultural environment. Further, identifies measures that the Project will take to avoid, minimise/reduce, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable. The EIA methodology follows the overall impact assessment approach illustrated in ***Figure 1.3***.

The approach and methodology adopted for screening and scoping of the project is discussed below, while the approach and methodology for baseline

[1] Associated facilities such as approach road connecting to National Highway, gas valve station, railway line and siding, HSD unloading and pumping system at Bangabandhu Bridge West Railway Station (RS), HSD pipeline from RS to Saidabad power generation complex, grid sub-station and transmission line for power evacuation are already existing facilities close to the site and currently being used by the existing NWPGCL Plant, which is located within the power generation complex.

data collection and assessment has been described in the beginning of the respective chapters of this report.

Figure 1.3 ***Impact Assessment Process***



1.6.1 Screening

At the initial stage of the EIA, preliminary information was obtained and discussions held to aid in the determination of what legal and other requirements apply to the Project. This step was conducted utilising a high level description of the Project and its associated facilities. The results of the screening exercise are reported in ***Annex C*** of this EIA Report.

1.6.2 Scoping

Scoping was undertaken to identify the potential Area of Influence for the Project (and thus the appropriate Study Area), to identify potential interactions between the Project and resources/receptors in the Area of Influence and the impacts that could result from these interactions, and to prioritize these impacts in terms of their likely significance. The findings of the scoping exercise are reported in ***Annex C*** of this EIA Report.

Table 1.1 presents the resources/receptors considered in the scoping stage, together with the changes that could/might indicate a Project-related impact.

Table 1.1 ***Resources/Receptors and Impacts Considered in Scoping***

Resources/Receptors	Impacts
Environmental	

Resources/Receptors	Impacts
Land Forms/Profile	Changes to • Geology • Geomorphology • Topography
Soil Quality	Changes to • Physical and chemical properties • Soil ecology • Erosion
Sediment Quality	• River/waterbed morphology, • Physical and chemical properties, • Benthic organisms.
Land use	• Changes in Landuse/land cover profile • Logistics
Air Quality	Emissions of • Gaseous pollutants (e.g. NOx, SOx, CO, VOC, ozone, etc.); and • Particulate matter (e.g. PM_{10} and $PM_{2.5}$)
Climate Change	• Greenhouse gases (CO_2, CH_4, and N_2O) emissions, • Increase in global warming; • Flooding.
Drainage Pattern	Changes in the • Drainage pattern, • Submergence, • Floods etc.
Surface Water Quantity and Quality	Changes to • Physical, chemical or biological quality of Jamuna River • Changes in surface water quantity • Changes in habitat quality, abundance, diversity; • Effluent discharge.
Ground water Quality	• Contamination of shallow or deep groundwater resources, • Change in ground water resource.
Ambient Noise Levels	• Change in noise levels
Vibration	• Changes in Vibration levels
Waste Solid Waste and liquid waste	• Generation of wastes-hazardous and non-hazardous
Terrestrial Ecology	• Impact on flora and fauna
Aquatic Ecology (Biodiversity)	• Changes in fisheries productivity and impact on aquatic form of various activities as dredging, water intake and discharge
Social/Socio-Economic	
Demographics (i.e. Displacement)	Changes in • Population, total population, gender ratio, age distribution. • Physical displacement from residence as a result of Project land take, or activities
Economy and livelihood	Change in • Local economy, • Employment, • Standard of living, • Occupation
Social and Cultural Structures	• Disruption in local authority and governance structure; • Change in social behaviours; alterations to social and cultural networks; • Intra and inter-ethnic conflict.
Economy and Livelihood	• Impact in Livelihood pattern.

Resources/Receptors	Impacts
Infrastructure and Services	• Improvement or pressure on existing urban/rural infrastructure or services including: transportation; power, water, sanitation, waste handling facilities etc.
Cultural Resources	• Physical disturbance of shrines, burial grounds, archaeological resources or other desecration;
Social/Community Cohesion	• Any social/community cohesions/ conflicts due to workers from outside or due to Project related activities
Vulnerable Groups	• Impact on livelihood, community networks, displacement induced impacts
Health	
Community Health and Safety	• Changes in the incidence and /or prevalence of sexually transmitted diseases and the factors that contribute to this (external workforce, transport routes etc. Changes in the incidence and or prevalence of vector borne diseases, the density of these vectors and their breeding grounds. • Changes in availability of and access to health care, nutritional status, food security etc.

In addition to the above, the approved TOR for EIA study has also been taken into consideration to define the scope of the EIA study. Copy of IEE exemption and TOR for EIA study is included as ***Annex D***. The project has also taken no objection certificate (NOC) from the Union Parishad, Saidabad and Upazilla Nirbahi Officer, Sirajganj Sadar (UNO), which are included as ***Annex E*** and ***Annex F***, respectively.

1.6.3 Baseline Data Generation

The primary objective of the environmental and social baseline study is to provide a baseline against which potential impacts from the construction, operational and decommissioning phases of the Project can be assessed. The methodologies of baseline data collection for physical, ecological and socio-economic environment are presented in ***Section 4.2*** and subsequent sections of ***Section 4*** and ***Section 5***.

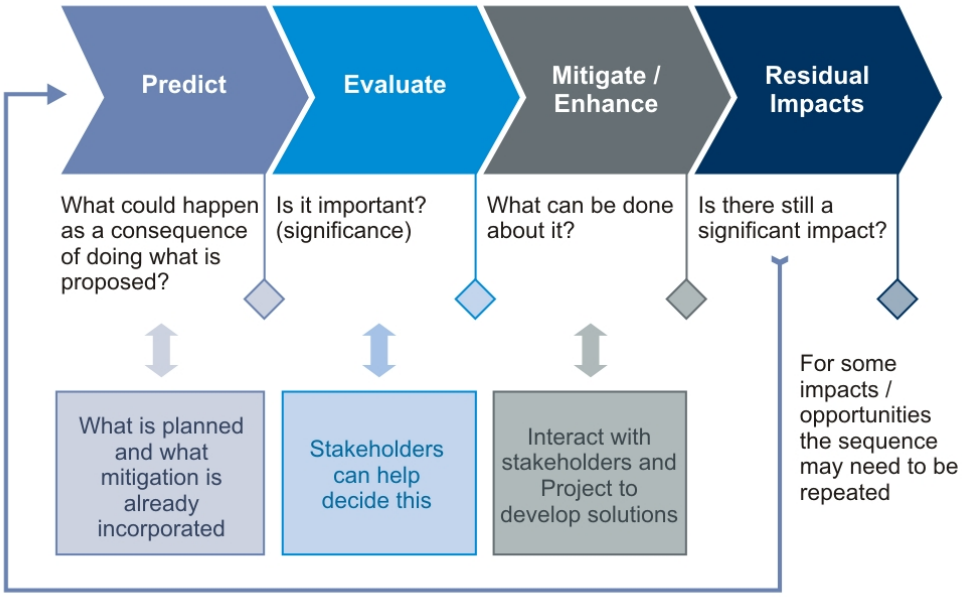
1.6.4 Impact Assessment and Management

Impact identification and assessment starts with scoping and continues through the remainder of the IA Process. The principal IA steps are summarized in ***Figure 1.4*** and comprises of:

- **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 measures.

Figure 1.4 Impact Assessment Approach



The detailed impact assessment methodology is presented in ***Section 6.3***.

1.7 EIA TEAM

ERM constitutied a team comprising of various experts to carry out the EIA study as detaiuled out in the table below:

Table 1.2 EIA team and their roles

S.No.	Name	Specialist
1.	Alastair Scott	Project Director and Technical review for Environment
2.	Neena Singh	Technical review for Social
3.	Dr.Arun Venkataraman	Technical review for Ecology and Biodiversity
4.	Naval Chaudhary	Environemental Specialist and Project Manager (Air and Noise)
5.	Dr.Swayam Panda	Social Specialist
6.	Dr.Koel Kumar	Environment Specialist (Water and waste)
7.	Dr.Rahul Srivastava	Ecology and Biodiversity Specialist
8.	Dr.Shankkar Chaterjee	Geology and Soil Specialist
9.	Arin Mukherjee	Risk assessment Specialist
10.	Kazi Farhed Iqubal (EQMS)	Stakeholder Consultation, Baseline data collection
11.	Mohammad Mamun Chowdhury	Fisheries Specialist
12.	Tauhidul Hasan (EQMS)	Baseline data collection

S.No.	Name	Specialist
13.	Aritra Mazumder	Socio-economic baseline and stakeholder consultation
14.	Akshita Misra	Stakeholder Consultation

1.8 REPORT STRUCTURE

The EIA report has been largely structured based on the ToR issued by DoE dated 10th March 2016. The layout of the Report has been divided into 10 sections as briefly described in ***Table 1.3***:

Table 1.3 Layout of the Report

Chapter No.	Chapter Title	Description
0	Executive Summary	This section includes • Brief summary of the entire EIA report
1	Introduction	This section includes • introduction about the project, • Project background, • Brief dsecription, • Scope of the EIA study • Approach and Methodology • EIA team
2	Policy, Legal and Administrative Framework	This section discusses • the national and local legal and institutional framework within which the environmental assessment is carried out. It also identifies project-relevant international environmental agreements to which the country is a party. • it also covers the applicable reference framework being used for the EIA study.
3	Project Description	This section describes • the proposed project; • its major components; and • its geographic, ecological, social, and temporal context, including • associated facility required by and for the project. This section also examines • alternatives to the proposed project site, technology, design, and operation—including the no project alternative—in terms of their potential environmental and social impacts; the feasibility of mitigating these impacts; their suitability under local conditions; and their institutional, training, and monitoring requirements. • It also states the basis for selecting the particular project design proposed and, justifies recommended emission levels and approaches to pollution prevention and abatement.
4	Description of the Environment	This section describes • relevant physical and biological conditions within the study area, and • looks at current and proposed development activities within the project's area of influence, including those not

Chapter No.	Chapter Title	Description
		directly connected to the project. It indicates the accuracy, reliability, and sources of the data.
5	Socio-economic Environment	This section describes • relevant socioeconomic conditions within the study area, and • looks at current and proposed development activities within the project's area of influence, including those not directly connected to the project. It indicates the accuracy, reliability, and sources of the data.
6	Anticipated Environmental and Social Impacts and Mitigation Measures	This section • predicts and assesses the project's likely positive and negative direct and indirect impacts to physical, biological, socioeconomic (including occupational health and safety, community health and safety, vulnerable groups and gender issues, and impacts on livelihoods through environmental media, and physical cultural resources in the project's area of influence, in quantitative terms to the extent possible; • identifies mitigation measures and any residual negative impacts that cannot be mitigated; explores opportunities for enhancement; identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions and specifies topics that do not require further attention; and examines global, transboundary, and cumulative impacts as appropriate.
7	Environmental and Social Management Plan (ESMP)	This section deals with • the set of mitigation and management measures to be taken during project implementation to avoid, reduce, mitigate, or compensate for adverse environmental and social impacts; • describes the mitigation, monitoring, implementation arrangements and performance indicators for effective implementation of the ESMP; and • Framework management plans for construction phase of the project. This section also describes: • the grievance redress framework, setting out the time frame and mechanisms for resolving complaints about environmental performance; and • structure of the grievance redress cell to be formed for the project.
8	Stakeholder Consultations and Participation	This section • describes the process undertaken during project design and preparation for engaging stakeholders, including information disclosure and consultation with affected people and other stakeholders; • summarizes comments and concerns received from affected people and other stakeholders and how these comments have been addressed in project design and mitigation measures, with special attention paid to the needs and concerns of vulnerable groups; and • describes the planned information disclosure measures and the process for carrying out consultation with

Chapter No.	Chapter Title	Description
		affected people and facilitating their participation during project implementation.
9	Risk Assessment	This section entails risk assessment to personnel and environment from consequences of accidental events as well as natural hazards and includes: • Hazard Identification • Consequence Analysis • Risk Reduction Measures and Recommendations
10	Conclusion and Recommendation	This section provides • the conclusions drawn from the impact assessment; and • recommendations for environmental and social management during the project lifecycle.

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.

This section focuses on the administrative framework under the purview of which the proposed Project will fall and the EIA study will be governed, namely:

- Bangladesh national and local, legal and institutional framework;
- International agreements and conventions ratified by Bangladesh; and
- IFC Performance Standards and EHS Guidelines.

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 phase-in 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 be conducted before projects are undertaken and the DOE is directed to review and approve all Environmental Impact Assessments.

2.2.2 National Environment 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. Applicable, as water for cooling is to be drawn from the Jamuna river with discharge of treated water on land and the river course will also be used for transport of heavy equipment.
National Landuse 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 landuse of the Project site is industrial and owned by BPDB.
Draft Wetland Policy, 1998	• Establishment of principles for the sustainable use of wetland resources	Not directly applicable, however may be applicable

Policy	Key Features	Applicability
	• Maintenance of the existing level of biological diversity • Maintenance of the functions and values of wetlands • Promotion and recognition of the value of wetland functions in resource management and economic development	once the draft policy is finalised
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	Applicable as water for cooling is to be drawn from the Jamuna river and the river will also be used for transport of heavy equipment.
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 public and private partnership, industrial development

2.3 *ENVIRONMENT AND SOCIAL RELATED LEGISLATIONS IN BANGLADESH*

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

2.3.1 *The Environment 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).

2.3.3 Acquisition and Requisition of Immovable Property Ordinance, 1982

The basic principles behind compensation of property in Bangladesh are founded in Articles 42 and 47 of the Constitution (1972). The current legislation for governing land acquisition in Bangladesh is the "Acquisition and Requisition of Immovable Property Ordinance (ARIPO), 1982 and amended in 1983, 1993 and 1994. Key features of the ordinance are as follows:

- This Ordinance provides the Deputy Commissioner (DC) with the power to initiate the acquisition of any property in any locality within his district that is likely to be needed for a public purpose or in the public interest.

- It describes the entire procedure of notice and intimations prior to acquisition of any property and process and timeframes for raising objections.
- Section 8 deals with matters to be considered in determining compensation which is based on the market value of the property at the date of publication of the notice under section 3.
- It defines the role and authority of Divisional Commissioner in decision making, compensation issues and in case of dispute. Among the matters to be considered in determining compensation are the following:
  - The damage that may be sustained by the person interested, by reason of the taking of standing crops or trees which may be on the property at the time of taking possession thereof by the Deputy Commissioner,
  - The damage that may be sustained by reason of the acquisition injuriously affecting his other properties, movable or immovable, in any other matter, or his earnings; and
  - If in consequence of the acquisition of the property, the person interested is likely to be compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change; In terms of compensation, the Ordinance explicitly states that the DC, when determining compensation, shall neither consider any disinclination of the person to part with the property, nor any increase in the value of the property to be acquired likely to accrue from the use of it after it has been acquired.
- The Ordinance also covers the case of temporary acquisition of property for a public purpose or in the public interest.

Section 7(1) (b) makes provision for apportionment of the compensation among all the persons interested in the property. Further, Section 10A makes specific provision for payment of compensation to bargadar (*share cultivators*).

Section-18 deals with requisition of property which is required for temporarily for a public purpose. Section 20 deals with the award of the compensation for requisition of the property under Section 18. The amount of compensation payable for the requisition of any property consist of a recurring payment in respect of the period of requisition (equal to rent of lease that would be revised in every two years) and other associated damages such as expenses on account of vacating, expenses on account of re-occupying the property, and damages other than wear and tear, caused to the property during the period of requisition. Section 23 makes provision for protection of the property to prevent deterioration and to ensure proper maintenance of the requisitioned property.

2.3.4 Administrative and Regulatory Guidelines and Instructions

In addition to the provisions in the law, the land acquisition process is regulated by certain administrative instructions and procedural requirements. The most important of these are summarised here.

- In 1976, the Government constituted land allocation committees at the district, divisional and central levels to control what was regarded as too lavish taking of land for public purposes. The committees were charged with ensuring 'the most rigid measures of economy in the use of land for purposes other than agriculture."

- The District Land Allocation Committees (DLACs) are chaired by the DC and have seven other members. These members include Executive Engineers of the R&H Department and the Public Works Department, and the Civil Surgeon. They are entrusted with land allocation within the district not exceeding two acres.

- The Divisional LACs are chaired by the Divisional Commissioner and have technical representation at the Superintending Engineer and Deputy Director level. These committees consider land acquisition cases involving between two and five acres of land. All cases of more than five acres go to the Central Land Allocation Committee (CLAC). This committee is chaired by the Minister of Land Administration and has technical representation at the Secretary level. In 1989, the Government ordered that in all cases involving the acquisition of land exceeding 10 bighas, the President would have to give consent.

2.3.5 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 proposed 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 pollution, conservation and improvement of environment • Declaration of Ecologically critical areas	Applicable
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 Jamuna 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	• Management and Control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly

Act/ Rule/ Law/ Ordinance	Enforcement Agency – Ministry/ Authority	Key Features	Applicability to proposed Project
	Development and Cooperatives		applicable when considering water usage management and sanitation facilities for the project
The Ground Water Management Ordinance, 1985	Upazilla Parishad	• Management of ground water resources • Installation of tube-wells at any place after license from Upazilla 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, and ground seepage
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 proposed 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 the BBA land.
Bangladesh Wild Life (Preservation) Act, 1974	Ministry of Environment and Forest; Bangladesh Wild Life Advisory Board	• Preservation of Wildlife Sanctuaries, Parks, and Reserves	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 bio-diversity in the study area including Jamuna River
National Water Bodies	Town development	• The characterization of water bodies as rivers, canals, tanks or	Applicable due to the

Act/ Rule/ Law/ Ordinance	Enforcement Agency – Ministry/ Authority	Key Features	Applicability to proposed Project
Protection Act, 2000	authority/Municipalities	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	proximity to and use of surface water bodies
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 intake point will be the Jamuna 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	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 1994, 1995 and 2004	Ministry of Land	• Current GOB Act and Guidelines, relating to acquisition and requisition of land	Applicable
Administrative and Regulatory Guidelines and Instructions ***for Land Acquisition***	Ministry of Land	• Regulation of land acquisition process by certain administrative instructions and procedural requirements	Applicable
The Building Construction Act 1952 and subsequent amendments	Ministry of Works	• This act provide 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

Act/ Rule/ Law/ Ordinance	Enforcement Agency – Ministry/ Authority	Key Features	Applicability to proposed Project
The Factories Act, 1965 Bangladesh Labour Law, 2006	Ministry of Labour	• 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 organisations under the administrative framework which would govern social and environmental functions related to the proposed Project, namely:

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

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

Environmental Clearance Process

As mentioned in the *Section 3.3.2*, ECR has classified projects to be assessed by the DOE in four categories based on the severity of impacts on IECs:

- Green: Nil;

- Orange A: minor;
- Orange B: medium; and
- Red: severe.

The applicability of environmental clearance and the process in Bangladesh is described in ***Figure 2.1***.

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

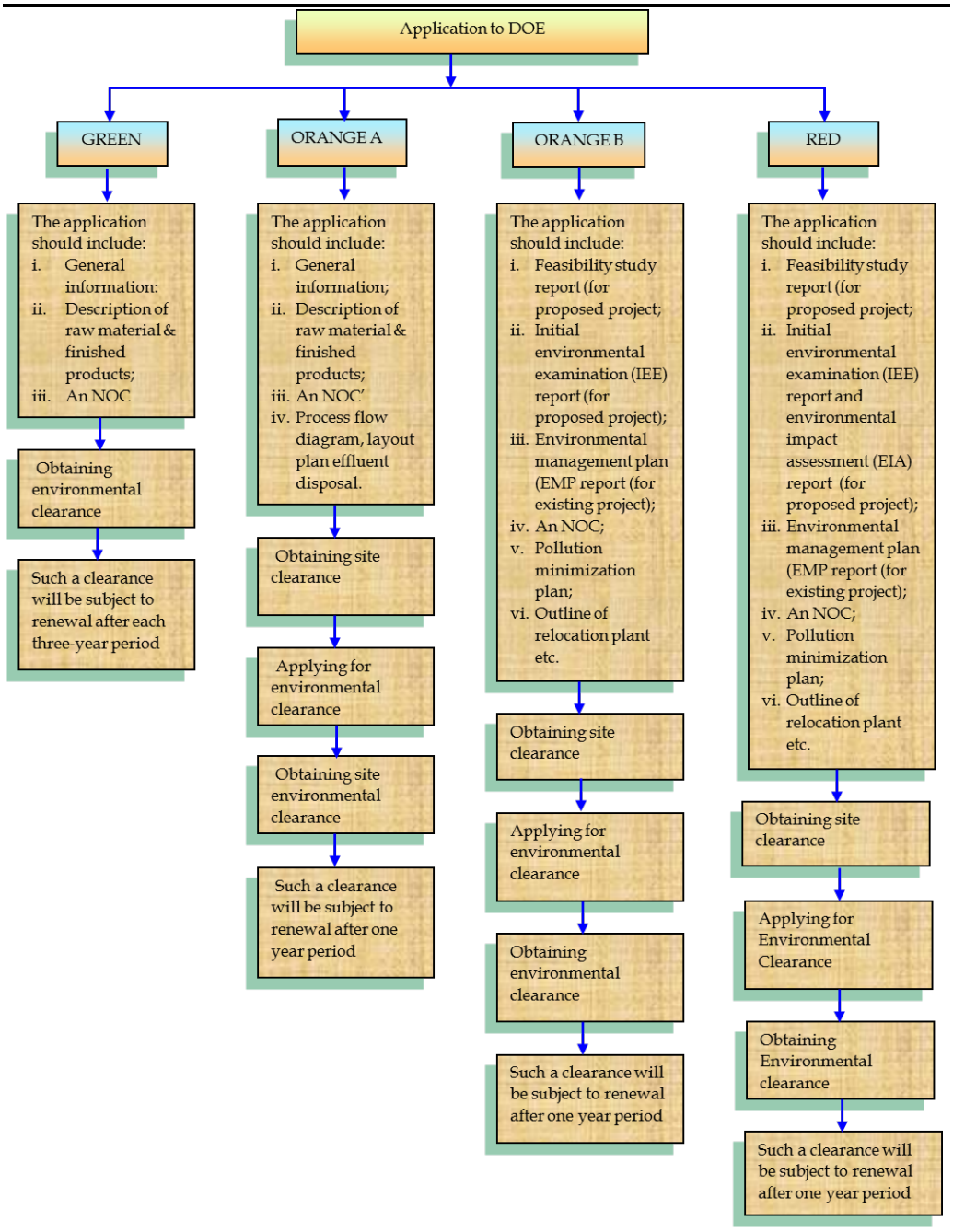
- Projects categorized as *Green* and *Orange-A* does not require IEE or EIA for environmental clearance however, the proponent must submit an application in a prescribed format along with specified documents;
- Projects categorized as *Orange-B* require an IEE to be submitted to the DOE along with an 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 and the *S**ubject Project fall under the Red category*** as referred below:

- *Item 6:* power plants; and
- *Item 64*: construction/ replacement/ extension of natural gas/water/HSD pipelines.

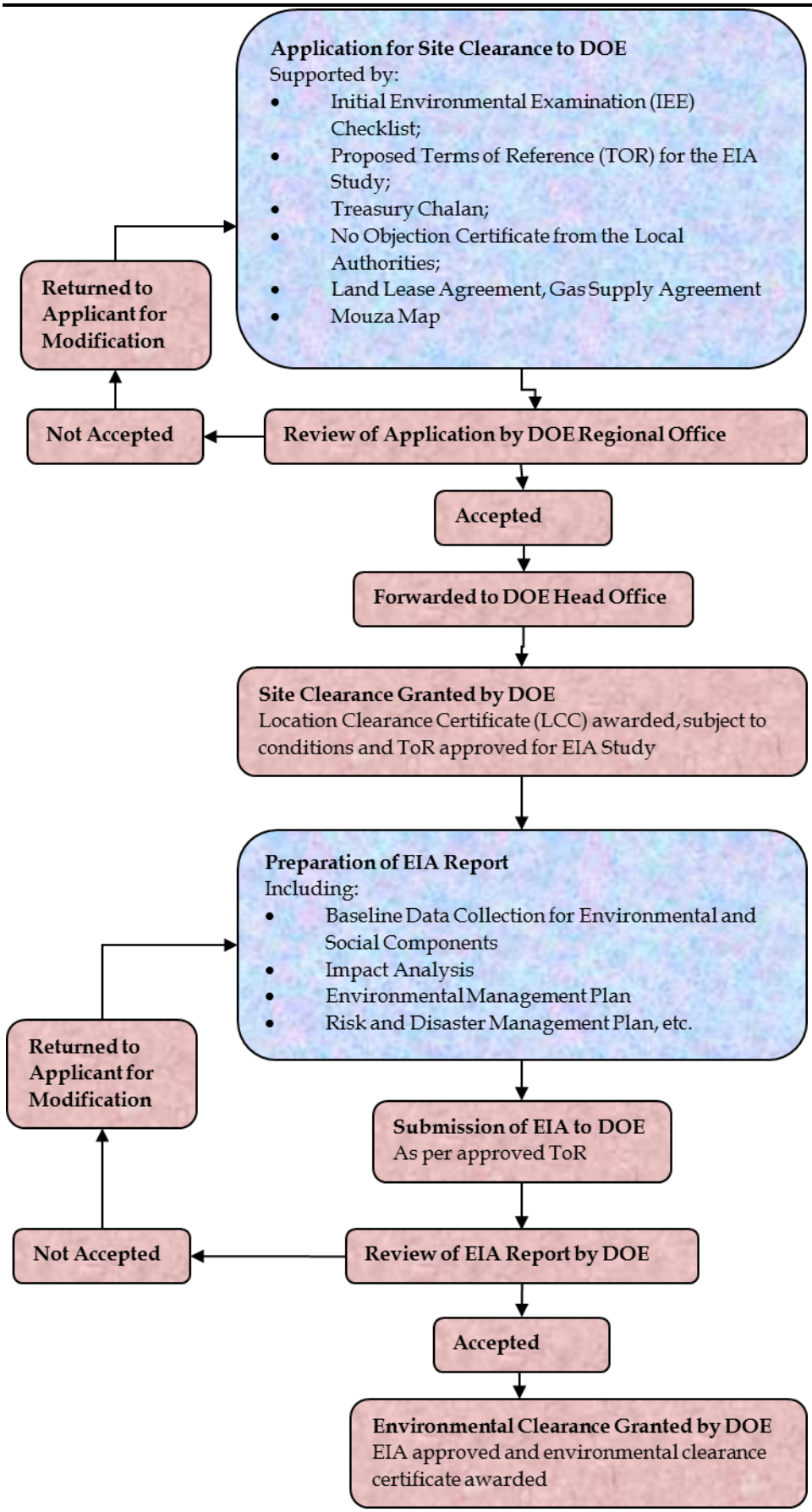
The process for obtaining an Environmental Clearance Certificate (ECC) for the proposed Project is outlined in Figure 2.2**.**

Figure 2.1 DOE Environmental Clearance Applicability and Procedure



Source: Adapted from DOE

Figure 2.2 Flow Chart of EIA Process Applicable to the Proposed Project



Source: Adapted from DOE

2.4.3 Status of Project Approval from DOE

The Project will apply for the site clearance and environmental clearance after signing of finalized Project agreements (such as LLA, IA, GSA, FSA etc.) with the regulatory authorities.

The EIA Report (this report), which is being prepared for the potential lenders (as per the safeguard requirement of the potential lenders **Section 2.7**), will be updated as and if necessary in accordance with the terms of reference (TOR) issued to be issued by the DOE and then submitted to the DOE for obtaining environmental clearance.

2.5 INSTITUTIONAL ARRANGEMENTS RELATED TO LAND ACQUISITION IN BANGLADESH

The administrative set up for land acquisition has two tiers under the Ministry of Land Administration. At the Division level, there is an Additional Commissioner dealing with land administration under the Commissioner. At the district level, there is an Additional Deputy Commissioner in charge of land administration. Under him, there is at least one Land Acquisition Officer and several Assistant Land Acquisition Officers. The number of officers depends on the size of the District. Non-gazetted officers in the land administration include Kanungos and surveyors.

The Deputy Commissioner allows 15 days to invite objections on the notice for land acquisition/requisition under section-3. If no objection is raised within the specified period, the Deputy Commissioner makes a decision within 10 days of the expiry of the notice period. If objections are received by Deputy Commissioner, then the records of the objection raised along with the inquiry made by him submits to the Divisional Commissioner if property does not exceed 50 standard bighas, and submits to the GOB, if the property exceeds 50 standard bighas. The decision of the Government or Divisional Commissioner as the case may be, is final provided the decision by Divisional Commissioner is made within 15 days and the decision made by the GOB is completed within 90 days. The decision by the Government or Divisional commissioner shall be conclusive evidence that the property is needed for a public interest.

The Deputy Commissioner serves the notice of acquisition of the property under section-6 requiring the all persons interested in the property to state the nature of their respective interests in the property and particulars of their claims to compensation for such interests not being earlier than fifteen days after the date of publication of the notice. After examining all the claims/ statements received from all interested parties shall make an award stating the compensation and any apportionment of the said compensation. Deputy Commissioner shall give notice of his award to the persons interested and send the estimate of the award of compensation to the requiring person within 7 days from the date of making award of compensation.

Section 10 makes the payment of the compensation before taking the possession of the property. If the persons entitled do not consent to receive it, or any dispute over the apportionment then the amount of the compensation is deposited in the Public Account of the Republic which is considered as deemed payment for the purpose of taking over possession.

Any person interested who has not accepted any award made by the Deputy Commissioner within 45 days of the service of the award, make an application to the arbitrator for revision of the award. Section-30 restricts the scope of the enquiry by the Arbitrator to a consideration of interests of the persons affected by the objection. Arbitrator shall be guided by the provisions of the sections 8, 9 or 20 provided that the compensation determined by the Arbitrator shall not exceed more than 10 per centum of the award of the Deputy Commissioner. An appeal shall lie to the Arbitration Appellate Tribunal against the award of the Arbitrator and the decision of the Arbitration Appellate Tribunal shall be final.

After the compensation for the property is paid or is deemed to be paid, Deputy Commissioner publishes a notice to that effect in official Gazette. The notice concludes the land acquisition procedure and vests the property absolutely in the government free from all encumbrances, and Deputy Collector takes the possession of the property.

2.6 *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	Applicability to Project
International Plant Protection Convention (Rome, 1951.)	01.09.78 (ratified)	Not applicable
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)	Not applicable
Plant Protection Agreement for the South East Asia and Pacific Region (as amended) (Rome, 1956.)	04.12.74 (accessed) (entry into force)	Not applicable
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969.)	04.02.82 (entry into force)	Not applicable

(1) [1] Department of Environment, Bangladesh

Environment related International convention and Treaties	Status	Applicability to Project
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) ("Ramsar Convention").	20.04.92 (ratified)	Not applicable as no Ramsar site in Project AOI
Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972.)	03.08.83 (accepted) 03.11.83 (ratified)	Not applicable as no such site in Project AOI
Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973.) ("CITES Convention")	18.02.82 (ratified)	Applicable
United Nations Convention on the Law of the Sea (Montego Bay, 1982.)	10.12.82 (ratified)	Not applicable
Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985.)	02.08.90 (accessed) 31.10.90 (entry into force)	Applicable
Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987.)	02.08.90 31.10.90 (accessed) (entry into force)	Applicable
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)	Applicable
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)	Applicable
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)	Applicable
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989.)	01.04.93 (accessed)	Applicable
International Convention on Oil Pollution Preparedness, Response and Cooperation (London, 1990.)	30.01.90 (signed) In the process of ratification	Not Applicable
United Nations Framework Convention on Climate Change, (New York, 1992.)	09.06.92 (signed) 15.04.94 (ratified)	Applicable
Convention on Biological Diversity, (Rio De Janeiro, 1992.)	05.06.92 (signed) 03.05.94 (ratified)	Applicable
International Convention to Combat Desertification, (Paris 1994.)	14.10.94 (signed) 26.01.1996 (ratification) 26.12.1996 (entry into force)	Not Applicable
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976.)	03.10.79 (accessed) (entry into force)	Not Applicable
Agreement Relating to the Implementation of Part XI of the United Nations Convention on	28.07.96 (signed)	Not Applicable

Environment related International convention and Treaties	Status	Applicability to Project
the Law of the Sea of 10 December 1982 (New York, 1994.)		
Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Paris, 1993.)	14.01.93 (signed)	Not Applicable
Convention on persistent Organic Pollutants, Stockholm	23.5.2001 (signed) 12.03.2007 (ratified)	Applicable and use of any persistent pollutants to be prohibited
Kyoto protocol to the United Nations Framework Convention on Climate Change	21.8.2001 (accessed)	Applicable

Source: DOE, Bangladesh

2.7 *INTERNATIONAL SAFEGUARD REQUIREMENTS*

As mentioned in the RFP for the proposed Project, financing sources and financial support for the Project will be available from multi-lateral financial institutions, such as IFC, CDC as well as from the export credit agencies of the countries where major pieces of equipment for the Project will be sourced. This support from multi-lateral financial institutions/ export credit agencies is also linked with adherence to international best practices and environmental and social safeguard requirements of the lenders. The following subsections outline the key environmental and social requirements of IFC, applicable to the Project.

2.7.1 *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 or commercial banks, which are signatory to the *Equator Principles, 2006*.

A brief description of the Performance standards is provided in ***Table 2.4.***

Table 2.4 IFC Performance Standards

Performance Standards	Specific Areas
Performance Standard 1:	Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2	Labour 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

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-sections 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 Social and Environmental Assessment to understand the social and environmental impacts and risks;
- A Management Program for mitigating the impacts and minimizing the risks identified in the assessment;
- Establishing and ensuring organizational capacity and requisite trainings to the staff to implement the Management Programme;
- Identification and engagement with range of stakeholders that may be interested in their actions;
- Development and implementation of Stakeholder Engagement Plan that is scaled to the project risks and impacts and development stage and tailored to the characteristics and interests of the Affected Communities;
- Engagement and consultation with the affected communities, subject to identified risks and adverse impacts from a project;
- Informed Consultation and Participation ("ICP") process for projects with potentially significant adverse impacts on affected communities;
- For projects with adverse impacts to Indigenous Peoples, requirement to engage them in a process of ICP and in certain circumstances requirement to obtain their Free, Prior, and Informed Consent (FPIC);
- Implementation and maintenance of procedure for external communications to receive and register external communications from the public, and their Redressal;
- 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 organisation, 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: Labour and Working Conditions

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

- Establishment of a sound worker-management relationship;
- Encouraging equal opportunity and fair treatment of workers; Promoting compliance with national labour and employment laws;
- Management of accommodation services with provision of basic services;
- Promoting healthy and safe working conditions for workers. and
- Analysis of alternatives for retrenchment prior to implementing any collective dismissals.

PS 2 requires project proponents to conduct its activities in a manner consistent with the four core labour standards (child labour, forced labour, 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 outline a project level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices with objectives to:

- avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from activities;
- promote more sustainable use of resources, including energy and water; and
- reduce project-related GHG emissions.

Key requirements of *PS3* are to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid or where avoidance is not possible, minimize adverse impacts on human health and the environment during the entire project life-cycle. In addition, a project need to follow good international industry practice (GIIP), as reflected in various internationally recognised sources including the World Bank Group Environmental, Health and Safety Guidelines.

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* requires 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.

A project needs to evaluate the risks and impacts to the health and safety of the Affected Communities during the project life-cycle and require establishing preventive and controlling measures consistent with GIIP, such as in the World Bank Group EHS Guidelines or other internationally recognized sources.

PS 4 recognises that project activities, equipment, and infrastructure often bring benefits to communities including employment, ecosystem 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 minimise 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:

- avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs;
- avoid forced eviction;
- anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost, and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected;
- improve, or restore, the livelihoods and standards of living of displaced persons;
- improve living conditions among physically displaced persons through the 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:

- Land rights or land use rights acquired through expropriation or other compulsory procedures in accordance with the legal system of the host country;
- Land rights or land use rights acquired through negotiated settlements with property owners or those with legal rights to the land if failure to reach settlement would have resulted in expropriation or other compulsory procedures;
- Project situations where involuntary restrictions on land use and access to natural resources cause a community or groups within a community to lose access to resource usage where they have traditional or recognizable usage rights;
- Certain project situations requiring evictions of people occupying land without formal, traditional, or recognizable usage rights;8 or
- Restriction on access to land or use of other resources including communal property and natural resources such as marine and aquatic resources, timber and non-timber forest products, freshwater, medicinal plants, hunting and gathering grounds and grazing and cropping areas.9.

This PS does not apply to resettlement resulting from voluntary land transactions (i.e., market transactions in which the seller is not obliged to sell and the buyer cannot resort to expropriation or other compulsory procedures sanctioned by the legal system of the host country if negotiations fail). It also does not apply to impacts on livelihoods where the project is not changing the land use of the affected groups or communities.

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

PS 6 aims at protecting and conserving biodiversity, maintaining ecosystem services, 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 objectives of this PS are to:

- protect and conserve biodiversity;
- maintain the benefits from ecosystem services; and
- promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

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[1].

PS 6 recognises 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.

For the purposes of implementation of this PS, habitats are divided into modified, natural and critical. Critical habitats are a subset of modified or natural habitats. For the protection and conservation of biodiversity, the mitigation hierarchy includes biodiversity offsets, which may be considered only after appropriate avoidance, minimization, and restoration measures have been applied. A biodiversity offset should be designed and implemented to achieve measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity; however, a net gain is required in critical habitats. The design of a biodiversity offset must adhere to the "like-for-like or better" principle and must be carried out in

PS 7: Indigenous Peoples

PS 7 acknowledges the possibility of vulnerability of indigenous people[2] 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 recognises that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalised 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:

[1] Given the complexity in predicting project impacts on biodiversity and ecosystem services over the long term, the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

[2] There is no universally accepted definition of "Indigenous Peoples." Indigenous Peoples may be referred to in different countries by such terms as "Indigenous ethnic minorities," "aboriginals," "hill tribes," "minority nationalities," "scheduled tribes," "first nations," or "tribal groups." This Performance Standard applies to communities or groups of Indigenous Peoples who maintain a collective attachment, i.e., whose identity as a group or community is linked, to distinct habitats or ancestral territories and the natural resources therein. It may also apply to communities or groups that have lost collective attachment to distinct habitats or ancestral territories in the project area, occurring within the concerned group members' lifetime, because of forced severance, conflict, government resettlement programs, dispossession of their lands, natural disasters, or incorporation of such territories into an urban area.

- ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples;
- anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts;
- promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner;
- establish and maintain an on-going relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle;
- ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present; and
- respect and preserve the culture, knowledge, and practices of Indigenous Peoples.

This PS also defines the private sector responsibilities where Government is managing indigenous peoples issues and states that where the government has a defined role in the management of Indigenous Peoples issues in relation to the project, the client will collaborate with the responsible government agency, to the extent feasible and permitted by the agency, to achieve outcomes that are consistent with the objectives of this Performance Standard. In addition, where government capacity is limited, the client will play an active role during planning, implementation, and monitoring of activities to the extent permitted by the agency. In this process, the client may need to include: (i) the plan, implementation, and documentation of the process of ICP and engagement and FPIC where relevant; (ii) a description of the government-provided entitlements of affected Indigenous Peoples; (iii) the measures proposed to bridge any gaps between such entitlements, and the requirements of this Performance Standard; and (iv) the financial and implementation responsibilities of the government agency and/or the client.

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 recognises the importance of cultural heritage with an objective to:
- Protect cultural heritage from the adverse impacts of project activities and support its preservation; and
- 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.

The requirements of this Performance Standard apply to cultural heritage regardless of whether or not it has been legally protected or previously disturbed. The requirements of this PS do not apply to cultural heritage of Indigenous Peoples; PS 7 describes those requirements.

2.7.2 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 categorisation. This categorisation 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. The IFC categories are:

- *Category A* Projects: Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented;
- *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;
- *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;
- Category *FI Projects:* All FI projects excluding those that are Category C projects.

IFC therefore categorises 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.

2.7.3 Categorisation of the 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 A*** 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, proposed and future projects, impact on aquatic ecology due to water intake from river, 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 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 socio-economic environmental conditions are anticipated due to existing S1 project and proposed S2 and S3 projects within the same complex. The nature of projects is similar and this will lead to increase in magnitude of impacts due to operations of all the plants in the complex.
- **Unprecedented:** The Project is a brownfield project. The Project site is a developed land, already earmarked for the 400 MW ± 10% dual fuel fired power plant. An operational dual fuel fired power plant is located adjacent to the Project site within the Saidabad Power Generation Complex. Associated infrastructure in the form of Approach road, HSD pipeline, Gas pipeline RoW, jetty, boundary wall, switch yard already exist. In addition, the GOB has proposed to set up an economic zone in an area of about 1000 acres in the southern and western part of the Saidabad Power Generation Complex. The Project and its impacts are therefore having precedence; however, the development will attract more industrial and infrastructure development in the neighbourhood, which is to some extent unprecedented. There will be no change of land use due to the Plant, however, associated infrastructure for water pipeline and gas pipeline will require some government non-agricultural khas land.

2.7.4 IFC EHS Guidelines

The *Environmental, Health, and Safety (EHS) General Guidelines*[1] *(April 30, 2007*) will be applicable for this Project. In addition to that, IFC's Sector specific *EHS Guidelines for Thermal Power Plants*[2] *(December 19, 2008*) will also apply.

2.8 APPLICABLE EHS STANDARDS

As per the Additional General Instructions (Section 6.4 of the RFP for the Project), the Project shall have to comply with Bangladesh environmental,

(1) [1] http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf

(2) [2] http://www1.ifc.org/wps/wcm/connect/dfb6a60048855a21852cd76a6515bb18/FINAL_Thermal%2BPower.pdf?MOD=AJPERES&id=1323162579734

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 the existing substation and transmission lines, electro-magnetic field and corona noise effects may have some impacts, which will be used by the proposed project as well.

2.9 *APPLICABLE ENVIRONMENTAL STANDARDS BOTH NATIONAL AND INTERNATIONAL*

The relevant environmental standards (national as well as international) for thermal power plants as applicable to the proposed Project are presented in the following tables:

Table 2.5 Air Emission Standards/ Guidelines

Parameter	Unit	Bangladesh*	World Bank**
PM_{10}	mg/Nm^3	150	50 (liquid fuel)
		-	N/A (natural gas)
SO_2		-	Use less than 0.5% sulphur fuel (liquid fuel)
		-	N/A (natural gas)
NO_x	mg/Nm^3	-	152 (74 ppm) – liquid fuel
	mg/Nm^3	30 ppm	51 (25 ppm) – natural gas
Dry Gas, Excess O_2 content	%		15 (natural gas)
	%		15 (liquid fuel)

Note:

* Schedule 11 (Standards for Gaseous Emission from Industries or Projects) of the Environmental Conservation Rules, 1997.

** Emission Guidelines for Combustion Turbines, WB/IFC EHS Guidelines for Thermal Power Plants (Source: EU (LCP Directive 2001/80/EC October 23 2001), EU (Liquid Fuel Quality Directive 1999/32/EC, 2005/33/EC), US (NSPS for Stationary Combustion Turbines, Final Rule – July 6, 2006).

Represents the standard values applicable to the Project.

Table 2.6 Ambient Air Quality Standards/ Guidelines

Parameter	Bangladesh**		WHO ***	
	24 hourly ($\mu g/m^3$)	Annual ($\mu g/m^3$)	24 hourly ($\mu g/m^3$)	Annual ($\mu g/m^3$)
SPM	200	-	-	-
PM_{10}	150	50	50	20
$PM_{2.5}$	65	15	25 (guideline)	10
SO_2	365	80	20	-
NO_x	-	100	-	40
CO*	10,000	-	10,000	-

Note:

* CO concentrations and standards are 8-hourly only.

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

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

Represents the standard values applicable to the Project.

As per the WB/IFC General EHS guidelines, ambient air quality results need to be compared with the relevant ambient air quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO air quality guidelines or other internationally recognised sources, such as the United States National Ambient Air Quality Standards and the relevant European Council Directives. *Since, Bangladesh has its own national ambient air quality standards, these local standards are considered as the applicable standard for the project.*

Table 2.7 Effluent Standards/ Guidelines

Parameter	Unit	Bangladesh*	WB/IFC**
pH	-	6-9	6-9
Total Suspended Solids (TSS)	mg/l	150	50
Oil and grease	mg/l	10	10
Total residual chlorine	mg/l	-	0.2
Chromium (total)	mg/l	0.5	0.5
Copper	mg/l	0.5	0.5
Iron	mg/l	2.0	1.0
Zinc	mg/l	5.0	1.0
Lead	mg/l	0.1	0.5
Cadmium	mg/l	0.5	0.1
Mercury	mg/l	0.01	0.005
Arsenic	mg/l	0.2	0.5
Temperature increase at the edge of the mixing zone	°C	40 (summer) 45 (winter)	Site specific requirement to be established by the EA. Elevated temperature areas due to discharge of once-through cooling water (e.g., 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point.

Note:

* Schedule 10 (Standards for Waste from Industrial Units or Projects Waste) of the Environmental Conservation Rules, 1997.

** Effluent Guidelines, WB/IFC EHS Guidelines for Thermal Power Plants.

Represents the standard values applicable to the Project.

Table 2.8 Standards for Sewage Discharge

Parameter	Unit	Standard Limit (Bangladesh)*
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solid	mg/l	100
Temperature	°C	30
Coliform	No./100 ml	1000

Notes:

(1) This limit shall be applicable to discharges into surface and inland waters bodies.

(2) Sewage shall be chlorinated before final discharge.

* Schedule 9 (Standards for Sewage Discharge) of the Environmental Conservation Rules, 1997

Table 2.9 Noise Level Standards/ Guidelines

Category of Area/ Receptor	Bangladesh*		IFC-WHO***	
	Day (dB(A))	Night (dB(A))	Day (dB(A))	Night (dB(A))
Silent Zone	45	35	55	45
Residential Area	55	45	55	45
Mixed Area	60	50	-	-
Commercial Area	70	60	70	70
Industrial Area	75	70	70	70

Note:

* The Bangladesh National Ambient Noise Standards have been taken from Schedule 4 (Standards for Sound) of the Environmental Conservation Rules, 1997 amended September 7, 2006.

** Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

*** As per IFC EHS noise level guidelines, Noise impacts should not exceed the levels presented in the above table or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Represents the standard values applicable to the Project.

In addition to the above, working noise limits which trigger noise protection to be provided to the workers shall be 85 dB(A) for an exposure duration of 8 hours per day. For every 3 dB(A) increase in sound levels, the 'allowed' exposure period or duration should be reduced by 50 percent[1].

It is evident from the above tables that except noise level standards, the WB/IFC guidelines are more stringent than the local standards. The RFQ for the Project (***Section 6.4 of RFQ***) also states that the Project shall comply with the Bangladesh environmental, health and safety laws and World Bank Group Guidelines. Hence, it is mandatory for the Project to meet the more stringent standards, as necessary.

Dutch Criteria for Assessment of Soil

There is no Bangladesh soil or groundwater regulation/standard. In the absence of local country standards, it is ERM's practice to use 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines - Soil and Groundwater Standards' to assess soil and groundwater quality and to determine the need, if any, for remedial action.

[1] The American Conference of Governmental Industrial Hygienists (ACGIH), 2006

The most recent issue of the Dutch Standards is published in the 'Soil Remediation Circular in 2009. These standards are used in the Netherlands to evaluate and provide targeted 'clean-up' levels for a range of possible pollutants in soils and groundwater (***Table 2.11***.)

The contaminants are subdivided into two categories ('T') and ('I'), depending upon the concentrations, and classified as follows:

- 'T' (Target) Values characteristic of clean, uncontaminated soils and waters; and
- 'I' (Intervention) Values define sites where some form of intervention would be required.

Table 2.10 Target values and soil remediation intervention values and background concentrations soil/sediment and groundwater for metals

Metals	**EARTH/SEDIMENT (mg/kg dry matter)**		
	Dutch National background concentration (BC)	**Target Value (incl. BC)**	**Intervention Value**
Antimony	3	3	15
Arsenic	29	29	55
Barium	160	160	625
Cadmium	0.8	0.8	12
Cobalt	100	100	380
Copper	9	9	240
Mercury	0.3	0.3	10
Lead	85	85	530
Molybdenum	0.5	3	200
Nickel	35	35	210
Zinc	140	140	720

Source: Dutch Ministry of Public Housing, Land-use and Environmental Guidelines Soil and Groundwater Standards

Values for soil/sediment have been expressed as the concentration in a standard soil (10% organic matter and 25% clay).

3 PROJECT DESCRIPTION

3.1 PRELUDE

The Project Description sets out the scope of the Project features and activities, with particular reference to the aspects which can impact on the environment. Details of the Project facilities' design characteristics, as well as planned and unplanned Project activities, are provided in the subsequent sections of this chapter.

The proposed dual fuel CCPP of 413.792 MW (Gas)/333.02 MW (HSD) will be located in district Sirajganj of Rajshahi division in north-western region of Bangladesh. The Project will be implemented BOO basis under the GOB's PPP program. The Plant will operate on natural gas as its primary fuel and is designed to operate on HSD for short periods of time as the back-up fuel in case of interruptions in gas supply. The electrical capacity and electricity generated will be sold under a 22 year Power Purchase Agreement ("PPA") with the Bangladesh Power Development Board (BPDB). SNWPCL will enter into a GSA with PGCL, a subsidiary of state-owned Petrobangla and a FSA with state-owned BPC for natural gas and HSD supply to the Plant, respectively. The water requirements for the Project will be met through Jamuna River, which is flowing on the eastern part of the Project site. As back up of water supply, ground water may be considered which is subject to the local authority approval. A 230 kV switch yard/ sub-station will also be constructed at the site as part of the Project and will be connected to the existing 230 kV substation for power evacuation from the Project. The PGCB grid station is situated adjacent towards north of the site.

3.2 LOCATION

The Project site is located within the Saidabad Power Generation Complex, located in Saidabad Union of the Sirajganj Sadar Upazilla in the Sirajganj District of Bangladesh. The Power Generation Complex is situated about 10 km from the Sirajganj District Headquarters and located about 2 km south-west of the Bangbandhu (Jamuna Multipurpose) Bridge. The Saidabad Power Generation Complex also has a newly constructed 225 MW dual fuel CCPP of NWPGCL, which is operational with combined cycle since July 2014.

The aerial view of the land already acquired by BPDB for the Saidabad Power Generation Complex with demarcation of Sirajganj 4 Project site on it is presented in ***Figure 3.1*** and the site layout plan of the Project has been presented in ***Figure 3.2***. The entire power generation complex has been raised during the site preparation by BPDB and an embankment about 4-5 m high has been constructed all along the site for flood protection, which is clearly

visible in the aerial view of the area.[1] Towards the river side concrete boulders have also been placed (refer ***Box 3.1***). The Project site co-ordinates are as follows:

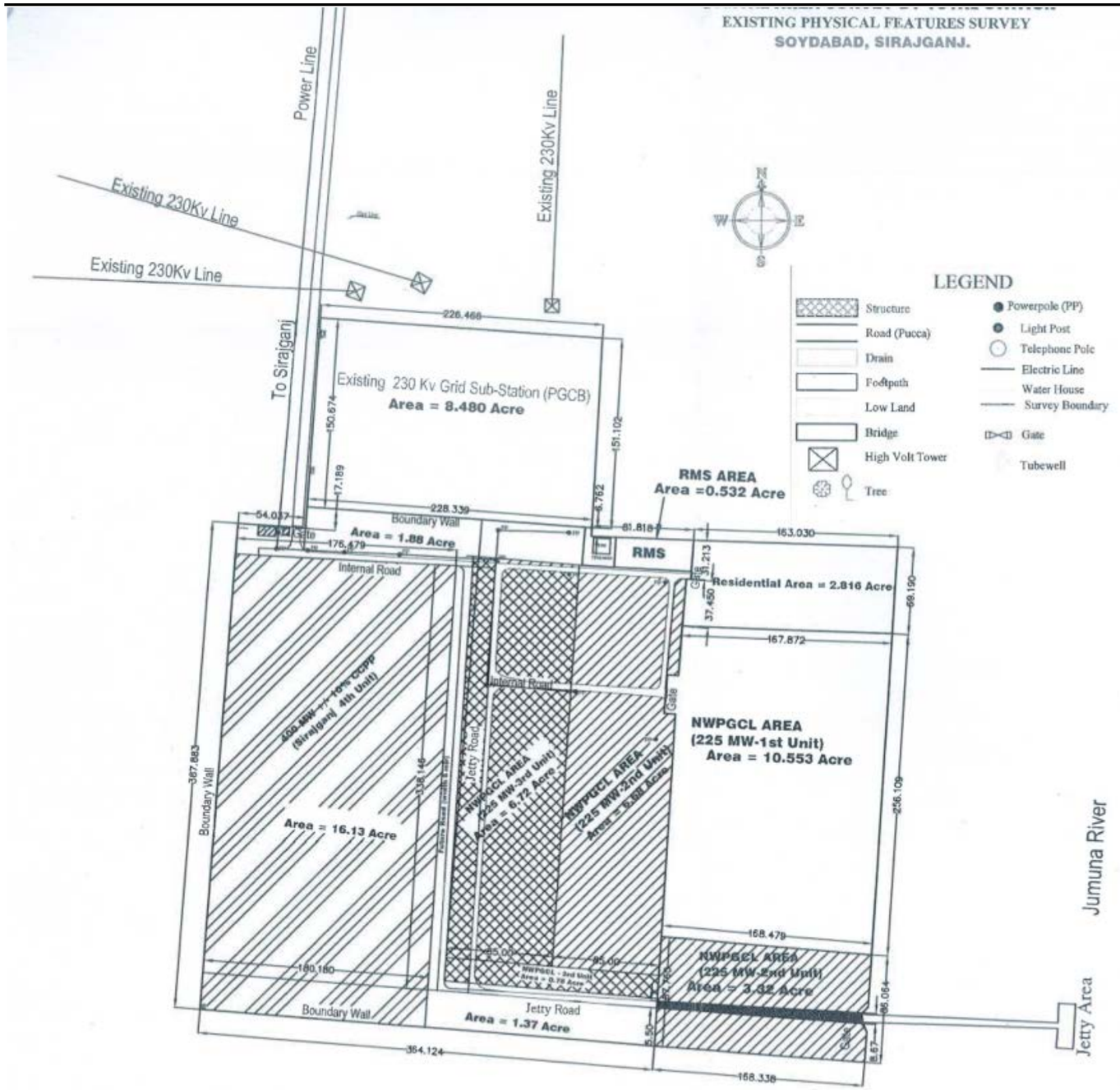
- NW corner: 24°23'14.16"N, 89°44'32.53"E
- NE corner: 24°23'14.24"N, 89°44'39.82"E
- SE corner: 24°23'2.45"N, 89°44'39.99"E
- SW corner: 24°23'2.45"N, 89°44'32.47"E

[1]The site preparation work was being done in the year 2006-2007. As per the information provided by the District Administration, the land was government khas land.

Figure 3.1 Aerial View of the Project Site in Sirajganj Power Generation Complex

Source: Developed based on reconnaissance survey on Google Earth Pro (Imagery Date: 15 April 2014)

Figure 3.2 Layout Plan of Saidabad Power Generation Complex showing Sirajganj 4 Location



Source: NWPGCL

Box 3.1 Flood Protection Measures – Saidabad Power Generation Complex

Source: ERM Site Visit (6 and 7 February 2015)

3.3 KEY FEATURES OF THE SITE AND SURROUNDINGS

The Project site with key features in the surrounding areas is presented in ***Figure 3.3*** The Project site is located on the western bank of the Jamuna River and falls within the active floodplain of the river. The site is an elevated (by land filling) and developed landmass, which is barren and unutilised at present and part of the Saidabad Power Generation Complex. The site is almost flat, with a gentle slope towards the south-east direction. The land has been developed for setting up the power plant and is connected with the National Highway (Dhaka – Rajshahi Road) by a dedicated access road that is approximately 6 m wide and 1.5 km long (***Box 3.2***). The access road is suitable for transportation of equipment and material for setting up the Plant and same was used earlier by NWPGCL for construction of the 225 MW CCGT plant. A valve station of Gas Transmission Company Limited ("GTCL") is located next to the access road near the highway and a Right of Way (RoW) of about 1.5 km, for gas supply to the Saidabad Power Generation Complex is already available for the existing 225 MW CCGT plant. A gas pipeline and a HSD pipeline for supplying gas and HSD to the NWPGCL power plant already exists (***Box 3.3***). Another gas pipeline for the Project will be laid next to the existing gas and HSD supply pipelines of NWPGCL from the GTCL Valve Station.

In the close vicinity (within 2 km from the centre) of the Project site, habitation is only present in the western, north-western and southern parts and the nearest habitations are *Khas Bara Simul* and *Bara Shimul Panchosona* villages of Saidabad Union. The nearest residential properties in each compass direction is as follows:

- Bara Shimul Panchosona Village – Approximately 220 m west from the Project Site boundary;
- Bara Shimul Village – Approximately 400 m west-north-west from Project Site boundary;
- Punorbason Village – Approximately 800 m north-west from Project Site boundary;

- Chak Boira Village – Approximately 900 m south from Project Site Boundary;
- Dharma Tatulia Village – Approximately 1,100 m south-west from Project Site boundary.

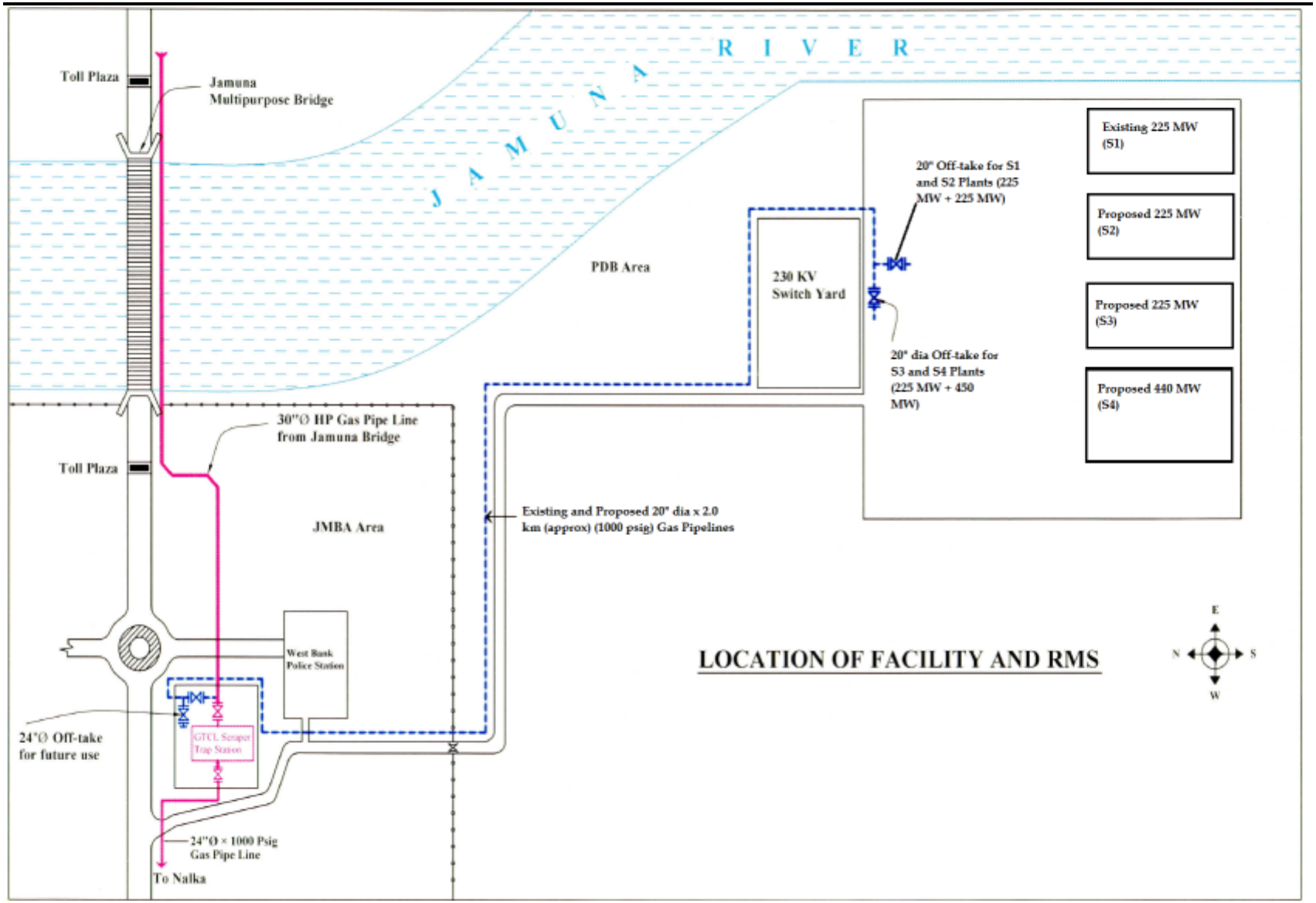
The northern part of the power generation complex and eastern part of the access road is the land allocated to the Bangladesh Bridge Authority ("BBA"). The land contains the West Guide Bund, an access road and dense plantation at present and is being maintained by BBA. To the East of the complex is Government Khas Land[1] and dried Channel of River Jamuna followed by Right Channel of Jamuna River, whereas to the southern of the complex is a dried channel of Jamuna River and Government Khas Land. The habitation is present on the other side of dried channel in this direction.

[1] Any land lost by river erosion and reappearing later on due to changes of river courses (accretion) is owned by the government and declared as Khas Land (state-owned land).

Figure 3.3 Key Features in the Surroundings

Source: Google Earth Pro (Imagery Date: 15 April 2014) and site reconnaissance survey (February 2015)

Figure 3.4 Location of PGCL Facility and RMS with Gas Pipeline Alignment



Source: Draft Gas Supply Agreement and Proposed Plan of Power Generation Complex

Box 3.2 Approach Road

Approach Road connecting National Highway

Approach Road near Entrance to Saidabad Power Generation Complex

Source: ERM Site Visit (February 2015)

Box 3.3 HSD and Natural Gas Arrangement of NWPGCL

HSD Pumping Station of NWPGCL at Bangbandhu Bridge West Railway Station

Dedicated Railway Siding of NWPGCL and Pumping Arrangement

GTCL Valve Station with Pillars indicating Underground Gas Pipeline RoW

Underground HSD Pipeline Pillar and Cathode Protection

Source: ERM Site Visit (February 2015)

Box 3.4 Surrounding Features of Saidabad Power Generation Complex

West Guide Bund of BBA

Internal Road Connecting to West Guide Bund

Plantation in BBA Land

Open BBA Land – North of PGCB Sub-station

Khas Land – Towards East of Power Generation Complex

Agricultural Activity – South of NWPGCL Jetty

Agricultural Activity – West of Saidabad Power Generation Complex

Agricultural Activity – West of Approach Road

Source: ERM Site Visit (November 2012 and February 2015)

The River Jamuna forms the boundary of the Sirajganj and Tangail Districts. The Jamuna River is a very dynamic braided river. Channel development and abandonment is a very commonly observed annual phenomenon.

Considering the erosion taking place every year during the monsoon season, and also to provide rail/road connectivity across the Jamuna River near Sirajganj, construction of Jamuna Bridge was started in 1995. The route of the Jamuna River around the location of the Jamuna Bridge changed significantly after the building of the Bridge. Currently the main river channel is about 1.5 km from the Project site. However, there is a connecting channel, which is about 0.5 km to the east of the Project site (refer to ***Figure 3.3***). Currently water availability in this channel is only during the monsoon season. It was observed during the site visit that this channel was not connected with the main channel due to siltation. A jetty has also been constructed at the south-eastern part of the power generation complex; however this does not reach the current path of the Main River or connecting channel. The jetty is 6 – 7 m higher than the level of the dry channel located some 50 m away (***Box 3.5***).

Box 3.5 NWPGCL Jetty

NWPGCL Jetty

NWPGCL Jetty and dried adjoining Channel

Source: ERM Site Visit (November 2012 and February 2015)

The entire Saidabad Power Generation Complex and access road has been elevated about 1m above the highest flood level and appropriate embankments have been constructed. Concrete boulders have also been placed along the embankment in the southern and eastern part of the complex boundary to provide additional protection from erosion (***Box 3.1***). In addition an embankment for protection of the Bangabandhu Bridge has also been constructed along the channel and a dense plantation has been planted by BBA on the land adjacent to it (***Box 3.4***).

Agricultural practices are being carried out in the adjacent western and north-western areas of the power generation complex. It has been reported that the agricultural areas lying along the western boundary of the Project site are at present used for growing crops throughout the year and these agricultural lands are moderately to significantly affected by floods in the monsoon season. Agricultural practices are being carried out in the adjacent western and north-western areas of the Power Generation Complex (***Box 3.4***).

3.4 SURVEY INFORMATION

Topographical survey map of the Project site is shown in **Figure 3.5.** The site elevation varies from 14.3 m above MSL on the southern side to 15.85 m above MSL on the northern side. Average elevation of the site is about 15 m above MSL. Detailed topographical survey map of the site is included as ***Annex G***.

3.5 SIZE AND MAGNITUDE OF OPERATIONS

The main power block of the Plant will consist of one dual fuel gas turbine (GT), one steam turbine (ST), one heat recovery steam generator (HRSG) and bypass and exhaust stacks. Black start and emergency diesel generators will be provided to provide black start and safe shutdown capabilities.

The Plant will be constructed to have a minimum continuous rating (MCR) capacity of 413.8 MW (net) output of combined cycle with natural gas as fuel, at the high voltage side of the outgoing terminals of the 230 kV transformer, corrected to the Reference Conditions at 0.85 power factor (lag). However with HSD as fuel, the net capacity of combined cycle will be 333.0 MW. The simple cycle output capacity with natural gas will be 282.0 MW (net) at the high voltage side of the outgoing terminals of the 230 kV transformer corrected to the Reference Conditions at 0.85 power factor (lag), whereas with HSD as fuel will be 236.8 MW. The overall performance of the CCPP based on 100 % load is outlined in ***Table 3.1***

Table 3.1 Overall Performance of Facility

Description	Unit	Gas		HSD	
Stage		Simple Cycle	Combined Cycle	Simple Cycle	Combined Cycle
Gross capacity	MW	288.9	427.18	243.73	342.37
Net capacity(1)	MW	282.0	413.792	236.805	333.02
Auxiliary load(2)	%	2.1%	2.8%	2.5%	2.4%
Heating Value of Fuel		0.95 MMBTU/MSCF		10,280 kcal/kg	
Net plant heat rate(3)	kJ/kWh	10,679	7,278	10,029	6,841

Source: Technical Specifications given by SNWPCL

(1) Preliminary figures provided by EPC are adjusted for degradation
(2) Auxiliary load expressed as a % of gross value
(3) HSD heat rate is quoted in LHV while Gas heat rate is quoted in HHV as per RFP

The basic process flow diagram of the power plant is included in ***Figure 3.6***. A 3-dimentional Virtual Plan of the Sirajganj 4 Project has been presented in ***Figure 3.7*** and general layout of the Project within the Saidabad Power Generation Complex has been presented in ***Figure 3.8***.

Figure 3.5 Topographic Survey of the Site

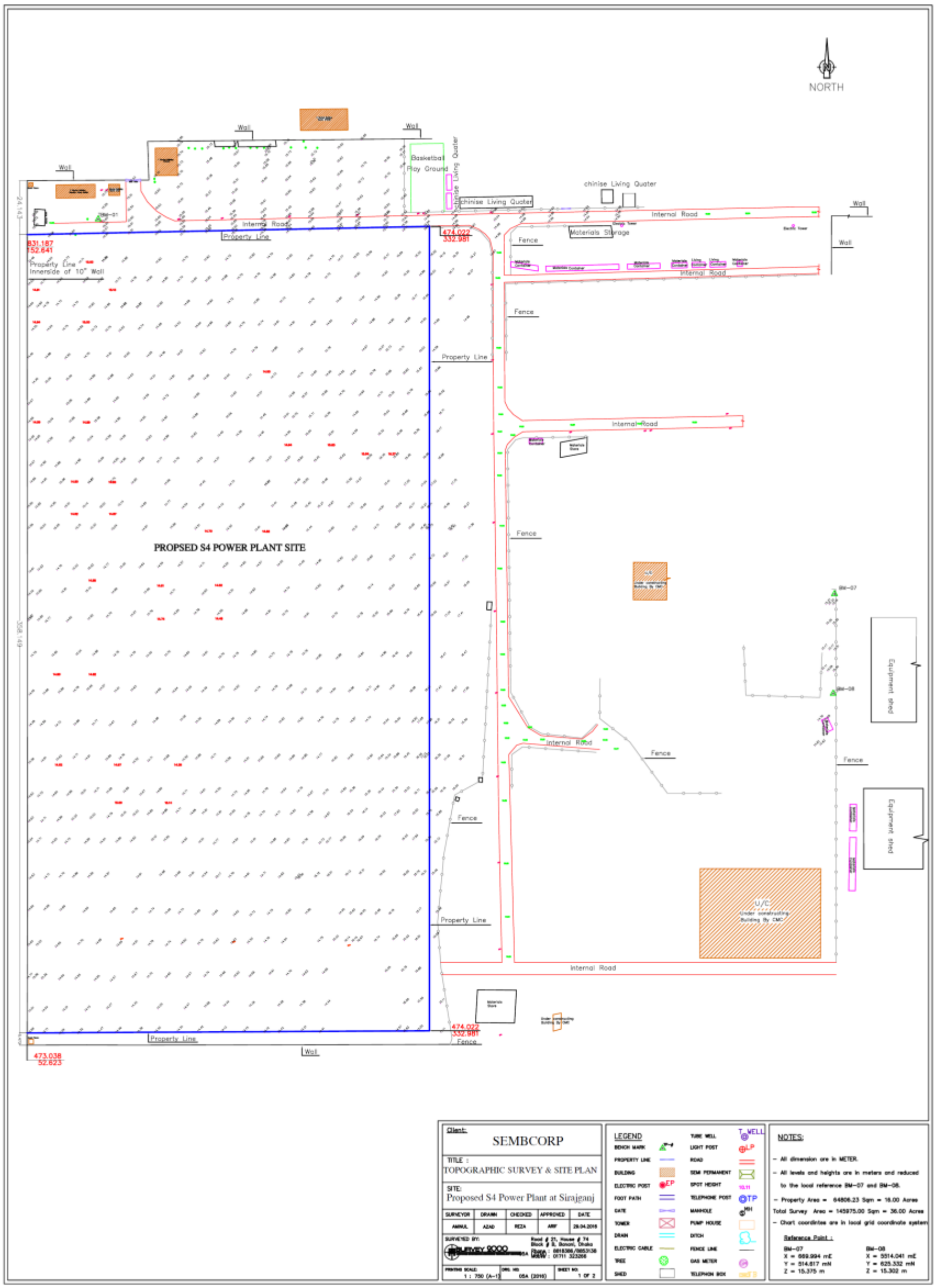
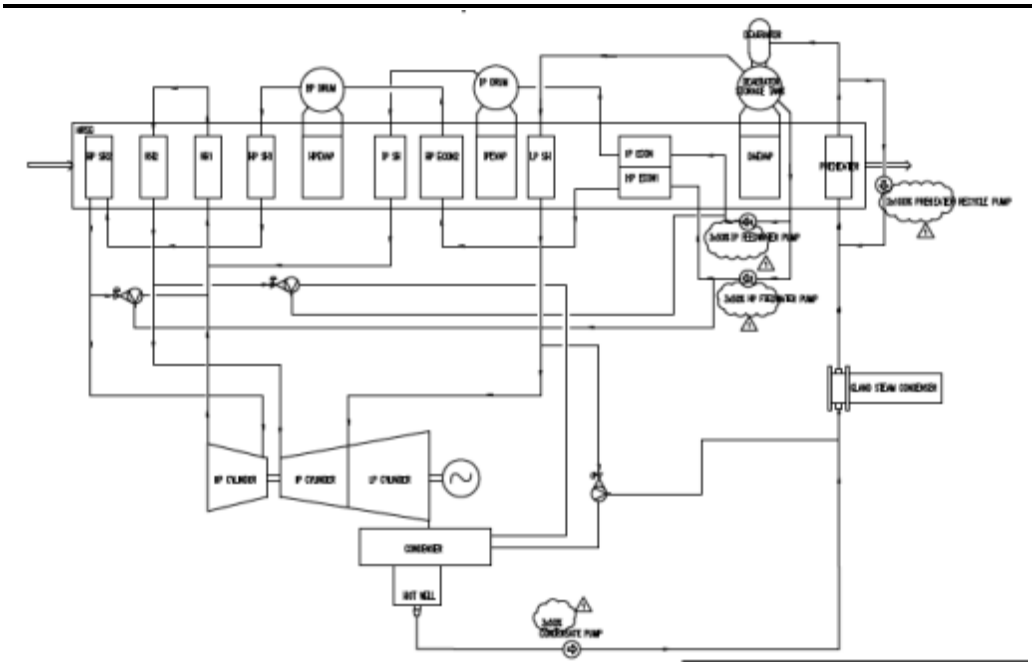


Figure 3.6 Process Flow Diagram

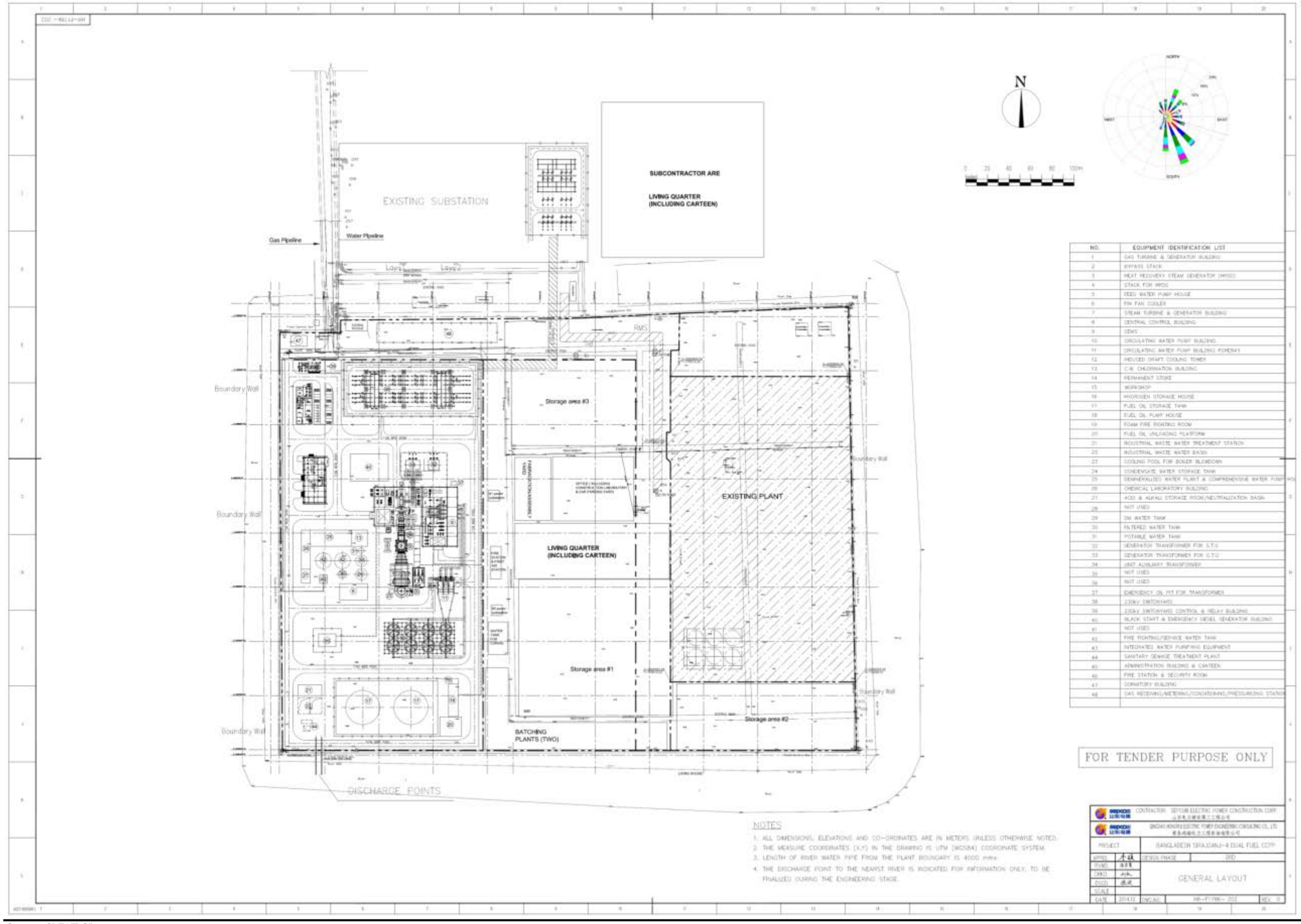


Source: SNWPCL

Figure 3.7 3-D Virtual Plan of Sirajganj 4 Project

Source: SNWPCL

Figure 3.8 General Layout of the Project



Source: SNWPCL

3.6 KEY COMPONENTS 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;
- HSD Storage;
- Water System including cooling water system;
- Electrical System
- Connection from S4 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 GTCL Valve Station to the RMS of S4 Project
- New water pipeline of about 4.0 km from River Jamuna, water intake structure and water pump house
- HSD pipeline from the tapping point provided in HSD pipeline within Saidabad Power Generation Complex.
- Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP) with 4 m^3/hr capacity each

3.6.1 Gas Turbine

The Project will have a heavy duty, single shaft M701F4 gas turbine that will be directly coupled to a 50 Hz generator. A new and clean M701F4 combustion turbine makes 282 MW at a heat rate of 10,679 kJ/ kWh (HHV) under reference conditions. The GT will be installed within an acoustic, ventilated enclosure with fire detection and protection systems. 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 in ***Table 3.2***.

Table 3.2 ***Gas Turbine Generator Specification***

Particular	Unit	Details
Combustion Turbine Manufacturer	-	Mitsubishi
Model/ Type	-	M701F4
Net Output	kW	281,911 (Gas) 236,805 (HSD)
Heat Rate at 100% load	kJ/kWh	10,679 (Gas) 10,029 (HSD)
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 generators, 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 (CW) system.

Control of emissions of NOx will be achieved by Dry Low NOx (DLN) burners. The gas turbines will be equipped with dual fuel systems, capable of burning the specified fuel gas and back-up fuel oil.

A Gas Detection System (GDS) will be provided to warn operation personnel immediately in the event of a leakage within the gas turbine and skid area. The detectors will be infrared (IR), suitable for natural gas detection, and will be located in front of the CTG enclosure ventilation fans and in the area of the fuel gas valves. Audible and visual alarms will be located in the supervised areas and at the control station. In addition, a Fire Detection System (FDS) will be provided at the following areas of the gas turbine building:

- Gas turbine combustion chamber equipped with flame and heat detectors;
- Lube oil skid equipped with smoke and heat detectors;
- Hydraulic skid equipped with smoke detectors;
- Generator bearings equipped with smoke detectors;
- Fuel gas skid equipped with smoke and heat detectors; and
- Power control containers equipped with smoke detectors.

3.6.2 Heat Recovery Steam Generator

The HRSG will be of a triple pressure, unfired, natural circulation and horizontal type, in accordance with the manufacturer's standard design and will be combined with the combustion turbine. The HRSG will mainly consist of an inlet gas duct, boiler (heating surfaces, steel structure and casing); outlet gas duct; main stack; high pressure (HP) and intermediate pressure (IP) drums; deaerator; piping trims; and auxiliaries, such as feed water pump, LP recirculation pumps and blow down tank. In addition, an economizer, evaporator, and super-heater tube bank section(s) with finned tubing, as appropriate, will be included to maximize heat transfer. Exhaust gas from the combustion turbine will enter into the HRSG through the inlet duct and will flow horizontally across heating surfaces and then exhaust through the outlet duct and stack.

The HRSG will be sized to operate over the full range of ambient temperatures specified. The HRSG consists of an economizer, evaporator, and super-heater tube bank section(s) with finned tubing, as appropriate, to maximize heat transfer. No supplemental firing facilities will be installed.

All pressure parts will be designed, manufactured and will be tested in accordance with "ASME Boiler and Pressure Vessel Code, Section 1, Power Boilers" or equivalent standards.

The HRSG will exhaust through a separate stack of approximately 60 m to provide for adequate dispersion of flue gases in accordance with the environmental standards requirements. The HRSG specification is provided in ***Table 3.3.***

Table 3.3 Heat Recovery Steam Generator Specifications

High Pressure Section	
Maximum continuous capacity	87.1 kg/s
Rated steam outlet pressure	127.8 Bar(a)
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

Source: SNWPCL

3.6.3 Steam Turbine

The ST will be of proven design and directly coupled to a 50 Hz generator to produce 142.5 MW. The ST exhaust and condenser configuration will be in accordance to manufacturer's standard design. The ST will be sized to pass the entire quantity of steam generated by the HRSG over the full range of ambient temperatures specified.

The condensing Steam Turbine Generator (STG) will be of proven design and complete with all auxiliary oil and steam systems. The steam turbine will be directly coupled to a 50 Hz generator. The STG installed will be designed to ensure a long creep life, cyclic duty and fast start-up.

The STG will be installed indoors for environmental protection (e.g., dust and rains) and to provide acoustic attenuation. The STG building will include an overhead travelling crane suitable for lifting the maximum heavy load for maintenance activities and suitable indoor laydown areas for plant maintenance. The steam turbine will be sized to pass the entire quantity of steam generated by the HRSG over the full range of ambient temperatures specified. The STG specifications are outlined in ***Table 3.4***.

Table 3.4 Steam Turbine Generator Specifications

Particular	Unit	Details
Manufacturer	-	Dongfang/ equivalent
Net Output	MW	142.5 MW (Gas) 105.9 MW (HSD)

Source: SNWPCL

3.6.4 Steam Turbine Condensers

The steam turbine condenser will be designed and constructed with sufficient margin and spare surface area for the maximum heat rejection duty under both normal operation and turbine bypass operation conditions for the operating regime specified. The condenser will be cooled by the cooling water system.

On the water side, the condenser will be divided vertically into two independent water paths. This arrangement will facilitate the operation of one half of the condenser when the other half is under maintenance.

The condenser will be provided with integral air cooling zone from where air and non-condensable gases are continuously drawn out with the help of air evacuation system.

3.6.5 Feed Water System

The feed water system will provide sufficient and reliable feed water to the HRSG. Feed water flow rate shall be approximately 100 kg/sec and the quality shall be in accordance with Electric Power Research Institute (EPRI) and HRSG Original Equipment Manufacturer (OEM) recommendations. The feed water system will include necessary feed water heaters, de-aerators, feed water pumps, control valves and auxiliaries. One feed water pump will be in service during 100% plant output with another pump on standby. Each feed water pump is provided with intermediate take-off to provide cooling water supply for pressure reducing stations.

3.6.6 Cooling Water System

The main cooling water system will provide cooling water to the steam turbine condenser by means of cooling water pumps installed in the cooling tower basin. The warm water from the condenser is returned to the multi-cell induced draft cooling tower, where it is cooled and collected in the cooling tower basin for return to cool the condenser. The induced draft cooling tower will be provided with the capacity for maximum heat rejection duty under all steam turbine operation conditions for the design conditions specified. The cooling tower shall have sufficient cells to allow for one cell to remain in standby under reference operating conditions.

The cooling tower will contain clarified raw water. A cooling tower chemical injection system will be provided to maintain the appropriate cooling tower chemistry. The Cooling water chemistry will be maintained at approximately 5 cycles of concentration (COC)[1]. Cooling Water blow down will be

[1] COC is the maximum allowed multiplier for the amount of miscellaneous substances in circulating water compared to the amount of those substances in make-up water. Higher cycles of concentration mean more water reuse and, therefore, correspondingly less make-up and treatment chemical requirements. COC upto 6 is generally considered good. As cycles increase, so does the fouling potential in the system. Suspended solids and contaminants also increase with the increased cycles of concentration. It is usually best to limit cycles at or below 6. Further increase does not result in significant makeup water and treatment chemical savings and may not warrant the possibility of deposit formation and system fouling.

discharged on the Southern boundary of the Sirajganj Power Complex. There is an existing adjoining channel in the downstream of the outfall location.[1]

3.6.7 Natural Gas System

A natural gas supply and treatment system to deliver gas will be installed in the vicinity of the Plant to meet the required gas quality and pressure specified by the GT manufacturer. The natural gas system will include backup metering equipment and all necessary compressors, pressure reduction stations, gas filter-separators, isolation and control valves, safety valves, and other equipment. Natural gas specification as per the draft GSA has been provided in ***Table 3.5***.

Table 3.5 Natural Gas Specification[2]

Constituent	Performance Specification (% by Volume)	Design Specification (Maximum % by Volume)
Methane	96.744	85 – 100
Ethane	1.774	6
Propane	0.299	5
Butane-N	0.147	3
Butane-I	0.000	
Pentane-N	0.399	2
Pentane-I	0.000	
Hexane	0.016	3
Oxygen	0.000	5
Nitrogen	0.455	
CO2	0.166	
H2S	No Data	
Total Mol %	100.000	
Net Specific Energy Design LHV (KJ/KG) per ISO 6976-1975	49,220	
Gross specific energy HHV (KJ/KG)	54,604	

Source: SNWPCL

Gas Pipeline

Design of the transmission pipeline will be as per ANSI B 31.8: Gas Transmission and Distribution Systems. The class rating will be as per ANSI Class 600. Welding of pipeline will be as per API Standard 1104. The welding joints will be enveloped with Heat Shrink Sleeves and the Induction Bends with two-ply polyethylene tape (Inner Wrap and Outer Wrap). The pipeline will have a minimum cover of 1.0 m on top of it. Cathodic protection will be

[1] It has been observed at the discharge point of existing Sirajganj 1 power plant that the amount of water is less and due to that the water does not flow towards the adjoining Channel. Furthermore, during the non-monsoon season, due to lower water level in River Jamuna and heavy siltation at the starting point of adjoining channel, there is no flow of water in the adjoining Channel.

[2] The draft gas supply agreement also mentions that the supplied gas shall be commercially free from objectionable odour and dust or other solid matter, liquid matter, gum and gum forming constituents, toxic or hazardous substances in concentration which might interfere with the proper operation of the Facility of which might present a health and / or safety hazard to Company's employee and / or the general public. No foreign particle/solid material beyond five (5) microns in size will be associated with the Gas.

in place for the buried section of the pipeline and the design will be based on soil resistivity.

The high-pressure gas transmission system for the supply of Gas to the Facility will be comprised of approximately 1.5 km considering the source point of 20"ND pipeline and as per design to be operated at maximum operating pressure of 1000 psig and at worst condition operating pressure will be 200 psig. This pipeline will be connected with source at one end at the Connection Point and the other end will terminate at the inlet of the RMS. The pipeline will be constructed on a strip of land of 8 m width (which is being used by NWPGCL as well for its gas pipeline) and is marked as required by the Gas Safety Rules, 1991, as amended up to 2003. No back-up gas pipeline will be available as per GSA.

Gas Pipeline Interconnection

SNWPCL will connect to GTCL's Common Point of Delivery of gas, located near to the highway, about 1.5 km from the Project site. This pipeline will provide a safe and efficient method for transporting gas. A Regulating and Metering Station ("RMS") will be installed by the Company to control the gas flow to the Plant. The interface between GTCL and the Company will be at the RMS. The gas received from GTCL will be regulated at the Site to ensure its suitability for the GT. The gas regulation station will include two 100% gas compressors, a filter, a pressure control valve and a flow control valve with full NFPA (National Fire Protection Association, United States of America) fire protection system.

RMS

The RMS will be designed, procured, installed, tested, and commissioned subject to the approval of design and specification of the RMS from the PGCL. The RMS specification will be as follows:

- RMS Capacity : 25% higher than the maximum daily consumption of the facility assuming HHV of 950 BTU per SCF but shall not at any time have HHV of less than 900 BTU per SCF (MMSCFD)
- RMS Inlet Pressure : 200 psig to 1000 psig
- RMS Delivery/ Outlet Pressure : 150 psig ± 10%
- Velocity Limits : 60ft/sec before filtration and 120 ft/sec after filtration.
- Pressure Regulation : Working monitor, two identical streams each of 100% capacity and a full capacity by-pass with two isolating Dynamic/Pressure Balance Plug Valves and a Hand-Control Valve. Regulators to be of axial flow type and having online maintenance facilities preferably.
- Over Pressure Protection : Slam-shut-off valve and relief valves as necessary
- Outlet Pressure Fluctuation : ± 1% of set pressure

3.6.8 HSD Supply System

HSD will be delivered via rail from BPC Depot in Chittagong/Daulatpur/ Khulna up to the nearest rail head at Saidabad (i.e. Bangbandhu Bridge West Railway Station), which is located approximately 3 km from the Project site. NWPGCL has constructed an HSD unloading and pumping station at the railway station and an HSD supply pipeline has been constructed up to the Saidabad Power Generation Complex by NWPGCL (***Box 3.3***). HSD supply arrangement of NWPGCL has been presented in ***Figure 3.9***. HSD unloading and pumping station consist of two separate rail spurs and a pumping station consisting of 4 operating pumps, 1 standby pump, unloading piping, transfer piping, simplex strainers, valves, associated instrumentation, local controls and alarms. The unloading facility that has 30 rail car connections for unloading purposes and screw type, electric motor driven, carbon steel pumps rated for 100m^3/hr at 70m head, capable of pulling suction, have been provided. The unloading facility has been designed to unload 3 complete trains (consists of 30 nos. oil tanker wagon having capacity of 42 ton each wagon) per day. The available unloading oil tanker wagons having capacity of 42 tons are available for use by BPC. BPC will use the same system for HSD supply as per the common agreement; however the exact location of the HSD receiving point is yet to be confirmed by SNWPCL.

Three days of HSD supply will be stored in two tanks with capacity equivalent to 15 days operation at 80% output on HSD, while the plant is running on Gas. The tanks will be installed on a bund of adequate size per environmental and safety requirements. Arrangements for sending HSD forward through pipeline will be provided. HSD heaters will also be provided, if required, between fuel oil forwarding skid and fuel oil filtering skid to meet the GT's requirements of fuel oil viscosity. HSD specifications as per the draft FSA are shown in ***Table 3.6***.

Table 3.6 HSD Specification

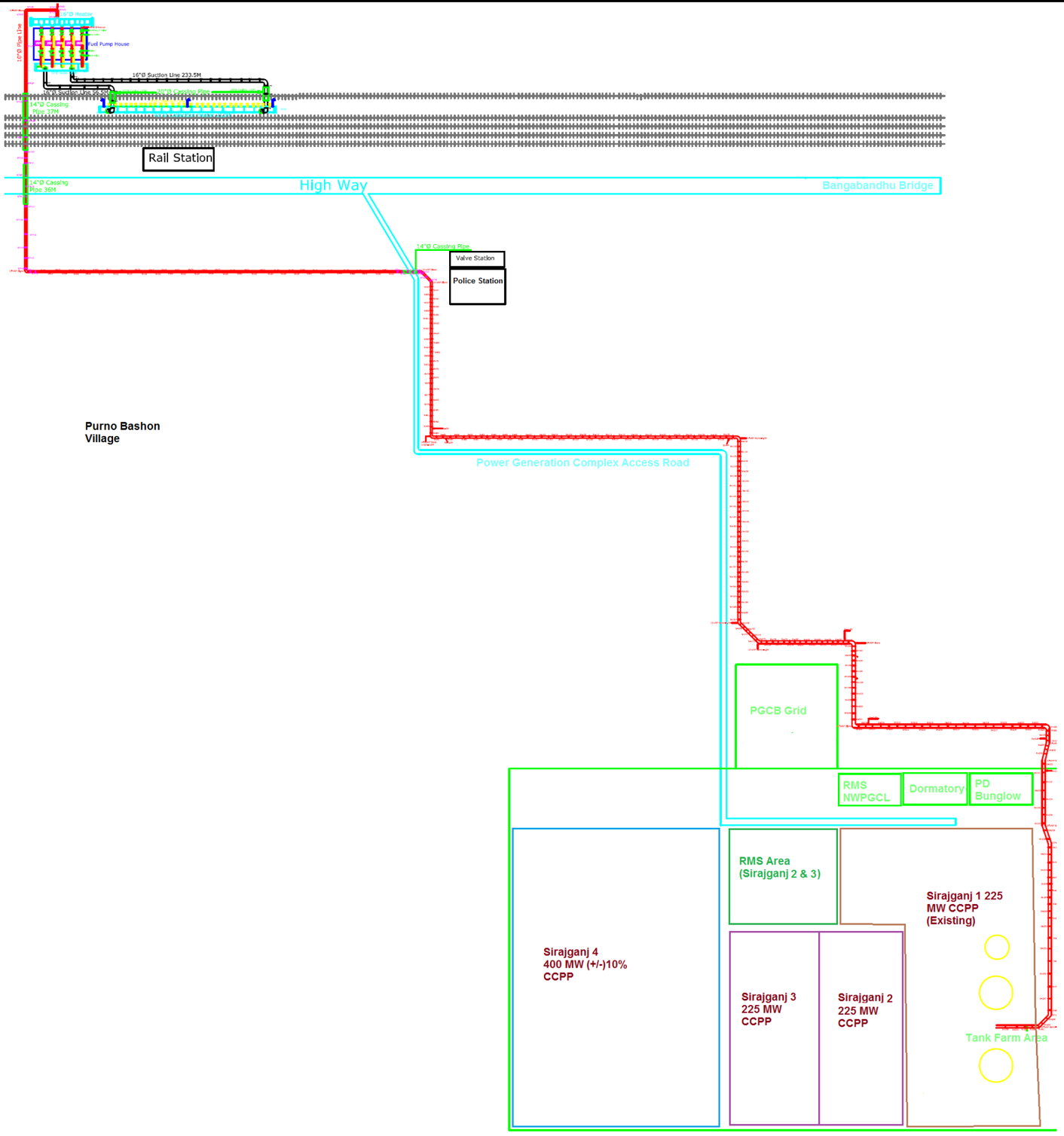
Test	Method	Limit
Density at 15 °C, Kg/L	ASTM D 1298	Min. 0.820 Max. 0.870
Colour, ASTM	ASTM D 1500	Max. 3.0
Neutralization Value: Strong Acid No, mg KOH/gm Total Acid No, mg KOH/gm	 ASTM D 664 ASTM D 974	 Nil Max. 0.2
Ash , % mass	ASTM D 482	Max. 0.01
Carbon Residue (Conradson) On 10% bottom, % wt.	ASTM D 189	Max. 0.2
Cetane Number	ASTM D 613	Min. 45
Cetane Index Calculated)	ASTM D 976	Min. 45
Pour point, °C	ASTM D 97	Max. 9 (Winter)** Max.12 (Summer)**
Copper Strip Corrosion (3 hours at 100 °C)	ASTM D 130	Max. No. 1

Test		Method	Limit
Flash point, PM(cc) / Abel,°C		ASTM D 93/ IP 170	Min. 32
Kinematic viscosity at 38 °C, cst		ASTM D 445	Max. 9.0
Sulphur total, % mass		ASTM D 4294	Max. 0.25
Sediment, % mass		ASTM D 473	Max.-0.01
Water content, % vol.		ASTM D 95	Max. 0.1
Distillation: 90 % vol. recovery, °C		ASTM D 86	Max. 375
Sediments and particulates for light distillate)	total d < 10 µm 10 ≤ d ≤ 25µm d > 25 µm	D6217/DIN EN12662 DIN51575	Max. 20 Max. 18.0 Max. 2.0 Max. 0
Ash		D482 / ISO6245 DIN51575 / DIN EN 2645	Max. -100
Vanadium		DIN 51790 ASTM D 3605	< 1
Lead		DIN 51790 ASTM D 3605	Max. 1
Zinc		DIN 51790 ASTM D 3605	Max 2.0
Total of Sodium + Potassium		DIN 51790 ASTM D 3605	< 1
Calcium		DIN 51790 ASTM D 3605	Max. 10
Nitrogen (FBN = Fuel Bound Nitrogen)		ASTM D 4629	Max. 0.015
Sulphur		D3246/D5453/ ISO6326	Max. 0.2
Acid Number		D664	Max. 0.1
Calorific Value Kcal/Kg			Max. 10280

Note:
* [Fuel oil will be tested by the Company, to confirm compliance with the above specification. The test result will be attached with this Agreement]
** Winter shall be the period from November to February (both months inclusive) and rest of the months of the year shall be deemed as Summer.

Source: Sembcorp, 2014 (extracted from the Draft FSA)

Figure 3.9 HSD Supply Arrangement of NWPGCL



Source: SNWPCL

3.6.9 Electrical Plant and Systems Requirements

In order to meet BPDB dispatch requirements, the Plant will be designed to meet, as a minimum, the technical limits described below:

Voltage Limits / Current Limits

Power station and system voltages will be selected from International Electro-technical Commission ("IEC") Standard 38, and will be capable of operating over the range of +10% to -20% of the nominal voltage.

230 KV Substation and Switchyard

The evacuation of electric power generated by the Plant will be via two 230 kV lines connected to the existing Sirajganj switchyard owned by PGCB. At the Site, the Company will construct a 230 kV substation which will connect to PGCB's switchyard. Ownership of the substation will be transferred from the Company to PGCB at the start of Simple Cycle operations. Thereafter, PGCB will be responsible for operating and maintaining the substation. The Company will be responsible for laying and terminating cables at the interface panel, which will be provided by PGCB within the switchyard control facility for receiving signals from the grid.

Power and Auxiliary Transformers

The Company will provide generator step-up, start-up and auxiliary transformers for facility services, including all protection and disconnection switches, as required.

Generators

Each generator will have a minimum short circuit ratio of more than 0.5. Each generator will comply with IEC Standard 34 and BPDB requirements, and be rated to match the turbine output over the full range of ambient temperatures specified. Generator and exciter windings will have insulation that is non-hygroscopic and of Class F type complying with IEC Standard 85, but compliant with temperature rises of Class B type under any operating condition within the specified output.

3.6.10 Water Supply Systems

The Plant will include the following water systems:

- Intake System
- Raw Water System
- Circulating Water System
- CW Blow-down System
- CW Make-up System
- Pre-treatment Plant Feed System
- Pre-treatment Plant
- Demineralization Plant
- Potabilisation Plant

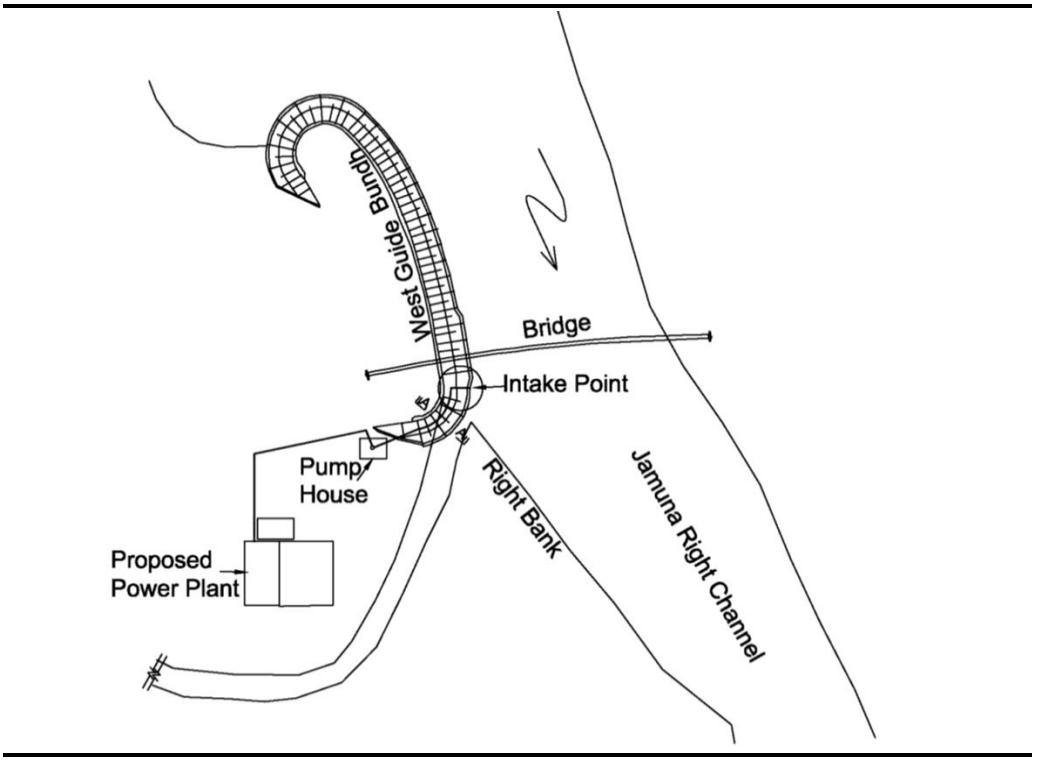
- Service Water Distribution System
- Potable Water Distribution System
- DM Transfer System
- Condensate Emergency Make-up System
- AC and Ventilation System Make-up Water System
- Fire Water Supply System
- Sump pumps, drainage pumps and submersible pumps.

Key water supply systems have been described below:

Raw Water System

Raw water will be drawn from the Jamuna River for cooling tower make up and water pre-treatment plant requirements. The raw water system will consist of an intake structure and vertical raw water pumps. The water supply system will be designed to maximum gross demand of water in all modes of operation. It is proposed to provide two buried river water pipelines, designed to meet the total pumping capacity of the water intake pumps. Suction pipe line will be laid mostly below the existing river bank and river bed ranging from intake mouth to pump. The pump house location will be located immediately downstream of the West Guide Bund (WGB). Due to presence of the WGB, the location is considered safe as no significant threat of bank shifting is present here. From the intake mouth a suction pipe line will be laid over the WGB Launching Apron as shown in ***Box 3.6***. Water will be pumped directly from the river necessitating a higher capacity pump due to the length of the suction pipe. Strainers will be fitted to the water intake point of suction pump to protect the pump impellers.

Box 3.6 Plan View of Water Intake Location

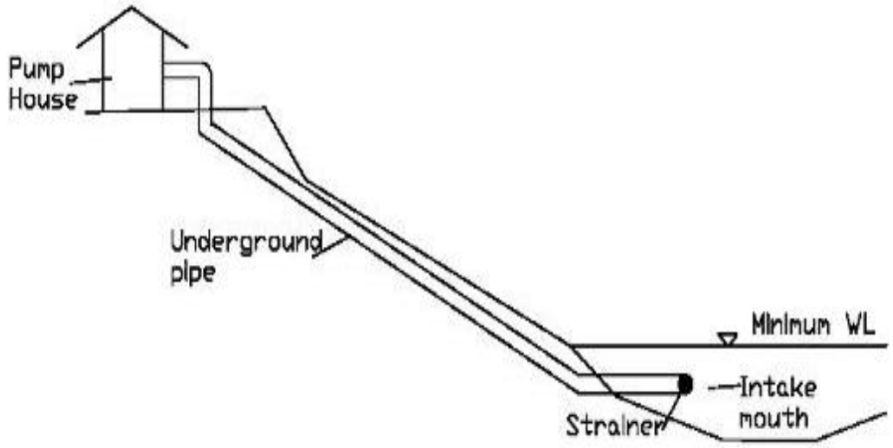


Source: Sembcorp

The IWM study had identified three alternatives for water intake location and abstraction mechanism (refer to ***Section 0.0.0*** for detailed analysis of alternatives) and out of those, following mechanism has been suggested:

The intake of suction pipe will be located below lowest water level to guarantee water supply in lean flow period and will be ahead of maximum possible extent of char to overcome possibilities of getting silted up. In the end, it will ensure constant water supply to the cooling tower. In this abstraction mechanism, suction pipe line will be laid mostly below the existing river bank and river bed ranging from intake mouth to pump as shown in the ***Figure 3.11***. Water will be pumped directly from river that will necessitate higher capacity pump due to long suction pipe. Strainers should be fitted to the water intake point of suction pump to protect the pump impellers.

Figure 3.10 Cross-section View of Preferred Option for Water Abstraction



Source: IWM Study

This abstraction mechanism has the advantage such as there is no chance of limiting the risks of the intake point pipe being silted up. Due to the uncertainty of the extent of the char, however there is mild risk of having silted up intake mouth even if intake mouth is placed beyond maximum possible extent of char. However, pump can function with silted up mouth. The pipe needs to be laid below scour level to avoid being exposed. Furthermore, in order to avoid the impingement and entrainment of fish within the hydraulic zone of influence of the intake, barrier nets/ fine mesh screens/ wedge wire screen will be provided. The details of these will be worked out during the design of water intake abstraction system.

A raw water intake pump house pit will be constructed with pumping capacity of approximately 600 m^3/hr and head of 30 m. Two pumps (1W+1S) will be provided at the pump house. The pipeline from the water intake point to the pump house will be along the West Guide Bund and will be overground, whereas after pump house, same will be underground.

From the in-plant reservoir, raw water will be supplied to a raw water pump house by gravity. The raw water pump house will have raw water make-up pumps to feed the Pre-Treatment (PT) plant by means of vertical turbine pumps (externally lubricated). An overhead storage tank for clarified water will be provided on the top of raw water pump house to provide adequate storage of clarified water to be used for lubrication of raw water make-up pumps.

As back up of raw water supply from river, the construction of groundwater wells is being considered to supply groundwater to the plant. However, the location and numbers of groundwater wells that are needed is still being confirmed and is subject to local authority approval.

Pre-Treatment Plant

Water from the raw-water pump house will be pumped to two (2) (2x60% capacity) reactor type clarifiers through one (1) flow control station (with bypass arrangement and isolating valves), one (1) RCC Aerator and one (1) RCC stilling chamber and through the isolating gates provided at the inlet to the inlet channels (with each channel provided with parshall flume) for each clarifier. Clarified water will be transferred to an above ground clarified water storage tank. Water will be pumped from this tank by CW make-up pumps to a cold water channel downstream of the cooling tower. These CW make-up pumps will be located inside the clarified water pump house adjacent to the clarified water storage tank. Clarified water pumps for supplying make-up water to A/C & ventilation system shall also be located in this clarified water pump house. These pump will draw water from the above mentioned clarified water tank.

From the clarified water storage tank, horizontal centrifugal split casing type filtered water pumps located in the clarified water pump house will draw water and supply clarified water to Demineralization plant through two (2) (1 Working + 1 Standby) dual media pressure sand filters (DMPSF). Back wash waste from dual media pressure sand filters will be collected in a backwash wastewater sump (in twin compartments) and will be recycled back to the clarifiers through two (2) (1 Working + 1 Standby) vertical wet pit type backwash wastewater transfer pumps. Filters will be provided with two (2) (1 Working + 1 Standby) air blowers for air scouring / bed fluidization during the backwash process. One sludge pit, in twin sections will be provided to collect the sludge from all the clarifiers periodically and each section of the pit will be provided with agitation by recirculation from the sludge pump discharge (jetting nozzles) system and air agitation system. The sludge will be transferred to the sludge treatment plant by means of two (2) (1 Working + 1 Standby) sludge transfer pumps.

Demineralization (DM) Plant

The DM Plant will include the following major equipment:

- Dual Media Filters (DMF) to reduce suspended solids from the feed water (2x100% capacity);
- Activated Carbon Filters (ACF), provided downstream of the DMF to remove organics, colour and residual chlorine (2x100% capacity);
- Strongly Acidic Cation (SAC) exchange units (2x100% capacity);
- Degasser system (2x100% capacity);
- Strong Base Anion (SBA) exchange units (2x100% capacity);
- Mixed Bed (MB) exchange units (2x100%capacity);
- Air blowers for the MB units (2x100% capacity);
- Ultra filters with all accessories to remove colloidal silica (2x100% capacity);
- An acid regeneration system;
- A alkali regeneration system;
- DM water storage tanks (2 x 500 m^3 capacity);
- DM water transfer pumps (2x 100% capacity);
- SBA resin alkaline brine cleaning system; and
- A neutralizing pit.

Closed Cooling Water System for GT Auxiliaries

Closed cooling water ("CCW") system will provide cooling water to various CT unit auxiliary coolers like generator coolers, lube oil coolers and air compressors. The CCW system will be in a closed circuit with Fin Fan coolers and passivized demineralized water as cooling media. CT CCW pumps will pump the demineralized water to various auxiliary coolers of the CT unit.

Closed Cooling Water System for ST and HRSG Auxiliaries

A CCW system will provide cooling water to various coolers associated with the ST and HRSG auxiliary equipment, lube oil coolers and boiler feed pumps. The primary circuit CCW pumps will pump passivized demineralized water through Plate Heat Exchangers to various coolers of auxiliary equipment. Hot water from these coolers will be re-circulated.

The secondary cooling water for the CCW Plate heat exchangers will be in open cycle with raw water as cooling media. Auxiliary cooling water will be used for cooling the vacuum pump seal coolers.

3.6.11 Control and Instrumentation System

A complete control and instrumentation system will be provided based on the DDCMIS philosophy. This will provide controlling sequence interlocks and equipment protection, monitoring, alarms etc. for HRSG, STG, Balance of Plant (BOP)[1] and common plant facilities.

(1) [1] Balance of Plant stands for the power plant area excluding the power generation units (GTG, STG and HRSG) and utilities.

The control requirements of the main power plant, comprising of CTG, HRSG, STG Auxiliaries, BOP system/ equipment like CW, ACW and other water systems, plant electrical system, etc., will require a microprocessor based Distributed Control System (DCS).

Programmable Logic Controller (PLC) based control systems will be provided for all other unit specific and common utility systems and auxiliary plants, including:

- DM/PT Plant;
- Fire Protection (PLC based) and Detection System (microprocessor based);
- A/C system;
- Raw water system;
- CW chlorination system; and
- Effluent Treatment Plant (ETP) system.

The control matrix for various plant systems along with control locations is shown in ***Table 3.7***.

Table 3.7 Control Matrix for Various Plant Systems

S. No.	System/ Plant	Control System	Control Location
1	GT	DCS	Operator stations in central control room
2	HRSG	DCS	Operator stations in central control room
3	ST	DCS	Operator stations in central control room
4	DM Cooling Water System	DCS	Operator stations in central control room
5	CW & ACW System	Remote DCS processor with input & output	Operator station in central control room
6	Instrument Air and Service Air Compressors including air drying plant	DCS	Operator station in central control room
7	Fuel oil unloading, storage, pressuring and heating system	Remote DCS processor with input & output Local control panel for fuel oil unloading	Operator station in central control room
8	ETP	PLC	Local control room
9	DM Plant	PLC	Local control room
10	Centralized Turbine Oil Purification System	Local control panel	
11	Fire Detection and Protection System	PLC based	Fire protection local control room
12	A/C system	PLC based	Local control room
13	Auxiliary Boiler	PLC	Local control room
14	Condenser online tube cleaning system & self-cleaning filter	PLC based	Field mounted PLC panel
15	River Water System	Relay based	Local control room

Source: SNWPCL

3.6.12 Civil Works

The civil works will comprise of the following:

- Site preparation works including protection for lay down areas, plant areas, site roads and drainage within plant boundary
- Security Gate House and Time Office;
- Foundations of Combustion Turbine and auxiliaries, CT buildings;
- Steam turbine building and foundations including Steam Turbine foundations, the powerhouse building and turbine auxiliaries;
- HRSG foundations and Boiler feed water pump building;
- Bypass Stack with diverter damper foundations;
- Main Stack foundations;
- Air Intake structure;
- Control room, administration offices and electrical annex;
- Workshop Building;
- Store Building;
- Generator Step up transformer area;
- Auxiliary transformer areas;
- Gas fuel skid areas and wash water module;
- DM Plant Building with neutralizing pit, storage tank foundation, laboratory and potable water treatment plant;
- Water treatment plant structures, foundations including cascade aerator, parshall flume clarifier and clarified water storage tank;
- Sludge treatment plant along with pump foundations;
- Fire Engine Building;
- Laboratory;
- Canteen Building;
- Chemical and Hazardous Goods stores building and tank foundations;
- Firewater pumps foundations and pump house;
- Cooling water conduits;
- Cooling water and Auxiliary Cooling water pumps foundations and Pump house, MCC/ Control Room for CW pumps;
- Water tank area/foundations;
- Clarified cum fire water tank foundation;
- Raw Water Intake system structures with Pump House, sump, control/ switchgear room, raw water pipe line, etc.;
- Raw water storage reservoir with pump house (requirements shall be defined as per system finalization);
- Clarified Water System with Chlorination Plant Structure;
- Black Start and Emergency Diesel Generator foundations;
- Air Compressor House;
- Incidental earthworks;
- Plant roads, drainage and underground services viz duct bank, pits etc.;
- Miscellaneous foundations and superstructure for pipe racks etc.;
- Foundations for sewage treatment plant;
- 230 kV Switchyard with control building civil works;
- RMS Control Room and Facilities

- Induced Draft Cooling Towers;
- Tank farm area with tank foundations, dyke wall, paving, fencing and all associated civil works;
- Service road along raw water pipe line; and
- Enabling works:
  - Temporary Site building/office
  - Fabrication Yard
  - Quality Control Laboratory
  - Staff Welfare Society
  - First Aid Building
  - Cement Godown
  - Temporary Store.

3.7 RESOURCES AND UTILITIES REQUIRED FOR THE PROJECT

3.7.1 Land

Approximately 23.6 acres of land is required for the Project. In addition to this approximately 19.3 acres of land will be required temporarily for construction laydown area and construction workers accommodation. The land required is currently owned by institutions including equity partner BPDB/NWPGCL and BBA. The land will be obtained by Land Lease Agreements with respective entities in consideration of a lease rent as per the market price. ***Table 3.8*** provides a summary of the land requirement for various components of the project for both the construction and operation phase.

Table 3.8 Break-up of Land Requirement for the Project and Associated Facilities

Project Component	Required Land Area (In acres)	Current Status of Land	Proposed Mode of Land Acquisition
Power Plant	16	Under Possession of BPDB. NWPGCL will apply for allocation.	The land will be obtained under a land lease agreement (LLA) for 22 years covering the entire period of Implementation Agreement. The lease rent paid to BPDB offsets part of NWPGCL's equity stake in the company.
Gas Receiving, Metering, Conditioning and Compression Station	0.9	Under Possession of BPDB	The Row will be granted by BPDB to SNWPCL.
Approach Road	0	Under Possession of BPDB	BPDB grants to the Company the right to the non-exclusive, free and unfettered use of the Access road throughout the term of the LLA.
Gas Supply Line	3.95	Under Possession of BBA	The RoW for gas pipeline will be obtained through a Land Lease Agreement between BPDB and BBA and finally right of way will be granted by BPDB to SNWPCL.

Project Component	Required Land Area (In acres)	Current Status of Land	Proposed Mode of Land Acquisition
Transmission Line (Underground)	0	Owned by PGCB	The 230KV PGCB Switchyard is located in the Adjacent Plot. Hence, there will be no land requirement for transmission line for connecting to the Grid.
HSD Supply System	0	Under possession of NWPGCL	No additional land is required as BPC will use the NWPGCL facility to deliver the HSD, i.e. transport the fuel by railway and thereon to the site by HSD pipeline, which will be laid across common land from the railway siding to the site.
HSD pipe line (From tapping point of the existing NWPGCL HSD line to site)	0.16	Under possession of BPDB and NWPGCL	The Row will be granted by BPDB to SNWPCL.
Water Intake, pump house and underground water pipeline	2.57	Land is under possession of BBA	The RoW for water intake will be obtained through a Land Lease Agreement between BPDB and BBA. Finally right of way will be granted by BPDB to SNWPCL. Discharge from the project will be on the southern boundary of the complex.
Laydown Area (Construction Phase)	10.95	Land is under possession of BBA	Outside the power generation complex in government land and this will be leased to the Project. The land is available between the national highway and railway line near the GTCL Valve Station.
Worker Accommodation (Construction Phase)	8.37	Land is under possession of BBA	70-80% of the labour will be locally employed. A small worker accommodation for migrant workers will be established outside the power generation complex. Open land is available between the PGCL Gas Pipeline Corridor and Punorbason Village along the National highway (about 50 m away from Highway).
Total	**42.9**		

3.7.2 Water

The water requirement for the construction phase of the Project will be met from Jamuna River. Analysis of water samples collected from Project site as well as Jamuna River indicated the quality of water is suitable to be used in the construction phase of the Project. The potable water requirement during

the construction phase will be provided by the EPC contractor. The contractor will ensure that the quality of drinking water is compliant with the applicable drinking water standards (Schedule 4 of ECR, 1997). The quantity of water required during the construction phase of the Project is presented in ***Table 3.9***.

Table 3.9 Water Requirement during the Construction Phase

S. No.	Purpose	Quantity (m^3/day)
1	Concreting	40
2	Curing/ cleaning	30
3	Dust suppression (as applicable)	10
4	Site office and other utilities	10
5	Others	10
	Total	***100***

Note: These are the peak quantities and the actual consumption will vary depending upon the construction activities.

The water requirement during the operation phase of the Project will be primarily for cooling water and "make up" water requirements. Proposed water intake location, pump house location and tentative route of the water pipeline has been presented in ***Figure 3.11***. The water requirement during the operation phase is presented in ***Table 3.10*** and the water balance diagram shown in ***Figure 3.12***.

The potable water requirement during the operation phase will be met through groundwater abstraction for which a bore well will be installed. Necessary permission for installation and abstraction of groundwater will be required from Upazilla Parishad. A potable water treatment plant will be installed so that quality of drinking water is compliant with the applicable drinking water standards (Schedule 4 of ECR, 1997). The industrial wastewater treatment flow diagram has been presented in Figure 3.13.

Table 3.10 Raw Water Requirement during the Operation Phase

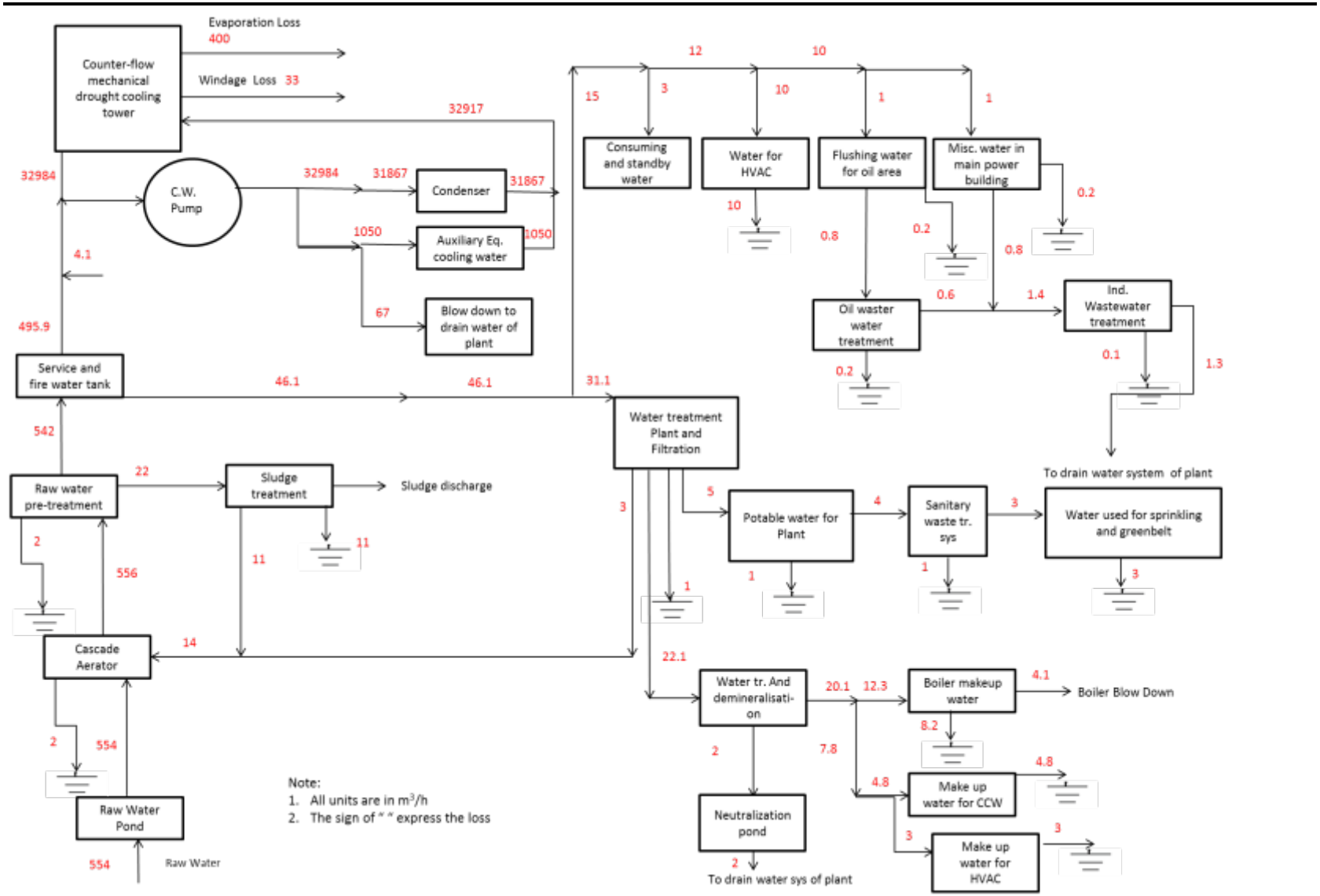
S. No.	Purpose	Quantity (m^3/hr)
1	Cooling tower make-up	500
2	DM Plant	22
3	Service Water for WTP, HVAC, Misc.	15
4	Potable Water	5
5	Sludge Treatment Plant (Raw water treatment)	22
6	Miscellaneous	36
	Total	***600***

* In addition to cooling, fire water storage (2 hours as per NFPA) will be available.

Figure 3.11 Water Intake Location and Raw Water Pipeline Route

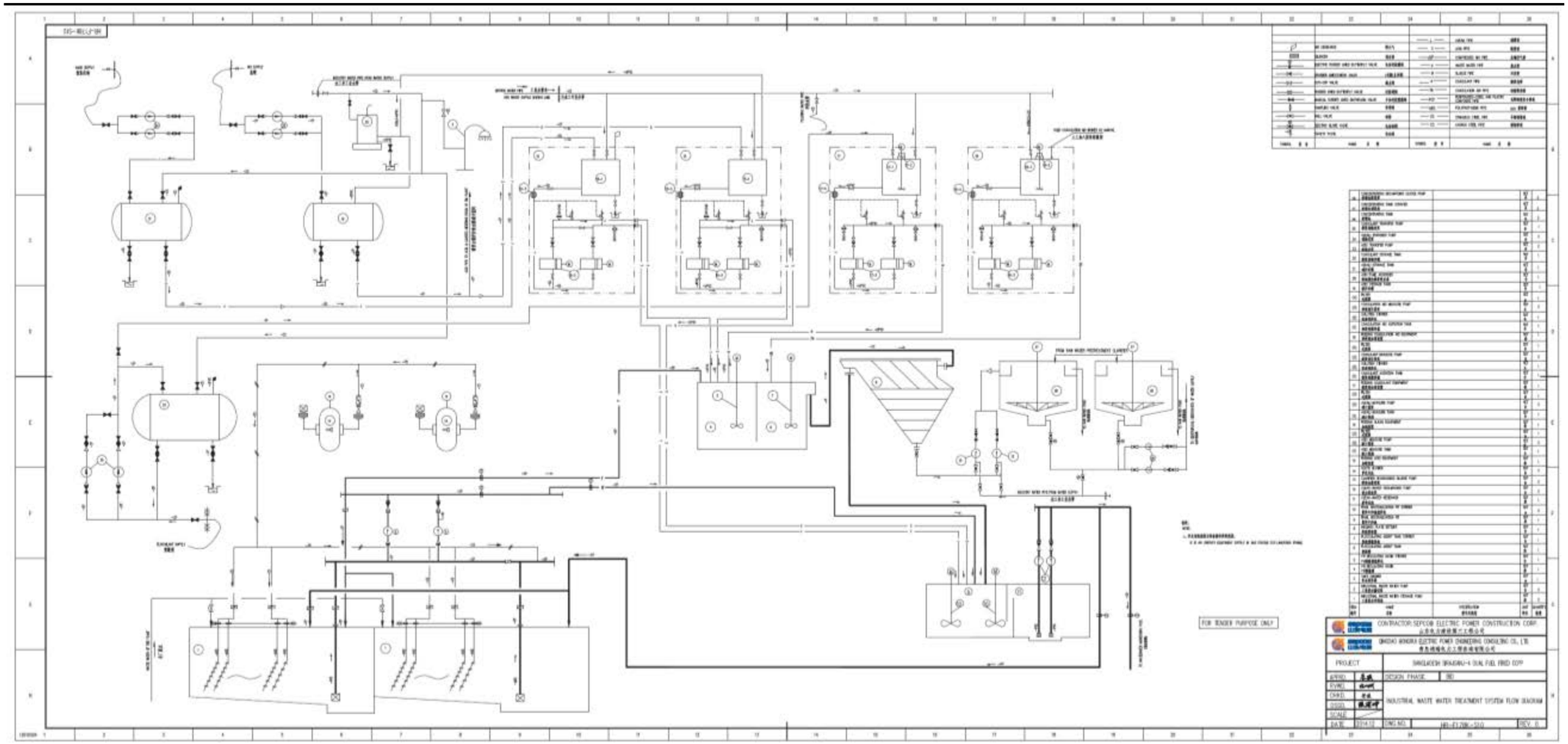
Source: Developed based on reconnaissance survey on Google Earth Pro (Imagery Date: 15 April 2014)

Figure 3.12 Water Balance



Source: SNWPCL

Figure 3.13 Industrial Wastewater Treatment System Flow Diagram



Source: SNWPCL

3.7.3 Auxiliary Power

The auxiliary power requirement for running the Plant will be as follows:

- Facility operation under Simple Cycle mode: 6.9 MW (Gas) and 6.925 MW (HSD); and
- Facility operation under Combined Cycle mode: 13.388 MW (Gas) and 9.35 MW (HSD).

One (1) Emergency Diesel Generator (DG) set will be connected to a 415 V Emergency Board, for meeting safe shutdown and emergency loads. In addition, three (3) set of Black Start DGs with 150% rated capacity will be connected to 6.6 kV unit switchgear, to start a gas turbine in the event of grid blackout conditions.

3.7.4 Materials Storage and Handling

The plant operation will require chemicals for water treatment and process requirements. A list of the hazardous chemicals which will be used in the Plant and the maximum quantity stored is presented in ***Table 3.11***.[1]

Table 3.11 Chemicals and Storage Capacity

S. No.	Chemical Name	Type (as per OSHA Classification 29 CFR 1910.1200)	Maximum Storage Quantity
1.	Hydrochloric Acid (30%)	Hazardous	30 m^3
2.	Caustic Lye (48%)	Hazardous	30 m^3
3.	Sulphuric Acid	Hazardous	40 m^3
4.	Ammonia (25%)	Hazardous	500 l
5.	Tri Sodium Phosphate	Hazardous	500 kg
6.	HSD		19,000 m^3

Source: SNWPCL

Acids and other hazardous materials will be stored in a dedicated room with adequate ventilation, at the water treatment plant area. HSD to be used as secondary fuel for power generation will be stored in two tanks with capacity equivalent to 15 days operation at 80% output on HSD. The storage arrangements for all chemicals will include secondary containment for spillage control. HSD will also be stored in above ground oil tanks located in the vicinity of the Black Start DGs and Emergency DG set.

3.7.5 In-house Laboratory

The Project will be having an In-house Laboratory for quality control as well as for testing and monitoring of quality of the intake water, treated water and

[1]Hazardous or toxic materials/waste shall not be imported as raw material for industry.

discharge water. In addition to that the stack emissions will be directly being monitored through the Continous Emission Monitoring System (CEMS) and the emissions will be monitored by the Plant Control Room. The portable instrument for the noise testing will be provided for the plant noise monitoring. All the monitoring, testing and analysis will be carried out by trained technicians.

Furthermore, the project will engage recognized third party monitoring agency for periodic monitoring of stack emissions, ambient air quality, water quality and noise (plant noise and ambient noise) monitoring and analysis, as per the proposed environmental monitoring programme for operation phase as well as based on the recommendations of the DoE.

3.8 OVERVIEW OF FACILITIES IN SAIDABAD POWER GENERATION COMPLEX

The Saidabad Power Generation Complex is already a developed area for power generation, with an operational power plant of NWPGCL and associated infrastructure for gas supply, HSD supply and power evacuation. A brief description of the proposed project components including Associated Facilities that would be used by the Project and other facilities in the Saidabad Power Generation Complex are described below and presented in Figure 3.14:

3.8.1 Sirajganj 4 - Project Facilities

Sirajganj 4 project components include:

- Power Plant – A new power plant will be developed within the developed area of Saidabad Power Generation Complex.
- Transmission Line – The project will have its own switch yard within the project site and same will be connected with the 230 kV substation of PGCB, which is located adjacent to the Saidabad Power Generation Complex boundary.
- Regulating and Metering Station (RMS) – As part of the project an RMS will be constructed within the site for fuel gas compression and conditioning.
- Gas Pipeline – A new natural gas pipeline of about 1.6 km from GTCL valve station to the RMS of S4 will be developed as part of the project.
- Water Pipeline – A new water pipeline of about 4 km length from River Jamuna to the Project site will be constructed as part of the project.
- HSD Pipeline – HSD supply connection for the project will be taken for the HSD pipeline of Sirajganj 1 and 2 Projects, located within the Saidabad Power Generation Complex.

3.8.2 Associated Facilities

The Associated Facilities[1] for the Sirajganj-4 project include the following:

- GTCL Valve Station – a GTCL valve station is available in a 30" East-West gas pipeline crossing the Bangabandhu Bridge, which is about 1.5 km from the project site. The valve station already has a provision to supply the natural gas to the Saidabad Power Generation Complex. The Sirajganj 1 operational power plant already has a gas pipeline connected to this valve station. As the Valve Station was provisioned to provide the Project as well as S1 and S2, this is considered an Associated Facility.
- PGCB Sub-Station and Transmission Line – there is an operational substation, owned and operated by PGCB, adjacent to the site with transmission lines connecting to the national grid. These were constructed for power evacuation from the Saidabad Power Generation Complex including sufficient capacity for the Project. Currently the operational power plant of NWPGCL (S1) is evacuating power from this facility.
- Approach Road – A dedicated approach road of about 1.5 km connects the Saidabad Power Generation Complex with the national highway. This road is a common facility for access to the complex and owned by the BPDB/NWPGCL but is considered an Associated Facility as without this road the Project would not be viable.

The impacts associated with the operation of these Associated Facilities are considered within this EIA.

3.8.3 Other Facilities

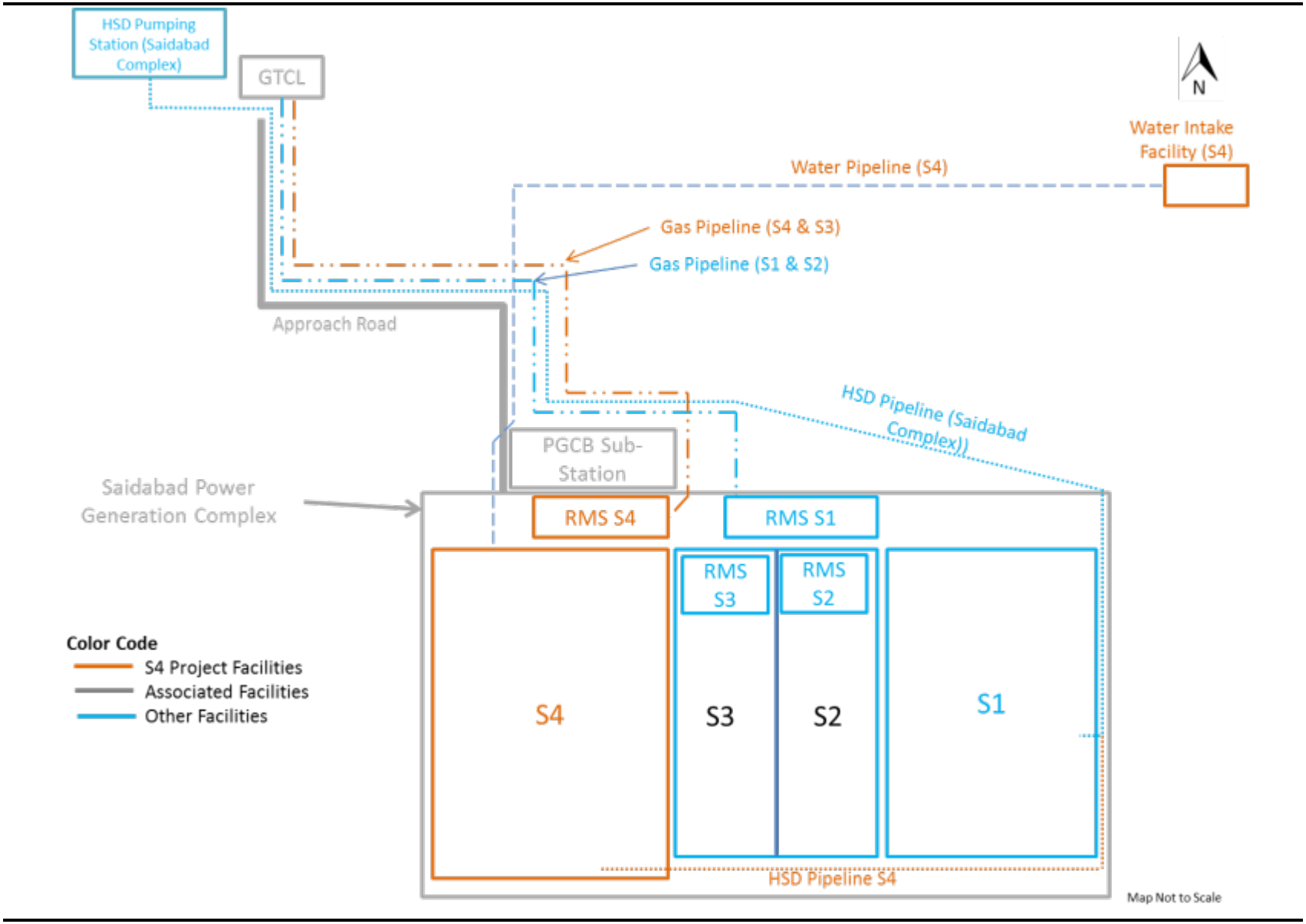
Other facilities in the Saidabad Power Generation Complex include:

- Sirajganj 1 Project – Sirajganj 1 is a 225 MW CCPP owned by NWPGCL and is operational with combined cycle operation since May 2014.
- Sirajganj 2 and 3 Projects – These two projects will have similar capacity to the existing project of NWPGCL (Sirajganj 1) and are currently in pre-construction stage. Land for these projects has been earmarked between the Sirajganj 1 and 4 projects. The projects are planning to share some infrastructure with the existing Sirajganj 1 project. However, the details of what infrastructure will be shared are currently unavailable.
- RMS – Sirajganj 1 has an existing RMS at site. Sirajganj 2 and 3 projects will have separate RMS within the earmarked areas for these plants. However, these are not Associated Facilities for the Sirajganj 4 project, as a separate RMS will be required for the S4 project.
- Gas Pipeline – The Sirajganj 1 project has an existing pipeline from the GTCL Valve station to the RMS of S1. It is understood that this pipeline is adequate to cater to the needs of the S2 project as well. However, this is not an Associated Facility for the S4 projects, because a new gas pipeline will be constructed for S4 project to connect with GTCL valve station. It has been reported that the Sirajganj 3 project will receive the gas from Sirajganj 4 project pipeline near RMS of S4.
- HSD Pipeline –NWPGCL has an HSD unloading and pumping station at the Bangabandhu Bridge West railway station and an HSD supply pipeline of about 3 km has been constructed up to the Saidabad Power Generation Complex by NWPGCL. The same pipeline will be used by the S2, S3 and S4 projects upto Saidabad Power Complex, however there will

be separate tapping points and pipelines inside the complex upto the HSD storage areas of the respective plants.

It is to be noted that all these facilities are owned and operated by other agencies and not directly linked with the Sirajganj 4 project. Therefore, these facilities cannot be considered as Associated Facilities for the Sirajganj 4 project however, as appropriate to the environmental issue under examination the cumulative impacts associated with their operation has been considered in the EIA.

Figure 3.14 Overview of Facilities



3.9 PROJECT LIFE CYCLE OVERVIEW ALONG WITH KEY ACTIVITIES AND SCHEDULE

Life cycle analysis of the project identifies the key issues and concerns that are likely to evolve over the entire lifespan of a project. In the case of the proposed Project, these issues may arise during the site preparation and construction, operation and maintenance, and decommissioning. These issues have been considered in this EIA study, prior to any irreversible actions being undertaken by the Company, contractors and other project associates. The following sub-sections identify the key activities to be completed and facilities to be constructed and operated over the lifetime of this Project.

3.9.1 Site Preparation

The site is elevated by land filling and is a developed landmass, which is barren and unutilised at present and forms part of the Sirajganj Power Generation Complex. The site is almost flat, with a gentle slope towards the south-east. The entire Power Generation Complex is having boundary wall of about 2 m height. The average elevation of the Project site is 15.75 m above mean sea level (MSL) and maintained above the recorded highest flood level (HFL) of Jamuna River. Hence, the Project does not require any site preparation work.

The level of the Project site is 2.4 m higher than the current danger level of the river and 0.64 m above the level reached in 63 years of recorded data (maximum level ever reached was 15.11 m in 1988) (refer ***Section 4.3.5*** for details).

3.9.2 Construction

The construction contractor and their subcontractors will construct the power plant and shall adhere to the "Master Specification Document" developed by SNWPCL for the Project.

Project site construction activities leading up to the operation of the power plant, are anticipated to take approximately 30 months after Notice to Proceed (NTP). The tentative schedule of construction phase milestones is presented in ***Table 3.12***. To complete the construction works within this time period, the total manpower requirement is estimated to be 1500 people during peak construction stage. This is broken down into 25% skilled labour and 75% unskilled and semiskilled. Most of the unskilled and semi-skilled manpower will be sourced from the neighbouring areas. The skilled manpower will mainly be specialized personnel required to complete construction tasks, such as, installation of the combustion turbine and GTG, HRSG, steam turbine and STG, DCS and other plant control systems.

Table 3.12 Tentative Schedule of Construction Phase Milestones

#	Description	No. of Calendar Months	
		Start	Complete
1	Procurement of major equipment	1	23
2	CTG foundations	3	10
3	Major equipment installation	13	17.5
4	Fuel receiving facilities	3	14.5
5	Electrical interconnection	13.5	16.5
6	Start-up and testing for initial operation	17.5	23
7	Start-up and testing for commercial operation in Simple Cycle	23	24
8	Commercial Operation of Simple Cycle Facility	24	24
9	Start-up and testing for commercial operation in Combined Cycle	28	29
10	Commercial Operation of Combined Cycle Facility	30	30

Source: SNWPCL

As set out in the "Specification Manual", the Construction Contractor will be required to provide toilets, construction water, potable water, wastewater disposal arrangement, site offices, first aid facility, etc. A labour camp will be constructed outside the power generation complex, which will be maintained by the construction contractor with adequate potable water, sanitation and waste management facilities.

During the peak construction stage there will be approximately 50 SNWPCL staff. Staff will stay in locally hired houses in Saidabad/ Sirajganj. The construction contractor will provide temporary site facilities including offices to accommodate 5 office rooms and workstations for 20 people; cafeteria and toilets with shower facilities.

As part of the "Specification Manual", the Construction Contractor will also develop construction dust control measures, sediment and erosion control measures and procedures to disposal of waste materials generated during construction.

All of the major power plant components (e.g., GTG, STG and HRSG) will be manufactured outside of Bangladesh and shipped via ocean barges to the nearby port facility in Chittagong/ Khulna and from there these will be transported by barges to the temporary jetty in Sirajganj, which was previously used by NWPGCL during the construction of its 225 MW power plant. Location of temporary jetty with respect to the Project site has been presented in ***Figure 3.15***. Total route length between the temporary jetty and the Project site is about 6.0 km. All other heavy machinery, construction equipment and construction material (aggregate, sand, cement, etc.) will also be transported to the site via road.

Transportation of personnel during the construction phase will be by local vehicles, such as, cars and autos for safe and secure transportation.

Construction power will be arranged from local 11 kV line and arranged by the EPC Contractor at a suitable place within the plant boundary.

Figure 3.15 Location of Temporary Jetty and Heavy Lift Movement Route

Source: Developed based on reconnaissance survey on Google Earth Pro (Imagery Date: 15 April 2014)

Box 3.7 Temporary Jetty Location – Earlier used by NWPGCL

Source: ERM Site Visit (February 2015) and Old Pictures provided by SNWPCL

3.9.3 Operation and Maintenance

There will be no Operation and Maintenance (O&M) contract with any third party operator, as the power plant will be owned and operated by SNWPCL. The O&M of the Project will be undertaken by SNWPCL with the support of a long term service agreement (LTSA) for the GT and ST with the manufacturer/s. The LTSA will cover the supply of spare parts, supervision and specialized labour for inspections, major and minor overhauls.

Pursuant to a technical service agreement (TSA), SNWPCL and NWPGCL will provide information, resources and technical assistance to the Company during the mobilization and operational phase.

O&M staff with relevant experience of operating similar plants and with adequate knowledge of comparable technology will be recruited prior to Simple Cycle commercial operation date (COD) to commission and take over the Plant from the Engineering, Procurement and Construction (EPC)

Contractor. Given the maturity of the power sector in Bangladesh and track record of combined cycle projects, it is expected that qualified engineers, technicians, fitters, operators, general labour and administration staff will be available locally in Bangladesh.

Maintenance

Hot gas inspections and maintenance overhauls will be scheduled and performed in order to maintain output and availability. The need and frequency of specific equipment overhauls will be established based on a combination of factors including manufacturers' recommendations, visual inspections, testing data, equipment histories, insurance company requirements, scheduling coordination with BPDB, electrical delivery needs and other contractual obligations. The maintenance staff will consist of mechanical and electrical maintenance, and plant support and auxiliary services. During maintenance overhauls, the maintenance staff will be supervised and supplemented pursuant to the LTSA and supported by SNWPCL and NWPGCL professionals under the TSA.

The maintenance schedule of the Plant is presented in ***Table 3.13.*** Annual availability of the Plant with HSD and Natural Gas as fuel is presented in ***Table 3.14*** and ***Table 3.15***, respectively. Monitoring schedule is presented in ***Table 7.2*** of ESMP.

Table 3.13 Maintenance Schedule

S. No.	Particular	Duration (No. of Days)	Time of Year (Season)	Cycle (No. of Operating Hours)
1.	Annual Maintenance Outage Schedule – HSD	15	Anytime	8,000
	Annual Maintenance Outage Schedule – Gas	10	Anytime	8,000
2.	Major Overall Outage Schedule – HSD	35	Anytime	100,000
	Major Overall Outage Schedule – Gas	35	Anytime	100,000
3.	Combustion Turbine Inspection Schedule - HSD	6	Anytime	8,000
	Combustion Turbine Inspection Schedule – Gas	4	Anytime	8,000
4.	Steam Turbine Inspection Schedule	30	Anytime	50,000
5.	HRSG Inspection Schedule	10	Anytime	8,000

Table 3.14 Annual Availability of the Plant with HSD as Fuel

S. No.	Particular	Detail
1.	Annual Availability while Running in Combined Cycle	80%
2.	Operational Availability	-
3.	Planned and Maintenance Outages	10%
4.	Forced Outages	8%
	Total	***100%***

Table 3.15 Annual Availability of the Plant with Gas as Fuel

S. No.	Particular	Detail
1.	Annual Availability while Running in Combined Cycle	90%
2.	Operational Availability	-
3.	Planned and Maintenance Outages	5%
4.	Forced Outages	5%
	Total	***100%***

As previously outlined, PGCL will supply natural gas to the power plant under the terms of the GSA. The draft agreement specifies the quality of the sulphur-free natural gas to be delivered to the Project site. A continuous supply of natural gas will be required for the operation of the power plant and to maintain uninterrupted power supply to the national grid.

Lubricating and hydraulic oils, in standard size steel drums, will be delivered to the power plant on regular basis. Estimated annual consumption of lube oil for CT and ST will be of the order of 1,200 to 1,500 litres, whereas hydraulic oil consumption for both control oil and the by-pass station will be approximately 100 litres. The drums will be stored at the Project in a dedicated area with secondary containment until their contents are transferred into use. The empty drums will be sent for reuse or for recycling in line with the Department of Environment (DOE) guidelines.

Waste lubricating and hydraulic oils will be collected and delivered to a licensed contractor with facilities to treat or recycle the waste oil for other purposes.

During the operation phase of the Project, the total workforce will be 69. This will consist of 49 skilled and 20 unskilled staff. The unskilled workers will be contract staff for cleaning, gardening, drivers, fitters, security and helpers. Workforce distribution for operating the Plant in three shifts is presented in ***Table 3.16***. The proposed organization chart for the Plant O&M is presented in ***Figure 3.17***.

Table 3.16 Shift-wise Skilled Workers Requirement during Operation Phase

Shift	No. of Persons
General	34
Shift 1	5
Shift 2	5
Shift 3	5
Total	***49***

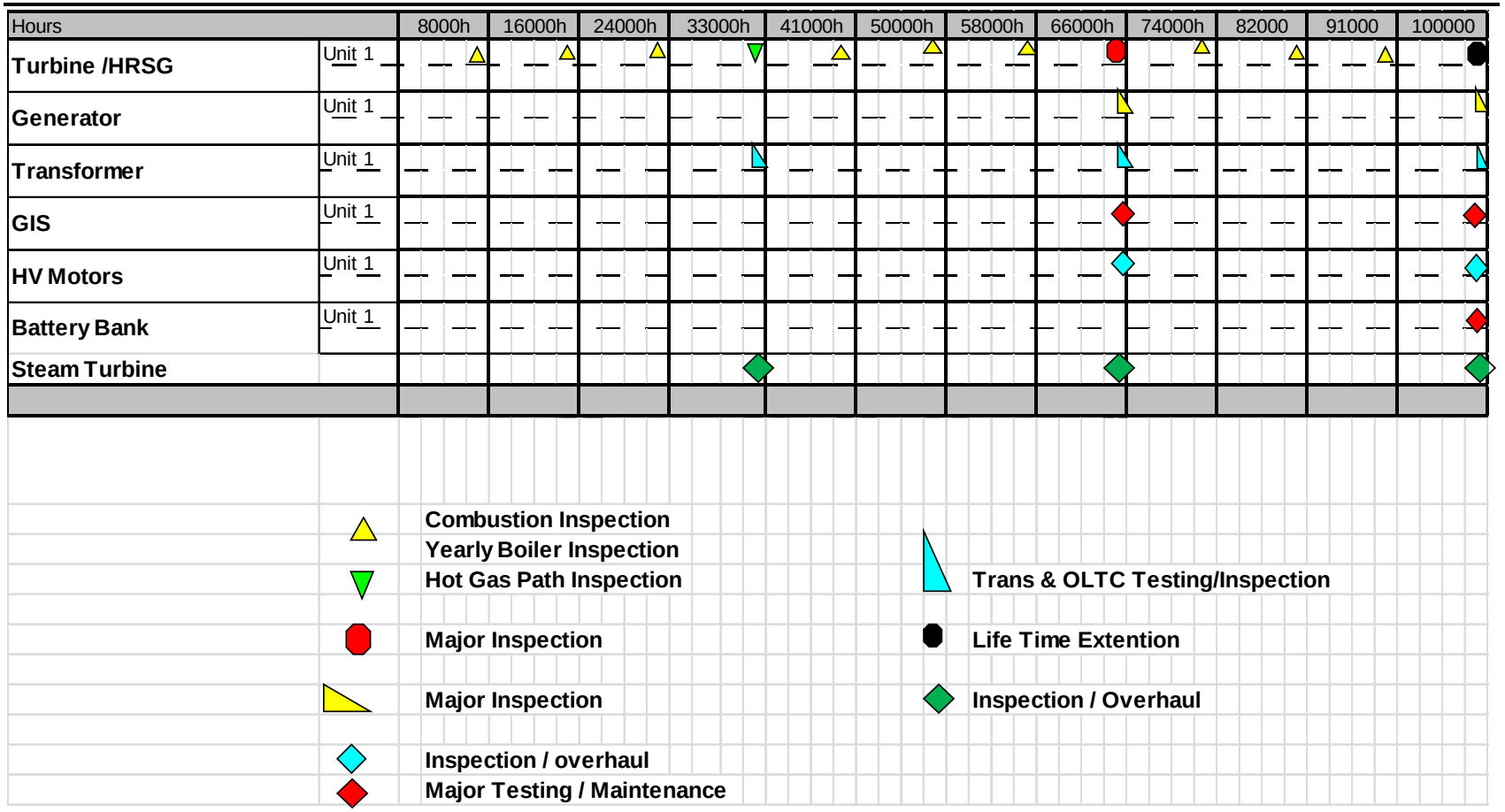
Most of the traffic associated with the Plant operations will be related to shift changes that may occur 3 times per day as per the shift schedule. Carpooling and use of public transport will be encouraged to minimize plant-generated traffic.

3.9.4 Decommissioning

The design life of the power plant is estimated to be 30 years, which is almost 8 years more than the Power Purchase Agreement term. If the Power Purchase Agreement, Land Lease 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.

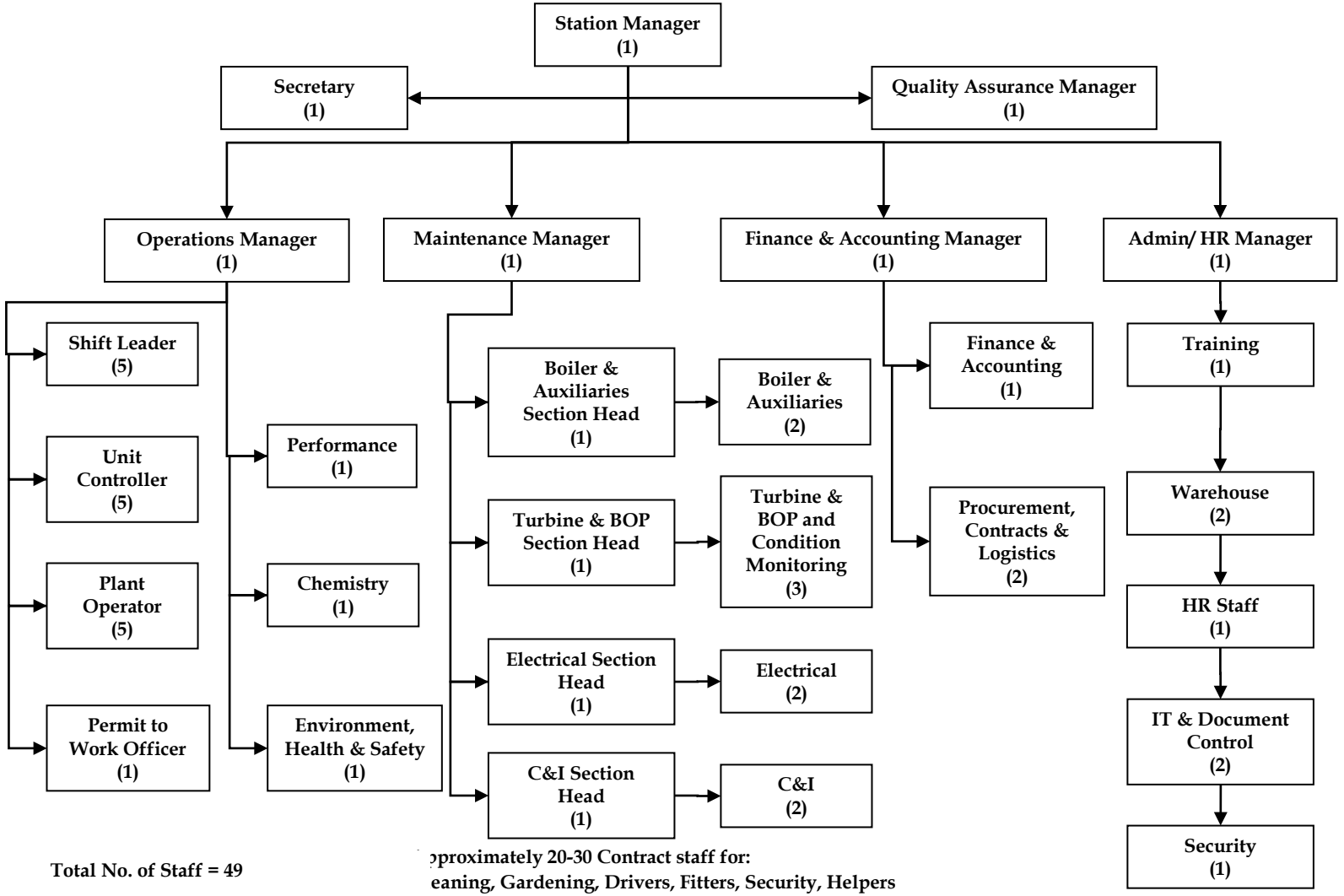
If retrofitting is not feasible and the operational life of the Power Plant expires, the power plant will be decommissioned according to the requirements of the authorities at that time.

Figure 3.16 Proposed Major Maintenance Schedule for the Project



Source: SNWPCL

Figure 3.17 Proposed Operation and Maintenance Organization Chart



Source: SNWPCL

3.10 SAFETY PROVISIONS

3.10.1 Fire Fighting System

The following protection systems are envisaged for the project for different areas as per the requirement.

- Hydrant system for the entire plant and buildings
- Spray system for Transformers and cable galleries
- Inert gas extinguishing system for Central Control Room and Shaft cable galleries
- Foam system for the HSD Tanks

Fire extinguishing system for Gas Turbine & its auxiliary equipment will be CO_2 gas extinguishing system. As per NFPA guidelines, the electric generating stations (other than hydro) come under the "Ordinary Hazard" category. Accordingly the fire protection system will consist of the following sub-systems.

Fire hydrant system (Indoor / Outdoor) including fire water pumps

The fire water network of existing plant will cover entire Power Plant area including all BOP buildings and switch yard building. Hydrant and spray system shall be tapped from a common header, separate piping network is not being provided. The fire water will be supplied with diesel engine pump which can be operated without power supply. The overall plant firefighting design will be finalized during detail design which will be in accordance with NFPA. The water for firefighting will be stored in fire water tanks which will be sourced from the raw water supply system of the plant.

- Hydrant Pumps: One (1) motor driven (main) and one (1) diesel engine driven pump (standby) of adequate flow will be provided for hydrant, MVW spray and sprinkler water requirements.
- Jockey Pumps: Two (2x100%) motor driven jockey pumps shall be provided.

Water Spray system (Deluge system)

- Automatic High Velocity Water Spray system (HVW Spray system): For all transformers located in the transformer yard and other transformers of rating 10 MVA and above.
- HVW Spray Pumps: No separate spray pumps are required as the water requirement shall be met from hydrant pumps.
- Automatic High Velocity Water Spray system (HVW Spray system): For cable galleries, cable spreader room, cable vault, cable riser/shaft in control room of main plant & switch yard building.

Automatic Inert gas fire extinguishing system

For main plant central control room (CCR) including above false ceiling and below false floor, control equipment rooms (CER) including computer room,

programmers room, UPS & INVERTER rooms including above false ceiling and below false floor. The system will be designed as per NFPA-2001.

Foam System for Fuel Tanks

Foam system will be used to protect the Fuel tanks and will be designed as per NFPA 11.

Portable fire extinguishers

Portable fire extinguishers shall be supplied for entire Plant including all buildings, equipment, etc. (***Table 3.17***)

Fire Detection, Alarm & Control System

For Power House building, switchyard control building, all auxiliary buildings, equipment, cable trays of cable spreader rooms etc. The fire detection alarm and control system mainly consists of main fire alarm panel, interface station, various types of fire detectors, repeater stations, local fire alarm panels etc.

Fire station and fire station equipment

Adequate size of Fire station and Fire station equipment will be provided as per NFPA requirement.

Table 3.17 Portable Fire Extinguishers with Requisite Quantities

S. No.	Type of Fire Extinguisher	Capacity
1	Pressurised water type (operated by CO_2 cartridge type)	9 l
2	CO_2 type	4.5 kg
3	Mobile type CO_2	22.5 kg
4	Dry chemical powder type	5 kg
5	Dry chemical powder type	2 kg
6	Mobile type dry chemical powder type	50 kg

3.10.2 Grounding

A grounding system designed for a fault level of 50 kA will be provided and designed in accordance with the IS/IEEE-80 standards to meet the requirements of safety and protective relaying. The earthing system will consist of MS rods for buried applications and GI flats for exposed earthing connections.

3.10.3 Lightning Protection

A lightning protection system for the Plant designed to satisfy the requirements of IS/BS-6651-1991 and IEEE 142-1991 standards will be provided in the Plant.

3.10.4 Underground Gas Pipeline Protection

The gas pipeline will be constructed in accordance with GSA specification and will be transferred to gas supplier 12 months after Simple Cycle COD.. The separation of this pipeline to the existing HSD pipeline and proposed water pipeline will be maintained as per **Gas Safety Rule 1991 and its amendment (2003) of Bangladesh**. It will be gas supplier's property as part of the gas supply network during our plant operation. The pipeline will have a minimum cover of 1.0 m on top of it. Cathodic protection will be in place for the buried section of the pipeline and the design will be based on soil resistivity. The gas supplier will ensure that there is no impact to adjoining communities as Bara Shimul, Punorbason Villages during its operation. The proposed alignment as well as the existing gas and HSD pipelines of the Sirajganj 1 project are on the eastern side of the approach road (on the embankment) and there are no habitations on that side except Police Station of Bangabandhu West. During the construction stage the following provisions for safety distances will be followed as per the applicable regulation:

- Safety Distance: The Safety Distance from the protected civil works will be 2.5 m from the edge of the pipe for pressure above 350 PSI and pipe diameter not greater than 20".
- If two High Pressure gas line crossed in underground, minimum 0.5m distance needs to be maintain vertically.
- If two High Pressure gas line laid parallel underground, minimum 1.5m distance needs to be maintain horizontally.

3.10.5 Health and Safety

Construction Phase

The Plant will be constructed, installed and commissioned and be operable and maintainable in full compliance with relevant health and safety requirements, all related acts, regulations, codes and statutory requirements of the Laws of Bangladesh.

The Construction Contractor will submit a Health and Safety Plan prior to commencing work on the Site.

The Health and Safety Plan will have method statements, which will include, but not be limited to, working methods, plant utilisation, construction sequence and safety arrangements. The Contractor's key duties will be to:

- develop and implement the Health and Safety Plan, including rules for management of the construction work;
- ensure that Sub-Contractors and workers comply with the health and safety plan;
- monitor the health and safety performance of Sub-Contractors and give directions as appropriate;
- arrange for competent and adequately resourced Sub-Contractors to carry out the work safety where it is subcontracted;

- ensure the co-ordination and co-operation of Sub-Contractors;
- obtain from Sub-Contractors the main findings of their risk assessments, the steps to be taken to control and manage the risks, including method statements for all aspects of the work;
- ensure that Sub-Contractors and workers have information about risks on Site and that there are co-ordinated arrangements for workers to discuss health and safety and offer advice to the Contractor;
- ensure that all workers are properly informed, consulted and trained on health and safety issues;
- ensure that only authorised people are allowed onto the Site; and
- pass information to the Employer for the health and safety file.

Operation Phase

The Company will implement an international standard environment, health and safety (EHS) program in the Plant, which will be in full compliance with relevant health and safety requirements, all related acts, regulations, codes and statutory requirements of the Laws of Bangladesh and of the World Bank. In addition, the Plant aims to be certified to OHSAS and ISO 14001 within 2 years of operation.

An offsite accident and emergency response plan to control and mitigate the effects of any catastrophic incidents in above ground installations (AGI) or underground installation (UGI) or road transportation will also be prepared by the project in consultation with the district administration. The offsite emergencies will also be communicated to the local people.

3.11 ANALYSIS OF ALTERNATIVES

The Project has considered alternatives in terms of site location, design and technology options. An analysis of these alternatives has been undertaken for the proposed Project including consideration of a no-Project scenario.

3.11.1 No-Project Scenario

The generation and supply of electricity has a significant impact on the national economy of any country. Presently, 68% of the total population has access to electricity and per capita generation is 348 kWh, which is significantly lower than other developing countries (Power Division 2015). [1] The total installed capacity of power plants in Bangladesh as of January 2015 is 10,817 MW, which includes 500 MW of imported power.[2]

In the public sector a number of the generation units have become very old and have been operating at much reduced capacities. As a result, their

[1] The neighbouring country India was having per-capita energy consumption in 2007-08 as 704.2 kWh (www.cea.nic.in), which in January 2012 is reported as 776 kWh per annum (The Wall Street Journal, January 3, 2012).
[2] www.bpdb.gov.bd (website of Bangladesh Power Development Board)

reliability and productivity has been poor. For the last few years actual electricity demand in the country has not been met due to a shortage of available generation capacity. In addition, due to a shortage of gas supply, some power plants are unable to reach their full generation capability.

The current supply-demand in Bangladesh also has a knock on effect on all other key sectors including agriculture, industry, commercial and domestic sectors. There is therefore no alternative to adding more power generating units to the existing power system of Bangladesh, to help improve and meet the energy demand for both domestic and industrial requirements.

The 'No Project Scenario' is also likely to have a negative effect on opportunities for employment, both directly from the proposed power project and its dependant sectors such as agriculture, industries and manufacturing that require stable power supply in order to operate and be competitive.

The electricity produced from the power plants are supplied to the distribution grid and GoB decides on the areas to which the power generated is to be supplied. So, though the power plant will be at Sirajganj, the local community in Project AOI may or may not benefit from the power generated. Therefore another perspective of the 'No Project Scenario' is whilst the country as a whole will benefit from power; the local area may get subjected to a disproportional impact vs the benefit to the whole nation.

3.11.2 With Project Scenario

Site Location

The Saidabad Power Generation Complex site was acquired by BPDB in 2005 to develop a major power generation complex in the north-west region of Bangladesh. NWPGCL (a subsidiary company of BPDB) has already constructed one 225 MW CCPP (Sirajganj 1) at this complex, which was funded by ADB under its Public Sector department. As per the master plan of the complex, space provision for three more power plants with capacity of 225 MW CCPP (Sirajganj 2), 225 MW CCPP (Sirajganj 3) and 400 MW±10%MW (Sirajganj 4) CCPP, respectively have been made. A 230 kV substation connects the complex to the national transmission system and the 30" East-West gas pipeline crossing the Jamuna Bridge is about 2 km from the site. Petrobangla has committed to provide gas to the Sirajganj complex. Considering the advantages of the present location described below, as well as the limited footprint and impacts, no alternative site location has been considered for the Project.

The site for the Project offers following advantages:

<u>*Technical*</u>

- Adequate area available for 300 - 450 MW dual fuel fired power plant and associated facilities;

- Proximity to PGCL Valve Station and small gas pipeline length required, (~ 2.0 km);
- Access to road and nearby water transportation networks;
- Proximity to the railway station/ siding;
- Available water supply source for process including cooling water;

Geological

- Geologically stable, moderate earthquake risks;
- Developed land with elevation above the highest flood level; and
- Constructed embankments for flood protection;

Social and Environmental

- No major sensitive environmental receptors (such as communities, hospitals, schools, etc.) in close proximity;
- No physical cultural resources on site and in close proximity (~500 m);
- Well connected with the National Highway through an access road developed specifically for the Saidabad Power Generation Complex;
- Already developed land with no physical displacement of people involved; and
- No resettlement requirements.

It must also be noted that the land for the Project was already identified by BPDB prior to the tendering process; therefore there was no possibility to explore alternative sites. BPDB selected the location, as 80% of the power plants in Bangladesh are concentrated in the eastern zone of the country close to the natural gas fields. This requires transmission of about 200- 300 MW from the eastern part of the country to western part. Thus, from this point of view, BPDB identified that power generation in the west is an urgent necessity. Jamuna multipurpose bridge is the only connectivity from the east to the west and locating the Sirajganj power hub nearest to the bridge is economic in terms of transporting raw materials (gas) to the site. Another key aspect of locating the Sirajganj power hub was its location adjacent to the 230/132 kV sub-station owned by PGCB which provides good access for the power produced from the power plant to transmission grid system.

Place in the Master Plan

In order to meet the demand of electricity in the country for the next 20 years, in 1995 BPDB prepared a Power System Master Plan (PSMP), with three alternatives scenarios High, Low and Reference. The PSMP was updated in 2005. This document identified several generation, transmission and distribution projects. NWPGCL along with Saidabad Power hub was one such identified Power hub which would cater to the peak demand of the country.

Further, there are other smaller plants in the western zone. Power from all these plants, together with the power imported from the eastern zone through the existing interconnector, are not sufficient to meet the normal demand of the western zone. Therefore, GoB and BPDB proposed installing the power

hub as an important step towards meeting the power requirements of the western zone[1].

In the existing scenario, about 400 - 500 MW is imported from the eastern part of the country. To minimize this dependence and cater to normal as well peak demand (as per PSMP), Sirajganj 4 was proposed to be developed.

Design

Plant Site

The BPDB had proposed to develop four power plants[2] within the Saidabad Power Generation Complex with all the four facilities being dual fuel fired. Primary fuel for the dual fuel fired power plants will be natural gas with a switch to HSD triggered after instructions from BPDB to operate on HSD in the event of a gas supply failure.

Transportation of Material

As previously outlined, the existing 6 m wide access road which connects the site with the national highway will be used for transportation of material to the site by road or from the nearby railway station. A temporary jetty will be used for unloading heavy plant components and machinery, manufactured outside of Bangladesh and shipped via ocean barges to Chittagong/ Mongla Port and then via inland waterways to the temporary jetty location in Sirajganj. Key raw material for power generation (i.e. natural gas/ HSD) will be transported by pipeline.

A Jetty has also been constructed at the south-eastern part of the Power Generation Complex; however this does not reach the current path of the Jamuna River or connecting channel. It was observed that the Jetty surface was at about 6 – 7 m higher than the water level in the nearby channel and is located about 50 m away from the channel. Considering this limitation, it has been proposed to use a temporary jetty located north of Bangabandhu Multipurpose Bridge, which was earlier used by NWPGCL during erection of 225 MW CCPP (Sirajganj 1).

Alternative Cooling Options

Two options available for cooling are once through cooling system and induced draft cooling tower. The channel close to the Jetty constructed by NWPGCL is not connected with Jamuna River throughout the year due to siltation. Therefore construction of intake and outfall for once through cooling system will not be cost effective and would require additional land area. In addition, once through cooling system will have impact on aquatic ecology due to the large quantity of cooling water that would be discharged with elevated temperature. Construction of a cooling tower will have cost

[1] http://www.powerdivision.gov.bd/user/brec/40/55

[2] Based on the information provided by NWPGCL and Sembcorp

implications, but it will reduce the water requirement for the Project as well as limit the quantity of warm water discharge from the project.

Adverse environmental and social impacts of cooling tower with respect to once through cooling system are limited and therefore, induced draft cooling tower has been considered in the Project design. This will also help in reducing the raw water requirement of the plant significantly.

Technology Options

The technology selected for the Project is based on the technology specified in the BPDB "Request for Proposal". No alternative technology option has therefore been considered.

As per the Request for Proposal, the simple cycle power plant (SCPP) will be ready for operation within 24 months from the signing of the Project Agreements including the PPA, FSA, GSA, IA, LLA and the SPA, whereas combined cycle power plant (CCPP) will be ready for operation within 36 months the signing of the Project Agreements. Advantages and disadvantages of both the options are presented below:

Simple Cycle Power Plant (SCPP)
The SCPP generates power by converting the heat and kinetic energies of hot, high pressure jets of gas into mechanical energy through the use of rotary blades, which in turn drives an electrical generator.

Advantages:

- Is a widely used technology for power generation;
- Has standardized design and manufacturing process;
- Has a wide range of capacity available: from 0.5 to 260 MW/unit;
- Requires a small area for the plant footprint Combined Cycle;
- Has a short construction period (1 to 18 months) due to standardized designs as compared Combined Cycle;
- Has flexible operation mode: can start-up and shutdown rapidly (referred to as "minimum up"), and can deal with rapid load changes; and
- Limited water requirement in comparison to Combined Cycle.

Disadvantages:

- It has a low thermal efficiency of about 32 - 38% at ISO standard conditions;
- Requires high quality fuels;
- Has high maintenance costs; and
- Requires expensive fuel treatment equipment and inhibitors for reducing hot corrosion if low quality fuels, such as HFO or crude oil are used. The capacity, efficiency and operating lifetime of the units will be considerably reduced.

Combined Cycle Power Plant (CCPP)

In the CCPP, a combustion turbine (CT) and steam turbine (ST) are used in combination to achieve greater efficiency. The gas turbine drives an electrical generator and the turbine exhaust is used to produce steam in a heat recovery steam generator (HRSG). The HRSG is then used by the ST to drive an electrical generator, providing the means to generate more electricity per unit of fuel. The proposed Project CCGT configuration will include 1 CT, 1 HRSG and 1 ST.

Advantages:

- Has standardized design and manufacturing process;
- Broad power capacity range: from 30 to 1,000 MW;
- Its footprint is smaller than that required for conventional thermal power plants;
- The construction period is short (~ 24-30 months) in comparison a conventional thermal power plant (~36 months);
- Has flexible operation features, such as it starts up and shuts down rapidly, and can be adjusted to rapid load changes;
- Is very efficient; can reach 57% at ISO standard conditions; and
- It has the lowest environmental impact with respect to other thermal power generation options.

Disadvantages:

- Requires high quality clean and pure fuels; and
- Economic lifetime of between 20-25 years.

Thus, the technology option proposed for the Project is the best suited option taken into consideration by BPDB. It has also been reported that the proposed Sirajganj 4 project, will be one of the most efficient power plant in Bangladesh

Alternative Fuel Options

The fuel option was already stipulated in the RFP issued by NWPGCL based on its analysis of the existing and available options in the country. A brief description of the existing renewable energy scenario in the country is presented to capture its availability/consideration in the proposed project.

Out of various renewable sources hydropower, geothermal, solar, tides, wind, biomass, and bio fuel can be effectively used in Bangladesh. To rule out a few, the progress of wind in Bangladesh has not been impressive and limited only to coastal regions. Micro hydro power projects can only be installed in the north-eastern hilly region of Bangladesh. Solar and biomass are the only potential renewable energy resources of the country which can be utilized in the inland plains. Solar power for a 414 MW power plant would occupy a vast

area of land[1] for installing the solar panels or PV modules and can be ruled out for the proposed location. Also solar radiation varies in Bangladesh from season to season and cannot serve as a dependable source of energy.

Bangladesh is an agricultural country and biomass is available in huge quantity. Rice husk as a biomass fuel is being explored as source of renewable energy and has the capacity to produce 364 MW electricity from 20% i.e. 7,000,000 metric tons of the total rice production of Bangladesh in 2010-2011. There are two biomass gasification based commercial power plants: a 250 kW in Gazipur, and another 400 kW in Thakurgaon[2]. The biggest renewable energy program in Bangladesh is solar home system (SHS). In Bangladesh, SHS project has been implemented under Infrastructure Development Company Limited (IDCOL) and so far installed 900,000 units and still increasing due to an integrated program undertaken by the government through its financial institution, IDCOL. IDCOL's program is considered as a successful model for installation of SHSs in the world. Till now, national capacity of renewable energy based power is approximately 50 MWe[3]. Of them, solar home system alone produces 45 MWe, wind energy produces 2 MWe, and biomass share is not more than 1 MWe.

From the above discussion it is clear that efficient utilization of renewable energy resources is yet to assume commercial dimensions in Bangladesh. In absence of the acceptable commercial renewable options, the chosen fuel seems to be the best available alternative.

Construction Camp and Laydown Area

For the location of the construction camp and laydown area, three locations were considered, (a) within the power generation complex, (b) area between the national highway and railway line near the Bangabandhu memorial (C1), and (c) the area available between the national highway and Punorbason Village fence line (C3). However, as the Sirajganj 2 project is expected to begin construction activities around the same time as the Sirajganj 4 project, the location within the power complex is presently not available for the construction camp and laydown area.

Of the other two possible locations identified by Sembcorp, C1 and C3, C1 has been identified for laydown area, whereas C3 has been identified for the construction phase labour camp. The following table provides an understanding of the two areas

[1] Daily average solar radiation varies between 4 to 6.5 KWh per square meter.(Ref; Present Sceanrio of Renewable Energy in Bangladesh and a proposed hybrid system to minimize power crises in remote areas by Nahid-ur-Rahman Chowdhury et al, International Journal of renewable energy research, 2012

[2] Infrastructure Development Company Limited (IDCOL) http://idcol.org/home/other_re

[3] Renewable Energy Bangladesh, Power Division, Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh, http://www.powerdivision.gov.bd

Table 3.18 Laydown Area and Construction Camp Locations Identified

Features	C1	C3
Total Area	10.95 acres	15.6 acres
Land Features	• The land is flat and is connected with a Jamuna Bridge Patrolling Road and also goes towards Jamuna Eco Park, which is used by the general public. • The area is bisected by a 2m x 1 m concrete open drain • At the eastern part of the land, railways sleepers were observed in an area of about 900 sq. m • No transmission line or gas pipeline pass through the area	• The land is located between the main highway and Punorbason (Resettlement) Village • The land is characterised by an elevated land, near the highway whereas the land between the road embankment and the village fence line is low lying • The elevated portion of the area is bisected by the Main Gas Pipeline corridor, of about 5-6 m width. • The area also has an embankment of about 1.6 acres, which cannot be used as a laydown area or for the labour camp due to the slope • The lower portion is approx. 8.37 acres (marked in green in Figure 6.14), and is characterised by two transmission lines of 11 KV (marked in black), NWPGCL's HSD pipeline (marked in orange) as well as numerous pedestrian access routes. These routes are being used by local villagers and they had cut fence at these places to have direct access to the main road and railway station. • This portion also serves as an accumulation point for runoff water from the highway and elevated areas as well as the drainage from the Punorbason Village, due to the terrain. • A 2-3 m wide village road is also present on the western side of this stretch, which provides the shortest access to the main road from Punorbason Village. • During the site visit, it was also observed that local village people also use this area for drying their crop as well as for cattle grazing. • Furthermore, it was observed that about 8-10 new hutments are currently being constructed on the eastern part of this land by local villagers.
Proposed Use	• Overall, the area is suitable for the use as laydown area including heavy equipment storage	• Overall, the area can be used for the labour camp during the construction phase, with certain mitigation measures put in place.

The Figure 3.18 shows the location of the laydown area identified (C1), while Figure 6.14 showcases the construction camp area identified.

Figure 3.18 Laydown Area Identified- C1

The reasons for C1 being identified for laydown area and C3 for construction camp are as follows:

- The area C1 is located on the opposite side of the highway from the project, thus, which would increase the risk of road accidents of labourers, if the labour camp is constructed there, as the traffic flow in the area is of a speed of more than 60 km/hr.
- Due to the presence of the Main Gas Pipeline Corridor in the C3 area, only an approx. 10 m wide corridor is available for the laydown in the elevated stretch
- Due to the proximity of the Punorbason Village (less than 10 m), C3 cannot be used for material storage, and the only option is to use the area for a construction camp.

However, the use of C3 for the labour camp may result in certain risks, which have been discussed along with their mitigation measures in ***Section 6.4.10***.

Water Intake Location

The river Jamuna has two prominent channels near proposed plants, one near the West Guide Bund (WGB) and other near East Guide Bund (EGB). Water from the Jamuna right channel will be extracted for cooling purpose. On top of that, there is seasonal variation of water level throughout the year. Therefore, thorough analysis has been undertaken to locate the intake facility.

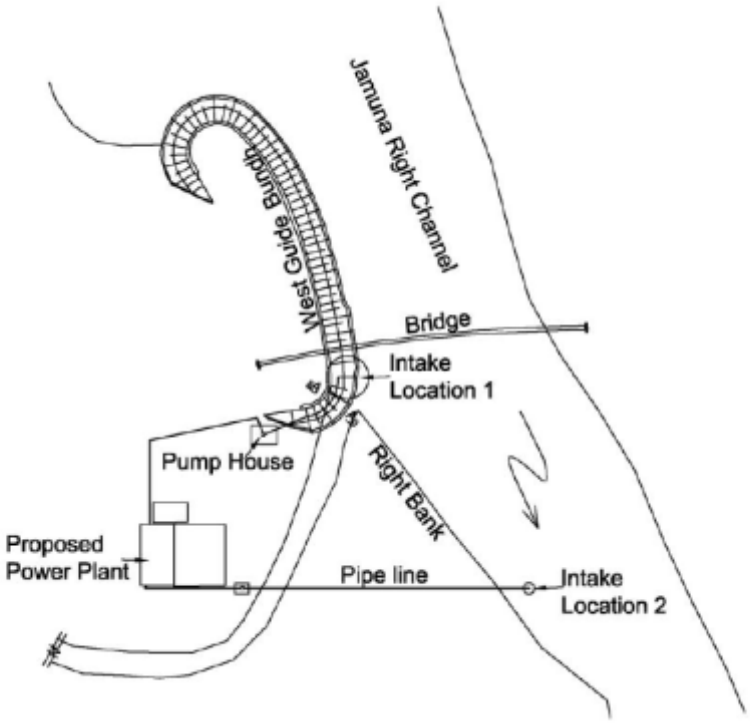
The water intake facility needs to be developed for withdrawal of surface water from nearby right channel of the Jamuna River and delivery of the surface water to the Sirajganj 4 Plant for cooling and other purposes. The required water withdrawal amount is about 600 m^3/hr. The existing Sirajganj 1 project is extracting ground water for their cooling purpose and other requirements. Sirajganj 2 project is also planning to use ground water, whereas at present there is no information about the source of water for

Sirajganj 3 project and it is assumed that this plant will also be dependent on ground water. Considering this fact and to receive mineral free water, Sirajganj 4 project has decided to install a surface water intake facility for Sirajganj 4 project.

Probable Intake Locations. Two intake locations were considered, one at downstream part of West Guide Bund (Location–1) and the other just opposite to proposed power plant (Location–2) as shown in Figure 3.19. The following four factors were mainly considered for selecting suitable intake point.

- Presence of near bank channel
- Near bank erosion/scour,
- Extent of char, and
- Suction pipe length

Figure 3.19 Proposed Intake Locations



Source: IWM Study

Location 1

The IWM study on selection of the intake location indicates that Location 1 has been selected to be located at the downstream end of the WGB (Figure 3.19). The last 10 years satellite images show that there is possibility of temporary char formation in this location. Maximum extent of char was found to be 910m in year 2011. This extent of char is the lowest comparing other locations in the vicinity of power plant and significant char at this location formed in only three years out of the last 12 years. In addition, pilot dredging has been accomplished along the right channel of Jamuna River at Bangabandhu Bridge site. According to cross-section survey carried out as part of the study, the extent of char is negligible along this location. Hence, abstraction of water from Location 1 was found to be feasible.

Location 2

In this location, the suction pipe line will need to cross a small channel besides the Power Plant (*Figure 3.19*). Moreover, the extent of char formation along this pipe line route is significantly higher. According to IWM study cross-section survey, the required suction pipe line length would be 1740 m. And analysis showed that the char extent could be up to 1860 m. Further, there is possibility of pipe line exposure due to bed scour. In addition, pump operation with a suction pipe length amounting to around 1800 m would be less efficient.

As such, Location 2 was ruled out based on the above analysis. It is noted that from bank erosion and near bank bed scour point of view, the proposed intake point (Location 1) at the downstream end of West Guide Bund is considered safer.

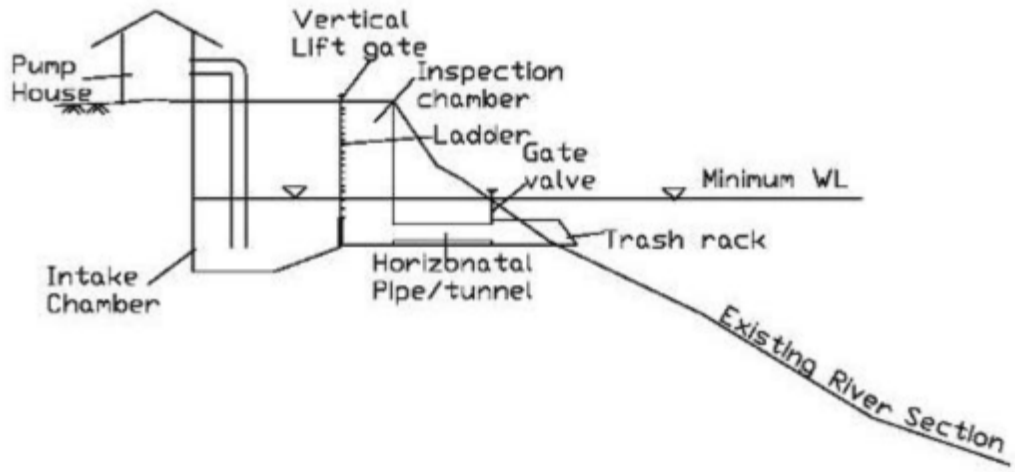
Water Intake/ Abstraction Mechanism Alternatives

Three alternatives were considered as described in the following sections.

Alternative 1

Pump house coupled with intake chamber (suction sump) will be located onshore as depicted in Figure 3.20. The mouth of the intake will be located below the lowest water level to guarantee water supply in lean flow periods and will be ahead of maximum extent of char to overcome possibilities of getting silted up. Two horizontal underground tunnels of diameter >= 900 mm will be laid extending from the intake mouth to the intake chamber. Surface water will be transferred to the intake chamber via the tunnels and stored there. Water will then be pumped up from the intake chamber to the power station. The purpose of installing two horizontal tunnels is to facilitate maintenance of the alternative underground tunnel including human movement along the tunnel during inspection. In this alternative, the pump will lift water directly from the intake chamber and surface water will flow to the intake chamber from the river under gravity action through the tunnels.

Figure 3.20 Typical Section View of Alternative 1



Source: IWM Study

Maintenance will be possible during all seasons. One gate valve will be installed at the river end of the tunnel and another vertical life gate will be installed at the intake chamber just before the intake chamber. An inspection chamber will be constructed just outside of the intake chamber. With this inspection chamber, it will be possible to get inside the tunnel. During maintenance, the gate valve at the river end and the vertical life gate at landside end will be closed. This way the tunnel under maintenance will be water tight. Water can then be pumped out from the tunnel to allow entrance to the tunnel via the inspection chamber. Trash rack needs to be provided at the intake mouth to prevent larger floating debris from entering inside the tunnel. Cleaning of debris can be performed during low flow.

This alternative has some disadvantages. The horizontal underground tunnel may become silted up. So the tunnel needs to be inspected regularly. Moreover due to uncertainty, there is risk of them both being completely silted up at the intake mouths even if they were constructed beyond the maximum extent of char, requiring dredging. Also, construction of a trash rack at the intake mouth and lay out of horizontal tunnel required deep excavation and dewatering.

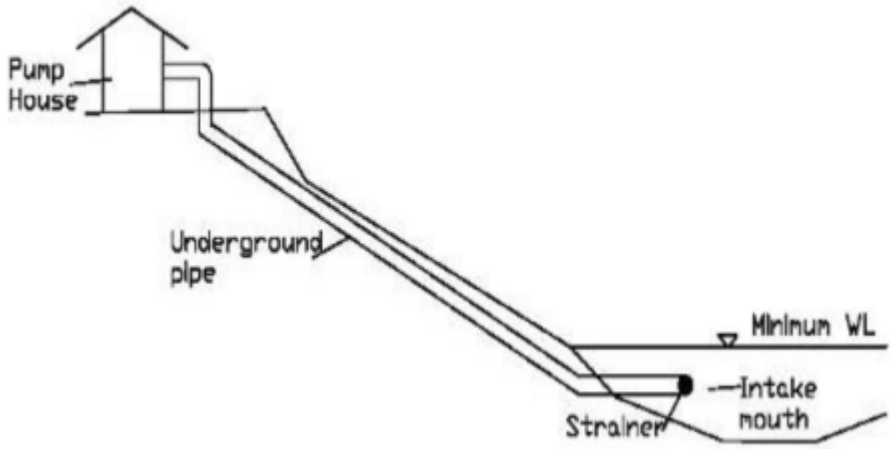
Alternative 2

According to this alternative, the pump house will be installed at the near bank. The intake of suction pipe will be located below lowest water level to guarantee water supply in lean flow period and will be ahead of maximum possible extent of char to overcome possibilities of getting silted up. In the end, it will ensure constant water supply to the cooling tower.

In this alternative, the suction pipe line will be laid mostly below the existing river bank and river bed ranging from intake mouth to pump as shown in the Figure 3.21. Water will be pumped directly from river that will necessitate

higher capacity pump due to long suction pipe. Strainers should be fitted to the water intake point of suction pump to protect the pump impellers.

Figure 3.21 Cross-section View of Alternative 2



Source: IWM Study

This alternative has advantage such as there is no chance of getting silted up pipe. Due to uncertainty on char formation, there is mild risk of the intake mouth becoming silted up even if it is placed beyond the maximum historical extent of char. However, the pump can still function with a silted up mouth. The pipe needs to be laid below the scour level to avoid being exposed.

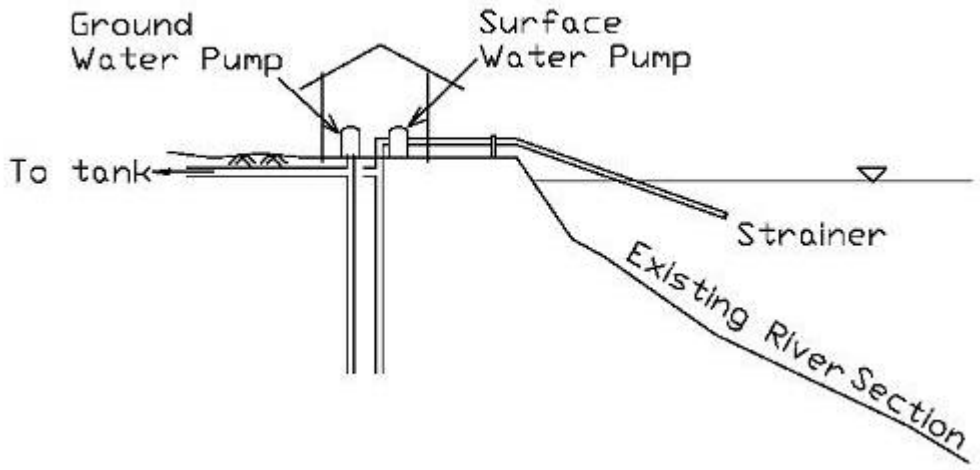
Sufficient sand filter media needs to be placed around the pipe intake mouth to guarantee constant water supply. In case the intake mouth is silted up, water will be readily available through this coarse filter media.

Alternative 3

In this option, surface water can directly be extracted from near bank channel during high flow period. However, during lean flow period channel is expected to be away from bank line. In that period, ground water will be extracted through pump instead of surface water abstraction. For groundwater abstraction, submersible pump may be installed. In addition another centrifugal pump will need to be installed at pump house for pumping surface water. Figure 3.22 presents this Alternative 3. No special arrangement needs to be implemented for surface water withdrawal during high flow period. Arrangements will be there to join the pipe with the pump as and when required. If necessary, additional pipe can also be added to the pipe line to extract surface water. Pipe will be laid over ground surface. The mechanism for surface water abstraction will require lowering the pipe below the river water level and pumping the surface water. As soon as river water level goes below a certain level, the centrifugal pump will reach its threshold capacity and groundwater abstraction will start. In this alternative, the chance of getting s silted up intake mouth is absent. However, screens (fine mesh

screen/ wedge wire screen/ aquatic filter barrier system) at the mouth will be required in order to reduce the risk of impingement and entrainment of aquatic life.

Figure 3.22 Cross-section View of Alternative 3



Source: IWM Study

Multi Criteria Analysis

The following multi-criteria analysis has been done as part of the IWM study to select the most suitable alternative out of the three selected alternatives as proposed.

Table 3.19 Multi-Criteria Analysis of Water Intake/ Abstraction Mechanism

Alternative Selection Criteria	Alternative 1	Alternative 2	Alternative 3
Economy in terms of construction expenditure	--	+/-	+
Safety in terms of siltation at intake mouth	+/-	+	++
Navigability at near bank channel	+/-	+	++
Economy in terms of maintenance and monitoring expenditure	-	+/-	+
Fulltime surface water abstraction	++	++	--
Simplicity of Construction work	-	+/-	+

Note: Very poor (--), Poor (-), Average (+/-), Good (+), Excellent (++)

Considering economy, navigability and safety in terms of siltation at intake mouth the decision matrix suggests Alternative 3 is the most promising. However, considering the all-weather availability of surface water from the

river and no withdrawal of ground water, Alternative 2 has been considered as the preferred option for water abstraction.

Pump House Location

Initially pump house installation over the bank of West Guide Bund was considered. But as the pipe and intake chamber cannot be laid out through guide bund slope protection measures, this location was ruled out. The pump house location is intelligibly selected at immediate downstream of WGB. Due to presence of WGB, the location is safe; no significant threat of bank shifting is present here. Moreover, the pump station will be constructed sufficiently inside bank line. Hence protection against erosion and scour is not necessary.

3.11.3 Conclusion

The 'No Project Scenario' is likely to have a negative effect on opportunities for employment, both directly from the proposed power project and its dependant sectors such as agriculture, industries and manufacturing that require stable power supply in order to operate effectively and be competitive. This will further affect the proposed industrial development in the Sirajganj District.

The site location is well suited for setting up of power plant with availability of adequate availability of land, water, access to road, rail and waterways, fuel source/supply arrangement. Associated facilities, such as, water intake and abstraction mechanism, pump house location, construction laydown and camp areas have also been selected based on the basis of alternative analysis and selection of best suited option.

The project design has considered embedded pollution control systems, which include NOx control, stack height for dispersion of pollutants, use of cleaner primary fuel (natural gas), use of Jamuna river water for the Project as opposed to ground water, induced draft cooling tower for reducing water requirement and no direct discharge of cooling water into Jamuna River/ Channel.

Best suited technological options have been considered by BPDB and the dual fuel system has been selected to provide more reliability of power generation.

To conclude, many of the alternatives as site location, gross capacity, fuel options were not directly under purview of Sembcorp as the proposed project will be implemented through a PPP model (with 29% stake of NWPGCL). . Within the available alternatives, Sembcorp has opted for best suited technological option for power generation.

4 BASELINE ENVIRONMENTAL CONDITION

4.1 THE ENVIRONMENTAL BASELINE

The baseline conditions define the physical and biological conditions that prevail in the Project Study Area. It includes information on all receptors and resources that were identified during the scoping stage of the Impact Assessment process as having the potential to be affected by the Project, as well as have an impact on the sustainability of the Project.

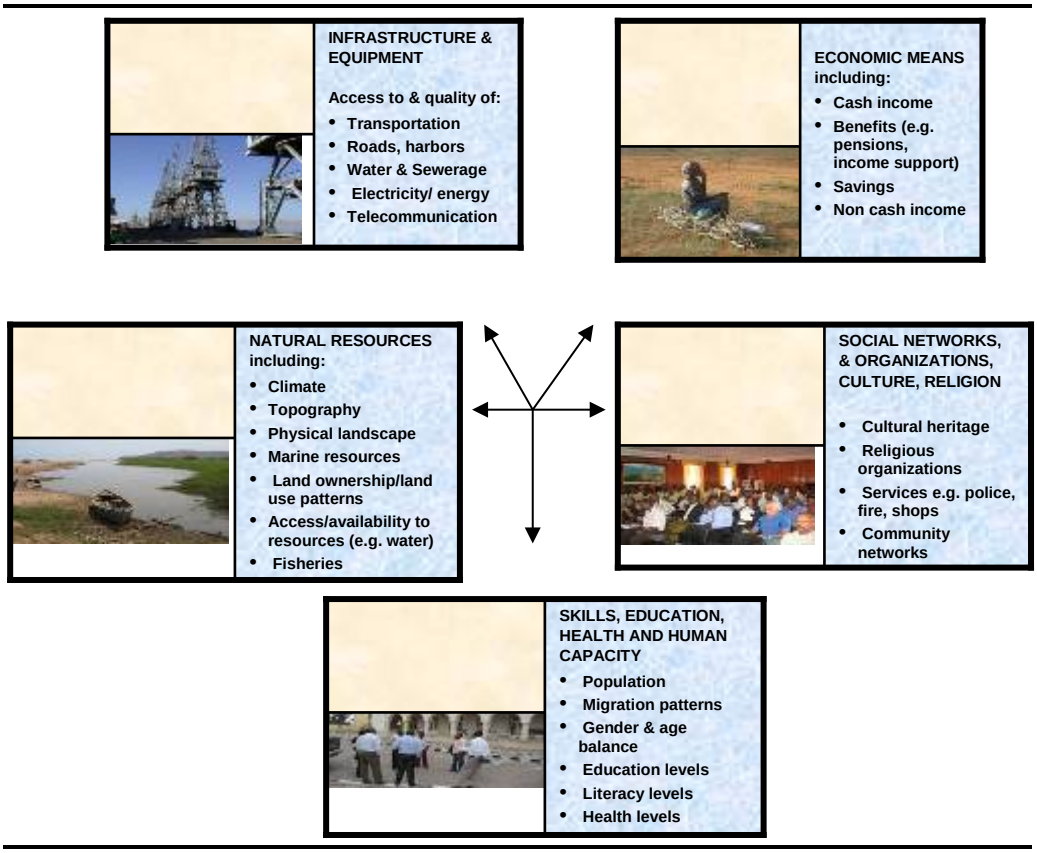
This section describes the environmental baseline conditions in the Study Area (defined below). The analytical framework for the impact assessment is based on the sustainable livelihoods framework (1), which focuses on putting people at the center of development (refer ***Figure 4.1***). The baseline therefore describes the interrelated resources and receptors, which in the livelihoods framework are termed 'capital'. The five broad areas of resource and receptors on which livelihood depends are as follows:

- **Natural Capital** – natural resource stocks, which include *physical* (e.g. climate topography, land use), *terrestrial* (e.g. flora, fauna), and *aquatic* (e.g. benthos, fisheries);

The baseline studies were carried over a period of three months from December 2012 to February 2013 (air, noise, soil, sediment, water and traffic) as part of an earlier EIA of the same project as well as an update over two weeks in February 2015 for this EIA Study (air and noise) and additional field surveys and consultations in May and June 2015. Reference has also been included to secondary sources.

(1) "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustained when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base." (UK Department for International Development – DFID)

Figure 4.1 Resources and Receptors as per Sustainable Livelihoods Framework



4.1.1 Project Site

The Project site is located in Saidabad Union of Sirajganj Sadar Upazilla (Sub-district) in the Sirajganj District of Bangladesh. The detail of the Project location along with site surroundings has been discussed in ***Section 3***.

4.1.2 Area of Influence

The Area of Influence (AOI) of the Project comprises of the Project Site and the surrounding area, where influence of the Project activities is anticipated. The areas likely to be affected by the Project and its associated activities may include:

- the project activities and facilities that are directly owned, operated or managed by the project proponent (including by contractors) and that are components of the project, such as the power plant, gas pipeline, water pipelines and transmission line to the power grid sub-station;
- impacts from unplanned but predictable developments caused by the project that may occur later or at a related location such as increase in traffic on the approach road;
- impacts on biodiversity or on ecosystem services upon which affected communities' livelihoods are dependent;
- associated facilities, that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable; and

- cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted e.g. existing Sirajganj 1 power plant, proposed Sirajganj 2 and 3 power plants of similar capacity and fuel types and proposed industrial area in the surroundings[1].

Further to this, the AOI with respect to the environmental and social resources was considered based on the following reach[2] of impacts:

Air Quality

- Gaseous pollutants (e.g. NOx, CO and SO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$)–typically up to 2-2.5 km from operations;[3]
- Cumulative impact of air pollutants emission from Sirajganj 1, 2, 3 and 4 projects; and
- Dust fall –typically up to 200 m from construction activities.

Noise

- Noise impact area (defined as the area over which an increase in environmental noise levels due to the project can be detected) –typically 500 m from operations and 100 m from the access roads; and
- Cumulative impact of noise generation from Sirajganj 1, 2, 3 and 4 projects

Water

- Surface water body –typically 500 m upstream and downstream of water intake point and 1-1.5 km upstream and downstream of discharge point.
- Other Surface water bodies within 2-2.5 km of the project footprint
- Ground water in 1-2 km radius of project footprint.

Flora and Fauna (Terrestrial and Aquatic)

- The direct footprint of the project comprising the project site.
- The areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence and project related activities (e.g., trampling, water intake/outfall, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas of about 500 m to 1 km from the activity areas.

[1] [1] An industrial area development project, namely "Sirajganj Economic Zone Development Project" is conceptualised adjacent to the Saidabad Power Generation Complex. The total area of this project is about 1041.43 acres. The land acquisition process in underway, however, details of the type of industries proposed in this industrial area are currently not known.

[2] Distance based on ERM's experience with similar projects

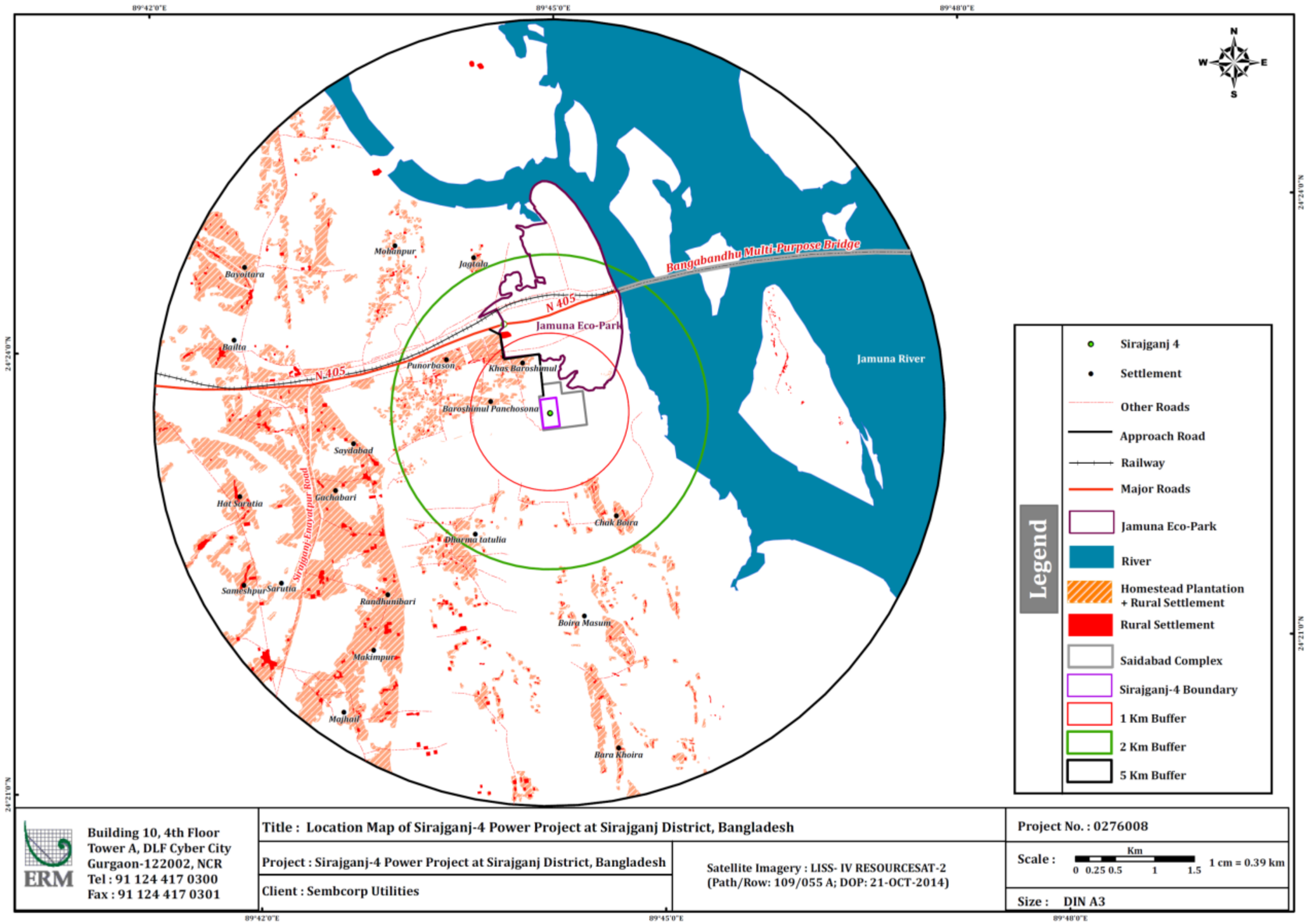
[3] The air quality dispersion modelling results also indicated that the maximum ground level concentration in all cases will occur between 1.5 to 2.0 km from the project site.

Resources

- Bridge of national importance, the Bangbandhu Bridge at approximately 1.75 km from project site.

Based on the above the AOI for environmental studies was limited to 5 km from the Project site.

Figure 4.2 *AOI at 5 Km from the Project Site with Receptors Locations*



Source: **Based** on Satellite Imageries, field surveys, Local GIS and LGED maps.

4.2 OBJECTIVE AND METHODOLOGY

The primary objective of the environmental and social baseline study is to provide a baseline against which potential impacts from the construction, operational and decommissioning phases of the Project can be assessed.

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

- Reconnaissance survey for scoping was carried out in January 2015 for the current study and in November 2012 for an EIA study of the same project. The detailed environmental and social field monitoring and survey was carried out during the period of February 2015 and December 2012 to February 2013 as well as additional field surveys and consultations in May and June 2015;
- Study area of 5 km radial zone from the centre of the proposed Project location was selected for the baseline studies considering the location of project components, associated components and nature of project activities;
- Primary environmental data collection was through monitoring and field survey for water, air, soil, sediment, noise, traffic and ecology;
- Social baseline of the study area was captured through 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 NATURAL CAPITAL: PHYSICAL ENVIRONMENT

4.3.1 *Landuse/cover - AOI*

Land use/cover inventories are an essential component in land resource evaluation and environmental studies due to the changing nature of land use patterns especially because of the Jamuna River in the AOI. The land use study for the proposed power plant and its 5 km buffer was undertaken with the following objectives:

- To study the land use/cover in the 5 km radius areas of the proposed power plant site and provide inputs for environmental planning of the proposed plant by analysing the existing land use/land cover scenario. For this the 5 km radius was divided into 3 radial zones of 1 km, 2 km and 5 km and detailed breakups of these radial zones were analysed to get a clear understanding of the landuse/landcover;
- To establish the existing baseline scenario using a GIS database for incorporation of thematic information on the different physical features including drainage and water bodies, settlements, transport networks and administrative boundaries etc.

- To identify and map the waterbodies, drainage and the streams in the study area.

Methodology

In the present study for delineation and analysis of land use / land cover, cloud free multi-temporal Satellite Imagery of IRS LISS- IV RESOURCESAT-2 (Path/Row: 109/055 A; DOP: 21-OCT-2014) has been used for Kharif seasons[1] (August to November) of 2014[2]. The details of the scenes, multi-spectral bands, spectral and spatial resolutions and date of pass are given in ***Table 4.1***. The date of over pass is optimum for classifying the Kharif crop / vegetation as it is in the peak of the season. Besides multi-spectral data set, reference sheets provided by the Local Government Engineering Unit, Local GIS Units and field surveys were used for detailed mapping of roads, railway line, etc. Land use classification was however analysed using the individual multi-spectral scenes only. The LANDSAT-ETM satellite data (geo-referenced) is used for Geo-referencing of the other reference maps/imageries.

All the data sets were processed using the ARC GIS software (version 10). All vectors are prepared with the following projection parameters:

- Projection Type: Transverse Mercator
- Spheroid Name: WGS 84
- Datum: WGS 84
- Zone: 45N

The area has good coverage of homestead vegetation which shows great mixing in digital classification. For better accuracy, land use /cover analysis was carried out using on screen visual interpretation technique. Different landuse classes were digitized as vector layer keeping the imagery on the back drop. These landuse vectors were stored separately, corrected topologically and assigned codes for individual landuse class. Area calculation done using the calculate geometry tool.

Table 4.1 Details of Satellite Data used in the Study

Satellite and Sensor	Orbit/row	Date of Pass	Spatial Resolution (meters)	No. of bands and Band width (Microns)
LISS-IV		15.1.2010	5.8	G : 0.52 – 0.59 R : 0.62 – 0.68 NIR : 0.77 – 0.86
Landsat 8(OLI)	LC8138043201 4304LGN00	31.10.2014	15	Coastal/Aerosol :0.433 - 0.453 B-G : 0.450 - 0.515 G: 0.525 - 0.600

[1] Due to non-availability of cloud free imageries of other season crops only kharif season crop could be studied.

Satellite and Orbit/row Sensor	Date of Pass	Spatial Resolution (meters)	No. of bands and Band width (Microns)
			R: 0.630 - 0.680 IR: 0.845 - 0.885 SWI : 1.560 - 1.660 SWI: 2.100 - 2.300 PAN: 0.500 - 0.680 Cirrus : 1.360 - 1.390

Landuse Interpretation of the Study Area

The evaluation of the existing environmental status of the study area was divided into 3 radial zones of 0-1km, 0-2 km and 0-5 km around the Project site. This revealed that the land use/land cover consists mainly of agricultural land, homestead plantation, built-up, wasteland, wetlands and water bodies on Level-I classification. A further detailed classification into Level II and Level-III was also carried out and the statistics for all the 3 zones and level classifications are presented in ***Table 4.2***. ***Figure 4.3*** gives the Land use/Land cover map for the AOI.

Brief descriptions of the land uses/land covers assessed in the AOI are provided below:

Built-up Land[1]

Built-up Land is defined as an area of human habitation development due to intensive non-agricultural use. They appear in dark bluish green in core built-up area and bluish in the periphery irregular and discontinuous in appearance in satellite imageries. These areas are classified and mapped using satellite data. Due to the large number of homestead plantations, the settlements are not clearly visible in the satellite imageries. The major categories discernible on the satellite data within the study area include several rural residential areas and very marginal mixed built-up areas. Settlement areas are very scattered. In the island areas settlement patches are visible adjacent to the Riverbed cultivated areas.

Some industrial activities are also seen within the study area. The proposed project site is located in such an area. Built up area including the rural settlement, Mixed Built Up, Transportation/open land and Industrial area acquired land covers only 2.46% of the 5 km buffer area around the proposed site.

Agricultural Land

Agricultural landuse by and large is dependent on agro-climatic condition prevalent in the area. Cropped areas appear in bright red in colour with varying shape and size in a contiguous to non-contiguous pattern. Due to the

[1] Built ups are normally hut/cottage like structures. Proper concrete structure is not common in the AOI therefore the reflection is less and creates problem to pick the settlements properly. Settlement location with considerable size were only counted as otherwise the whole map gives a salt pepper effect..

non-availability of the cloud free data, only the Kharif season satellite data is analysed and the single crop (Kharif only) is classified and mapped. The riverbed cultivation areas were found to be confined to the areas around the Jamuna river and other natural drains and streams.

Agricultural land is the major land use class in the study area as agriculture is the main source of livelihood in the area. The total agriculture area is 29.806 sq.km (38.04%) comprising of Kharif crop lands, River bed cultivation and fallow lands. Fallow land observed is 12.946 sq. km (16.52%) lying vacant during this cropping season of the total land cover.

Wasteland

Wasteland is described as 'degraded land' which can be brought under vegetative cover with reasonable effort and which is currently under-utilized for the lack of appropriate water and soil management or on account of natural causes. In the study area existent wasteland classes are those sandy areas of Jamuna River as well as the scrub lands near the river sides. The width of the Jamuna River is large and therefore sedimentation and siltation occur on the river banks. Those areas covered under sedimentation and river sand are unused landuse of the study area buffer. These areas are barren and with high reflectance and easily marked in the imagery. Area under sand cover is categorised as waste land within the project buffer. Some areas are covered with dried scrubs which are also included under this class.

Wasteland is a very important category of landuse class of the study area. Total area under wasteland is recorded as 15.082 Sq. Km (19.25%) of the total geographical area of the studied 5 km buffer zone.

Water bodies

River/streams, tanks are the important waterbodies seen in the study area. The major river in the study area is Jamuna River flowing along the eastern most corner of the proposed project site. This river is used for navigation purpose also. Within the AOI, the streams and natural drainages are found to be discontinuous. At some places drainages break and develop some waterbodies. In some places dark patches of water like signature were observed but interestingly those places are under cultivation. Water bodies cover 22.210 Sq. Km (28.34%) of the total geographical area of the 5 km buffer zone. The river Jamuna covers 18.469 Sq. Km (23.57%) area.

Plantation

Plantation appears in dark red to red tone of different sizes with regular and sharp edges in satellite images. The area covered under Plantation is 2.020 Sq. km (2.58%). This category includes the entire agricultural plantation as well as the roadside plantation and plantation in the Jamuna Eco Park. Along the major roads good plant cover are visible. Jamuna Eco Park is a considerable feature falling in this category. This park has lots of plantation maintained by the forest department. It shows very dark signature like forest in the imagery signifying its thick plant density.

Others

Homestead Plantation is also an important class observed in the study area. Scattered patches of homestead plantation with different sizes are observed. Due to these homestead plantations, the settlement areas are not visible properly in the satellite imageries. Homestead plantation with rural settlement covers 7.308 Sq. Km (9.33 %) of the study area.

From the landuse/land cover assessment it can be concluded that majority of the area is under agriculture in the 5 km AOI. Under agricultural landuse, fallow land is more than the cropland. However, this may be the scenario because present statistics are drawn based on Kharif season imagery and the crop area will definitely increase with the addition of the Rabi crop. The next major category is waterbodies followed by wasteland and plantations in the AOI. Landuse under built up is the lowest.

Landuse Interpretation of the Fuel Pipeline with 100 m buffer

In order to evaluate the land use/ land cover along the pipelines associated with the project, a 100 m buffer on both side of these pipelines has been considered and studied based on the satellite imageries and other resources including ground trothing of these areas. This revealed that the land use/land cover within the 100 m buffer of the fuel pipelines consists mainly of built-up land (36.65%), waste land (30.71%), agricultural land (14.55%) and homestead plantation with rural settlement (12.96%), whereas within 100 m buffer of the water pipeline the landuse/ land cover mainly consists of waste land (31.36%), plantation (27.68%), built-up land (14.16%) and agricultural land (12.69%). A further detailed classification into Level II and Level-III was also carried out and the statistics and level classifications for the fuel and water pipelines are presented in Table 4.3. Figure 4.4 and Figure 4.5 gives the Land use/Land cover map along the fuel and water pipelines with 100 m buffer.

Table 4.2 Landuse/ Land cover statistics of the Project AOI

Level-1	Level-2	Level-3	1 km Radial Zone		2 km Radial Zone		5 km Radial Zone	
			Area (sq.km)	% of Area	Area (sq.km)	% of Area	Area (sq.km)	% of Area
Built-up	Rural	Rural Settlement	0.002	0.050	0.060	0.48	0.575	0.73
		Mixed Built Up	0	0	0	0	0.007	0.01
		Transportation/ Open Land	0.046	1.47	0.745	5.93	1.074	1.37
	Industrial	Saidabad Complex	0.273	8.690	0.273	2.18	0.273	0.35
		Sub Total	***0.321***	***10.22***	***1.078***	***8.58***	***1.929***	***2.46***
Agriculture	Cropland	Kharif Crop	0.361	11.51	1.759	14.01	13.081	16.69
		Riverbed Cultivation	0.290	9.23	0.868	6.91	3.779	4.82
	Fallow Land	Fallow Land	0.382	12.17	2.468	19.66	12.946	16.52
		Sub Total	***1.034***	***32.81***	***5.095***	***40.58***	***29.84***	***38.08***
Waste land	Waste Land	Scrub Land	0.229	7.29	0.349	2.78	1.624	2.07
		Other Waste Land	0.540	17.18	1.221	9.73	3.357	4.28
		Sand covered areas	0.361	11.50	0.761	6.06	7.235	9.23
		Sandbars	0	0	0	0	2.867	3.66
		Sub Total	***1.130***	***35.97***	***2.331***	***18.56***	***15.082***	***19.25***
Water bodies	River	River	0	0	1.417	11.29	18.469	23.57
		Stream Natural Drainage	0.164	5.22	0.369	2.94	2.747	3.51
		Water bodies	0	0	0.128	1.02	0.993	1.27
		Sub Total	***0.164***	***5.22***	***1.914***	***15.24***	***22.210***	***28.34***
Plantation	Plantation	Agri+Road side+ Jamuna Eco Park	0.340	10.83	1.337	10.65	2.020	2.58
		Sub Total	***0.340***	***10.83***	***1.337***	***10.65***	***2.020***	***2.58***
Others	Homestead Plantation	Homestead Plantation + Rural Settlement	0.153	4.86	0.801	6.38	7.308	9.33
		Sub Total	***0.153***	***4.86***	***0.801***	***6.38***	***7.308***	***9.33***
		Total	**3.141**	**100.00**	**12.555**	**100.00**	**78.355**	**100.00**

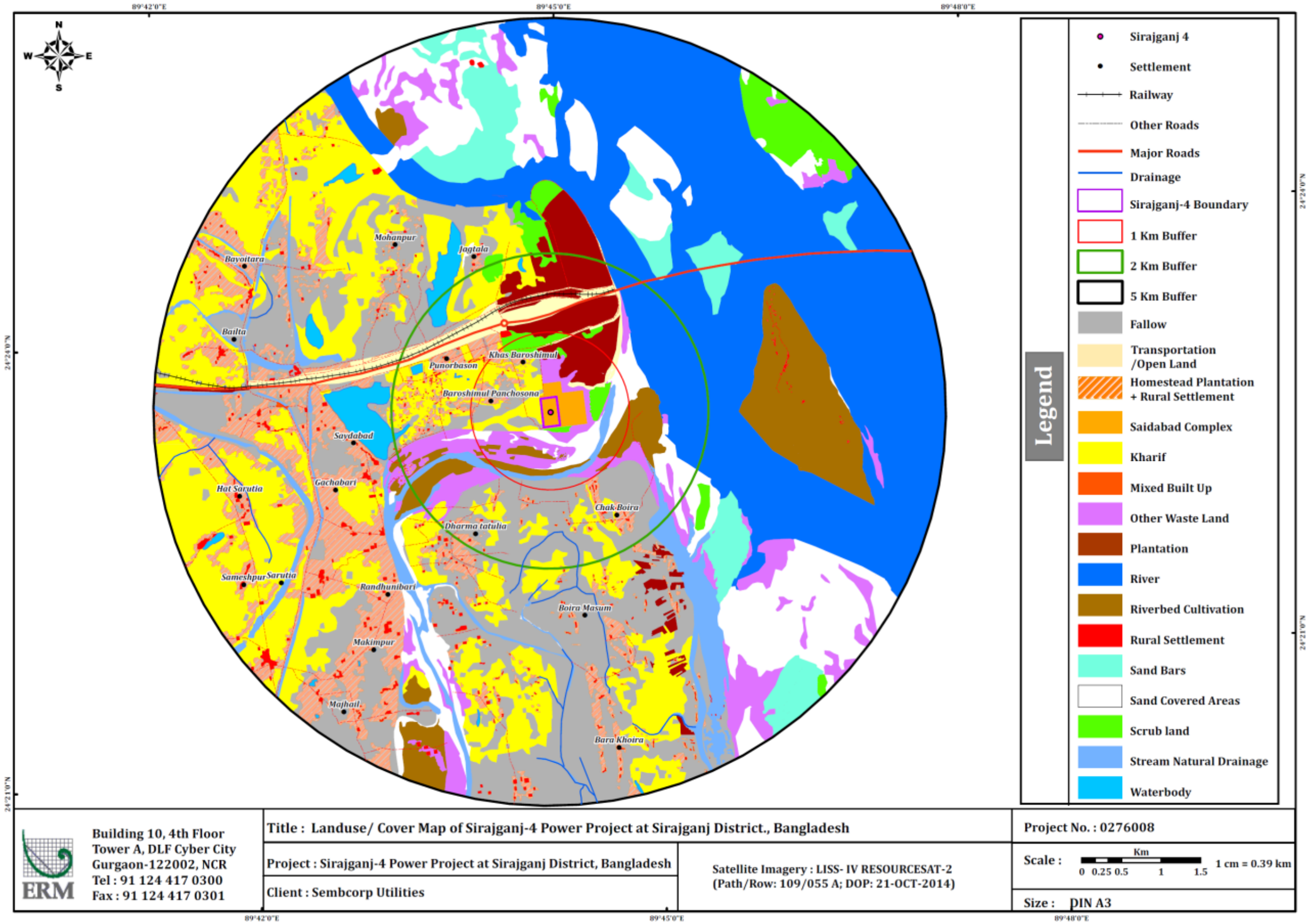
Source: Based on Satellite Data (refer Table 4.2), ground truthing and local GIS Unit and Upazilla maps

Table 4.3 Landuse/ Land cover statistics of the Fuel Pipelines (Gas and HSD) and Proposed Water Pipeline with 100 m buffer

Level-1	Level-2	Level-3	Fuel Pipeline with 100 m Buffer		Water Pipeline with 100 m Buffer	
			Area (sq.km)	% of Area	Area (sq.km)	% of Area
Built-up	Rural	Rural Settlement	0.009	1.61	0.001	0.12
		Transportation/ Open Land	0.130	24.34	0.051	9.38
	Industrial	Saidabad Complex	0.057	10.69	0.026	4.66
		Sub Total	***0.195***	***36.65***	***0.078***	***14.16***
Agriculture	Cropland	Kharif Crop	0.039	7.41	0.043	7.87
		Riverbed Cultivation	0	0	0	0
	Fallow Land	Fallow Land	0.038	7.14	0.026	4.82
		Sub Total	***0.077***	***14.55***	***0.070***	***12.69***
Waste land	Waste Land	Scrub Land	0.068	12.75	0.126	23.03
		Other Waste Land	0.096	17.96	0.046	8.33
		Sub Total	***0.163***	***30.71***	***2.331***	***18.56***
Water bodies	River	River	0	0	1.417	11.29
		Stream Natural Drainage	0	0	0	2.94
		Water bodies	0	0	0.128	1.02
		Sub Total	***0***	***0***	***0.172***	***31.36***
Plantation	Plantation	Agri+Road side+ Jamuna Eco Park	0.027	5.14	0.152	27.68
		Sub Total	***0.027***	***5.14***	***0.152***	***27.68***
Others	Homestead Plantation	Homestead Plantation + Rural Settlement	0.069	12.96	0.027	4.94
		Sub Total	***0.069***	***12.96***	***0.027***	***4.94***
		Total	**0.532**	**100.00**	**0.548**	**100.00**

Source: Based on Satellite Data (refer Table 4.2), ground truthing and local GIS Unit and Upazilla maps

Figure 4.3 Landuse/ Landcover Map of the Project AOI



Source: Based on Satellite Data (refer Table 4.1), ground truthing and local maps

Figure 4.4 Land Use/ Land Cover Map of Fuel Pipelines with 100 m Buffer

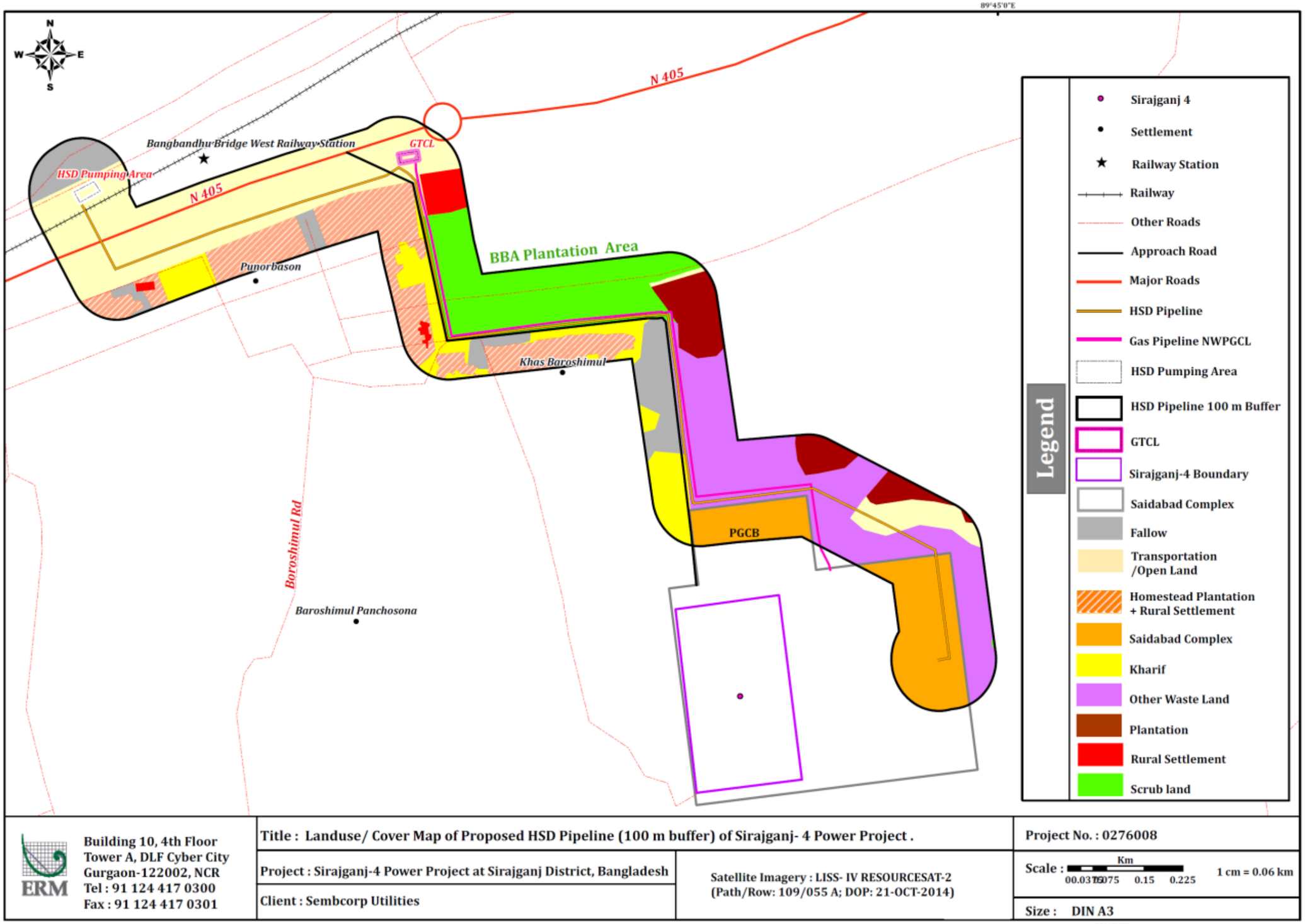
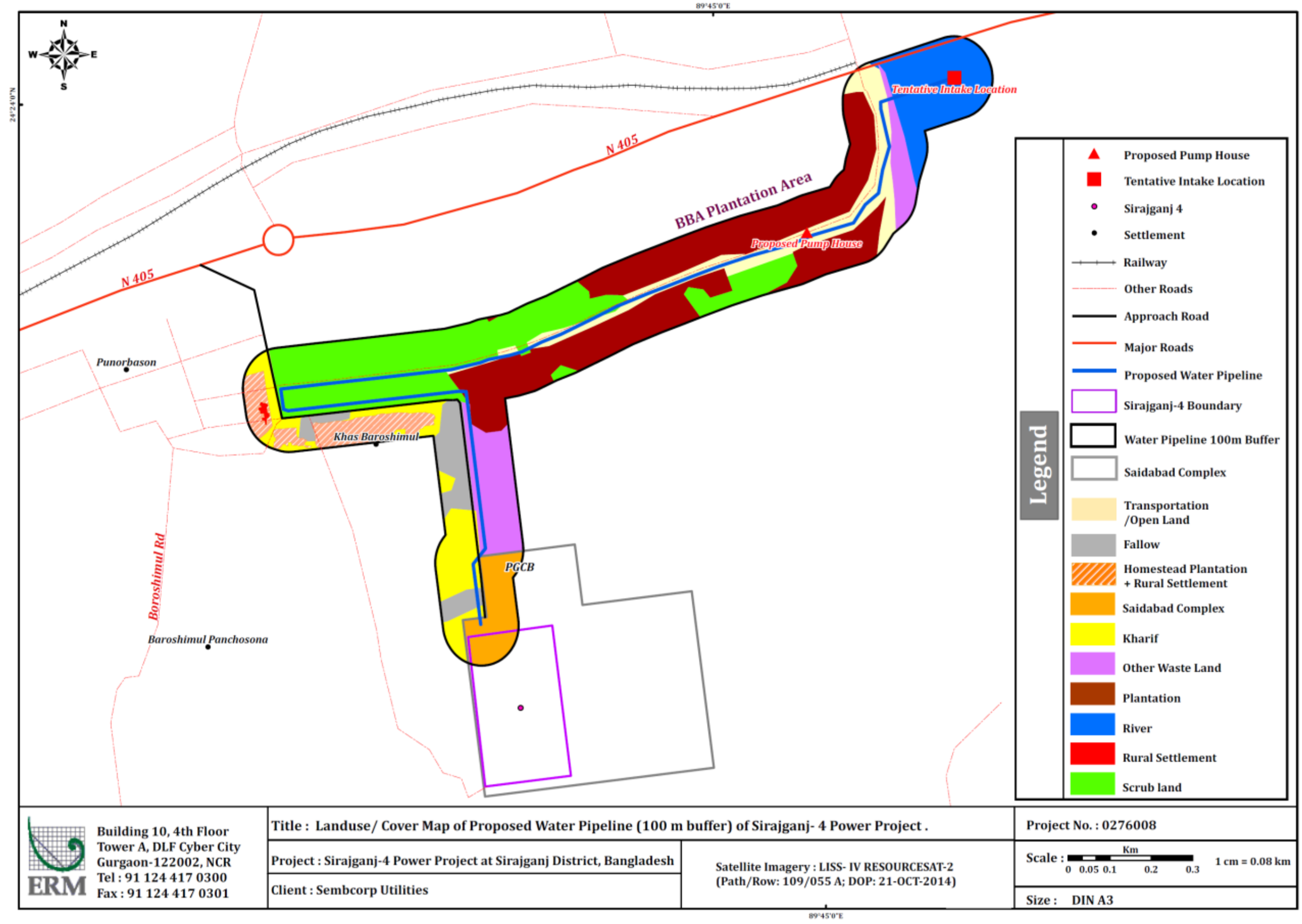


Figure 4.5 Land Use/ Land Cover Map of Water Pipeline with 100 m buffer



4.3.2 Topography

Most of Bangladesh is plain land except the hilly regions to the east and northeast. The plain land mainly consists of fluvio-deltaic sediments deposited by the Padma, the Brahmaputra (currently named as Jamuna) and the Meghna River systems. The elevation of the major part of the floodplain ranges from 3 to 5 meters. As the floodplains approach the Himalayas from the northern part of the Pabna District (Sirajganj District is just north of Pabna District) the elevation gradually increases.

A digital elevation model (DEM) or 3-D representation of the terrain surface of 5 km Project AOI is shown with the height range in ***Figure 4.6***.

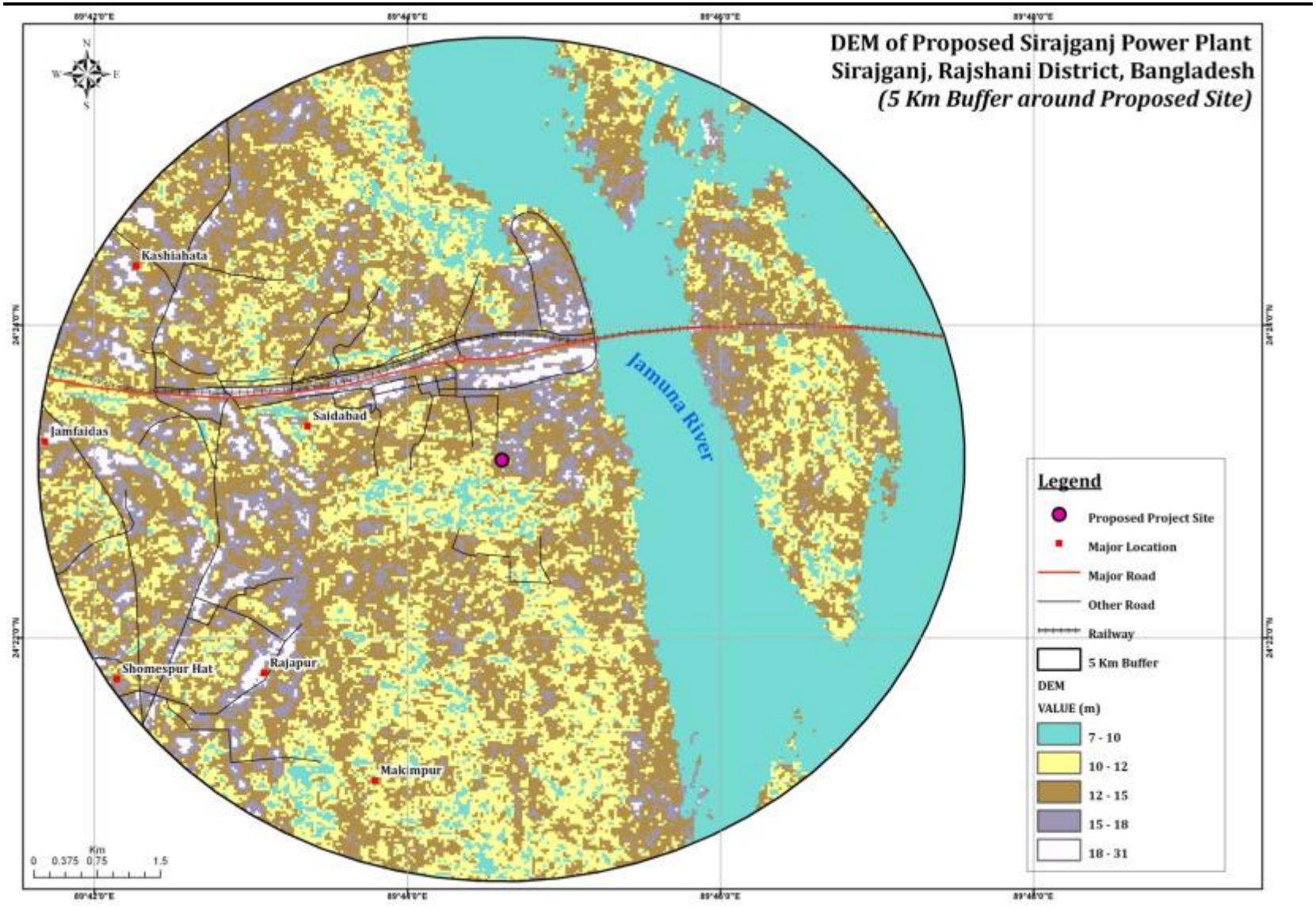
Contours of the Project AOI are generated from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) relief maps and relevant information are extracted from the Shuttle Radar Topography Mission (SRTM) DEM. All the processing was completed using the ARC GIS 9.3 software.

Contour maps derived from DEM shows that the topography of the Project AOI is predominantly flat terrain with depressions in the Jamuna River section. However, interestingly the sandbars/ island areas within the River are clearly visible with higher elevation values. The Jamuna Eco Park and Saidabad Power Generation Complex can be observed to be in the elevation range of 12-18 m above MSL from the map. As referred from the Project report of NWPGCL's 225 MW CCPP, the average elevation of the NWPGCL's plant site is 15.75 m above MSL. The proposed Project site is on the same level as the NWPGCL's plant as the entire Power hub was raised by sand filling as a flood protection measure.

A slope map of the 5 km Project AOI is represented in ***Figure 4.7***. The area has no considerable slope variations. More than 80 % of the area falls in the gradient range of 0-5 % and some places have 5-10 % slope. Very few areas fall in the 20-27% gradient range, i.e. near Saidabad, near river bank of Jamuna Eco Park and at the edges of few char areas on the Jamuna River. The entire river bank can be seen to have a slope range of 10-15% variation because of the difference in the land embankment and the river level.

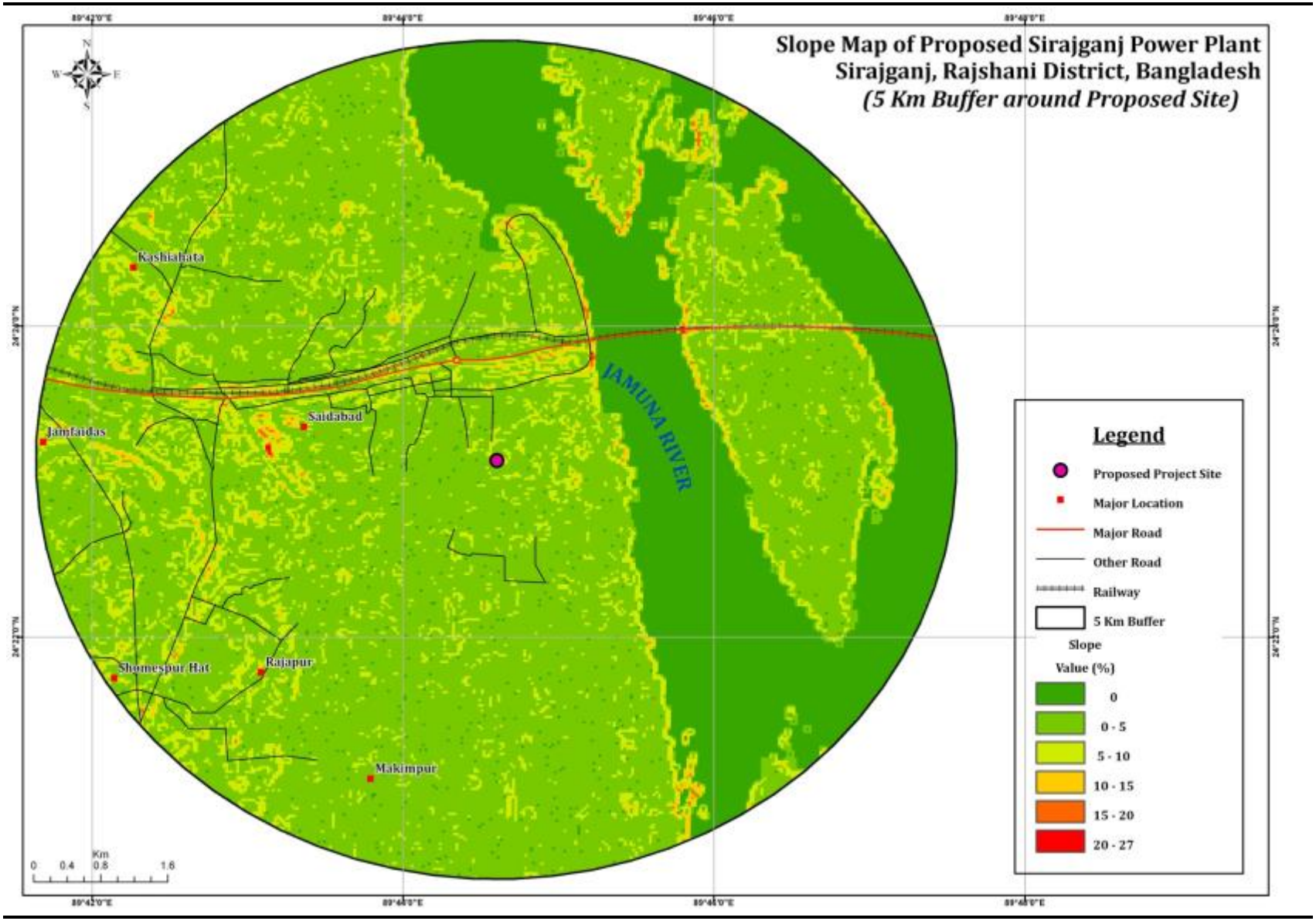
The Saidabad Power Generation Complex including the Project site has a very gentle slope from north east to south west i.e. from the land towards the River.

Figure 4.6 DEM Map of Project AOI



Source: Based on Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) relief maps and processing through GIS Arc GIS 9.3 software

Figure 4.7 Slope Map of Project AOI



Source: Based on Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) relief maps and processing through GIS Arc GIS 9.3 software

4.3.3 Geology

The geological evolution of Bangladesh is related to the uplift of the Himalayan mountains and outbuilding of deltaic landmass by major River systems having their origin in the uplifted Himalayas. This geology is mostly characterised 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. The floodplains of the Ganges, the Brahmaputra (Jamuna) and the Meghna Rivers cover approximately 40% of Bangladesh.

The geology of Bangladesh can be divided into three distinct regions each having distinguishing characters of its own:

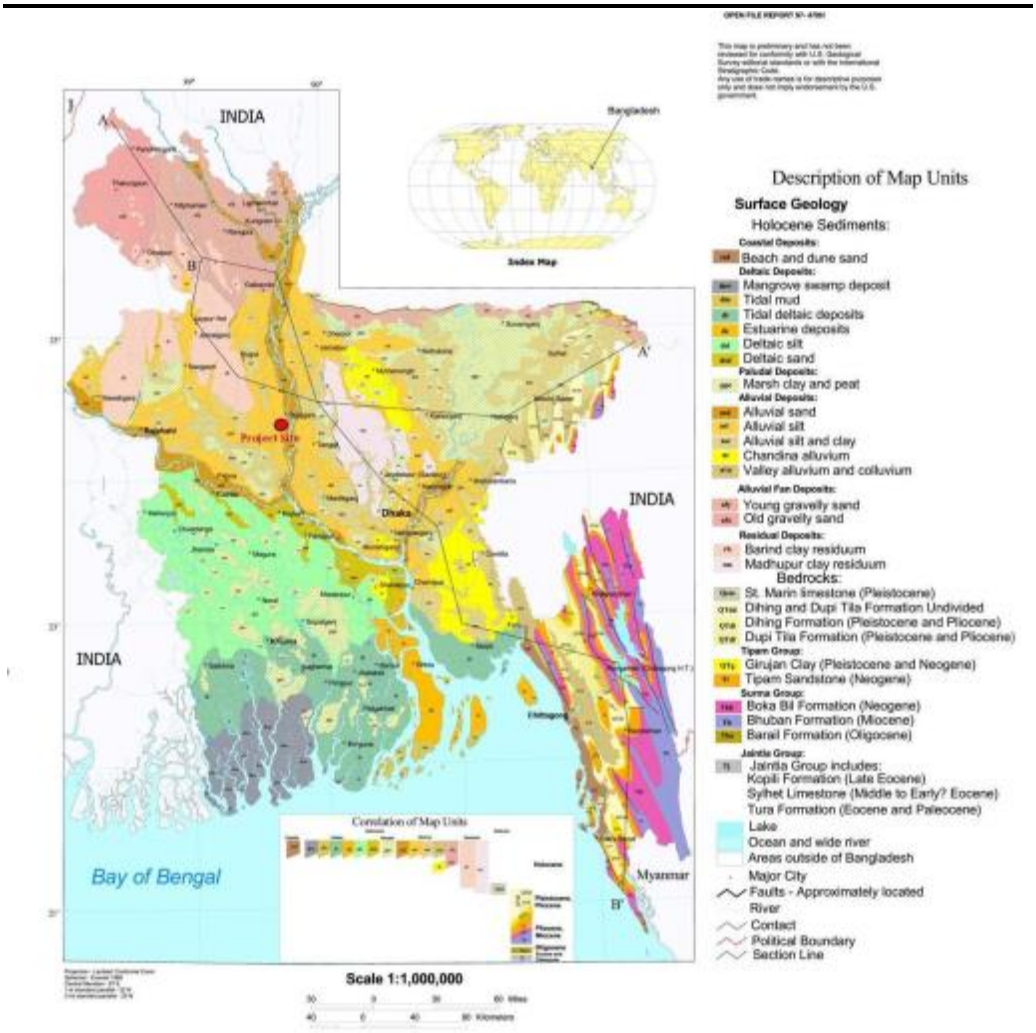
- **Stable Precambrian Platform in the North West**- characterised by limited to moderate thickness of sedimentary rocks above a Precambrian igneous and metamorphic basement.
- **Geo-Synclinal Basin in the southeast**- characterised by the huge thickness of clastic sedimentary rocks, mostly sandstone and shale of tertiary age. The basin is further subdivided into two parts, i.e. fold belt in east and a fore deep to the west. As the intensity of the folding decreases towards the west, the fold belts unit merges with the fore deep unit, which is characterised by only mild or no folding. So the sedimentary layers are mostly horizontal to sub-horizontal and free from major tectonic deformation in the fore deep area covering the central part of the basin and this is expressed as River to delta plain topography of the land.
- **Hinge Zone**-is a 25 km wide northeast-southwest zone that separates the Precambrian platform in the northwest from the geosynclinals basin to the south east. It is also known as the Ecocene hinge zone.

Geology of Sirajganj

Sirajganj lies in the Rajshahi Division of Bangladesh which falls under a stable Precambrian platform and is characterised by limited to moderate thickness of sedimentary rocks above a Precambrian igneous and metamorphic basement. This unit is geologically stable in relative terms and has not been affected by fold movement.

The AOI lies in the active delta region of the Brahmaputra- Jamuna floodplain and the surface geology consists of alluvial deposits of alluvial silt and sand. The geological map of Bangladesh indicating the Project site is shown in ***Figure 4.8***.

Figure 4.8 Geological Maps of Bangladesh



Source: Geological Survey of Bangladesh (www.gsb.gov.bd)

4.3.4 *Soil and Sediment Quality*

Sampling Methodology and Locations

The soil and sediment sampling strategy was designed to assess the existing soil quality over the study area. Samples were collected from a total four (4) locations within the study area. The detail of the sampling locations is presented in ***Table 4.4*** and ***Figure 4.9***. A composite sampling technique[1] was used for soil and sediment sampling from each location.

(1) [1] In this technique at any location 2-3 soil samples are collected from different point and then mixed homogeneously to prepare a sample for analysis. Similarly for sediment, 2-3 sediment samples are collected from different points and mixed homogeneously to prepare a sample for analysis.

Table 4.4 Location of Soil and Sediment Samples

S. No.	Sample type	Sample Code	Sampling Location	Geographical Location	Landuse and justification
1	Soil	SQ1	Top soil from the Site	24°23'13.20"N 89°44'33.44"E	Project site filled with river sand
2	Soil	SQ2	Top Soil from Punorbason Village	24°23'17.43"N 89°44'4.86"E	Agricultural field near Project site
3	Sediment	SE1	Jamuna River-Upstream of Project Area	24°23'58.45"N 89°45'15.21"E	Waterbody-Jamuna River representing sediment near water intake
4	Sediment	SE2	Near the existing jetty next to the site	24°23'0.89"N 89°44'59.98"E	Water body – Channel from Jamuna River adjacent to Project site representing sediment near water outfall

Soil samples were collected using tools from a depth of 45 cm from the top soil surface. At each location, soil samples were collected from three spots and homogenized. The homogenized samples were collecting following quartering technique and then packed in polythene plastic jars and sealed. The sealed samples were sent to the laboratory for analysis.

Sediment samples were collected using a sediment sampler from the Jamuna River and its channel. At each location, sediment samples were collected from three spots and homogenised. Care was taken to minimize the surface disturbance to the sediments. The homogenised samples were then packed in polythene plastic bags, sealed and sent to the laboratory for analysis.

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

Analysis Results and Discussions

The analysis results of physico-chemical parameters of soil and sediment samples are presented in ***Table 4.5.***

Figure 4.9 *Soil (SQ1-SQ2), Sediment (SE1 – SE2) and Water (SQ1 – SQ2) Sampling Locations*

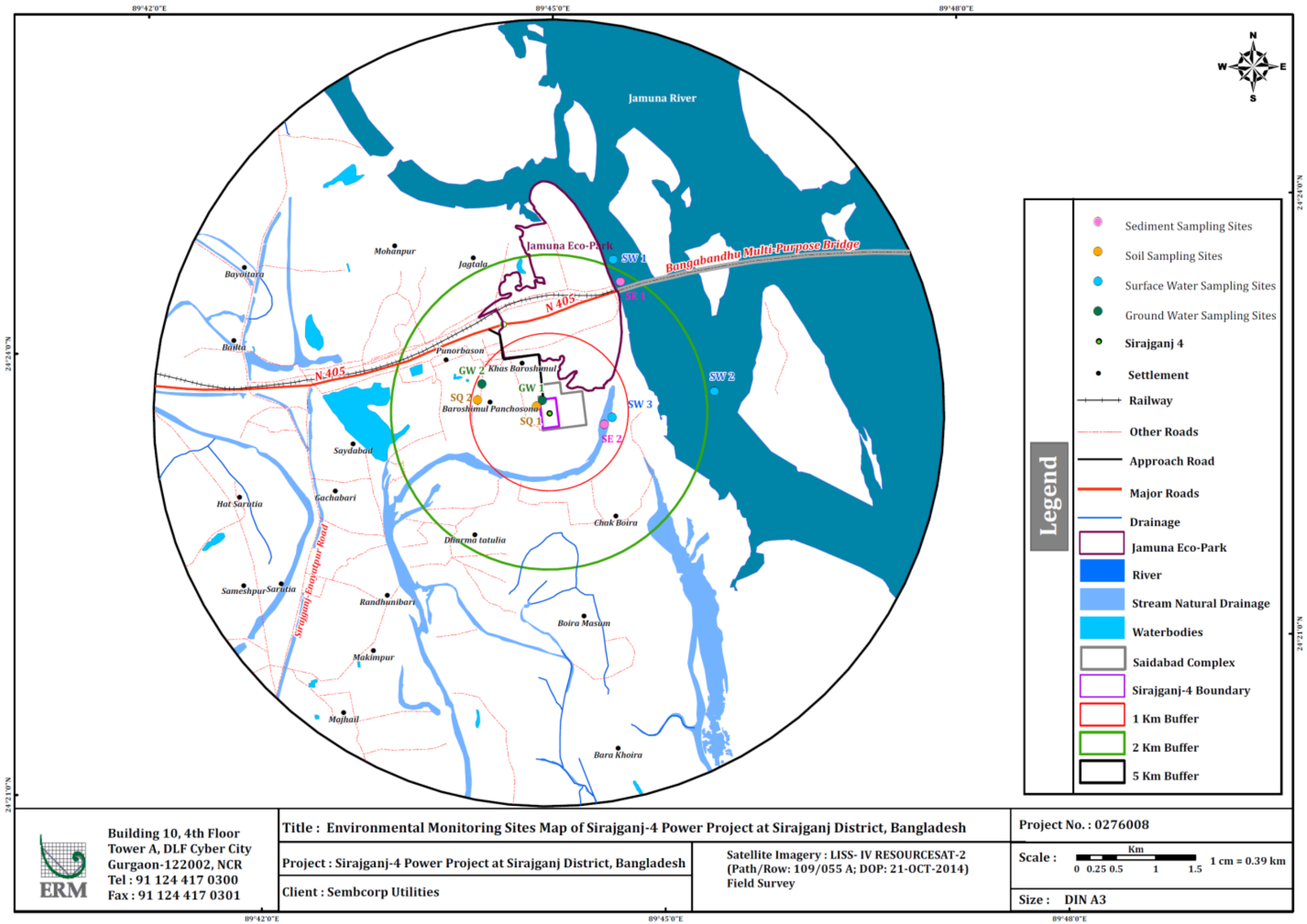


Table 4.5 Soil and Sediment Quality

S. No.	Parameters	SQ1	SQ2	SE1	SE2
1.	Particle size distribution	Sand-70% Silt-25% Clay-5%	Sand-12% Silt-57% Clay-31%	Sand-22% Silt-42% Clay-36%	Sand-18% Silt-45% Clay-37%
2.	Texture	Sandy loam	Silty clay loam	Clay loam	Silty clay loam
3.	EC (dS/m)	1.8	0.79	0.53	0.48
4.	Bulk Density (g/cm^3)	1.67	1.29	1.29	1.27
5.	Cation Exchange Capacity	0.03	0.05	1.04	0.08
6.	pH	7.8	7.3	7.6	7.2
7.	Organic Content (%)	0.43	1.05	0.63	0.51
8.	Calcium (mg/kg)	4.35	6.24	12.61	10.54
9.	Magnesium (mg/kg)	3.73	4.80	13.5	15.7
10.	Potassium (mg/kg)	0.09	0.25	2.7	3.1
11.	Sodium (meq/100g)	1.05	2.4	5.62	4.57
12.	Ammonium-Nitrogen (mg/kg)	17.62	38.5	-	-
13.	Nitrogen (mg/kg)	0.02	0.08	-	-
14.	Phosphorus (mg/kg)	1.82	4.5	2.78	2.13
15.	Sulphur (mg/kg)	24.41	31.8	3.76	2.43
16.	Boron (mg/kg)	0.08	0.15	0.07	0.05
17.	Copper (mg/kg)	2.4	4.3	32.5	21.2
18.	Iron (mg/kg)	24	76.3	76.7	68.3
19.	Manganese (mg/kg)	19.4	37.9	67.4	72.7
20.	Zinc (mg/kg)	1.68	2.6	49.63	42.51
21.	Lead (mg/kg)	9.45	24.6	25.8	20.6
22.	Cadmium (mg/kg)	0.05	0.01	0.1	0.1
23.	Arsenic (mg/kg)	0.13	0.28	0.70	0.62
24.	Mercury (mg/kg)	0.06	0.04	0.09	0.05

Source: Lab Analysis Report, February 2013

Physical Characteristics of Soil and Sediments

The particle size distribution of the soil and sediment samples shows major percentage of silt in all the samples. The soil at the Project site has 70% sand and is of sandy loam texture. This can be attributed to the infilling with Jamuna river sand depositions in the entire Project site to raise it above flood level initially during site preparation. In the soil sample from agricultural land (SQ2) located nearby Punorbason village shows more percentage of clay as compared to sand. The sediment samples are clay loam and silty clay loam in texture.

pH of Soil and Sediments

The pH of the soil sample from the site and the sediment sample from Jamuna River was found to be slightly alkaline as per the standard soil classification given in ***Table 4.6***. The soil sample from the Punorbason agricultural land and sediment from the adjoining Channel were found to be neutral.

Table 4.6 Standard Soil Classification

pH	Classification
<4.5	Extremely acidic
4.51-5	Very strong acidic
5.01-5.5	Strongly acidic
5.51-6	Moderately acidic
6.1-6.5	Slightly acidic
6.51-7.3	Neutral
7.31-7.8	Slightly alkaline
7.81-8.5	Moderately alkaline
8.51-9.00	Strongly alkaline
>9	Very strongly alkaline

Source: http://www.esf.edu/pubprog/brochure/soilph/soilph.htm

Organic Content in Soil

The organic content of soil greatly influences the plant, animal and microorganism populations in soil. The soil of the Project site was found to have low organic content of 0.43% and that of Punorbason village of 1.05 % respectively.

Soil Minerals and Nutrients

Nitrogen, Phosphorus and Potassium (NPK) are the main nutrients that define soil fertility. Phosphorous was observed to be 1.82 and 4.5 mg/kg for the project site and Punorbason agricultural land respectively. The potassium content was 0.09 and 0.25 mg/kg for the project site and Punorbason agricultural land respectively, whereas the nitrogen content was 0.02 and 0.08 mg/kg for the project site and agricultural land of Punorbason village, respectively.

Metals in Soil and Sediment

Copper, Iron, Manganese, Zinc, Lead, Cadmium, Arsenic and Mercury were detected in the soil and sediment samples. Among these metals, the content of iron, manganese and zinc were highest.

Criteria for Assessment of Soil

There is no Bangladesh soil or groundwater regulation/standard. In the absence of local country standards, it is ERM's practice to use globally recognized 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines - Soil and Groundwater Standards' to assess soil quality and to determine the need, if any, for remedial action (***Refer Section 2.9***).

Conclusions

Metals analysed in baseline quality of both soil and sediment were observed to be well below the threshold limits for Intervention as per the Dutch Standards.

4.3.5 Hydrology and Drainage Pattern

The Sirajganj District mostly falls under the Brahmaputra-Jamuna floodplains on the eastern side and Karatoya-Bangali floodplains on the western side. The Jamuna River borders the eastern side of the Sirajganj District and divides it from the Tangail District. The other important rivers of the district are Baral, Ichamati, Karatoya, Bangali, Sarsagar, Gumni, Gohala and Phuljhuri.

The hydrological regime of the Project AOI is governed by the Jamuna River and it is the main drainage channel of the area. Historically, the sediments carried by the Jamuna River have been deposited in the area. The Jamuna River is a braided River characterised by a network of interlacing channels with numerous sandbars enclosed in between them. The sandbars, known locally as "Chars" do not, however, occupy a permanent position. The river deposits them in one year often to destroy and redeposit them in the very next rainy season. The process of deposition erosion and re-deposition goes on continuously making it difficult to precisely demarcate the boundary between the district of Sirajganj and Tangail. Some of the chars have stabilized due to continuous depositions every year and people have started using it because the fertile alluvial deposits provide good agricultural yield.

Another river within the Project AOI is Hurasagar River, a tributary of Jamuna River in the western side of the Project AOI. There are also many small streams and ponds within the Project AOI. Through the eastern and southern boundaries of the Saidabad Power Generation Complex flows a Channel branching out of the main Jamuna River. This channel carries water during the rainy season (June onwards) and gets dry after January, till the arrival of rains, due to siltation on the mouth of the channel.

The general run-off pattern is from west to east through the Jamuna River. The drainage map of the Project AOI is shown in ***Figure 4.10***.

Jamuna River Hydrology

The water level data for the Sirajganj Hardpoint was collected from the Bangladesh Water Development Board (BWDB) office for last 65 years (1950-2014). The danger level is 13.35m and from the data it was observed that almost every year during rains between July to September, the River crosses the danger level mark. The recorded highest water level till date at Sirajganj is 15.11 m on 30.8.1988. The last reported major flood in the area was in 2007 when the maximum level of Jamuna reached 14.95 m on 1st August. In 2014 the maximum level reached was 13.51 m on 29th September. The Project site along with the Saidabad Power Generation Complex is situated at an elevation of 15.75 m which is 0.64 m above the level reached in 65 years of recorded data (maximum level ever reached was 15.11 m in 1988). Water level rise due to any climate change impacts have been discussed in ***Section 1***.

The maximum water levels reached by Jamuna River at Sirajganj over the 65 years span are shown in ***Table 4.7*** and the historical variation in the water level is shown in ***Figure 4.11.***

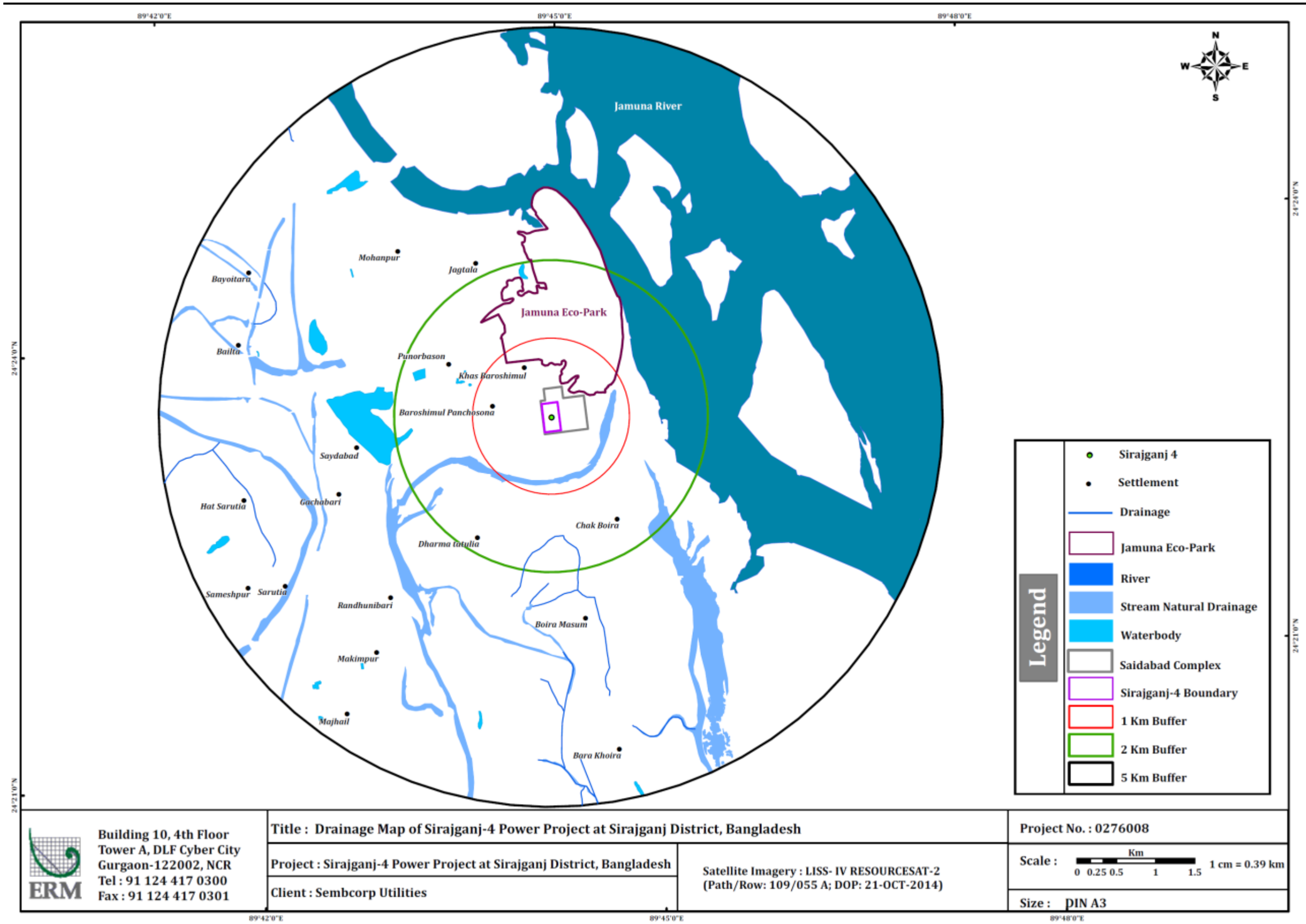
Table 4.7 Maximum Water levels of Jamuna River at Sirajganj

S. No.	Date	Maximum Water Level (m)	Danger Level (m)
1.	01-09-1950	13.40	
2.	20-07-1951	13.43	
3.	16-07-1952	14.03	
4.	01-08-1953	13.87	
5.	01-08-1954	14.22	
6.	07-08-1955	14.17	
7.	25-06-1956	13.38	
8.	13/14-08-1957	13.90	
9.	30-08-1958	13.83	
10.	1959	Data not available	
11.	1960	Data not available	
12.	1961	Data not available	
13.	24-08-1962	14.15	
14.	1963	Data partially available	
15.	06-08-1964	13.89	
16.	16/17-08-1965	13.77	
17.	01/02-09-1966	13.87	
18.	22/25-07-1967	13.45	
19.	26/27-07-1968	13.94	
20.	25-07-1969	13.77	
21.	29-07-1970	14.22	
22.	1971	Data not available	
23.	02-08-1972	13.90	
24.	11-08-1973	14.22	
25.	07-08-1974	14.24	
26.	06-08-1975	13.46	
27.	06/07-07-1976	13.46	
28.	22-08-1977	13.90	
29.	29-06 and 01-07 -1978	13.46	
30.	11-10-1979	13.67	
31.	22-08-1980	14.50	
32.	08-07-1981	13.87	
33.	21/22-09-1982	13.73	
34.	16-09-1983	14.19	
35.	20-09-1984	14.62	
36.	30-07-1985	14.14	
37.	05-08-1986	13.45	
38.	17-08-1987	14.57	
39.	**30-8-1988**	**15.11**	13.35
40.	21-07-1989	13.42	13.35
41.	27/30-07-1990	13.95	13.35
42.	15-07-1991	14.37	13.35
43.	01-07-1992	13.25	13.35
44.	03-09-1993	13.74	13.35
45.	18-08-1994	13.05	13.35
46.	10-07-1995	14.69	13.35
47.	19-07-1996	14.01	13.35
48.	15-07-1997	13.58	13.35
49.	08-09-1998	14.76	13.35
50.	27-08-1999	14.10	13.35
51.	06-08-2000	14.04	13.35
52.	04/05-08-2001	13.44	13.35

S. No.	Date	Maximum Water Level (m)	Danger Level (m)
53.	29-07-2002	14.38	13.35
54.	14-07-2003	14.34	13.35
55.	23-07-2004	14.81	13.35
56.	01-09-2005	13.31	13.35
57.	19-09-2006	12.94	13.35
58.	01-08-2007	14.95	13.35
59.	07-09-2008	14.33	13.35
60.	22-08-2009	13.68	13.35
61.	15-09-2010	13.83	13.35
62.	25-07-2011	13.41	13.35
63.	28-09-2012	13.98	13.35
64.	11/12-09-2013	13.51	13.35
65.	29/30-08-2014	13.79	13.35

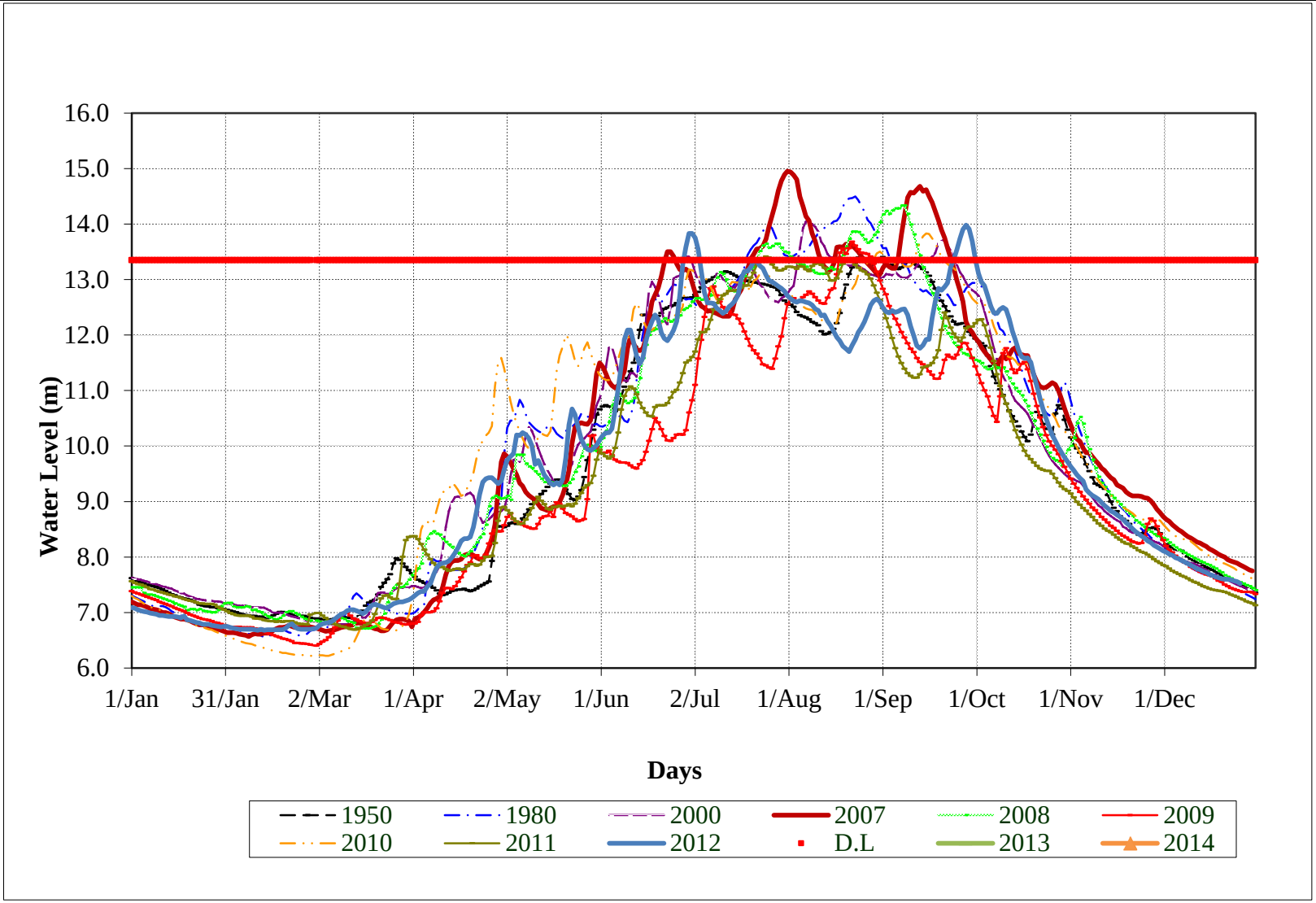
Source: Data collected for Station ID SW49-Sirajganj from BWDB office at Sirajganj and Dhaka

Figure 4.10 Drainage Map of Project AOI



Source: Based on Satellite Data, ground truthing and local maps

Figure 4.11 Water Level variation in Jamuna River at Sirajganj Hardpoint



Source: Based on Data collected from BWDB

Water Discharge

Water discharge and maximum velocity data for 2000-2014 was also collected from BWDB for Station SW46.9L (Bahadurabad-Transit) the nearest upstream data collection location[1] from Sirajganj. A brief summary of the data collected has been presented in **Table 4.8** reflecting the dynamics and water availability in the Jamuna River.

Table 4.8 Water Discharge Data

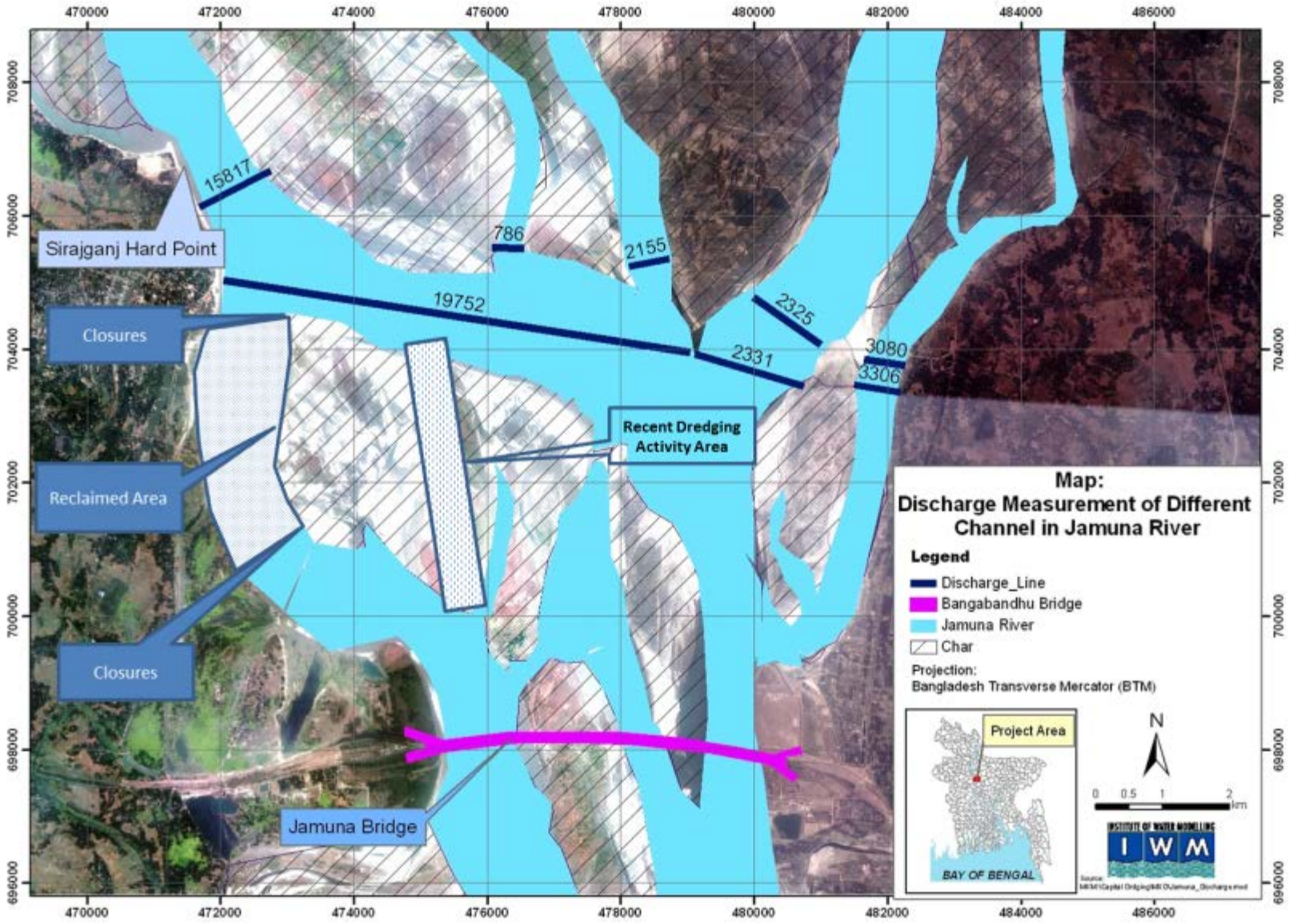
S. No.	Variation	Date	Water Level(m)	Discharge (m^3/sec)	Cross section (m^2)	Maximum Velocity (m/sec)
1.	Minimum	02-05-2000	15.75	3,095.50	14,301.38	1.76
	Maximum	07-08-2000	20.06	69,320.37	45,347.40	3.58
2.	Minimum	24-02-2001	13.19	3,178.02	7,136.63	
	Maximum	07-08-2001	19.06	49,229.56	32,153.78	
3.	Minimum	28-02-2002	12.93	4,512.01	9,596.28	1.05
	Maximum	30-07-2002	19.97	69,727.84	67,006.77	
4.	Minimum	12-03-2003	13.28	4,278.34	9,474.23	0.86
	Maximum	14-07-2003	19.86	65,683.93	35,026.66	2.78
5.	Minimum	01-03-2004	13.04	5,613.66	10,781.52	0.81
	Maximum	12-07-2004	20.10	96,105.52	64,579.89	3.19
6.	Minimum	08-02-2005	13.27	6,566.08	10,316.53	1.07
	Maximum	29-08-2005	19.45	58,766.89	42,495.20	2.84
7.	Minimum	20-02-2006	12.95	8,366.66	12,303.75	1.10
	Maximum	17-07-2006	18.57	47,666.45	36,965.29	2.45
8.	Minimum	12-02-2007	13.31	14,358.65	14,258.06	1.43
	Maximum	01-07-2007	18.85	42,240.84	40,183.47	1.91
9.	Minimum	17-03-2008	13.41	5,222.52	7,290.24	1.27
	Maximum	02-09-2008	19.60	62,378.87	47,045.09	2.71
10.	Minimum	02-03-2009	13.16	5,043.83	11,174.21	0.74
	Maximum	19-01-2009	13.52	86,939.11	12,644.53	1.25
11.	Minimum	23-02-2010	13.03	3,749.42	5,569.48	1.13
	Maximum	26-07-2010	19.52	45,775.37	37,068.89	2.09
12.	Minimum	08-03-2011	13.27	3,796.70	6,608.00	1.17
	Maximum	26-07-2011	19.57	53,317.36	41,449.40	2.28
13.	Minimum	28-02-2012	12.62	3,293.76	5,654.11	1.00
	Maximum	25-09-2012	20.11	55369.47		
14.	Minimum	05-03-2013	12.48	2036.82	-	0.65
	Maximum	10-09-2013	19.72	75660.06	-	3.66
15.	Minimum	12-05-2014	14.25	6715.24	-	1.17
	Maximum	22-08-2014	19.83	62924.48	-	2.54

Source: Based on data collected from BWDB office, Dhaka,

The water discharge measurement carried out by the Institute of Water Modelling (IWM), Dhaka for the purpose of capital dredging project on the Jamuna River near the Sirajganj Hardpoint is shown in ***Figure 4.12***. As can be observed from the values, about 25,389 m^3/sec is the total discharge measurement just after the Sirajganj Hardpoint.

[1]BWDB at Sirajganj Hardpoint maintains water level data only. Discharge, cross section and velocity data is collected at Bahadurabad transit.

Figure 4.12 Water Discharge Measurement at Sirajganj Hardpoint



Source: BWDB and Institute of Water Modelling (IWM) and updated based on field surveys between February and June 2015

4.3.6 Water Availability in Jamuna River

A mathematical modelling and survey of the Jamuna River was carried out by Institute of Water Modelling (IWM) in Feb 2013[1] in connection with the proposed Power plant with the following objectives:

- Assess the planform of the Jamuna right channel in the vicinity of the project site, for its persistence over time;
- Assess the availability of water in the right channel of the Jamuna to facilitate water intake for the proposed power plant; and
- Suggest workable and suitable suction point, pipeline route and sustainable location pump house for the entire project life of 22 years;

Based on the last 15 years data of water flow in the River Jamuna as recorded by BWDB, minimum flow of the River was measured as 2,036.82 m^3/s on 5th March 2013. Whereas the proposed water requirement of the Sirajganj 4 project is about 0.17 m^3/s. This amount is only 0.008% of the lean season flow of the Jamuna River in Sirajganj. Furthermore, the study conducted by IWM also revealed that the minimum discharge of the channel near the West Guide Bund (WGB) is about 745 m^3/s and the maximum char extent between the channel and WGB is around 910 m at intake location and 1040 m after 250 m downstream. Considering the lean season flow of the channel near intake location, the water intake is of the order of 0.02%. Considering the lean season water availability in the River Jamuna as well as the channel near WGB, it is evident that the amount of water intake is negligible in the context of water availability in the River/ Channel. The amount of intake is also considered incapacble of changing the morphology of the right channel.

4.3.7 Water Quality

Water sampling and analysis was undertaken to understand the overall baseline water quality characteristics of the surface and groundwater in the Project AOI. The surface water sampling was based on the identification of the major surface water body and its interaction with the project e.g. Jamuna River. Groundwater sampling locations were selected to obtain representative water samples from various zones within the AOI. The samples were collected from existing tube well (hand-pumps being used by the villagers) and bore well.

A total of 5 samples, three (3) surface water and two (2) ground water samples were collected. Details of the sampling locations is provided in ***Table 4.9*** and depicted in ***Figure 4.9.***

[1] The study was carried out by IWM on behalf of LANCO Power International Pte Ltd for the proposed project.

Table 4.9 Details of Surface and Ground Water Sampling Locations

S. No.	Sampling Location	Code	Geographical Location	Type of Source	Justification for selection of location
1	Jamuna River upstream of Project's water intake pint	SW1	24°24'7.87"N 89°45'13.27"E	River	Representing water quality upstream of water intake
2	Jamuna River downstream of water intake point	SW2	24°23'8.87"N 89°45'51.01"E	River	Representing water quality downstream of intake
3	Adjoining channel near the jetty next to the site	SW3	24°23'3.50"N 89°45'3.91"E	River Channel	Representing water quality of outfall point
4	Project Site	GW1	24°23'14.04"N 89°44'33.74"E	Borewell	Represents ground water quality at projects site
5	Punorbason Village	GW2	24°23'23.79"N 89°44'7.69"E	Tubewell (hand pump)	Represents ground water in nearest village in Project AOI

The samples were analysed for parameters covering physical, chemical and bacteriological characteristics as mentioned in the scope of work which includes certain heavy metals, trace elements and toxic constituents.

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

The samples were analysed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by the American Public Health Association (APHA). Details of the analysis method and protocol are presented in ***Table 4.10***.

Table 4.10 Method for Water Analysis

S. No.	Parameter	Method	Protocol
1.	Temperature	Digital Thermometer	
2.	Turbidity	Turbidity meter	APHA., 2130 B
3.	pH	pH meter	APHA., 4500 H+ B
4.	Salinity	Digital Salinity Meter	APHA., 2520 B
5.	Dissolved Oxygen	Digital DO Meter	
6.	Conductivity at 25 ^{0} C	Conductivity meter	APHA., 2510 B
7.	Total Dissolved Solids	Digital TDS meter	
8.	Oil and Grease	Partition Gravimetric method	APHA., 5220 B
9.	COD	Open reflux method	APHA., 5210 B
10.	BOD	BOD 5 day	APHA., 5210 B
11.	Total Coliform	Multiple tube technique	APHA 9221 B
12.	Fecal Coliform	Faecal coliforms Procedure	APHA 9221 E

S. No.	Parameter	Method	Protocol
11.	Nitrate as NO_3	Ion chromatography	APHA.,4110 B
12.	Nitrite	Ion chromatography	APHA.,4110 B
13.	Manganese	Atomic Absorption Spectrophotometer (AAS)	APHA 3113 B
14.	Phosphate	Colorimetric	APHA 4500-P.C
15.	Iron as Fe	AAS	APHA 3113 B
16.	Turbidity (NTU)	Nephelometric	APHA 2130 – Part (B)
17.	Oil and Grease (mg/L)	Partition Gravimetric	APHA 5520 B
18.	Alkalinity (HCO_3)	Titrimetric	IS 3025 - Part (23)
19.	Total Hardness (as $CaCO_3$) (mg/l)	EDTA Titrimetric	APHA 2340-Hardness(C)
20.	Chloride (Cl) (mg/l)	Argentometric	APHA 4500(B)
21.	Arsenic (As) (mg/l)	Silver diethyldithiocarbamate	APHA 3500(B)
22.	Calcium (Ca) (mg/l)	AAS	APHA 3500 –Ca (B)
23.	Chromium (Cr^{+6}) (mg/l)	Colorimetric	APHA 3500 - Cr (D)
24.	Fluoride (F) (mg/l)	Colorimetric	APHA 4500 – F^- (D)
25.	Cadmium (Cd) (mg/l)	AAS	APHA-3500-Cd (B)
26.	Lead (Pb) (mg/l)	AAS	APHA 3500 - Pb (B)
27.	Mercury (Hg) (mg/l)	Dithizone	APHA 3500 - Hg (C)
28.	Potassium (K) (mg/l)	AAS	APHA-3500-K (B)
29.	Sodium (Na) (mg/l)	AAS	APHA-3500- Na (B)
30.	Boron (B) (mg/l)	AAS	APHA-3500-B (B)

Source: Laboratory Results Report, January 2013

The quality of surface water was compared with the standards for *Inland Surface Water*, Environment Conservation Rules (ECR), 1997-Schedule 3 (A). Few additional parameters were also analysed, apart from those given in Schedule-3 (A), for determining the ambient water quality of the Jamuna River. The groundwater was compared with the *Drinking Water Standard* E.C.R.-Schedule-3(B), 1997. The standards have been presented along with the monitoring results of surface and groundwater for comparison.

Surface Water Quality

The surface water Quality was compared with the Bangladesh ECR standard for best practice based classification criteria. ***Table 4.11*** shows the analysis results.

As per the best practice based classification standards of the Bangladesh ECR, the quality of none of the three surface water samples from the Jamuna River is of a level that can be utilized for any purposes as per the classification i.e. source of drinking water after disinfection, recreational activity, fisheries, industrial process and cooling purpose and for irrigation. This is because of the high levels of total coliform are far above the standard limits.

Some of the water analysis parameters are discussed below in detail:

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

Dissolved Oxygen (DO): DO of all three samples range in between 7.5 to 8.2 mg/l and thus meets the surface water classification for all usages.

Biochemical Oxygen Demand (BOD): The BOD levels range between 1.1 to 1.6 mg/l and is below the limit of 2 for being utilized as drinking water source.

Coliform levels: The Total coliform levels range between 20000 to 26000 number/100ml which is notably higher than the classification limits of 5000 or less to be used for any criteria as irrigation, industrial purposes etc. Even the faecal coliform levels are in the range of 9000 to 12000 no./100 ml which indicates high levels of contamination which may be from disposal of untreated sewage and run-offs in the upstream of the River.

Heavy Metals: Among the heavy metals analysed in the Jamuna River samples, Iron was found in the range of 0.19 to 0.24 mg/l, whereas Arsenic, Lead, Chromium, Mercury, Manganese and Cadmium were found below the detection limits.

Table 4.11 Surface Water Quality Analysis

S. No.	Parameter	Unit	Sample Location			Bangladesh standards (Best practice based classification)*					
			SW1	SW2	SW3	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
1.	Temperature	°C	17	18.6	19.64	-	-	-	-	-	-
2.	TDS	mg/L	100	100	90	-	-	-	-	-	-
3.	EC	µS/cm	210	210	180	-	-	-	-	-	*2250 (at temp of 25 °C)*
4.	DO	mg/L	7.5	8.2	7.8	*6 or above*	*5 or above*	*6 or above*	*5 or above*	*5 or above*	*5 or above*
5.	pH	-	7.93	7.11	7.06	*6.5-8.5*	*6.5 – 8.5*	*6.5 – 8.5*	*6.5 – 8.5*	*6.5 – 8.5*	*6.5 – 8.5*
6.	Salinity	mg/L	0.10	0.10	0	-	-	-	-	-	-
7.	BOD_5	mg/L	1.3	1.1	1.6	*2 or less*	*3 or less*	*6 or less*	*6 or less*	*10 or less*	*10 or less*
8.	COD	mg/L	31	27	29	-	-	-	-	-	-
9.	Fecal Coliform	No:/100 ml	11000	12000	9000	-	-	-	-	-	-
10.	Total Coliform	No:/100 ml	**24000**	**26000**	**20000**	*50 or less*	*200 or less*	*5000 or less*	-	*5000 or less*	*5000 or less*
11.	Nitrate	mg/L	0.4	0.5	0.5	-	-	-	-	-	-
12.	Nitrite	mg/L	<0.05	<0.05	<0.05	-	-	-	-	-	-
13.	Manganese	mg/L	BDL	BDL	BDL	-	-	-	-	-	-
14.	Phosphate	mg/L	0.45	0.41	0.55	-	-	-	-	-	-
15.	Iron	mg/L	0.21	0.24	0.19	-	-	-	-	-	-
16.	Turbidity	NTU	195	180	90	-	-	-	-	-	-
17.	Oil and Grease	mg/L	0.2	0.1	BDL	-	-	-	-	-	-
18.	Alkalinity (HCO_3)	mg/L	147	142	137	-	-	-	-	-	-
19.	Total Hardness (as $CaCO_3$)	mg/L	47	38	42.3	-	-	-	-	-	-
20.	Chloride (Cl)	mg/L	23.53	20.13	18.47	-	-	-	-	-	-
21.	Arsenic (As)	mg/L	BDL	BDL	BDL	-	-	-	-	-	-
22.	Calcium (Ca)	mg/L	4.96	5.12	4.84	-	-	-	-	-	-
23.	Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	-	-	-	-	-	-
24.	Fluoride (F)	mg/L	0.54	0.57	0.49	-	-	-	-	-	-
25.	Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	-	-	-	-	-	-
26.	Lead (Pb)	mg/L	<0.01	<0.01	<0.01	-	-	-	-	-	-

S. No.	Parameter	Unit	Sample Location			Bangladesh standards (Best practice based classification)*					
			SW1	SW2	SW3	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
27.	Mercury (Hg)	mg/L	BDL	BDL	BDL	-	-	-	-	-	-
28.	Potassium (K)	mg/L	3.92	4.13	3.7	-	-	-	-	-	-
29.	Sodium (Na)	mg/L	13.18	17.11	10.08	-	-	-	-	-	*Less than 26% (at temp of 25 °C)*
30.	Boron (B)	mg/L	0.25	0.12	0.17	-	-	-	-	-	*Less than 0.2% (at temp of 25 °C)*

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

Groundwater Quality

The results of two groundwater samples collected from the borewell at the Project site and tube well (hand pump) from Punorbason village are shown in ***Table 4.12***.

Table 4.12 Groundwater quality analysis

S. No.	Parameters	Units	GW1	GW2	Applicable Standards*
1.	Depth	m	~ 36.5	~ 28	
2.	Temperature	^{O}C	23°C	19.8 °C	***20-30°C***
3.	TDS	mg/l	180	280	***1000***
4.	EC	µS/cm	370	540	***-***
5.	pH		6.85	6.91	***6.5-8.5***
6.	Dissolved Oxygen	mg/l	5.2	5.9	***6***
7.	Salinity	mg/l	0.20	0.20	***-***
8.	Alkalinity (HCO_3^-)	mg/l	287	276.7	***-***
9.	Total Hardness (as $CaCO_3$)	mg/l	317	292	***200 – 500***
10.	Chloride (Cl^-)	mg/l	256	347	***150-600***
11.	Arsenic (As)	mg/l	0.01	0.01	***0.05***
12.	Calcium (Ca)	mg/l	12.72	27.35	***75.0***
13.	Chromium (Cr)	mg/l	<0.01	<0.01	***0.05***
14.	Cadmium (Cd)	mg/l	<0.001	<0.001	***0.005***
15.	Fluoride	Mg/l	0.2	0.4	***1***
16.	Iron (Fe)	mg/l	2.1	2.9	***0.3-1.0***
17.	Lead (Pb)	mg/l	BDL	BDL	***0.05***
18.	Mercury (Hg)	mg/l	BDL	BDL	***0.001***
19.	Potassium (K)	mg/l	4.73	6.46	***12.0***
20.	Sodium (Na)	mg/l	153	168	***200***
21.	Boron (B)	mg/l	0.2	0.3	***1.0***
22.	Fecal Coliform	No:/100ml	Nil	Nil	***0***
23.	Total Coliform	No:/100ml	Nil	Nil	***0***

* *Bangladesh Environment Conservation Rules, 1997- Schedule 3 (B) (Standards for drinking water)*

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

pH: The pH of the samples of Project site is 6.85 and that of Punorbason Village is 6.91 which are within the standard range of 6.5 to 8.5.

Total Dissolved Solids: The total dissolved solids content in the Project site and Punorbason Village are 180 mg/l and 280 mg/l, which are well below the standard limits of 1000 mg/l.

Total Hardness (as $CaCO_3$): Total Hardness varied in the Project site ground water is 317 mg/l and that of Punorbason Village is 292 mg/l, well within the upper limit standard of 500 mg/l.

Chloride: The chloride content in the Project site groundwater is 256 mg/l and that of Punorbason village is 347 mg/l and is well within the upper limit permissible standards of 600 mg/l.

Coliform: Both the total coliform and faecal coliform levels were found to be nil in the ground water samples meeting the drinking water standard requirement of 0 number/100ml.

Iron and Arsenic: The iron content of the groundwater sample at Project site is 2.1 mg/l and that of Punorbason village is 2.9 mg/l which exceeds the standard range of 0.3 to 1 mg/l indicating high iron content in the ground waters of the study area.

Arsenic content was observed 0.01 mg/l for both the groundwater samples analyzed. The level of arsenic is below the standard limit of 0.05 mg/l.

Other Heavy Metals: The other heavy metals, Mercury, Cadmium, Lead and Chromium were below the detection limits in both the groundwater samples in the area.

Conclusion

A high level of iron was found in the groundwater of study area. This is a common occurrence in many parts of Bangladesh and can be attributed to predominance of reducing conditions in the aquifers of Bangladesh[1]. Apart from iron, other parameters fall within the standard permissible limits for drinking water. Arsenic contamination is also found in the Project AOI though both the groundwater samples analysed were within limits. Arsenic contamination of geological origin has been reported in many districts of Bangladesh[2] and Sirajganj District is also affected by it. Data about arsenic contamination in the Sirajganj Upazilla is shown in ***Box 4.1***.

[1] Groundwater studies of Arsenic contamination in Bangladesh, DPHE/BGS/DFID, 2000

[1] Groundwater studies of Arsenic contamination in Bangladesh, DPHE/BGS/DFID, 2000

Box 4.1 Arsenic contamination in Sirajganj District

The data available from the Department of Public Health Engineering (DPHE) of Sirajganj Sadar Upazilla shows the number of arsenic contaminated and safe tube wells in 12 unions of Sirajganj Sadar Upazilla along with the number of patients affected with Arsenicosis.

Union Name	Tubewell Surveyed					Population Surveyed	
	Surveyed	Operative	Arsenic Safe	Arsenic contaminated	Contamination (%)	Surveyed	Total Patients of Arsenicosis
Bagbati	4,778	4,735	4,289	466	9.42	55,687	19
Bahuli	3,066	3,034	2,897	137	4.52	35,549	04
Chhangaccha	3,142	3,097	2,895	202	6.52	30,385	10
Kalia Haripur	3,386	3,356	3,212	144	4.29	33,916	01
Kaoakola	1,322	1,305	1,283	22	1.69	15,578	01
Khoksabari	3,368	3,313	3,182	131	3.95	38256	02
Mechhera	2,681	2,651	2,636	15	0.57	27,020	00
Ratankandi	2,783	2,756	2,488	268	9.72	25,107	13
Saidabad	**3,283**	**3,213**	**2,987**	**226**	**7.03**	**31,912**	**01**
Siyalkol	2,705	2,657	2,457	192	7.23	26,859	08
Total	**30,514**	**30,117**	**28,334**	**1783**	**5.92**	**3, 20, 269**	**59**

Source: Data for 2011-2012, Department of Public Health Engineering, Sirajganj Upazilla

4.3.8 Meteorology

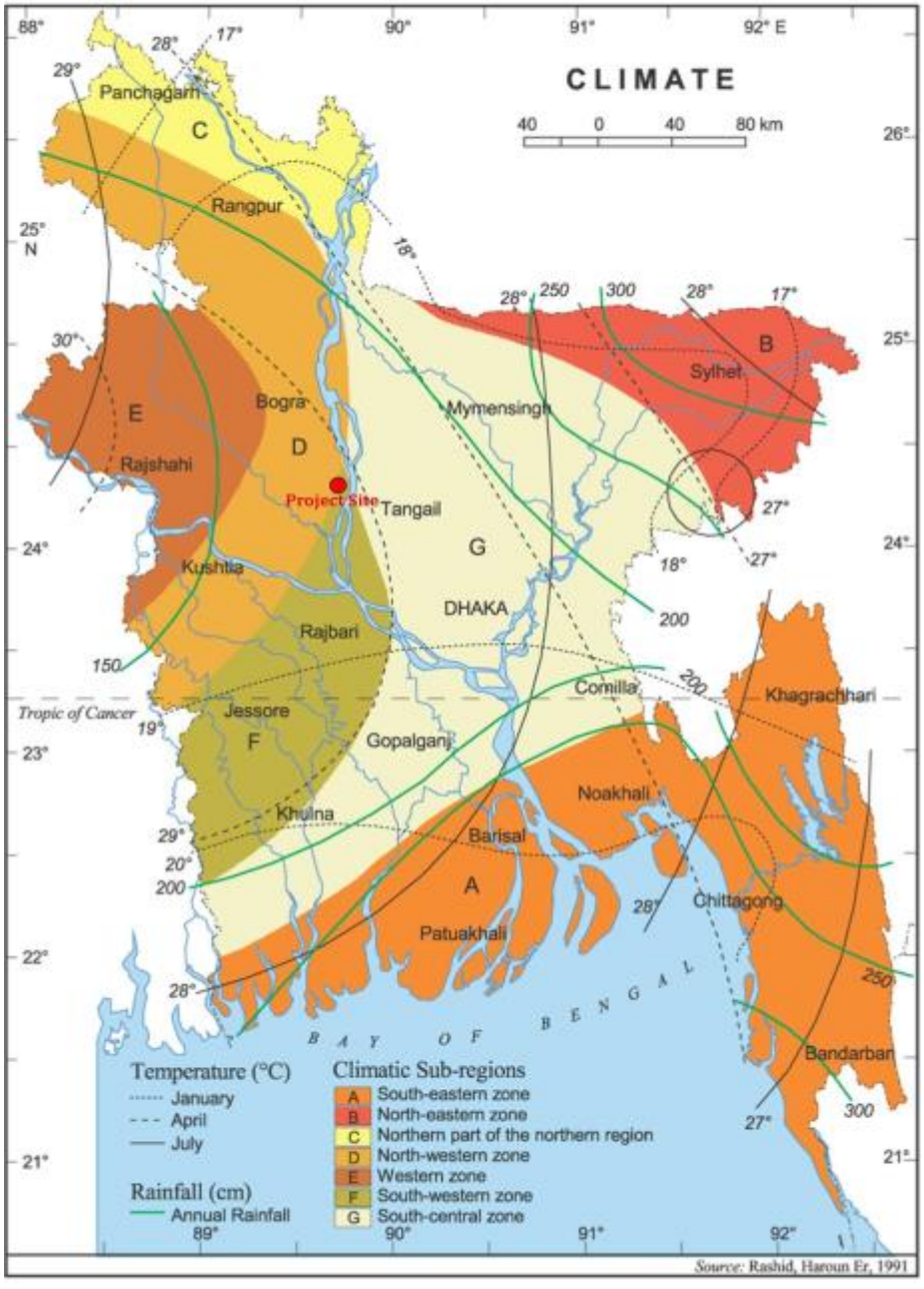
Climate

Bangladesh is located in the tropical monsoon region and its climate is characterised by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. From the climatic point of view, three distinct seasons can be recognised 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. Most rains occur during the monsoon (June-September) and little in winter (November-February). Moderate rains are also reported in the months of March, April and October.

Climatic sub-regions of Bangladesh are presented in ***Figure 4.13*** and as per that, the Sirajganj District falls in two climatic sub-regions of South-Western (in the southern portion) and North –Western (in the Northern portion) zones.

The nearest Bangladesh Meteorological Department (BMD) [1] meteorological station is at Tangail, which is the neighbouring district of Sirajganj on the east. The climatic conditions as recorded at Tangail are therefore considered applicable for the Project AOI. To assess the climatic conditions of the area, climatology data has been obtained from BMD.

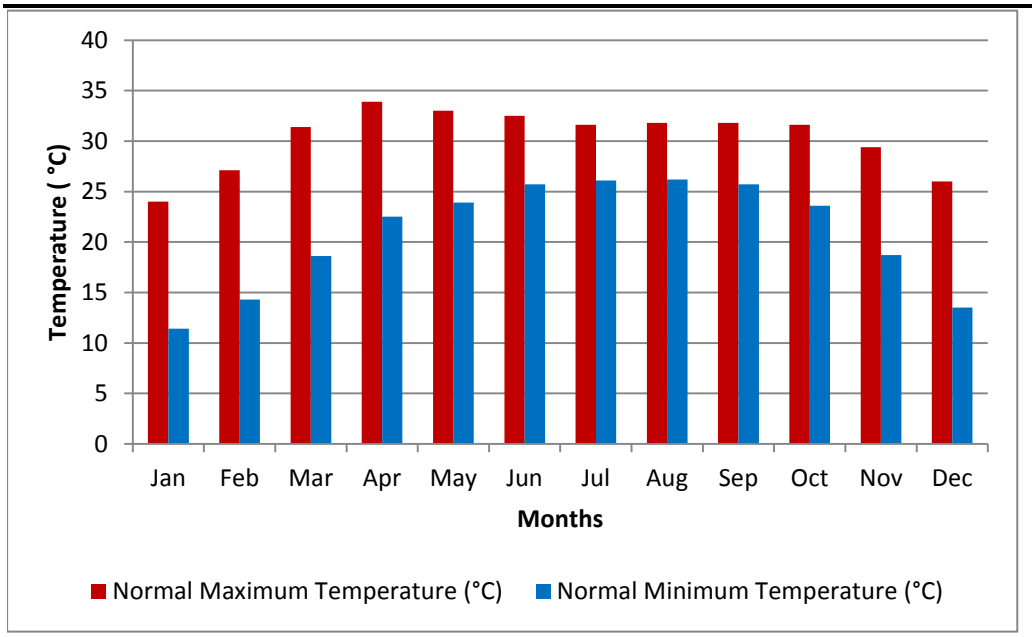
Figure 4.13 Climatic Sub-regions of Bangladesh



Source: http://www.poribesh.com/Maps/Climate.htm

[1] Bangladesh Meteorological Department is the authorised Government organisation for all meteorological activities in Bangladesh. It maintains a network of surface and upper air observatories, radar and satellite stations, agro-meteorological observatories, geomagnetic and seismological observatories and meteorological telecommunication system.

Figure 4.14 Normal Maximum and Minimum Temperature Profile in Tangail

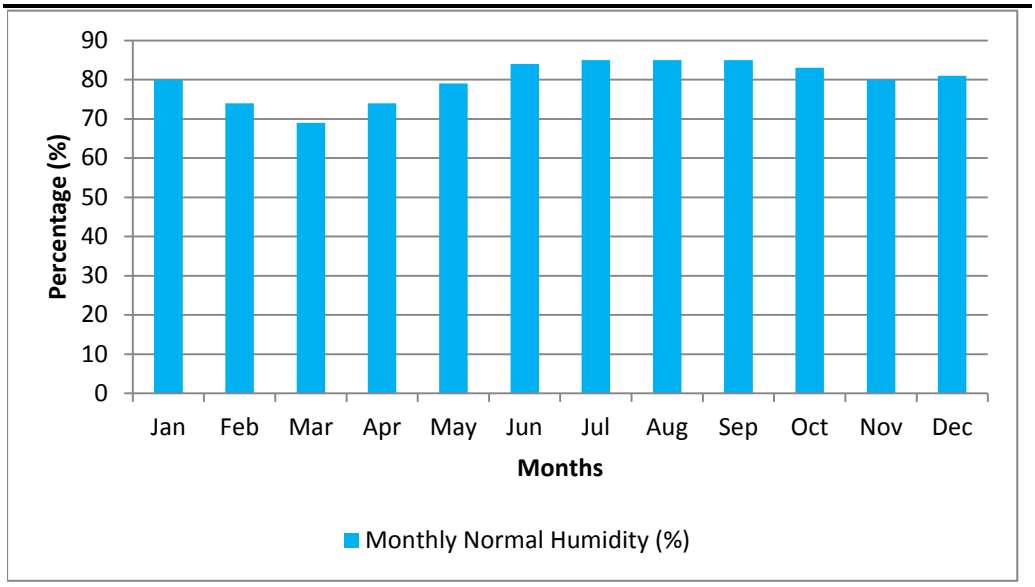


Source: BMD

Humidity

Due to heavy rainfall and proximity to the Bay of Bengal, the humidity levels in Bangladesh remains high. Relative humidity in the Project AOI is generally above 80% during June to December. The month of March is the driest with relative humidity around 69%. Relative humidity normally varies in the range of 69-85% throughout the year. The monthly variation of normal humidity in Tangail has been presented in ***Figure 4.15***.

Figure 4.15 Normals of Relative Humidity in Tangail



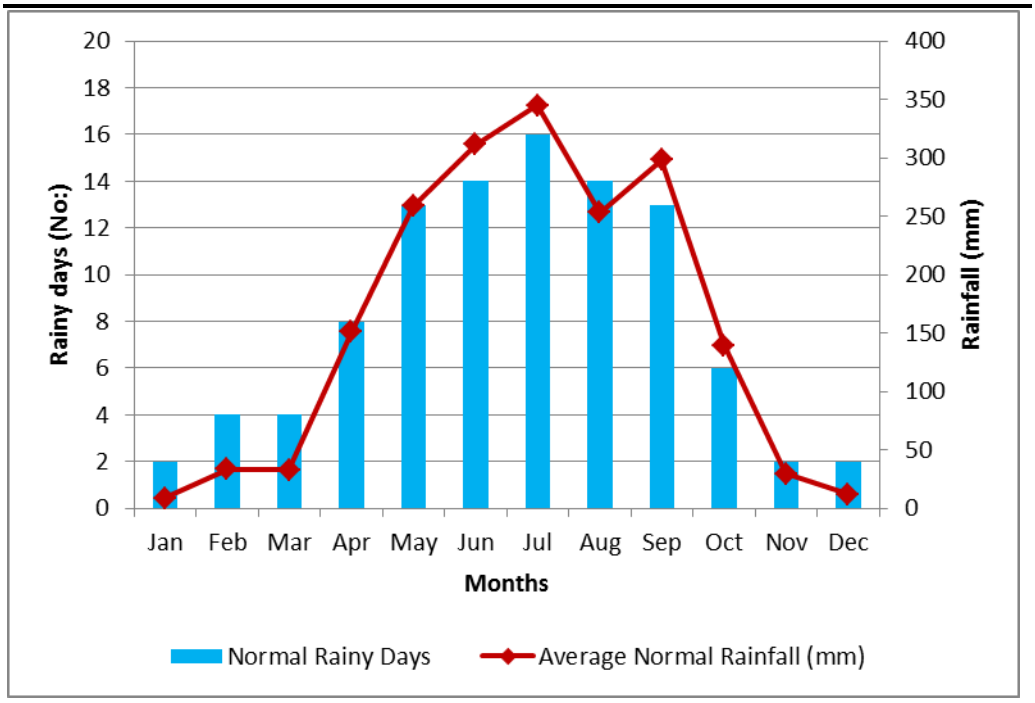
Source: BMD

Rainfall

About 80% of the precipitation occurs during five monsoon months (May to September) with June and July getting the maximum rains. Minimum precipitations are reported during the months of November to February, whereas average showering does occur in March, April and October.

The monthly average normal rainfall variation based on the climatology data and number of normal rainy days in each month in Tangail has been presented in ***Figure 4.16***

Figure 4.16 Normals of Rainfall and number of Rainy days in Tangail



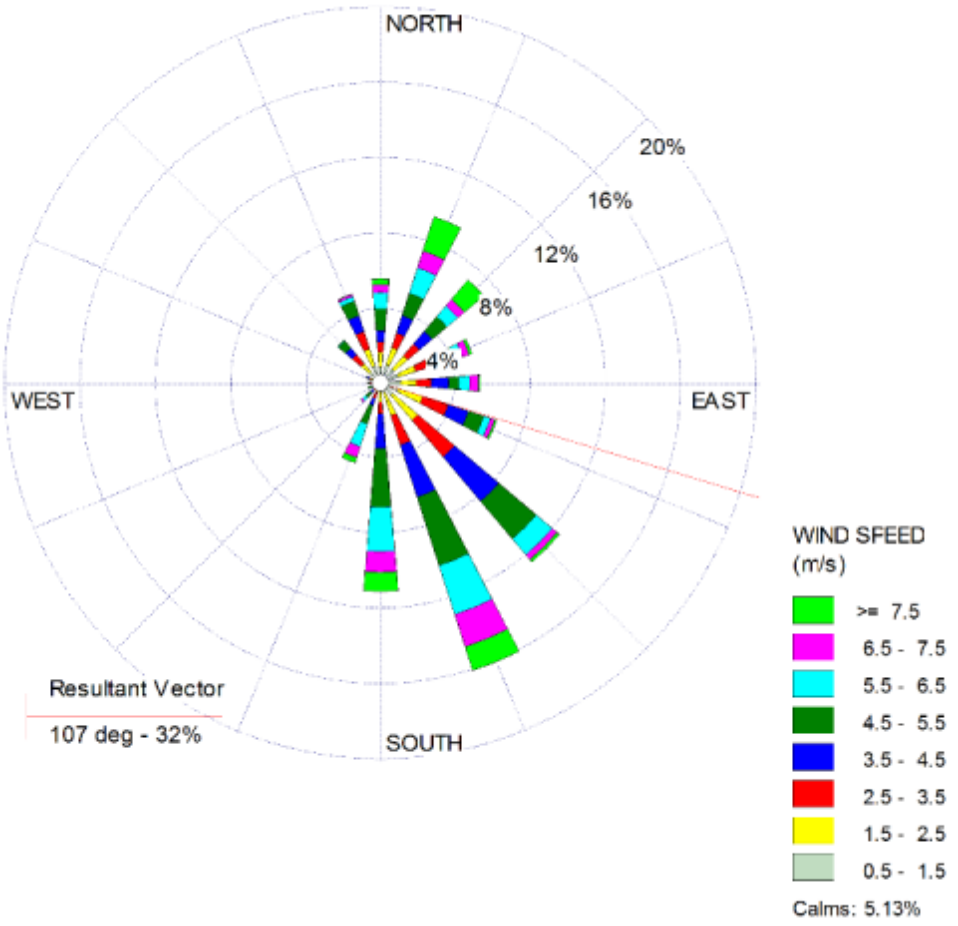
Source: BMD

Wind Speed and Wind Direction

Wind direction and speed exhibits seasonal variation. Winds are generally moderate during non-monsoon season, whereas during the monsoon season, these are moderate to strong. The wind speed varies from 1.02 m/s to 7.71 m/s, with wind speed varying in between 2.31 to 3.34 m/s most of the times.

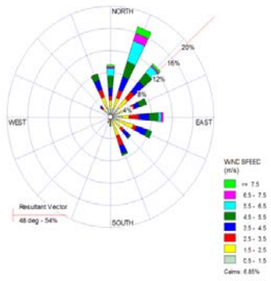
The annual windrose shows the predominant wind direction to be SSE to NNW. During the months of May to October the predominant wind direction is SSE to NNW and during November to April it is NNE to SSW. The annual windrose and monthly wind roses based on the pre-processed meteorological data from MM5 (Fifth Generation NCAR/Penn State Mesoscale Model) are presented in ***Figure 4.17*** and ***Figure 4.18***, respectively.

Figure 4.17 Annual Windrose of Project Site

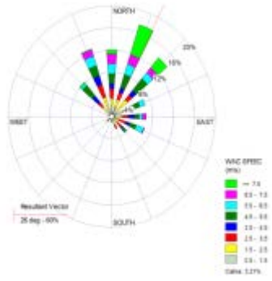


Source: Pre-processed meteorological data from MM5 for Project Site

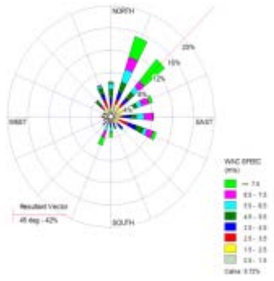
Figure 4.18 Monthly Windrose Diagrams of Project Site



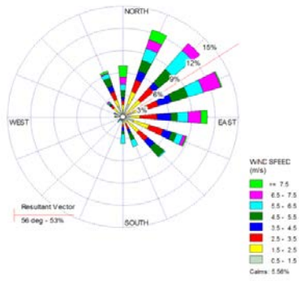
January



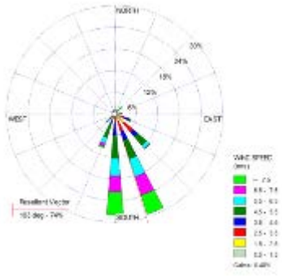
February



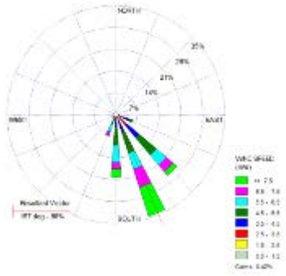
March



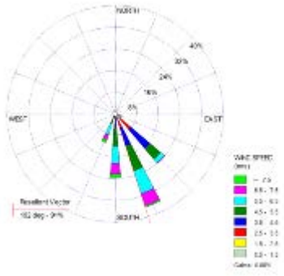
April



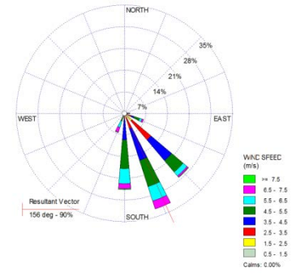
May



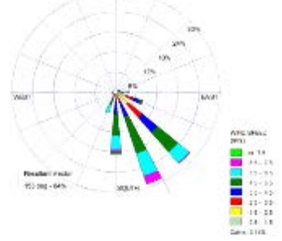
June



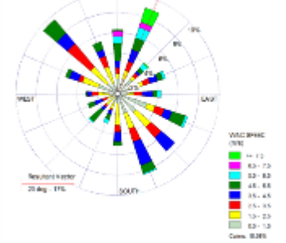
July



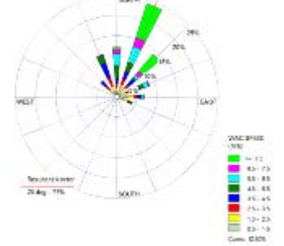
August



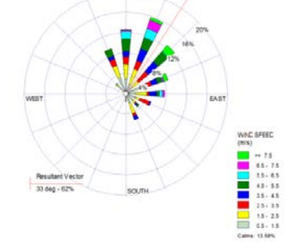
September



October



November



December

Source: Pre-processed meteorological data from MM5 for Project Site

4.3.9 Natural Hazards

Earthquakes

As per the Seismic Zoning Map of Bangladesh, the country is divided into three seismic zones (***Figure 4.19***). The northern part of the country that includes the greater districts of Rangpur, Mymensingh, and Sylhet are in the Zone-I where earthquake shock of maximum intensity of IX of the Modified Mercalli Scale is possible. The Zone-II includes the greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The southern part of the country, the least active region, where the maximum intensity is not likely to exceed VII, is in the Zone-III. The Project site falls in the Zone-II area with a basic seismic coefficient of 0.05g and at moderate risks from earthquakes.

Cyclone and Storm Surges

Bangladesh, due to its unique geographic location, repeatedly becomes the landing ground of cyclones formed in the Bay of Bengal. These cyclones are devastating and cause extensive damage to life, property and livestock. The cyclones occur in two seasons, April-May and October-November – i.e. before and after the rainy season.

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

- depression (winds upto 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.).

As shown in ***Figure 4.20*** the Project site does not fall under cyclone affected area. There are reports of a Tornado in 1991, wind storm in 2001 and tropical storm in 2002[1].

[1] (www.adrc.asia/publications/databook/ORG/...20th/BGD8.xls, 2008)

Figure 4.19 Earthquake Zone Map of Bangladesh

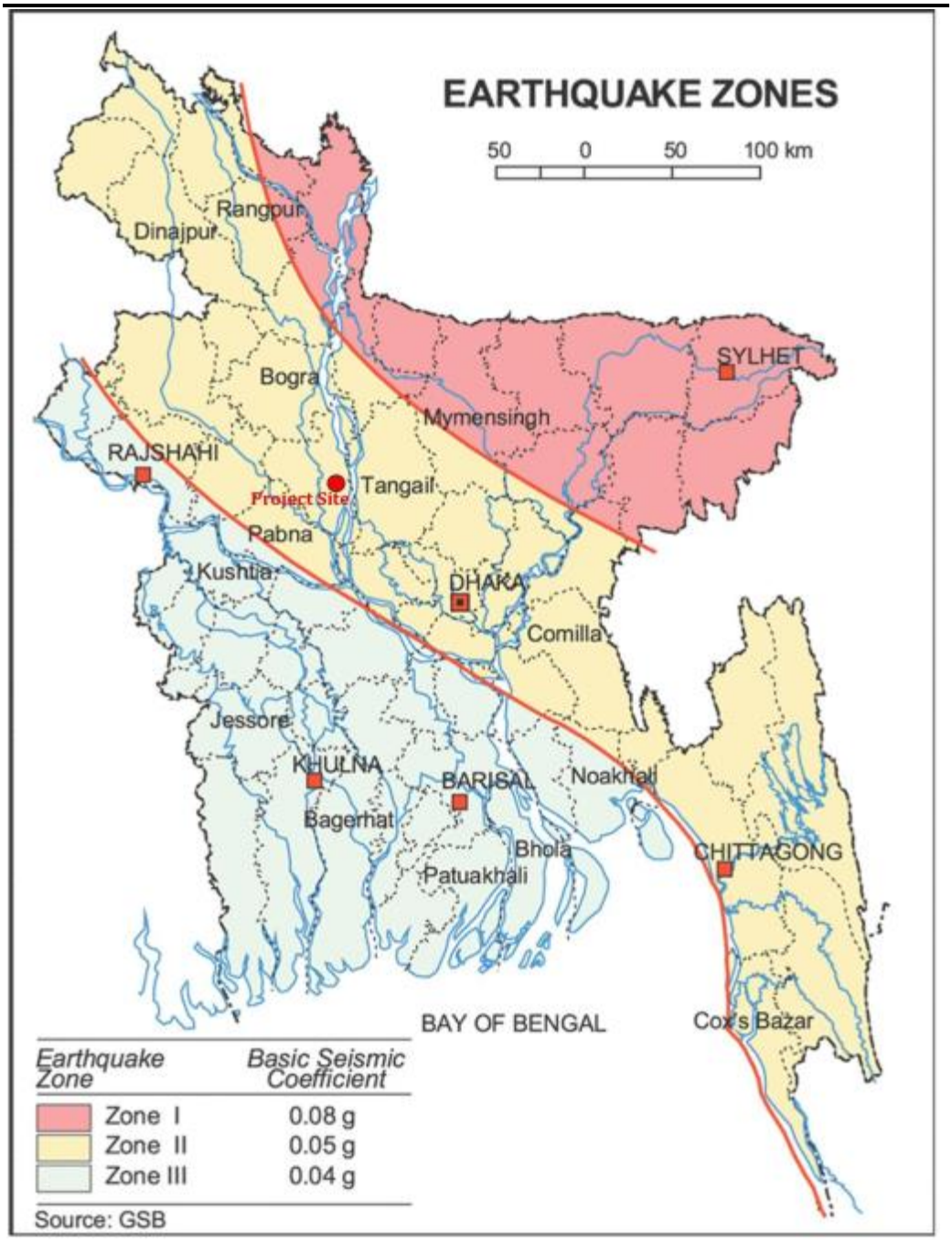
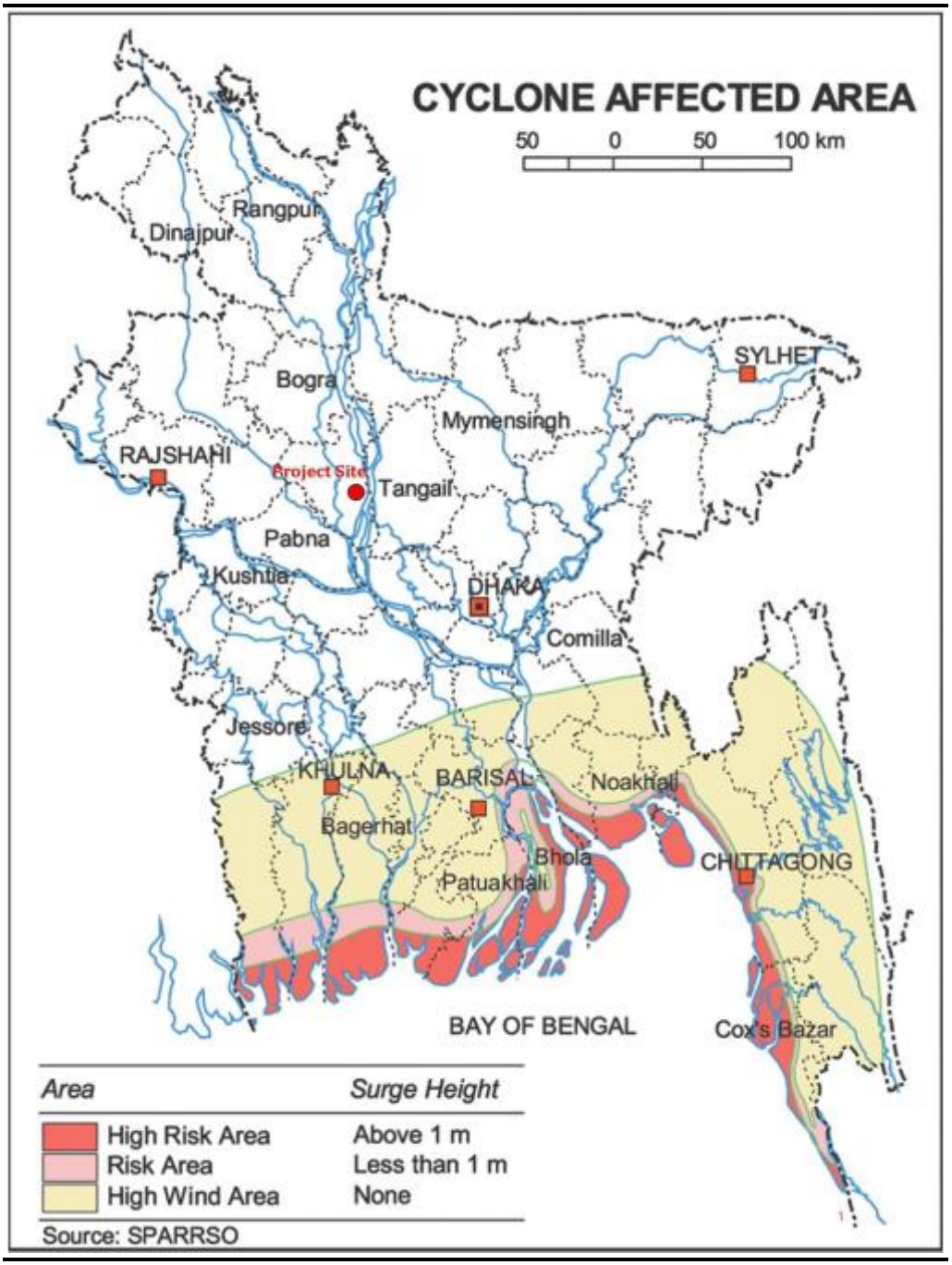


Figure 4.20 Cyclone map of Bangladesh



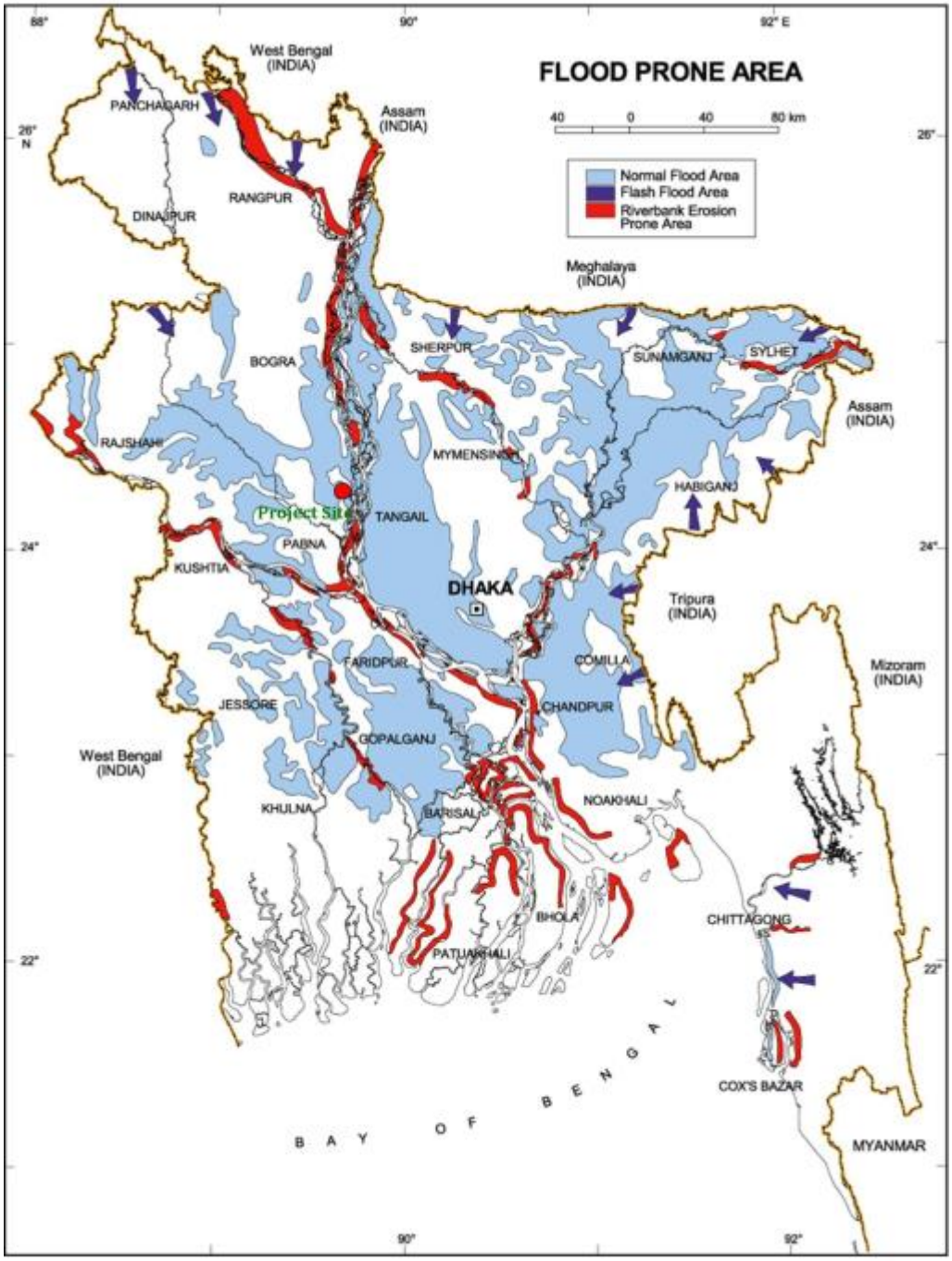
Floods

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.

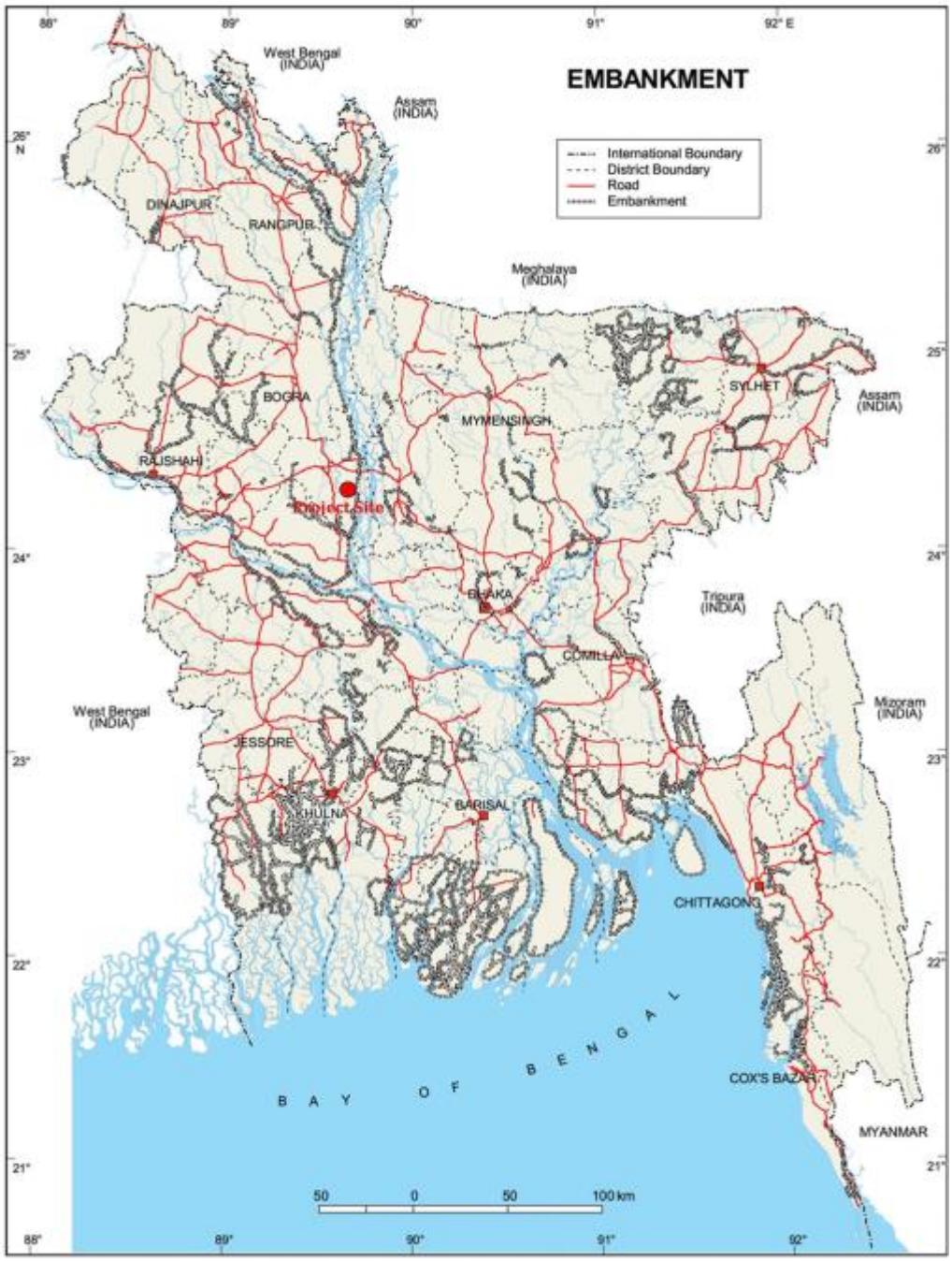
Figure 4.21 shows the flood affected areas of Bangladesh. The Sirajganj district is heavily prone to floods. The project AOI also gets inundated with flood waters of Jamuna River every year during rainy season and is highly prone to River bank erosion. The Project site also used to get affected by flood waters prior to its raising and embankment construction. However, with the construction of the 225 MW NWPGCL plant, the entire Power hub including the site has been raised by 2.5 m – 3m and embankment constructed all around the power hub. Currently, the Project site lies at an elevation level of 15.75 m as against the danger level of 13.35 m. The river embankment Map of Bangladesh is shown in ***Figure 4.22.***

Figure 4.21 Flood Map of Bangladesh



Source: mapofbangladesh.blogspot.com

Figure 4.22 River Embankment Map of Bangladesh



Source: http://www.bpedia.org/E_0049.php

A brief note on the Flood Control measures being carried out by BWDB on Jamuna River in Sirajganj Sadar Upazilla is given in ***Box 4.2.***

Box 4.2 Flood Control Measures on Jamuna River in Sirajganj

Bangladesh is one of the most disaster prone countries in the world. Among different disasters, flood is one of the most threatening disasters for Bangladesh as it causes damage to people and their properties and frequently covers most of Bangladesh. Though flood affects almost every part of the country, the intensity and frequency of flood vary from region to region. Sirajganj is one of the most flood vulnerable districts of the country and Sirajganj Sadar Upazilla is one of the highly flood and erosion prone areas in the Sirajganj district.

As a flood protection measure, Brahmaputra Right Bank Embankment was one of the first embankments constructed in 1960s to provide flood protection to about 230,000 ha lying on the western side of the Brahmaputra-Jamuna and Tista Rivers. It is 217 km long and extends from Kaunia in Rangpur at the northern end up to Bera upazilla in Sirajganj district at the southern end. Construction of the embankment started in 1963 and was completed in 1968 at a cost of about Tk 8 crores[1]. The average height is 4.5m, crest width 6m and side slope 1:3 on both sides. The embankment has been under constant threat of erosion by the Jamuna river and needs relocation further away from the riverbank. This embankment is present throughout the Project AOI.

Further, during the construction of Bangabandhu Jamuna Multipurpose Bridge in 1998, around 2.5 kilometres long Sirajganj town protection embankment (also called Sirajganj Hard point) was built at a cost of Tk 350 crore to protect Sirajganj district town from erosion by the Jamuna River. However, the town protection embankment has been breached several times in the last few years, though it was built with an estimated longevity of 100 years. The embankment was breached three-times in July 2011 and could be affected by future breaches any time due to the rising or falling of the water level of the Jamuna. The BWDB declared the town protection embankment as a KPI (Key Point Installation) in 2011 and started the process to implement capital dredging (theindependent 2011).

The government has taken up a three-year long project and already sanctioned Tk 1000 crore through BWDB to dredge about 20-kilometer portion of Jamuna River from Bangabandhu Jamuna Bridge to Mesra in a bid to keep the flow of water in the river smooth and protect Sirajganj district town. The government also directed the Sirajganj WDB to spend the money in three phases in three years.

As discussed with BWDB officials at Sirajganj and observed during field visit, dredging work is ongoing in the main Jamuna River channel upstream of the Saidabad Power Generation Complex. The BWDB officials also discussed about regular monitoring of the embankment and water levels at the Sirajganj hard point.

[1] *1 crore = 10 million*

Dredging Machines on Jamuna River

Dredging Pipes

Geobags at various points in the Jamuna River

Trawler for carrying dredged sediments

Source: During field survey by ERM team

4.3.10 Ambient Air Quality

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study area. The profile of the Project AOI is mainly rural on the western and Jamuna River on the eastern side. The major sources of air pollution noted within the study area include heavy vehicular movement on the Dhaka-Rajshahi National Highway and domestic emissions apart from the existing NWPGCL's power plant. No major industrial activity is reported in the study area.

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

Methodology of Air Quality Monitoring

The existing ambient air quality of the study area was monitored at four (4) locations during the monitoring period (Dec 2012 – Feb 2013 and Feb 2015). The monitoring parameters included Particulate Matter (Suspended Particulate Matter (SPM), PM_{10} and $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_x) and Carbon Monoxide (CO). All the parameters except CO were monitored on 24-hourly basis twice a week during the duration of the study. CO was monitored as eight-hourly average.

Selection of Sampling Locations

The baseline status of ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations ***(Table 4.14)*** 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 Tangail and Bogra;
- Topography of the study area; and
- Location of sensitive receptors such as major settlements.

The particulate and gaseous samples collected during the monitoring have been analysed as per the procedures specified in ***Table 4.13.*** The geographical locations and setting of the ambient air quality monitoring locations has been presented in ***Table 4.14*** and are depicted in ***Figure 4.23*** and photographs of ambient air quality monitoring are presented in ***Box 4.3***.

Table 4.13 Methodology for Analysis of Ambient Air Quality

S. No.	Parameter	Analysis Procedure
1.	SPM	Gravimetric method
1.	PM_{10}	Gravimetric method
2.	$PM_{2.5}$	Gravimetric method
3.	SO_2	Colorimetric method at 560nm using spectrophotometer (West-Gaeke method)
4.	NO_x	Colorimetric method at 540 nm using spectrophotometer (Jacob and Hochheiser method)
6.	CO	Digital CO meter (Model GCO-2008)

Table 4.14 Ambient Air Quality Sampling Locations

S.N.	Sampling Station	Station Code	Distance from Project Boundary	Direction from Project Site	Geographical Location	Location Setting
1	Project Site	AQ1	0	-	24°23'14.35"N 89°44'33.00"E	Part of Saidabad Power Generation Complex with nearby 225 MW power plant
2	Near the Access road	AQ2	980 m	NNW	24°23'42.17"N 89°44'19.02"E	Small commercial area and proximity to the National Highway
3	Punarbason Village	AQ3	800 m	WNW	24°23'23.84"N 89°44'7.67"E	Village and Rural Setting
4	Radhunibari Village	AQ4	2,800 m	SW	24°21'58.81"N 89°43'18.53"E	Village and Rural Setting

Box 4.3 Site Photographs - Ambient Air Quality Monitoring Locations

AQ1

AQ2

AQ3

AQ4

Ambient Air Quality in the Study Area

The monitored ambient air quality is summarized in ***Table 4.15*** and results are annexed in ***Annex H***.

Table 4.15 Ambient Air Quality in the Study Area

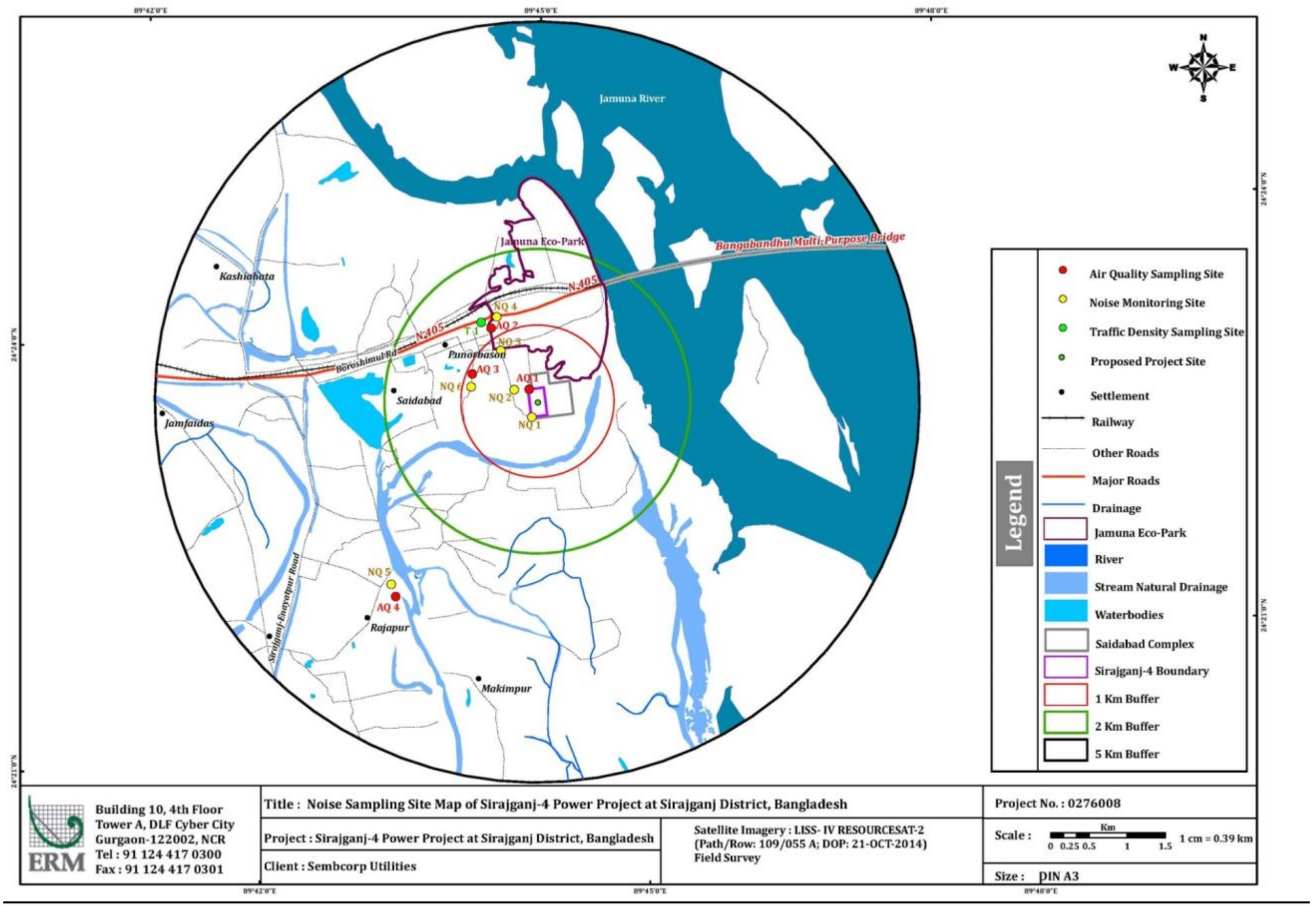
Monitoring Period	Location	Observed	Concentration in (µg/m³)					
			SPM	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO*
December 2012 – February 2013	AQ1	Maximum	237.4	152.5	22.7	2.8	20.9	2300.0
		Minimum	172.5	117.5	14.6	1.2	6.0	0.0
		Average	208.0	134.4	18.1	2.1	10.3	575.0
		98 Percentile	236.1	152.0	22.5	2.7	20.0	2047.0
	AQ2	Maximum	292.8	172.6	24.8	4.0	20.8	2300.0
		Minimum	218.5	134.7	10.4	1.5	8.6	0.0
		Average	253.3	150.8	19.3	3.0	15.2	1533.3
		98 Percentile	290.8	170.5	24.7	3.9	20.7	2300.0
	AQ3	Maximum	202.0	140.3	19.1	2.9	13.3	1150.0
		Minimum	149.5	102.6	11.4	1.2	4.2	0.0
		Average	170.3	117.7	14.4	1.9	7.8	95.8
		98 Percentile	199.9	137.5	19.0	2.7	12.5	897.0
	AQ4	Maximum	285.4	137.7	22.6	3.6	20.6	1150.0
		Minimum	164.8	109.7	11.0	1.6	11.6	0.0
		Average	207.7	120.3	15.0	2.5	15.2	191.7
		98 Percentile	275.0	136.1	22.0	3.5	20.1	1150.0
February 2015	AQ1	Maximum	188.5	145.8	16.4	5.7	19.0	1375.0
		Minimum	162.5	136.9	12.8	3.6	16.7	750.0
		Average	174.6	140.4	14.6	4.5	17.9	1031.3
		98 Percentile	187.8	145.4	16.4	5.6	18.9	1360.0
	AQ2	Maximum	239.8	142.8	20.6	7.2	18.3	1875.0
		Minimum	215.7	128.6	17.8	5.2	15.7	1375.0
		Average	228.3	136.0	18.7	6.2	16.7	1656.3
		98 Percentile	239.4	142.4	20.5	7.1	18.1	1867.5
	AQ3	Maximum	167.5	118.7	16.7	1.8	7.1	1250.0
		Minimum	141.8	105.5	14.5	1.2	4.2	0.0
		Average	155.3	111.8	15.6	1.5	5.4	437.5
		98 Percentile	167.3	118.3	16.7	1.8	7.0	1190.0
	AQ4	Maximum	165.8	113.5	18.7	2.8	16.6	0.0
		Minimum	152.7	101.9	14.1	1.9	10.2	0.0
		Average	159.2	107.2	16.4	2.3	12.9	0.0
		98 Percentile	165.5	113.2	18.6	2.7	16.4	0.0
	Standards Bangladesh	***24 hourly***	***200***	***150***	***65***	***365***	***-***	***10,000***
		Annual	***-***	***50***	***15***	***80***	***100***	***-***

Note:

* CO concentrations and standards are 8-hourly only.

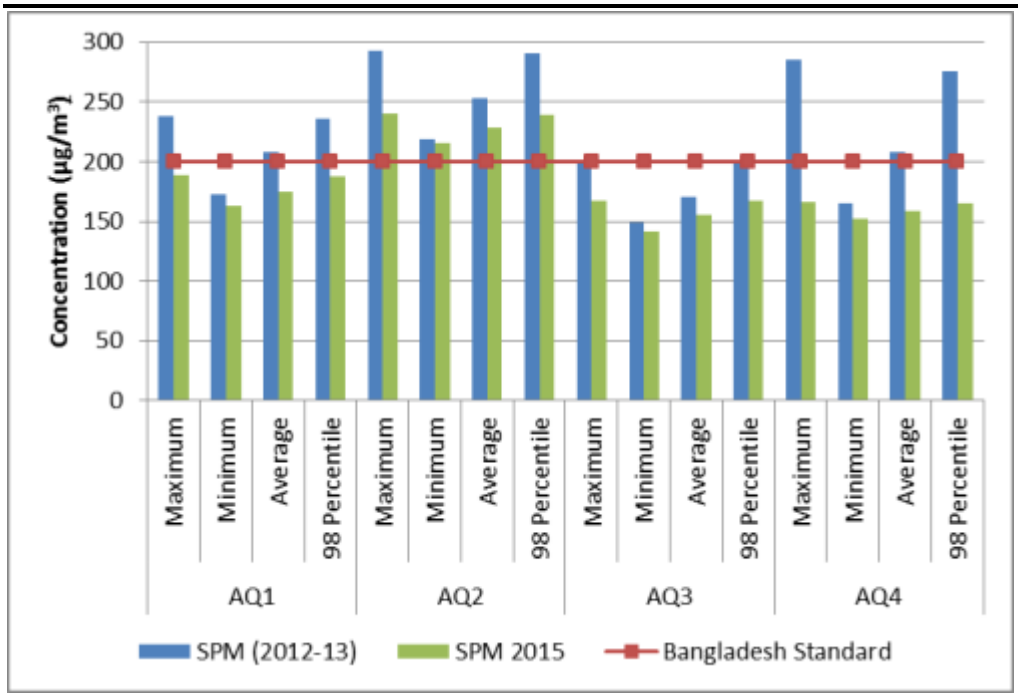
** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005.

Figure 4.23 Air Quality (AQ 1 – AQ 4) and Traffic Monitoring (T1) Locations



SPM: The 24-hourly average SPM concentration in ambient air was recorded in the range of 141.8 – 292.8 µg/m^3. The 98th percentile SPM concentration at the four monitoring locations was recorded in the range of 199.2 – 290.1 µg/m^3. Average concentration of SPM at the monitoring locations was reported in the range of 166.52 – 247.0 µg/m^3. During the monitoring period, the maximum SPM concentration was reported at AQ2 as 292.8 µg/m^3. Higher SPM concentrations at this location are primarily due to unpaved road stretches, traffic movement and agricultural activities. SPM level at three locations (except AQ2 – refer Table 4.14 for location details) were observed slightly higher than the National Ambient Air Quality Standards of Bangladesh. The SPM pattern in the study area has been presented in ***Figure 4.24***. While comparing the air quality results of monitoring being carried out in 2012-13 with additional monitoring done in 2015, it was noted that the SPM levels were only exceeding at the AQ2 location, with highest concentration of 239.75 µg/m3, whereas in other three locations, the levels were found between 141.75 µg/m3 and 188.5 µg/m3, which are well within the applicable standard of 200 µg/m3. Similarly, the air quality monitoring data of S1 and S2 projects monitored by the DOE in September 2013 indicated the SPM levels at the Sirajganj Power Generation Complex between 135.25 µg/m3 and 144.12 µg/m3. Considering these the airshed cannot be considered as degraded as the industrial activities in the area are very limited and the higher SPM levels are mainly resulted due to the traffic induced dust, open agricultural areas and windblown dusts.

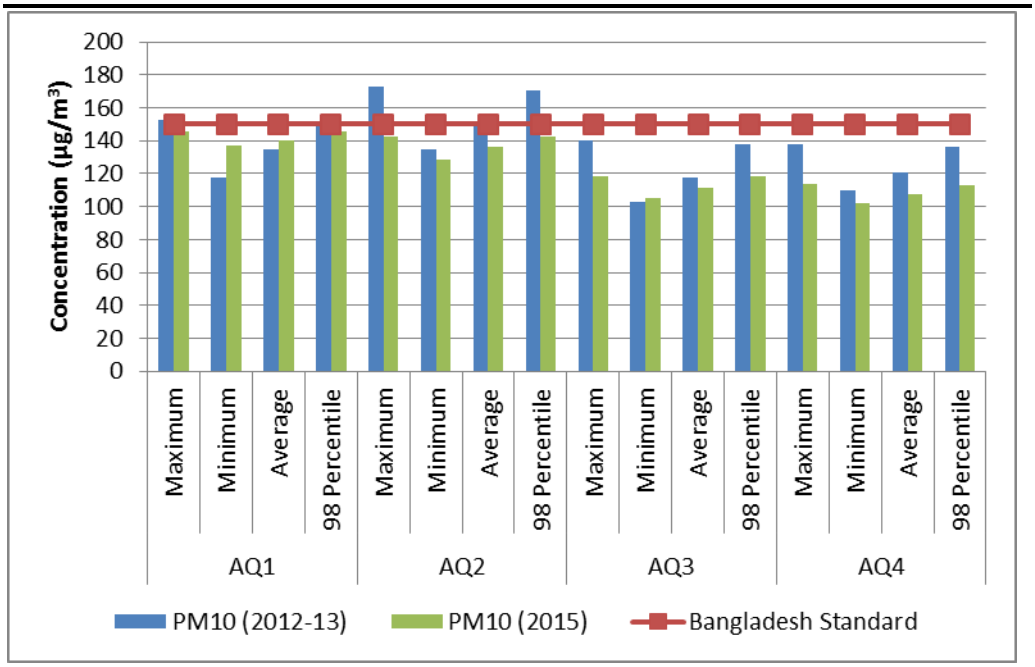
Figure 4.24 SPM Concentration Pattern in the Project AOI



PM$_{10}$: The 24-hourly average PM$_{10}$ concentration in ambient air was recorded in the range of 102.6 – 172.6 µg/m^3. The 98th percentile PM$_{10}$ concentration at

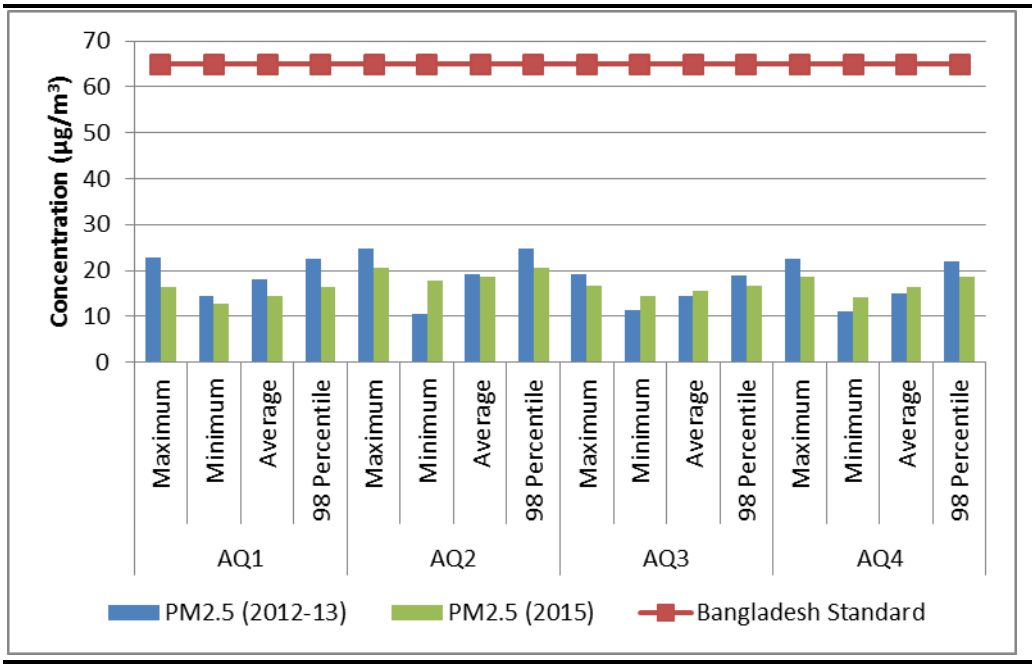
the monitoring locations was recorded in the range of 136.1 – 169.76 µg/m³. Average concentration of PM_{10} was reported in the range of 117.7 – 150.8 µg/m³. During the monitoring period, the maximum PM_{10} concentration was reported from AQ2 as 172.6 µg/m³. PM_{10} level (98th percentile) at AQ1 and AQ2 were reported slightly above 150 µg/m³, which is a 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{10} in Bangladesh, whereas PM_{10} level (average) at three monitoring locations (except AQ2) was reported below the NAAQS. The PM_{10} pattern in the study area has been presented in ***Figure 4.25***. While comparing the air quality results of monitoring being carried out in 2012-13 with additional monitoring done in 2015, it was noted that the PM_{10} levels were found to be within the applicable standard of 150 µg/m3 in 2015, with highest concentration of 145.75 µg/m3 at location AQ1 and minimum concentration of 101.85 µg/m3 at location AQ4.

Figure 4.25 ***PM_{10} Concentration Pattern in the Project AOI***



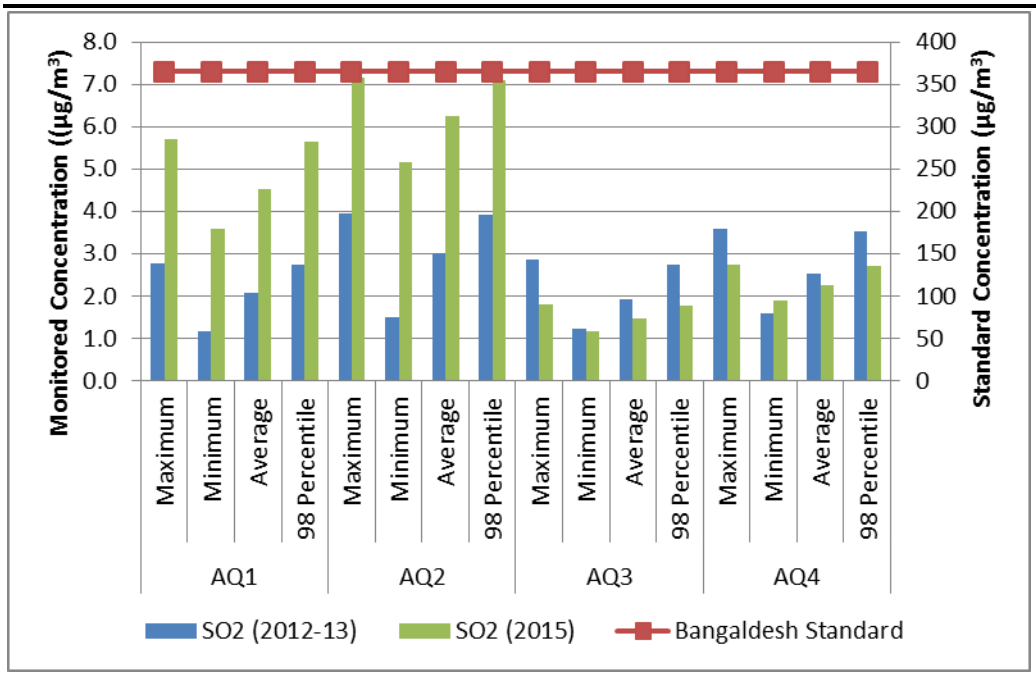
$PM_{2.5}$: The 24-hourly average $PM_{2.5}$ concentration in ambient air was recorded in the range of 10.9 – 24.7 µg/m³. The 98th percentile was recorded in the range of 19.0 – 24.7 µg/m³. Average concentration of $PM_{2.5}$ was reported in the range of 14.4 – 19.1µg/m³. During the monitoring period, the maximum $PM_{2.5}$ concentration was reported at AQ2 as 24.7 µg/m³. $PM_{2.5}$ level (98th percentile as well as average) at all the locations were reported well within the 24-hourly National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in Bangladesh (65 µg/m³). The $PM_{2.5}$ pattern in the study area has been presented in ***Figure 4.26.***

Figure 4.26 $PM_{2.5}$ Concentration Pattern in the Project AOI



<u>SO_2:</u> The 24-hourly average SO_2 concentration was recorded in the range of 1.1 – 5.7 µg/m³. The 98th percentile was recorded in the range of 2.7 – 6.9 µg/m³. Average concentration of SO_2 at the monitoring locations was reported in the range of 1.9 -3.8 µg/m³. SO_2 concentrations (both average and 98th percentile) at all the monitoring locations were reported well below 365 µg/m³, which is the 24-hourly National Ambient Air Quality Standard (NAAQS) for SO_2 in Bangladesh (Figure 4.27).

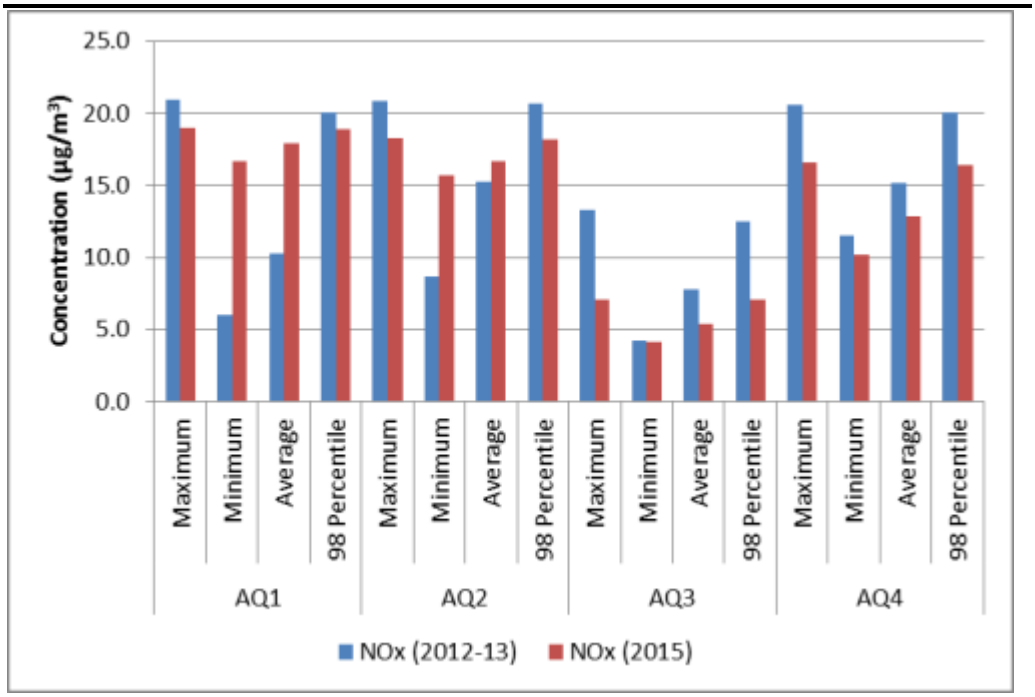
Figure 4.27 SO_2 Concentration Pattern in the Project AOI



<u>***NOx:***</u> The 24-hourly average NO_x concentration was recorded in the range of 4.2 – 20.9 µg/m³. The 98th percentile was recorded in the range of 12.5 – 20.7

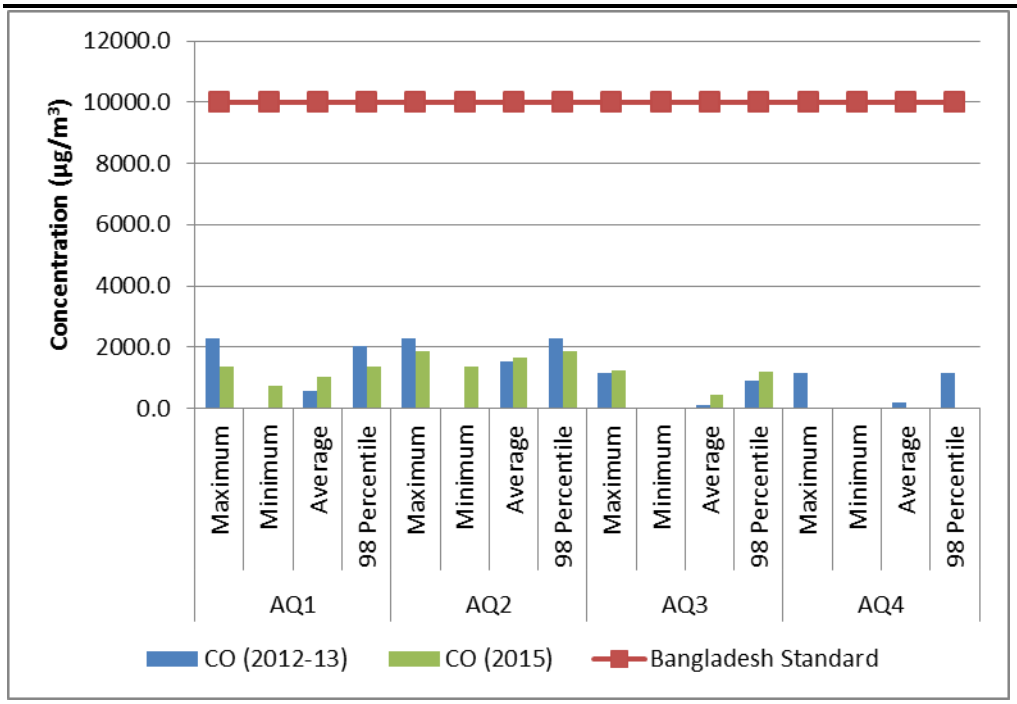
µg/m³. Average concentrations of NOx at all the monitoring locations were reported in the range of 7.8 – 15.6µg/m³. The NOx pattern in the study area has been presented in **Figure 4.28**. There are no stipulated standards for 24-hourly NOx concentration in Bangladesh. The annual Bangladesh standard for NOx is 100 µg/m³ and present 24 hourly average concentrations at all the locations are well below these values.

Figure 4.28 NOx Concentration Pattern in the Project AOI



CO: The 8-hourly average CO concentration was recorded below the detection limits or ranged up to maximum of 2300µg/m³. The 98th percentile was recorded in the range of 1082.650.0 – 2300.0µg/m³. Average concentrations of CO are reported low at all the monitoring locations while comparing with the Bangladesh Standards (10 mg/m³). The CO pattern in the study area is presented in **Figure 4.29**.

Figure 4.29 CO Concentration Pattern in the Project AOI



Conclusion

It is evident from the above comparison of ambient air quality results with the applicable standards that the ambient air quality of the project AOI is good with respect to the gaseous pollutants and fine particulate matter ($PM_{2.5}$). Industrial activity in the area is currently limited to the operational 225 MW power plant of NWPGCL and small scale handlooms at household level. Further the comparison of the ambient air quality monitoring carried out in 2012-13 and 2015 in the same area indicated that the levels in 2015 were much lower than previous monitoring results and that clearly indicates that the AOI is not a degraded airshed.

4.3.11 Ambient Noise Levels

Noise levels were recorded at six locations in the study area during the monitoring period of Dec 2012 to Feb 2013. Noise levels were recorded in the form of sound pressure levels using a digital sound level meter. The details of noise monitoring locations are given in ***Table 4.16*** and depicted in ***Figure 4.23.***

Noise levels were also recorded at 14 locations in the study area during Feb 2014 to map the current noise levels with the operational 225 MW NWPGCL's plant. The details of noise monitoring locations are given in ***Table 4.17 and Figure 4.30.*** Photographs of noise monitoring locations are presented in ***Box 4.4***.

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. 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 4.16 Details of Ambient Noise Monitoring Locations carried out during Dec 2012 to Feb 2013

S.N.	Location Code	Stations	Distance from Project Boundary	Direction from Project Boundary	Geographical Location	Location Setting
1	NQ1	Project Site boundary on south western corner	0	-	24°23'2.47"N 89°44'32.60"E	Industrial area with NWPGCL's plant in vicinity
2	NQ2	Khas Bara Shimul	220	W	24°23'15.07"N 89°44'25.50"E	Village setting (nearest receptor)
3	NQ3	Settlement Near access road (MMS office)	665	WNW	24°23'32.20"N 89°44'22.12"E	Village setting with access road near by
4	NQ4	Starting point of access road near National Highway	945	WNW	24°23'42.17"N 89°44'19.02"E	Mixed Setting (commercial and road nearby)
5	NQ5	Makimpur village	3000	SW	24°21'53.98"N 89°43'19.42"E	Village and Rural Setting
6	NQ6	Punorbason Village	760 m	NW	24°23'23.84"N 89°44'7.67"E	Village and Rural setting

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 4.17 Ambient Noise Monitoring Locations, February 2015

S.N.	Location Code	Stations	Distance from Project Boundary	Direction from Project Boundary	Geographical Location	Location Setting
1.	NL1	Center of the Project area	0	-	24°23'9.68"N 89°44'36.09"E	Industrial with 225 MW operational plant in vicinity
2.	NL2	North-East Corner (In front of rest house)	0	-	24°23'14.85"N 89°44'50.08"E	Industrial with 225 MW operational plant in vicinity
3.	NL3	South side of the Mosque	0	-	24°23'14.76"N 89°44'34.82"E	Vicinity of access road
4.	NL4	Jetty Ghat	0	-	24°23'3.42"N 89°44'56.88"E	Industrial setting Near Jamuna River
5.	NL5	North-west corner of the boundary	0	-	24°23'15.25"N 89°44'32.45"E	Boundary of power complex
6.	NL6	Middle point of the west side boundary (outside)	30 m	-	24°23'7.76"N 89°44'31.12"E	Boundary of power complex
7.	NL7	South west corner of the boundary	0	-	24°23'2.67"N 89°44'32.59"E	Boundary of power complex
8.	NL8	In front of the GTCL's quarter	0	-	24°23'14.70"N 89°44'42.50"E	Boundary of power complex
9.	NL9	Khas Bara Shimul village (Suruzzan Shek's house)	220 m	W	24°23'14.94"N 89°44'25.44"E	Village setting
10.	NL10	Khas Bara Shimul village (Salim Uddin's house)	220 m	W	24°23'8.02"N 89°44'25.07"E	Village setting
11.	NL11	Chak Boira Village (Akter Mia's house)	680 m	S	24°22'40.44"N 89°44'55.06"E	Village setting
12.	NL12	Chak Boira Village (Ala-Uddin's house)	840 m	SW	24°22'41.17"N 89°44'12.56"E	Village setting
13.	NL13	Bara Shimul village (Tota Mia's house)	490 m	N	24°23'31.35"N 89°44'31.33"E	Village setting with access road nearby
14.	NL14	Khas Bara Shimul village (Samsul Islam's house)	560 m	W	24°23'15.23"N 89°44'13.59"E	Village setting

Box 4.4 Site Photographs - Ambient Noise Monitoring Locations

NL1

NL2

NL3

NL4

NL5

NL6

NL7

NL8

NL9

NL10

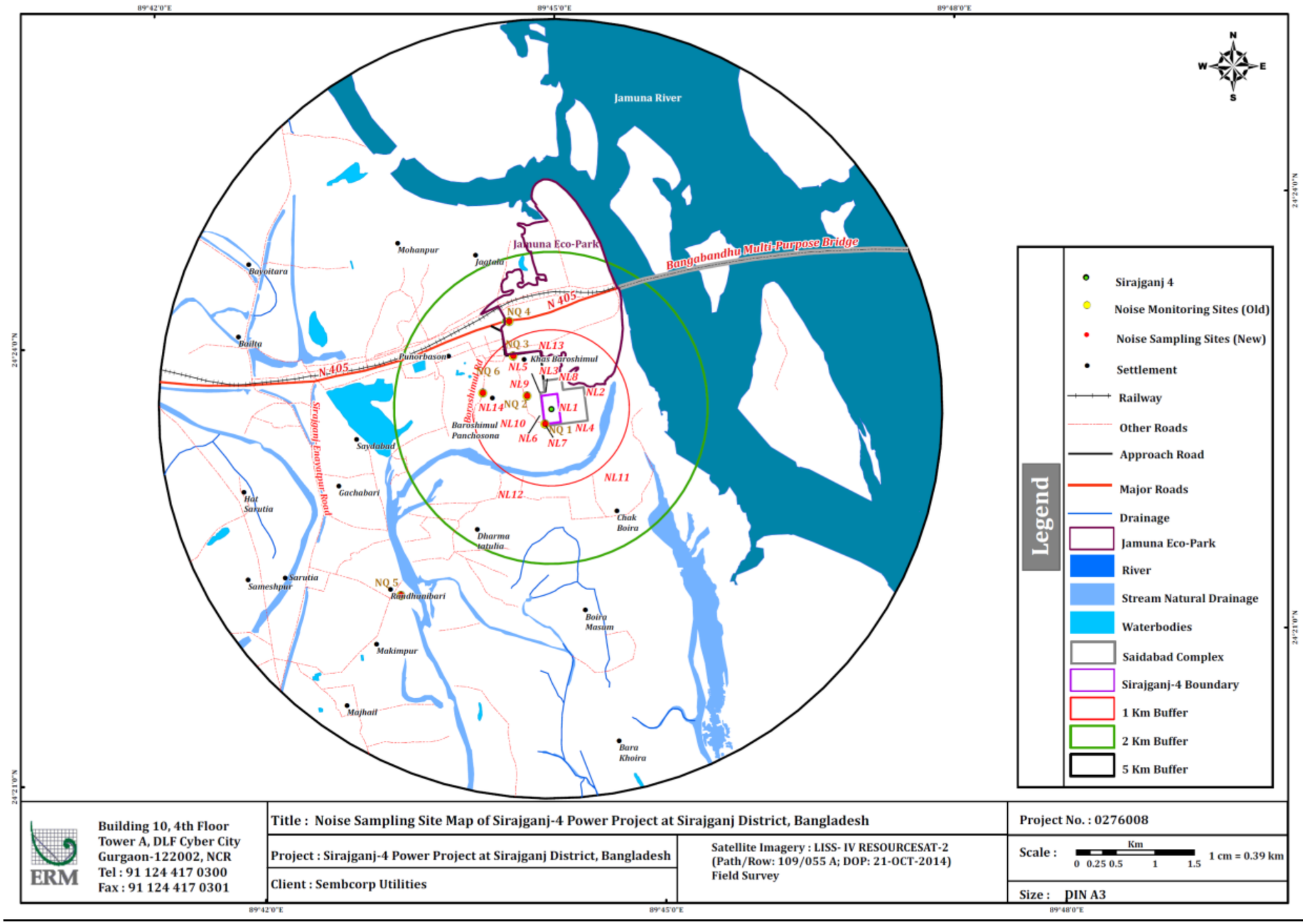
NL11

NL12

NL13

NL14

Figure 4.30: Noise Monitoring locations (NQ1 – NQ6) (December 2012 to February 2013) and (NL1-NL14) (February 2015)



Observations

The recorded noise levels in the Project AOI during January – February 2013 are summarised in ***Table 4.18***. The equivalent sound pressure level (Leq) during day and night time measured during the monitoring period is presented in ***Figure 4.31.***

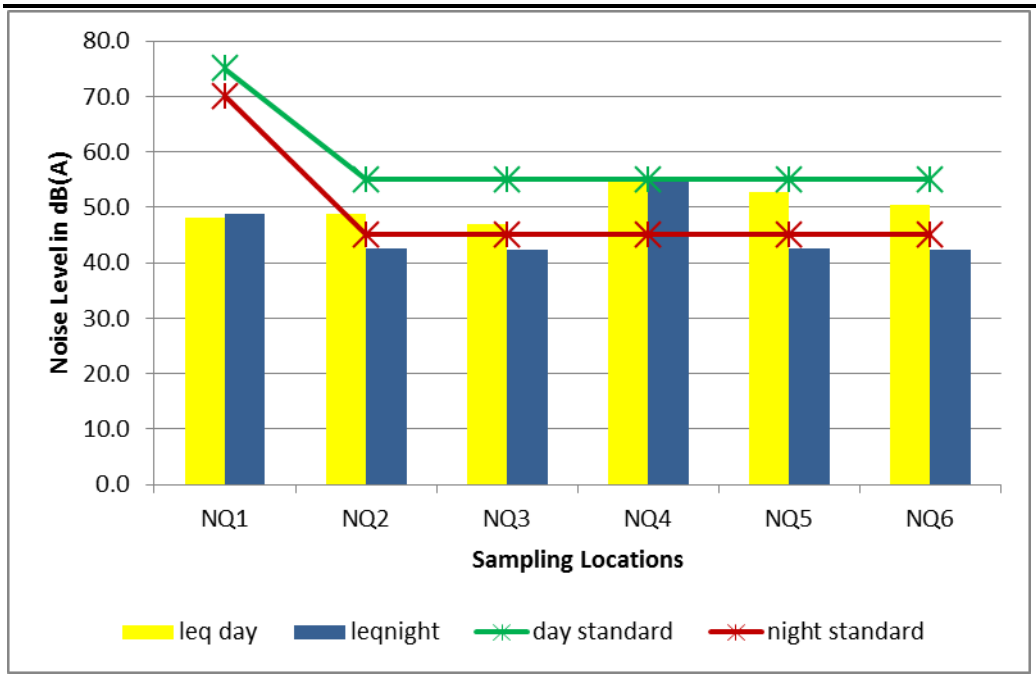
Table 4.18 Noise Levels in the Study Area, (January – February 2013)

Locations	Noise level (dB(A))				Applicable Standard (dB(A))* as per Landuse	
	Leq_{day}	Leq_{night}	L_{max}	L_{min}	Day	Night
NQ1	48.2	48.9	49.9	45.2	***70***	***70***
NQ2	48.9	42.5	56.3	35.2	***55***	***45***
NQ3	47.0	42.4	54.2	38.6	***55***	***45***
NQ4	54.5	55.3	57.1	52.1	***55***	***45***
NQ5	52.8	42.6	56.2	36.6	***55***	***45***
NQ6	50.4	42.4	55.3	36.3	***55***	***45***

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.
Source: Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

Ambient daytime noise level **(Leq_{day})** was recorded in the range of 48.2 to 52.8 dB (A). Whereas, ambient night time noise level (Leq_{night}) in the study area varied in the ranged of 42.4 to 55.3 dB (A). Maximum noise levels (L_{max}) at the monitoring locations were recorded in the range of 49.9 to 56.3 dB(A) and the minimum noise levels (Leq_{min}) at the monitoring locations were recorded in the range of 35.2 to 52.1 dB(A).

Figure 4.31 Noise Levels Recorded in the Study Area during Dec2012-Feb 2013



The noise sources at the Project site in 2012-13 were mainly the ambient noise and from the activities related to commissioning of the 225 MW Power plant.

In other locations, the main sources of noise are traffic (especially at NQ4), noise from the agricultural activities, sound of engines – diesel generators, small water pumps etc. in and around the monitoring locations.

The recorded noise levels in the Project AOI during Feb 2015 are summarised in ***Table 4.19***. The equivalent sound pressure level (Leq) during day and night time measured during the monitoring period is presented in ***Figure 4.32.***

Table 4.19 Noise Levels in the Study Area, Feb 2015

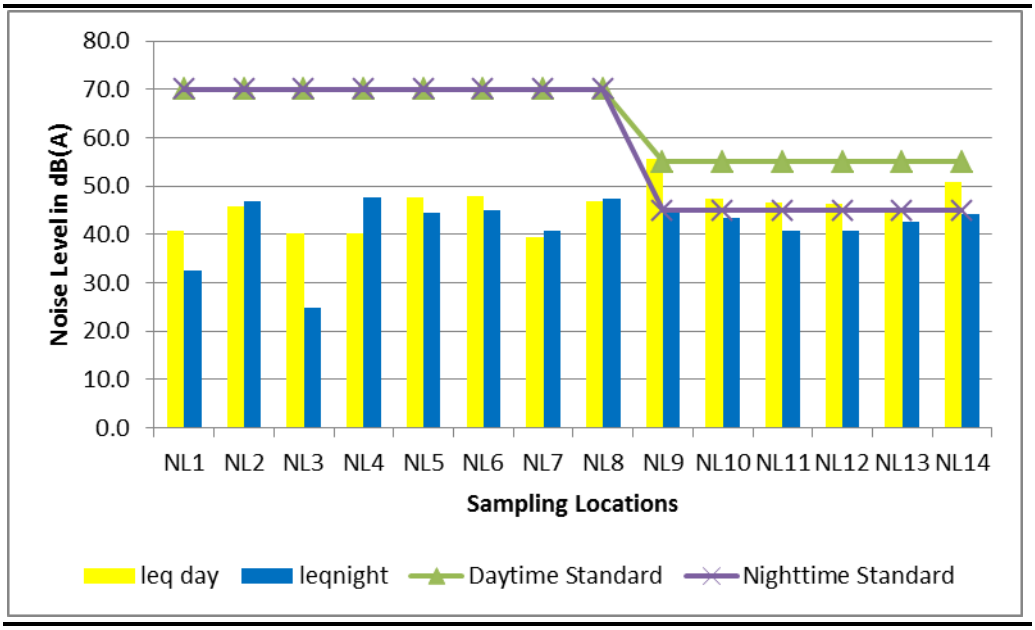
Locations	Noise level (dB(A))				Applicable Standard (dB(A))* as per Landuse	
	Leq_{day}	Leq_{night}	L_{max}	L_{min}	Day	Night
NL1	40.7	32.4	48.0	41.9	***70***	***70***
NL2	45.9	46.9	54.7	53.2	***70***	***70***
NL3	40.2	24.8	46.9	34.3	***70***	***70***
NL4	40.2	47.6	53.4	47.7	***70***	***70***
NL5	47.7	44.5	49.7	43.5	***70***	***70***
NL6	48.0	45.1	51.2	44.2	***70***	***70***
NL7	39.5	40.6	48.3	46.8	***70***	***70***
NL8	46.8	47.5	55.9	53.8	***70***	***70***
NL9	55.6	45.2	60.9	47.4	***55***	***45***
NL10	47.3	43.5	49.4	42.6	***55***	***45***
NL11	46.5	40.7	49.9	39.0	***55***	***45***
NL12	46.4	40.8	53.6	39.7	***55***	***45***
NL13	44.6	42.6	47.4	41.0	***55***	***45***
NL14	50.8	44.2	54.3	42.2	***55***	***45***

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.

Source: Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

Ambient daytime noise level **(Leq_{day})** was recorded in the range of 39.5 to 55.6 dB (A). Whereas, ambient night time noise level (Leq_{night}) in the study area varied in the ranged of 32.4 to 47.6 dB (A). Maximum noise levels (L_{max}) at the monitoring locations were recorded in the range of 48.0 to 60.9dB(A) and the minimum noise levels (Leq_{min}) at the monitoring locations were recorded in the range of 39.0 to 53.8 dB(A).

Figure 4.32 Noise Levels Recorded in the Study Area, Feb 2015



Conclusion

From the above it can be concluded that ambient noise levels in the rural and village setting of the Project AOI between Dec 2012- Feb 2013 were within the prescribed limits for residential landuse, which is 55dB(A) for day time and 45 dB(A) for night time at most of the locations. At that point of time, only NQ-4 (starting point of the access road near National Highway) a mixed landuse location was found to exceed the night time limit of 50 dB(A) for mixed area mainly because of increased heavy vehicular movement at night time. It also shows higher noise levels during night time as compared to the daytime noise levels. This indicates the heavy traffic movement during night time on the national highway.

In the current scenario with the 225 MW operational plant, the noise levels around the power complex boundary when compared to the prescribed limits for industrial landuse was well within the limits. However at NL-9, location in Bara Shimul Panchosona Village, monitoring results marginally exceed both day and night time limits for residential land use. Detailed analysis of the monitoring data indicated that the noise levels on the day of monitoring at this location were in the range of 58.5 to 60.9 dB(A) between 15:00 to 18:00 hrs. This has resulted into higher daytime noise levels. Since NQ2 and NL9 are the same locations of noise monitoring and the comparison of the results indicated that the noise results of February 2015 are not a regular phenomenon and it is being contributed due to the anthropogenic activities on the day of monitoring. When the results at NL9 are compared with NL1 to NL8 results (monitoring locations within and around the Saidabad Power Generation Complex), which provide the baseline due to the operation of existing NWPGCL power plant, it is evident that the noise levels at NL9 are higher than these monitoring results. This clearly indicates that majority of noise at NL9 is not being contributed by the existing power plant operations.

It is also to be noted that the locations NL9, NL 10 and NQ 2 are equidistant from the boundary of Saidabad Power Generation Complex in the west direction. The comparison of monitoring results of these three locations clearly indicate that the noise is only exceeding at location NL9 from the applicable standard during day and night time, whereas the monitoring carried out on the west boundary of the Saidabad Power Generation Complex (NL5, NL6 and NL7) show much lower noise levels than NL9. This clearly depicts that the higher noise levels at NL9 are due to anthropogenic activities near the monitoring location and not a result of noise generated due to the operation of S1 project.

4.3.12 Traffic

The current traffic assessment was identified for two locations in the Project AOI, which are connected to the Project Site**.** The traffic assessment locations were selected based on discussions with the client and survey of main access roads which will provide connectivity to the Project for transportation of manpower and materials. The two location details are provided in ***Table 4.20***. However, daily traffic data (both way movement) for one of the location i.e. Bangabandhu Bridge was available from the BBA Toll Plaza office and the same has been used in this study. For the other location i.e. access road to the Project site, the traffic volume was monitored continuously for 24 hours, one time, during the study period.

Table 4.20 Locations of Traffic Survey

S N	Location Code	Geographical Coordinates/ Location	Location detail and justification
1	TD1	BBA East and West Toll Plaza	Traffic on National Highway 405 connecting Dhaka-Rajshahi and fro and connects the Project area to Dhaka and Rajshahi. Represents the main traffic on National Highway connecting the Project area to other districts.
2	TD2	24°23'45.12"N 89°44'14.70"E	Acess Road connecting Project Site to the National Highway 405 and fro. Represents traffic on the main access road.

The BBA Toll Plaza collects the traffic data categorized as Motor Cycles, Light Vehicles (LV which indicates Cars, jeeps, micros), Trucks- Small trucks (ST), Medium trucks (MT) and Large trucks (LT), Buses - Small buses (SB) and Large buses (LB). Similar format was used for traffic data collection for the access road to the Project site with addition of non-motorized vehicles as cycles, rickshaws, vans and others as battery driven auto rickshaws and CNG autos. These additional categories i.e. non-motorized vehicles, battery driven auto rickshaws and CNGs are forbidden to pass Bangabandhu Bridge but used within the town and village areas as a means of transport by villagers and local people.

The summarised details of the traffic data collected from the Toll Plaza and survey at the access road are given in ***Table 4.21***. The detailed traffic data is included in ***Annex I***.

Table 4.21 Existing Traffic Volumes on the National Highway and Connecting Road

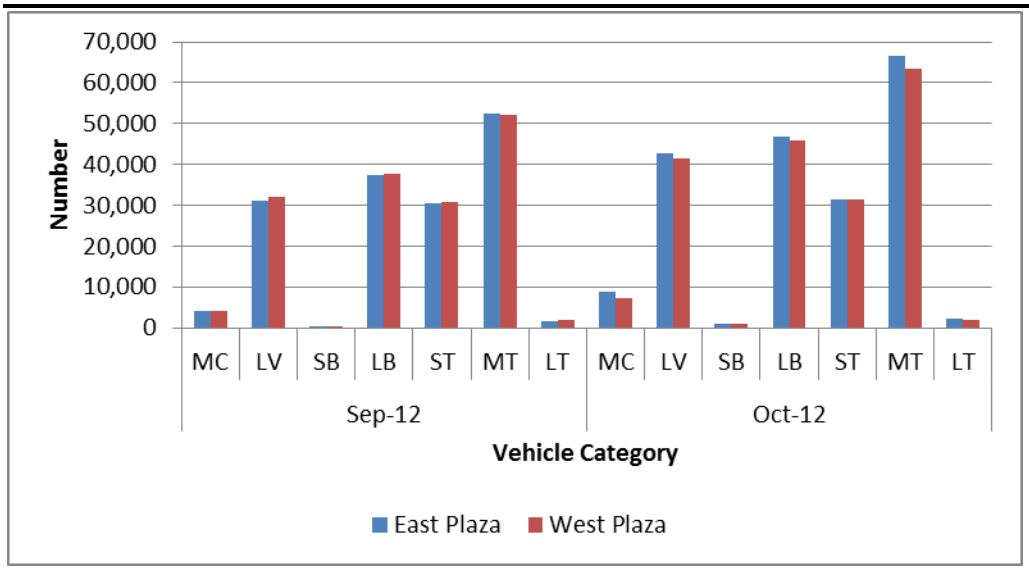
Description	Traffic on National Highway 405 connecting Dhaka-Rajshahi and fro*	Acess Road connecting Project Site to the National Highway 405 and fro**
Number of Motor Cycles	250	89
Number of LVs	2033	25
Number of Trucks	5937	36
Number of Buses	2264	2
Number of Non-motorized Vehicles (cycles, Rickshaws and vans)	Prohibited	99
Number of Other Category Vehicles (battery driven and CNG auto rickshaws)	Prohibited	42
Total Traffic (Nos.)/24 Hours (To and fro)	10,484	449
Average Traffic Flow/Hr.	437	19
Max Traffic Flow (Nos)/Hr.	-	55 (12.25%) 15.00-16.00 hrs.
Min Traffic Flow (Nos)/Hr.	-	0 1.00 -5.00 hrs
Peak Traffic hours (over 8% of total daily traffic)	-	11.00-12.00 hrs 15.00-17.00 hrs 8.00-10.00 hrs

Source: *(BBA Toll Plaza office) 1st October 2012 Data ** Primary data collection.

The National Highway is at a distance of about 1.5 km from the Project site gate and the Bangabandhu Bridge[1] starts at about 3 km from the Project site towards east from the highway. The highway is 4 laned with a RoW of approx. 14 m and connects the Rajshahi Division to the eastern parts and Capital Dhaka via the Bangabandhu Bridge. The highway faces heavy traffic as it provides an important connectivity. The traffic trends for the months of September and October 2012 of Bangabandhu Bridge is shown in ***Figure 4.33.***The month of October reflects higher traffic compared to September because of increased travel related to the main festival of Id-ul Fitr celebrated in that month.

[1] The Bangabandhu Bridge also called the Jamuna multipurpose Bridge is a strategic link connecting the north western Bangladesh to the eastern parts and Capital Dhaka. The Bridge is 4.8 km long and 18.5 m in width. The carriageways are 6.315 metres wide separated by a 0.57 metre width central barrier. The toll plaza at the Bridge was used as a traffic assessment location as there are no major roads jutting in or out till the Bridge and reflects the traffic on the national highway connecting to the Project site access road.

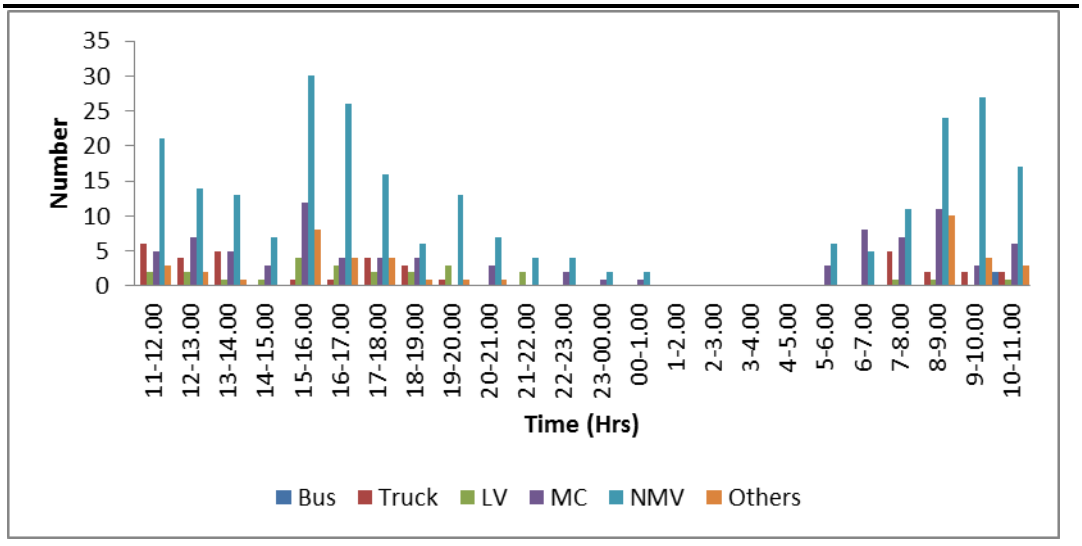
Figure 4.33 Traffic Trend for the Bangabandhu Bridge



*MC- Motorcycle, LV-Light Vehicles, SB-Small Bus, LB-Large Bus, ST-Small Truck, MT-Medium Truck, LT-Large Truck

The access road connecting the Project site from the National Highway is about 6 m in RoW. This road was built with the sole purpose of providing access to the Saidabad Power Hub i.e. the existing NWPGCL's 225 MW power plant, proposed power plant and related facilities as the grid station. However, local villages of Punorbason, Boro Simul and Panchosona also started using this road for connectivity as this is accessible even in the monsoon season. The maximum number of vehicles are non-motorized (22%) followed by motor cycles (19.82%), being used by the local villagers and labourers for commuting to the under commissioning NWPGCL power plant. The heavy vehicles movements i.e. truck and buses contribute only 8.4% of the total traffic. The hourly traffic variation in the access road connecting the Project site is shown in ***Figure 4.34.***

Figure 4.34 Traffic Volume in the access road connecting the Project site



LV-Light Vehicle, MC-Motor Cycle, NMV- Non-motorized Vehicles, Others-battery operated rickshaws and CNGs

4.4 NATURAL CAPITAL – BIODIVERSITY BASELINE

4.4.1 Terrestrial and Aquatic ecology

Bangladesh is situated in the "oriental region", between the Indo-Himalayas and Indo-Chinese sub regions. The country has a total area of 147,570 sq. km, of which about 80 % comprises of one of the largest deltaic plains in the world, formed at the confluence of the Ganges, the Brahmaputra (Jamuna), and the Meghna Rivers. The remaining 20 % of the land area is comprised of the undulating, forested hill tracts. Distinct physiographic characteristics, variations in hydrological and climatological conditions, and difference in the soil properties in Bangladesh contribute in developing diverse forms of ecosystems enriched with great diversity of flora and fauna.

4.4.2 Introduction to the Project AOI

The Project AOI (5 km radius from the project site) is situated at the right bank of Jamuna (Brahmaputra) River at a distance of 1.5 km from the Jamuna Multipurpose Bridge. The proposed power plant area is situated at Saidabad Union of Sirajganj Sadar Upazilla of Sirajganj District in Bangladesh. The annual average temperature reaches a maximum of 34.6 °C, and a minimum of 11.9 °C. The annual rainfall is 1610 mm (63.4 in). The soil/ land pattern of the district is flood plain, loose sandy soil.

Jute, Mustard Seed, Pulses, Ground Nut, Sweet Potato, Chilli, Onion, Garlic, Wheat, Sugarcane, Tobacco, Sesame, Paddy and winter vegetables are common crops cultivated in the agricultural lands of Project AOI while Jackfruit, Mango, Banana, Papaya, Jujube Fruit, Bengal Quince, Black Berry, Olive and Guava are the most common among horticultural or fruit crops.

The majority of the project AOI falls in agricultural uses comprising 40.23% of the project AOI, followed by 24.84% of waste land and 20.14 % of water bodies. Plantation area comprises only 4.23%. Agricultural lands are very fertile due to deposit of alluvial soil from Jamuna River. It is under the agro ecological zone of *Active Brahmaputra – Jamuna Floodplain*. The region has an irregular relief of broad and narrow ridges and depressions, interrupted by cut off channels and active channels.

The Project site is located at an elevated dredged area called the Saidabad Power Generation Complex**.**

4.4.3 Objective of the Ecological Study

The study was undertaken with following broad objectives:-

1. Terrestrial Flora and Fauna Survey
   - Assess the status of major floral and faunal components of all the terrestrial habitats (Forest, grassland, fallow land, riverine land, agro-ecosystem and homestead plantation) present in the Project AOI (including the project site) adopting different standard techniques;
   - Collection and compilation of secondary information on the status of floral and faunal components and habitats from the concerned stakeholders – Forest department and others;
   - Provide quantitative information on different floral and faunal components: using statistical analysis and derive diversity indices;
   - Identification and listing of floral and faunal species of conservation significant (rare, endangered and threatened – RET species and endemic species in accordance with International Union of Conservation for Nature - IUCN RED List/ MoEF) in the Project AOI;
   - Identification of areas of conservation significance (Protect Areas: Sanctuary, National Parks, Biosphere Reserve, landscape and Sacred grows- pertaining to Floral diversity) areas in the vicinity of the (within 5 km Radius) Project AOI; and
   - Assess the status of floral components (macro and micro flora) of perennial aquatic habitats (lake, reservoirs/dams and rivers) present in the Project AOI (Including the project site) adopting standard techniques.

2. Habitat Survey
   - Identification of different habitat types (forest/vegetation types) of the Project AOI and provide information on forest types, species composition, terrain and topographical features. This will then allow for the identification of natural and modified habitat for a critical habitat assessment.
   - Provide a biodiversity action plan to improve the habitat quality of the project area to enhance the overall biological diversity (Flora and Fauna).

3. Aquatic Ecology
   - Aquatic survey, including fish and stream macro invertebrates;
   - Identify and evaluate the likely impacts on faunal components (Amphibians reptiles, terrestrial and aquatic birds and mammals) due to proposed projects and associated activities;
   - Physico-chemical variables of river water and quantitative enumeration of phytoplankton and zooplankton; and
   - Suggest mitigation measures to minimize and/or to avoid identified impacts on different faunal components.

4. Fisheries Survey
   - Identification of various fish species found in the Project AOI based on survey and market survey;
   - Identification of fishermen villages in the Project AOI;
   - Consultation with local people and in local fish markets;

- Focused Group Discussions with Fishermen community in the Project AOI;
- Identification of threatened/ endemic and protected fish species in the Project AOI;
- Assessment of migratory movement of fish species in the Jamuna River based on previous studies conducted in that area, if any.

4.4.4 Approach and Methodology-Terrestrial Ecology

Floral Survey

Ecological surveys were undertaken from 22nd to 28th January 2013 in the Project AOI using quadrate sampling method for different habitats. Different quadrate sizes for different type of vegetation class were taken. Details of the same are provided in the ***Table 4.22*** and shown in ***Figure 4.35.***

Table 4.22 Sampling details of Landuse Class in the Project AOI

Land Use Class.	Area	Quadrates	Coordinates	Dist. and Dir. from Plant Boundary
Forest Plantation (5 Quadrates each of size 20m x 20 m)	Jamuna Ecopark (North Side of Bangabandhu Multipurpose Jamuna Bridge)	FQ1	N 24°24'32.73" and E 89°44'56.44"	2.39 km/N
		FQ2	N 24°24'31.72" and E 89°44'57.16"	2.36/N
		FQ3	N 24°24'8.85" and E 89°44'49.15"	1.6 km/N
	Forest Plantation area South Side of Bangabandhu Multipurpose Jamuna Bridge	FQ4	N 24°23'34.98" and E 89°44'34.70"	0.59 km/N
		FQ5	N 24°23'39.66" and E 89°44'57.24"	0.92 km/NE
		FQ6	N 24°23'42.07"and E 89°45'8.80"	1.17 km/NE
Homestead Plantation (3 Quadrates each of size 30m x 30 m)	Punorbason Village	HPQ1	N 24°23'12.76" and E 89°43'45.62"	1.32 km/W
	Village north of National Highway 405	HPQ2	N 24°23'51.88" and E 89°43'20.99"	2.39 km/NW
	Village West of Saidabad Power Generation Complex	HPQ3	N 24°23'14.42" and E 89°44'24.57"	0.22 km/W
Riverine Habitat (3 Quadrates each of size 5m x 5m)	Right Bank of Jamuna River near Bangabandhu Multipurpose Bridge	RQ1	N 24°23'42.09" and E 89°45'12.56"	1.28 km/NE
	Right Bank of Jamuna River near Bangabandhu Multipurpose Bridge	RQ2	N 24°23'42.75" and E 89°45'13.07"	1.29 km/NE
	Right Bank of Jamuna River near Bangabandhu Multipurpose Bridge	RQ3	N 24°23'44.74" and E 89°45'13.98"	1.35 km/NE
Agriculture Land (3 Quadrates each of size 1m x 1m)	West of Saidabad Power Generation Complex	AGQ1	N 24°23'12.79" and E 89°44'29.75"	0.08 km/W
	West of Saidabad Power Generation Complex	AGQ2	N 24°23'13.18" and E 89°44'28.56"	0.11 km/W
	West of Saidabad Power Generation Complex	AGQ3	N 24°23'0.56" and E 89°44'33.91"	0.06 km/S

Land Use Class.	Area	Quadrates	Coordinates	Dist. and Dir. from Plant Boundary
Grasslands (4 Quadrates each of size 1m x 1m)	Jamuna Ecopark (North Side of Bangabandhu Multipurpose Jamuna Bridge)	GQ1	N 24°24'34.24" and E 89°44'56.83"	2.53 km/NE
	Jamuna Ecopark (North Side of Bangabandhu Multipurpose Jamuna Bridge)	GQ2	N 24°24'34.41" and E 89°44'56.80	2.47 km/NE
	Jamuna Ecopark (North Side of Bangabandhu Multipurpose Jamuna Bridge)	GQ3	N 24°24'34.82" and E 89°44'57.26"	2.49 km/NE
	Jamuna Ecopark (North Side of Bangabandhu Multipurpose Jamuna Bridge)	GQ4	N 24°24'36.21" and E 89°44'56.05"	2.53 km/NE
Fallow Land (3 Quadrates each of size 1m x 1m)	West of Saidabad Power Generation Complex	FLQ1	N 24°23'13.15" and E 89°44'29.22"	0.09 km/W
	West of Saidabad Power Generation Complex	FLQ2	N 24°23'13.08" and E 89°44'26.05"	0.1 km/W
	South of Saidabad Power Generation Complex	FLQ3	N 24°23'01.08" and E 89°44'35.25"	0.04 km/S

Note: The habitat types present within the AOI has been assessed in the subsequent sections as per IFC Performance Standard 6 on biodiversity conservation, 2012

Table 4.23 shows the sampling efforts undertaken at Project AOI.

Table 4.23 Summary of Field Activities between January 22-29th 2013 and June 1-4th 2015

Dates	Activities	Remarks
22 January 2013	Reaching Site from Dhaka ,Reconnaissance visit to AOI	Identification of Habitats and Sampling points, Discussion with Survey team for the requirement of data collection, survey methodology discussion
23 January 2013	Flora and Fauna Survey	Quadrate survey at project site and Jamuna Eco Park
24 January 2013	Fishery Survey, Flora & Fauna Survey	Quadrate survey at Agricultural Land and Fallow Land
25 January 2013	Fishery Survey, Flora & Fauna Survey	Quadrate survey at Jamuna Eco Park in Grassland and Riverine Habitat
26 January 2013	Fishery Survey, Flora & Fauna Survey, Phyto and Zoo Plankton Survey	Quadrate survey at Jamuna Eco Park and Southern Plantation Area
27 January 2013	Fishery Survey, Flora & Fauna Survey, Phyto and Zoo Plankton Survey	Quadrate survey at Jamuna Eco Park and Southern Plantation Area
28 January 2013	Flora & Fauna Survey	Homestead Plantation Area
29 January 2013	Fishermen Survey& Fish market Survey	Jamuna River and Fish Markets of Sirajganj and adjoining areas
30 January 2013	Return to Dhaka	
1 June 2015	Reaching Site and target survey	Visit to Temporary Jetty Area (from Land side and Water side)
2 June 2015	Transportation route survey within	Jamuna Eco Park
3 June 2015	Dolphin and Turtle habitat survey	Jamuna river

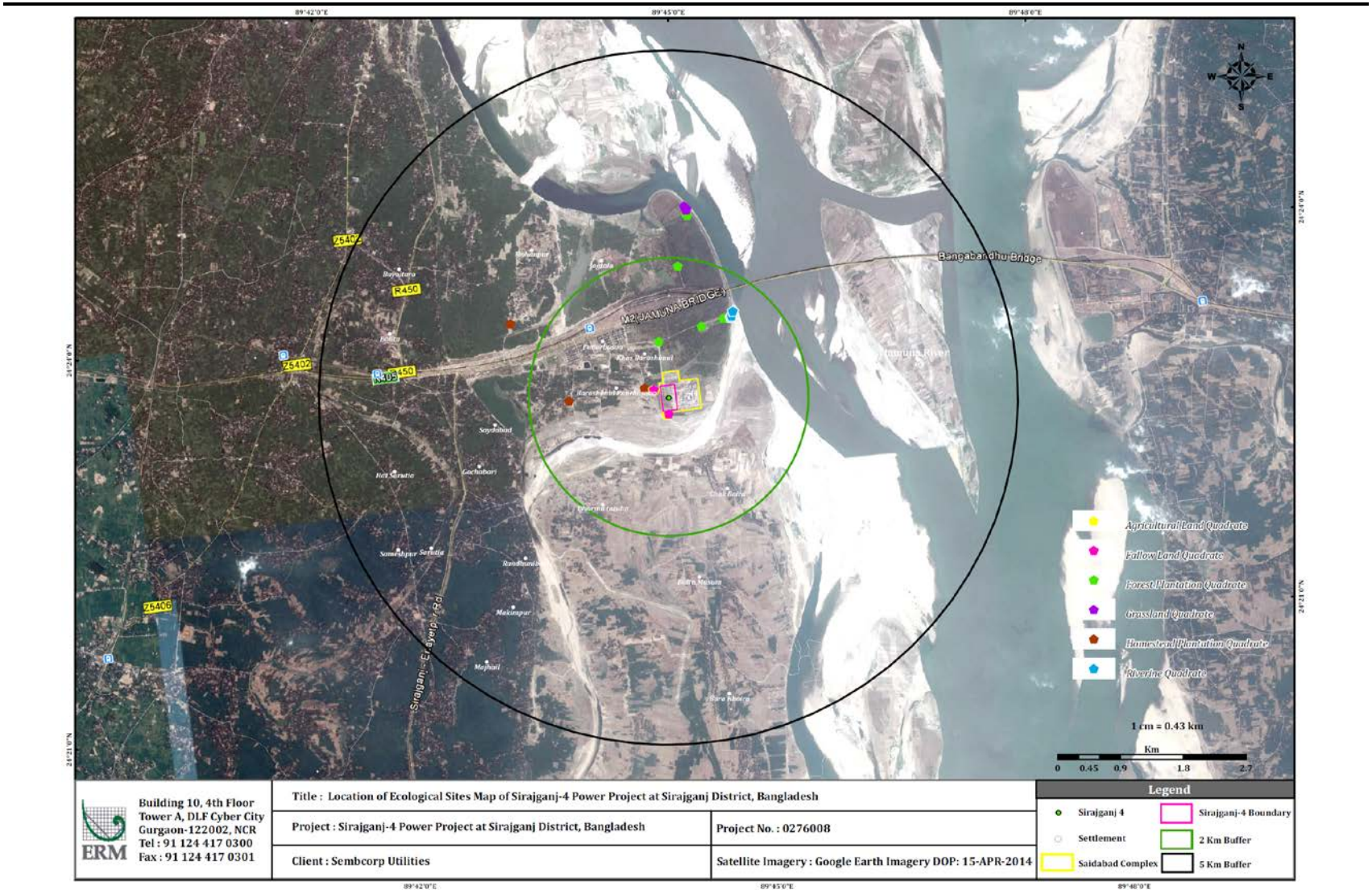
Dates	Activities	Remarks
4 June 2015	Construction Camp Survey and Return to Dhaka	

Micro level approach involved mainly the field based primary data collection on different components of the project objectives/scope of work using well established and accepted ecological methods in different habitats identified within the Project AOI. The field data collection mainly included biodiversity status assessment of different life forms of floral elements such as trees, shrubs, climbers, herbs and grass. Faunal diversity was assessed by inventorizing the major taxa like herpetofauna (amphibian and reptiles), avifauna (both aquatic and terrestrial) and mammals.

Faunal Survey

A faunal Survey was conducted based on the opportunistic search method in different habitats as detailed in ***Table 4.22***. The survey included the fauna such as herpetofauna, avifauna and mammals. Photographic evidences were collected in order to facilitate identification of species. Focused group consultations were also undertaken in order to confirm the range of fauna occasionally visiting the Project AOI.

Figure 4.35 Ecological Monitoring Locations in Project AOI



Source: Google Earth Pro (Imagery Date: January 8 2015) and site reconnaissance survey (January 2013)

Quantitative Analysis

Quantitative analysis such as density, frequency, and abundance of tree species, shrubs, sedges, climbers and herbs species were determined [(1)] .

Density and Relative Density

Density is an expression of the numerical strength of a species where the total number of individuals of each species in all the quadrates is divided by the total number of quadrates studied. Density is calculated by the equation:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total Number of Quadrates studied}}$$

Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density} = \frac{\text{Number of individuals of the species x 100}}{\text{Number of individuals of all the species}}$$

Frequency and Relative Frequency

Frequency refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. It was studied by sampling the Project AOI at several places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates in which sample occurred x 100}}{\text{Total number of quadrates studied}}$$

Relative Frequency is the degree of dispersion of individual species in an area in relation to the number of all the species occurred. It is calculated by the equation;

$$\text{Relative Frequency} = \frac{\text{Number of occurrance of the species x 100}}{\text{Number of occurrances of all the species}}$$

Abundance and Relative Abundance

Abundance is the study of the number of individuals of different species in the community per unit area. By quadrates method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrates divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{Total number of a species in all quadrates}}{\text{Total number of quadrates in which species occurred}}$$

Relative Abundance describes the relationship between the number of species observed in a field study as a function of their observed abundance. It is represented by the equation:

(1) Curtis, J. T., and R. P. McIntosh. 1950. The Interrelations of Certain Analytic and Synthetic Phytosociological Characters. Ecology 31:434–455. http://dx.doi.org/10.2307/1931497

$$\text{Relative Abundance} = \frac{\text{Abundance of the species}}{\text{Total abundance of all the species}}$$

Biodiversity Indices

Species Richness: Species richness in the Project AOI was determined by using **Margalef's Index** (1) , **Menhinik's Index** (2) and **Peet Index** (3)

$$\text{Margalef's Index SR} = \frac{S-1}{\ln(n)}$$

$$\text{Menhinick's Index SR} = \frac{S}{\sqrt{n}}$$

$$\text{Peet's Index SR} = S(n)^{1/2}$$

Where, SR= Species Richness; S= Number of Species; N=Number of Individuals

Species Diversity: Species diversity is calculated based on **Shanon Weiner Index**. (4)

$$H = \sum_{i=1}^{s} \left(\frac{n}{N}\right) log2 \left(\frac{n}{N}\right)$$

Where H'=Shannon Weiner Diversity Index; n =Individuals of a species; N= Individuals of all the species

4.4.5 Terrestrial Ecology

Floral Component-Phytosociology

Quantitative Plant surveys were conducted in six habitats to enumerate the vegetation occurring within the Project AOI. These are discussed below. A comprehensive list of flora in the Project AOI is provided in ***Annex J***.

Project Site

The proposed power plant Project site is mainly harbouring naturalized shrubs, herbs, grasses and weeds as listed as ***Annex K***. None of the plant species are listed as RED category by IUCN and are commonly occurring in the Project AOI.

Plantation

A total of 3.32 sq. km area (i.e., 4.23% of the Project AOI) is under plantation. The plantation is spread within the fenced area and outside fenced area and jointly forms the Jamuna Eco Park. Out of 6 quadrats studied a total of 18 species of trees belonging to 15 genera of 10 families were found occurring in the quadrats studied in Project AOI. Major plantation areas within the Project

(1) Margalef DR 1958, Information theory in ecology. Gen. Sys. 3:36-71

(2) Menhinick EF 1964. A comparison of some species-individual diversity indices applied to samples of field insects. Ecology 45: 859-861

(3) Peet RK 1974 The measurement of species diversity Ann. Rev. Ecol. Syst. 285-307

(4) Shannon CE and W Weaver 1949 The Mathematical Theory of Communication. University of Illionis Press. Urbana, IL USA.

AOI are present within the Jamuna Eco park area on the north and south of west end of Bangabandhu Multipurpose Bridge. Major plant species planted by the Forest department are *Terminalia arjuna, Dalbergia sisso, Eucalyptus citiodora, Albizia lebbeck* with species density more than 0.5. Forest department has planted the trees by step plantation way or block system like fruit plants, medicinal plants, timber yielding plants, ornamental plants, road side plantation/ revenue plant etc. Among these species *Dipterocarpus turbinatus* is identified as critically endangered and *Hopea odorata* as a vulnerable species as per IUCN (2015 v2)

Lower storied vegetation was dominant with the most common grasses-Ulu/son (*Imperata cylinderica*), Kash (*Saccharum spontaneum*), Durba (*Cynodon dactylon*), Benajoni (*Sporobolus diander*), *Paspallum* sp., *Eleusine indica*; Cedges-Mutha (*Cyperus* spp.), *Fimbristyllis* sp.; and angiospermic weeds like Dhudhia (*Euphorbia hirta*), Tripotri (*Desmodium trifolium*), Kontikari (*Solanum xanthocarpum*), Mukhia (Mukhia sp.), Choto dhudhia (*Euphorbia nerrifolia*), Bon marich (*Croton* sp.), Sukuria (*Lindernia* sp.), Bhui (*L. cilliata*), Jhonjoni(*Crotalaria* sp.), Futka (*Physalis minima*), Bhui Amla (*Phyllanthus* sp.), Khet Papri (*Oldenlandia* sp.), Bon Okra (*Triumfetta romboidea*), Berela (*Sida rombifolia*), Dron (*Leucas indica*), Misrirdana (*Scoparia dulsis*), Choto berela (*Sida acuta*), Bhui Okra (*Phyla nodiflora*), Kanduli (*Murdania* sp.) etc. were found in the grass lands of the Jamuna Ecopark. The result of these surveys is provided in ***Table 1.0 of Annex L.***

Agriculture Land

A total of 31.59 sq. km (40.23 % of the Project AOI) falls under agriculture land within Project AOI. The agriculture pattern in the Project AOI is given in ***Table 4.24. .***

Table 4.24 Major Cropping Pattern in the Project AOI

Land Type	Rabi	Kharif I	Kharif II
Medium Highland	Mustard	Aus/Jute	Fallow
	Mustard	Mixed broadcast Aus and Aman	
	Blackgram	Millets/Aus/Jute	Fallow

Source: Department of Agriculture Extension, Sirajganj District

A variety of naturalized weeds also grow along with the crops listed in ***Table 2.0 of Annex L.*** Out of 3 quadrats studied a total of 21 species belonging to 19 genera of 12 families occur in the agricultural lands of Project AOI. Agricultural lands are dominated with herbs like *Lippa alba, Xanthium indicum, Alternanthera sesilis, Grangea sp., Dentalla repens, Eclipta alba, Lens esculenta etc.*, having density more than 0.7. Sedges like *Cyperus rotundus* are commonly occurring in the agricultural lands. Grasses like *Cynodon dactylon* and *Paspalum conjugatum* can be found in the natural state. Climbers like *Vicia hirsuta* and *Ipomea indica* also occur in the Project AOI.

Fallow Land

A total of 14.56 sq.km (18.55%) area has been identified as fallow land**.** Out of 3 quadrates studied a total of 22 species belonging to 22 genera of 15 families occur within the quadrates studied in Project AOI listed in ***Table 3.0 of Annex F.*** A detailed list of species occurring in the fallow lands is provided in ***Table 3.0*** of ***Annex L.*** Fallow lands were dominated by herbs species of *Xanthium indicum, Alternanthera sesilis, Lipia ciliate, Cyperus rotundus, Persicaria praetermissa, Croton caudatus* and *Desmodium triflorum* exhibiting density more than 0.7. Shrub species of *Anisomeles indica, Cassia tora* and *Crotalaria pallida* were also found commonly occurring with a density of more than 0.7. Among the grasses *Cynodon dactylon* was found occurring in all quadrats studied.

Grassland

A total of 29 species belonging to 25 genera of 13 families were recorded from the 4 quadrats studied within Project AOI listed in ***Table 4.0 of Annex L.*** Seven (07) species of grasses were identified. Among them *Sparobollus diander, Saccharum pontaneum* and *Imperata cylinderica* were found most commonly occurring with density more than 0.8. Herbs were represented by 19 species dominated by *Euphorbia hirta, Solanum xanthocarpum, Desmodium trifolium* and *Triumfetta rhomboidea* with density more than 0.8.

Homestead Plantation

A total of 7.46 sq.km area (9.5% area of the Project AOI) was represented by Homestead Plantation. Out of 3 quadrates studied a total of 33 species belonging to 32 genera of 21 families were reported listed in ***Table 5.0 of Annex L.*** Twenty six (26) species of fruit and vegetable bearing trees were recorded in these quadrats. *Swietenia mahagoni* tree species is endangered as per IUCN (2015 v 2) classification. *Cocos nucifera, Eucalyptus citriodora, Mangifera indica, Psidium guajava, Ricinus cummunis, Lichi chinensis, Ziziphus mauritiana, Carica papaya, Lannea coramandelica, Moringa oleifera, Citrus aurantifolia, Sweitenia mahagoni, Musa sapientum, Musa paradisiac, Atrocarpus heterophyllus, Ficus hispida* and *Syzygium cumunii* were recorded most commonly occurring trees with density more than 0.7. Beside trees, 4 species of shrubs, 2 species of climbers and one species of herb were also recorded from the quadrates laid in Homestead Plantation areas.

Riverine Areas

A total of 3 quadrats were laid in the riverine areas which enumerated 21 species belonging to 20 genera of 15 families listed in ***Table 6.0 of Annex L.*** *Linderina ciliate, Cyperus rotundus, Saccharum spontaneum, Alternanthera sesilis, Lippia alba, Cynodon dactylon, Fimbristylis sp., Amania sp., Ludwigia decurrens, Grangia sp., Rananculus sp., Rumax sp., Hydrocotyl asiatica, Centella asiatica* and *Dentella sp.* were reported in the riverine areas with density more than 0.7.

The threatened floral species observed from these habitats are discussed in ***Table 4.25*** and represented in ***Figure 4.36.***

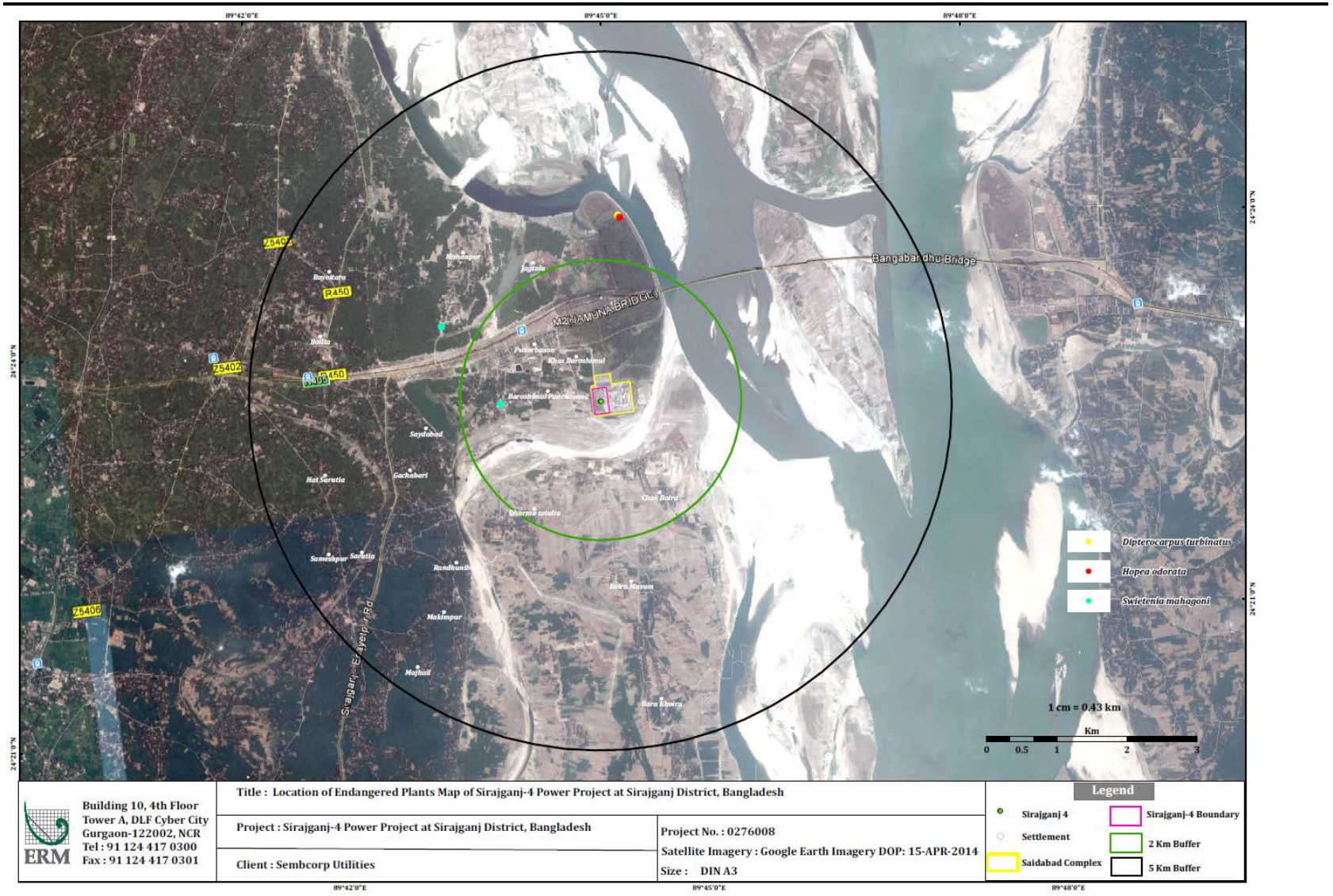
Table 4.25 Threatened floral species from the Area of Influence

S. No.	Floral Species	Vernacular Name	Conservation Status	Location of Sighting	Distance/Direction from Project Boundary
1	*Dipterocarpus turbinatus*	Teli-garjan	Critically Endangered	Jamuna Eco Park	2.47 Km/North-eastern Direction
2	*Hopea odorata*	Telsur	Vulnerable	Jamuna Eco Park	2.45 Km in North-eastern Direction
3	*Swietenia mahagoni*	Mahogany	Endangered	Punorbason Village	2.31 Km in North West Direction
				Khas Chtragachha	1.31 Km in West Direction

Note: Species reported based on Primary Survey

None of the species as described in ***Table 4.25*** were observed in Temporary Jetty route survey and water intake pipeline route survey undertaken in May – June 2015.

Figure 4.36 Threatened floral species observed within AOI



Source: Google Earth Pro (Imagery Date: January 8 2015) and site reconnaissance survey (January 2013)

Species Richness and Species Diversity

Species Richness is generally described as number of species occurring in a unit area. It is also calculated with Margalef's, Menhinik's and Peet's index. ***Table 4.26*** depicts the total number of species in habitats and quadrates studied in each habitat. In addition, species richness indices have been calculated for quadrates studied in each habitat.

On the diversity scale, biologically realistic H' values range from 0 (only one species present with no uncertainty as to what species each individual will be) to about 4.5 (high uncertainty as species are relatively evenly distributed). In theory, the H' value can be much higher than 4.5, although most real world estimates of H' range from 1.5 to 3.5 (1) Species Diversity index (Shannon Weiner Index-H') has been also calculated for each habitats based on the quadrats studied.

Table 4.26 Species Richness and Species Diversity Indexes

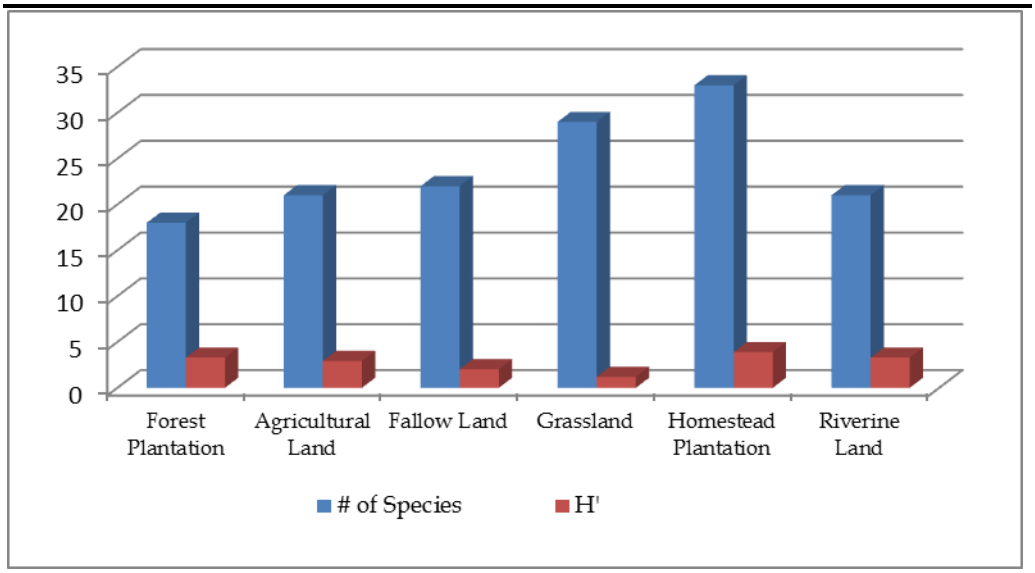
Status of Habitats	Indexes Calculated	Quadrats Studied						Species Diversity H'
Forest Plantation		FPQ1	FPQ2	FPQ3	FPQ4	FPQ5	FPQ6	3.3
18 Species	# of Species	7	12	7	4	2	4	
15 Genera	Margalef Index	1.3	2.8	1.8	0.9	0.4	0.8	
10 Families	Menhinik Index	0.7	1.7	1.3	0.8	0.6	0.6	
	Peets Index	72.4	84.9	37.0	20.4	7.2	25.0	
Agricultural Land		AGQ1	AGQ2	AGQ3				2.93
21 Species	# of Species	14	14	11				
19 Genera	Margalef Index	2.14	2.16	1.81				
12 Families	Menhinik Index	0.67	0.69	0.70				
	Peets Index	291.99	283.13	173.93				
Fallow Land		FLQ1	FLQ2	FLQ3				2.04
22 Species	# of Species	17	11	12				
22 Genera	Margalef Index	2.60	1.96	1.76				
15 Families	Menhinik Index	0.78	0.85	0.53				
	Peets Index	368.16	141.73	274.17				
Grassland		GLQ1	GLQ2	GLQ3	GLQ4			1.2
29 Species	# of Species	12	13	10	22			
25 Genera	Margalef Index	1.58	1.76	1.36	3.14			
13 Families	Menhinik Index	0.37	0.43	0.36	0.78			
	Peets Index	43.27	394.31	274.04	621.48			
Homestead Plantation		HPQ1	HPQ2	HPQ3				3.9
33 Species	# of Species	22	20	25				
32 Genera	Margalef Index	3.81	3.96	5.04				
21 Families	Menhinik Index	1.39	1.81	2.31				
	Peets Index	98.39	220.91	270.42				
Riverine Land		RLQ1	RLQ2	RLQ3				3.3
21 Species	# of Species	15	13	13				
20 Genera	Margalef Index	2.12	2.05	2.28				
15 Families	Menhinik Index	0.55	0.70	0.93				
	Peets Index	54.08	241.81	181.54				

(1) Sagar, R. and Singh, J.S. 1999. Species diversity and its measurement. The Botanica 49: 9-16.

Source: Primary Data Survey January, 2013

Based on the results presented in ***Table 4.26*** and graphically represented in ***Figure 4.37*** homestead plantation represents maximum species richness (# of species 33) and diversity (H'-3.9).

Figure 4.37 Species Richness and Species Diversity



H'- Shannon Weiner Index

Faunal Component

Faunal Studies were undertaken in the Project AOI by opportunistic search methods where habitats of the different faunal species were repeatedly visited 3 times to confirm their presence and usage of the habitats. Focus was given on the larger animals which are under threat of frequent urbanization and industrialization in the area. The survey schedule is discussed in ***Table 4.23.*** The target faunal species studied are Mammals, Avifauna, Reptiles, Amphibians, etc. A complete checklist of the fauna occurring in the Project AOI is provided in the ***Annex M*** and discussed below;

Mammals

Ten species of terrestrial mammals belonging to the 6 genera of 8 families were recorded to occur in wild in the Project AOI. Golden Jackal (*Canis aureus*), Bengal Fox (*Vulpes bengalensis*), Indian Gray Mongoose (*Herpestes edwardsi*) and Black Napped Hare (*Lepus nigricolis)* were seen visiting the forest plantation areas to the south of the Bangabandhu Multipurpose Bridge during the field survey by the ERM team. Three Striped Squirrel (*Funambulus palmaram),* Jungle Cat (*Felis chaus)* and Black Napped Hare (*Lepus nigricolis)* were reported to be seen by locals during field consultations in the forest and homestead plantation areas. None of the species are reported to be listed in RED category of IUCN 2015 v 2 however, Indian Gray Mongoose (*Herpestes edwardsi),* Three Striped Squirrel (*Funambulus palmaram),* Jungle Cat (*Felis chaus)* and Asian House Shrew (*Suncus murinus)* are reported to be listed in

Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capturing.

Avifauna

A total of 40 species belonging to 37 genera of 25 families was observed to be in the Project AOI during field survey by ERM team in 22-29 January, 2013 during the winter season. These species are present in variety of habitats from Grassland to riverine and aquatic habitat. The list of species is included in ***Table 2.0*** of ***Annex M***. Out of these 40 species, Red Vented Bulbul (*Pycnonotus cafer),* Black Drongo (*Dicrurus macrocercus),* Oriental Magpie Robin (*Copsychus saularis),* Long Tailed Shrike (*Lanius schach),* Spotted Dove (*Streptopelia chinensis),* Black Kite (*Milvus migrans),* Large Billed Crow (*Corvus macrorhynchos),* Rufous Treepie (*Dendrocitta vagabunda),* Indian Roller (*Coracias benghalensis),* Common Hoopee (*Upupa epops),* Black Rumped Flameback *(Dinopium benghalense),* White Throated Kingfisher (*Halcyon smyrnensis),* Pied Kingfisher (*Ceryle rudis),* Fulvus breasted Woodpecker (*Dendrocopos macei),* Shikra (*Accipiter badius*), White Wagtail (*Motacilla flava),* Red Wattled Lapwing (*Vanellus indicus),* Asian Koel (*Eudynamys scolopacea),* Rock Pigeon (*Columba livia),* Common Stonechat (*Saxicola torquate)* Common Myna (*Acridotheres tristis),* Jungle Myna (*Acridotheres grandis)* and Green Beeeater (*Merops orientalis)* are reported to be listed in Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capture.

The proposed Power Plant Project Site harbours species such as Spotted Dove, Red Watted Lapwing, Black Kite, Black Drongo, Rock Pigeon, Long –tailed Shrike and Common Myna. These species are common in the area and sufficient habitats are available within AOI once the construction and operation activities are commenced. None of the species were listed as threatened as per IUCN classification.

Reptiles

A total of 9 species belonging to 9 genera of 5 families are reported from the Project AOI. Out of these House Gecko *(Hemidactylus brookii)*, Rat Snake (*Coluber mucosus*)and Checkered Keelback (*Xenochropis piscator)* were observed by ERM team during field survey in January 2013. Rest of the reptilian fauna were reported to be observed by locals during field consultations in the villages of AOI. Among the 9, Grey Indian Monitor (*Varanus benghalensis*) and Ganges Soft Shell Turtle (*Nilssonia gangetica*) are reported to be listed in Bangladesh Wildlife Prevention Order,1973 as Sch-III which protects them from hunting, killing and capturing. Two turtles and one terrapin , the Ganges Soft Shell Turtle (*Nilssonia gangetica)* are listed as Vulnerable, River Terrapin (*Batagur baska)* as Critically Endangered and Striped Roof Turtle *(Kachuga dhongoka)* as Endangered as per IUCN (2015, v 2) category.

During recent survey (May-June 2015) habitat mapping for the above threatened species was undertaken in order to understand the sensitivities related to their nesting/egg laying sites near the Temporary Jetty area and Water Intake location. Consultations were also carried with the fishermen in the area in order to identify habitats of these threatened species. The location details are given below;

The details of these species including their sighting (as reported) have been presented in ***Table 4.27***. Reported sighting locations with respect to the Project site are presented in Figure 4.38. ***Table 4.27*** also provides a brief note of reported reptile species with conservation status in the study area.

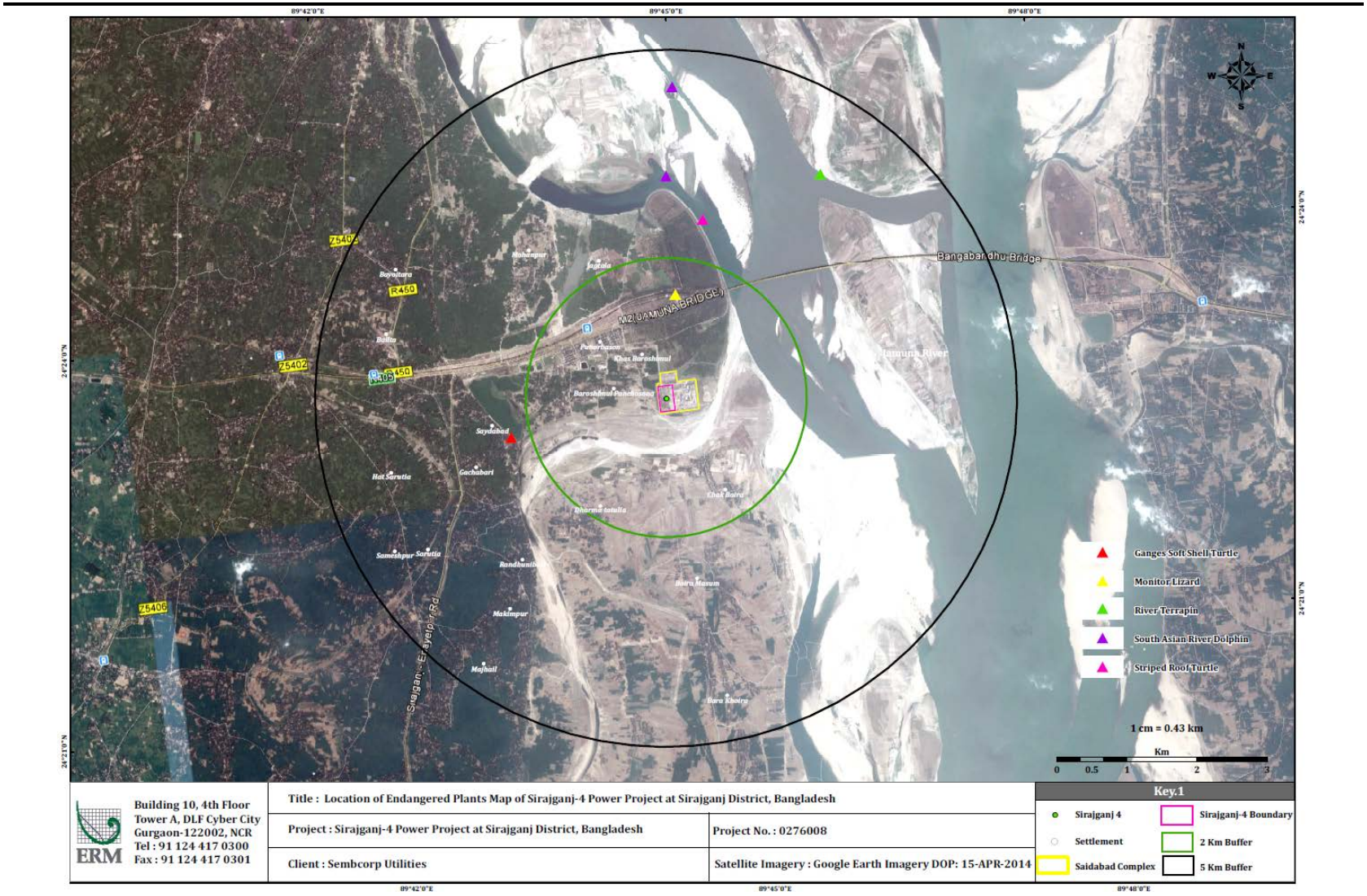
Table 4.27 Endangered Reptile Species with the Study Area

S. No.	Reptile Species	Common Name	Conservation Status	IUCN 2015 ver.2	Location of Sighting	Dist. from Temporary Jetty	Dist. from Water Intake Structure	Dist. from Project Boundary
1	*Varanus benghalensis*	Grey Indian Monitor	Bangladesh Wildlife Prevention Order,1973 as Sch-III	Least Concern	Reported	1 km/E	2.5 km/NW	1.3 km (N)
2	*Nilssonia gangetica*	Ganges Soft Shell Turtle	Bangladesh Wildlife Prevention Order,1973 as Sch-III	Vulnerable	Reported	2.42 km/E	2.28 km /NE	4 km (NE)
3	*Batagur baska*	River Terrapin	Bangladesh Wildlife Prevention Order,1973 as Sch-III	Critically Endangered	Reported	2.45 km/E	2.28 km/NE	3.9 km (NNE)
4	*Kachuga dhongoka*	Striped Roof Turtle	Bangladesh Wildlife Prevention Order,1973 as Sch-III	Endangered	Reported	2.51 km/E	1 km/NE	2.94 km (NNE)

Note: None of these species were observed during the field assessment and are reported based on fishermen consultation after providing visual aids for identification.

Further consultation with IUCN Bangladesh and a recent study conducted by IUCN (EIA of the River Management Improvement Programme (Bangladesh Water Board, Ministry of Water Resources, May 2015) revealed that major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore despite a report by fishermen, it is unlikely that these species are found here. Fisheraen reports tend to be through memory and therefore reports of the species may have been due to sightings further north. Species presence in this area is very unlikely.

Figure 4.38 Location of Threatened Species within Project AOI



Source: Google Earth Pro (Imagery Date: January 8 2015) and site reconnaissance survey (November 2012 and December 2012 and May-June 2015) Note: None of these species were observed during the field assessment. The sightings are marked based at consultation (May June 2015) with the local villagers and fisherman after providing them visual aids for identification.

Amphibians

A total of 5 species belonging to 5 genera of 3 families were observed by the ERM team during the field survey in January, 2013 from the Project AOI. None of the species are reported for conservation status under the Bangladesh Wildlife Prevention Order, 1973 or by the IUCN.

4.4.6 Protected Areas

It is to be noted that the entire study area does not have any protected area[1] earmarked by the GOB. The study area has an eco-park, named Jamuna Eco-Park[2], which was developed by the Bangladesh Bridge Authority (BBA) on the west-guide bund constructed for the protection of the Bangabandhu Multi-purpose Bridge from erosion. The plantation in this eco-park is being developed and maintained by the Forest Department and this eco-park is being used for eco-tourism and recreational purposes. The Jamuna Eco Park is frequently visited by locals during weekend holidays. However, Jamuna Eco-Park is neither a classified forest nor notified by the Government of Bangladesh as Protected Area[3]. A map of protected areas, eco-parks and safari parks of Bangladesh is presented in the ***Figure 4.39***.

It is evident from this figure that the nearest protected area from the project site is Madhupur National Park (IUCN: Category V) (4) , which is located in Tangail and Mymensingh districts of Bangladesh and is about 42 km in north-east direction from the project site.

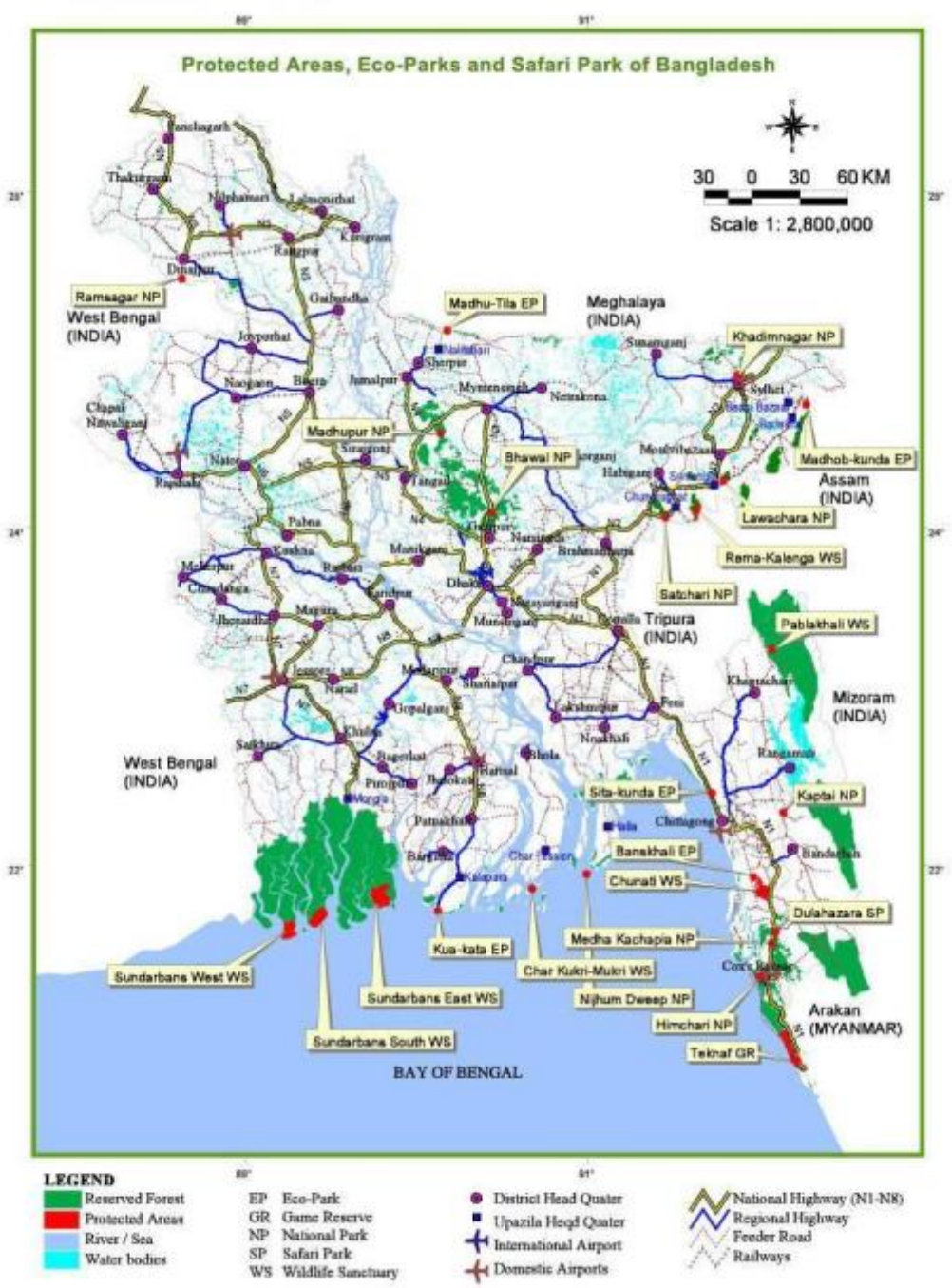
[1] "Protected Area" means all sanctuaries, national parks, community conservation areas, safari parks, eco-parks, botanical gardens notified under the provisions of sections 13, 17, 18 and 19 under Chapter IV and special biodiversity conservation area established under the provisions of section 22 under Chapter V and traditional heritage and kunjaban declared under section 23

[2] The Jamuna Eco Park is having a total area of about 600 acres and out of that only 124 acres area is fenced and is being used for recreational and eco-tourism activities.

[3] In Bangladesh, there are a total of eight (8) eco-parks are covered under the conservation sites. (http://www.bforest.gov.bd/index.php/protected-areas). However, Jamuna Eco-park is not covered in that list as well.

(4) IUCN (1990). IUCN Directory of South Asian Protected Areas. IUCN, Gland, Switzerland and Cambridge, U.K. xxiv + 294 pp.

Figure 4.39 Protected Areas Map of Bangladesh



Source: http://www.poribesh.com/Maps/Protected_Forest.htm

Important Plant Areas, Key Biodiversity Areas, Alliance for Zero Extinction Sites

The AOI does not hold any Important Plant Areas (IPAs) as identified as Plantlife International, Key Biodiversity Areas as identified by IUCN and Alliance for Zero Extinction Sites (AZE)

Ramsar Sites

The AOI does not hold any RAMSAR Sites.

Important Bird Areas (IBAs)

Jamuna-Brahmaputra river is identified as an Important Bird Area (IBA) as category (A1, A4i[1]:) : The Jamuna-Brahmaputra River IBA (BD009) was assessed in Year 2004 and covers an area of 200,000 ha. The IBA area covers the entire Jamuna River (from its Northern end at the India Bangladesh Border and Southern end at the confluence of Jamuna River with the Padma River). The boundary of the IBA passes through the AOI and the overlap is very small. Only3 % of the AOI overlaps with the IBA. This overlap area represents an insignificant portion of the total IBA area. Furthermore the primary survey conducted during 22nd to 28th January 2013 did not identify the presence of such species as described in ***Table 4.28***. Also a recent study (2) did not suggest the presence of the species listed in ***Table 4.28*** in the AOI. The details of the IBA and IBA trigger species which are reported from the IBA are given in ***Table 4.28.***

Table 4.28 Details of IBA: Jamuna-Brahmaputra River (3) and IBA trigger species

Species	Season	Period	Population estimate	Quality of estimate	IBA Criteria	IUCN Category
Northern Pintail *Anas acuta*	unknown	2004	present	-	A4i	Least Concern
Gadwall *Mareca strepera*	unknown	2004	present	-	A4i	Least Concern
Garganey *Spatula querquedula*	unknown	2004	present	-	A4i	Least Concern
Common Teal *Anas crecca*	unknown	2004	present	-	A4i	Least Concern
Common Pochard *Aythya ferina*	unknown	2004	present	-	A4i	Least Concern
Ferruginous Duck *Aythya nyroca*	winter	2004	present	-	A4i	Near Threatened
Tufted Duck *Aythya fuligula*	unknown	2004	present	-	A4i	Least Concern
White-rumped Vulture *Gyps bengalensis*	non-breeding	2004	present	-	A1	Critically Endangered
Indian Skimmer *Rynchops albicollis*	winter	2004	present	-	A1	Vulnerable

The species listed above were not observed in the previous surveys (December 2012 – January 2013) as the river water recedes during the winter season and other surrounding waterbodies dried up or had limited water availability. The fish breeding areas are also subject to a lot of disturbance due to fishing activities as well as dredging activities in the Jamuna River for riverbank erosion control. The activities might disturb the habitat of migratory species

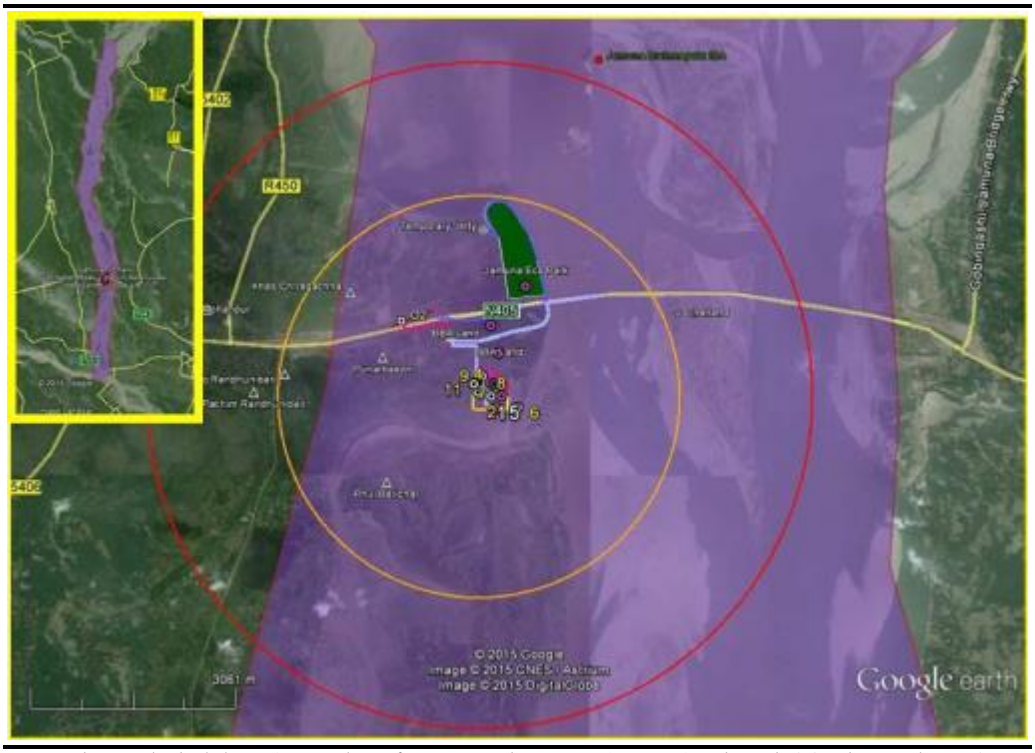
[1] A1: Threatened Species) and A4i: Site known or thought to hold, on a regular basis, ≥ 1% of a biogeographic population of a congregatory waterbird species. for the thresholds of this criterion, relevant flyway populations are combined to produce biogeographic population estimates).

(2) Rahman, H., Jaman, M.J. & Rahman, MS (2013) Ecology and Diversity of Wildlife in the Eco Park of the Jamuna Bridge and its adjacent area, Sirajgonj, Bangladesh Ecoprint 20: 27-36.

(3) BirdLife International (2015) Important Bird Areas factsheet: Jamuna-Brahmaputra river. Downloaded from http://www.birdlife.org on 22/07/2015

hence reduced the number of birds in the AOI. During the recent survey (May-June 2015) 3 individuals of Tufted Duck (*Aythya fuligula*), a late migrant was observed near the Temporary Jetty area.

Figure 4.40 Important Bird Area Boundary (Jamuna River) passing through AOI



Notes: The Purple shaded area is Boundary of Jamuna-Brahmaputra river passing through AOI, the complete IBA map is given in Yellow Boundary line
Source: http://www.birdlife.org/datazone/sitefactsheet.php?id=15228,

4.4.7 Approach and Methodology-Aquatic Ecology

Plankton Survey

Jamuna River was surveyed for the planktonic diversity within the Project AOI. The details of the area surveyed are given in ***Table 4.29.***

Table 4.29 Planktonic Survey sampling details

Sample Area Code	Area	Coordinates
L1	Near Water Intake Point in Jamuna River	N 24°23.817' and E 89°45.259'
L2	Near Water Intake Point in Jamuna River	N 24°23.687' and E 89°45.475'
L3	250 m from the Water Outlet Point in Jamuna River	N 24°23.606' and E 89°45.420'
L4	Near Water Intake Point in Jamuna River	N 24°23.446' and E 89°45.638'

Replicate phytoplankton samples, each of 50 L, were collected from various locations around each station by means of a 5L plastic bucket and filtered through bolting silk conical plankton net of 50 µ mesh size with little

modification in design or improvement in accuracy. The filtrate was transferred from the filtering sample container of plankton net to a plastic PET (polyethylene terephthalate) bottle and preserved immediately in 1:100 Lugol's solution.

Zooplankton sampling was undertaken using vertical haul to sample the water column. The plankton net was lowered to the desired depth (upto 1.5 to 2 m) and hauled slowly upwards. At least 1 replicate of sample were collected from each selected site. Sample from the filtering cone of the plankton net was transferred to a plastic PET (polyethylene terephthalate) bottle and preserved immediately in 5% buffered formalin. After preservation procedure bottles were tightly screwed and covered with commercial packaging tape for further safety and transferred to the laboratory.

These samples were identified in the laboratory using an upright light microscope with white light achromatic objectives of 10x, 20x, 40x and 100x magnification and Sedgwick-Rafter (S-R) cell were used to count the numbers of phytoplankton and zooplankton. Sedgwick-Rafter (S-R) cell is a device commonly used for plankton counting because it is easily manipulated and provides reasonably reproducible data when used with a calibrated microscope (APHA, 1998). Plankton was counted on the bottom of the S-R cell. Large cells or colonies are counted at 100 x while the majority of cells is counted at 200x. Plankton number in the S-R cell derived from the following equation;

$$\text{Plankton No./mL} = \frac{\text{C x } 1000\ mm^3}{\text{LxDxWxS}}$$

Where,
C = number of organisms counted,
L = length of each strip (S-R cell length), mm,
D = depth of a strip (S-R cell depth), mm,
W = width of a strip (Whipple grid image width), mm, and
S = number of strips counted.

The number of cells per millilitre was multiplied by a correction factor to adjust for sample dilution or concentration. Identification of phytoplankton and zooplankton was undertaken following the descriptive keys of Prescott (1), Edmondson (2) and APHA (3)

Fish Survey

The objective of the baseline fisheries survey was to examine and evaluate the existing environmental status concerning aquatic habitat and overall fisheries state of affairs prevailing in and adjacent areas of the Project site viz. Jamuna river within the 5 km radius and concerned fish culture ponds and fishermen

(1) Prescott, G.W. 1982. Algae of the Western Great Lakes Area. Otto Koeltz Sci. Publ., W-Germany. pp. 977.
(2) Edmondson, W.T. 1959. Freshwater Biology. Wiley, New York, New York, USA
(3) APHA, 1998, Standard Methods for the Examination of water and waste water, 20t ed. American Public Health Association.

community in villages including fish landing and marketing network scenario within the Project AOI.

To meet these objectives the following activities were undertaken:

a) Identification of current aquatic habitat types vis-à-vis to collect data on important aquatic flora and fauna within the Project AOI and to establish a realistic inventory of Upstream and downstream of Jamuna River from the Project Site including associate canals and flood plains through Primary Productivity Analysis;
b) Build up data bank and information through practical assessment of existing species-wise quantity of fish catch in open water capture fisheries (Jamuna riverine tract, its shallow canals, marshy area and floodplain) in order to determine community structure ("Catch Per Unit Effort (CPUE)" Data) as part of fish population dynamics study;
c) To collect data on current status of closed water culture fisheries (fish-culture in pond) in the Study Villages under the Project AOI by field survey;
d) Collection of information/ data on existing Fish Landing Centres within and adjacent to the Project AOI through gathering data from both primary and secondary sources as well as recording of quantum of each major species fish landed/ marketed in each centre during specific period of its operation with pricing structure and also identifying the modus operandi of these centres.
e) Identification and interpretation of Fish Spawning /Rearing Ground and Fish Migration Routes/ Gateway of most major species of fish in the Jamuna River and associated flood plain through gathered data/ information from secondary source.

Five (5) important and basic survey processes were used to obtain the primary data and information (through application of Structured Survey Questionnaires and modules) with a view to make qualitative and quantitative situational impression and assessment of the Project AOI about aquatic diversity, open water capture fisheries and closed water pisciculture. Survey Process Modules was applied to the following 'Field Study Components';

a) Limnological and Water Quality Parameter surveys to identify and quantify aquatic habitat characteristics, which includes collection of data and information on limnological parameters for primary productivity analysis and water quality indices analysis to know the aquatic habitat conditions as well as water pollution load as indicator for determining fish species abundance and richness suitability along with their seasonal variation in the AOI ;
b) Fish catch surveys in Jamuna River and associated canal, flood plains to obtain data and information;

c) Species-wise fish catch and effort data analysis for traditional fishing along the AOI under Fish Community Structure Study which constitutes one of the component of 'Fish Population (Dynamics);
d) Closed water culture fisheries (pisciculture in Pond) surveys in Villages in the Project AOI to gather data and information of number of ponds, areas, physical condition and culture status and fish; and
e) Fish Landing and Marketing Network surveys to obtain data on fish landing and marketing network including fish pricing strata, marketing structure and distribution system occurring in different season within the Project AOI.

Four main tools/procedures comprising of participatory observation, field survey through Checklist and Focused Group Discussion (FGD) techniques, and review of observed/ collected data and analysis with interpretation of findings/ results were used to develop and establish survey design and to undertake in-depth field survey process studies on 6 different aspects of fisheries state of affairs prevailing within the Project AOI.

Data on fish species availability, fish catch, seasonal variation of fish catch, its weight and value, fish spawning ground and migration route, fish landing and marketing centres were collected through direct observation, survey processes, and interviewing fishermen/ fish traders with structured questionnaire during field studies was undertaken through FGD. These exercises have been undertaken to test the applicability/ suitability of the design of sampling schemes of the survey processes including methodology and data collection procedures during field studies.

Secondary information was also collected from the following organizations and sources were either contacted or consulted;

- District Fishery Officers of Sirajganj District.
- Upazilla Fishery officers of Sirajganj Sadar Upazilla.
- Department of Fisheries, Government of Bangladesh (GOB)
- Bangladesh Inland Water Transport Authority (BIWTA), GOB
- Bangladesh Water Development Board (BWDB), GOB
- Bangladesh Fisheries Development Corporation (BFDC), GOB
- Department of Fisheries, Dhaka University
- Fisheries Resource Survey System of Department of Fisheries, GOB
- Meteorological Department, GOB
- Bangladesh Bureau of Statistics Publication Division
- Relevant Flood Action Plan (FAP) Reports
- Relevant Survey Reports

4.4.8 Aquatic Ecology

A total of 15.82 sq.km (20.14%) of the Project AOI represents the water body including Jamuna River, natural streams/drainage and stagnant water bodies. The aquatic bodies support as a habitat to variety of plants and animals.

Plankton Study

In Primary Productivity Analysis of Inland Open Water ecosystem, the biological part of the limnology study of Phytoplankton and Zooplankton are of paramount importance. These play vital role in the food chain (in water body) of fish, plankton, zoobenthos and other animals, etc. and provides data/ information in the productivity of a given aquatic eco-system as well as to determine the type of Aquatic Habitat which is related to the seasonal abundance, relative occurrence of planktonic flora and fauna and their relationship with some important physico-chemical quality conditions of water bodies of Jamuna river adjacent to the Proposed Power Station Area.

Four (04) planktonic samples in duplicates were collected in the Jamuna River in order to assess the planktonic types and their population. The details of phyto and zooplanktons are given in the ***Table 4.30*** and ***Table 4.31*** below.

Table 4.30 Phytoplankton Details from Jamuna River

Phytoplankton Genera	**Number (individuals/L)**							
	Station 1		Station 2		Station 3		Station 4	
	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B
Navicula	6,450	6,300	4,980	5,100	2,800	2,740	3,200	3,400
Synedra	12,580	12,750	12,000	11,650	7,600	7,230	11,400	10,800
Cyclotella	9,110	9,350	8,050	8,400	4,250	4,300	7,230	6,900
Coscinodiscus	17,200	17,600	17,550	17,200	14,600	14,100	14,700	14,400
Anabaena	910	950	430	520	1,340	1,200	1120	1,150
Nostoc	850	870	670	700	1,200	1,,250	920	950
Oscillatoria	2,150	2,160	2,250	2,350	910	940	1,500	1,610
Chlorella	450	430	650	510	820	880	610	690
Spirogyra	650	600	750	820	890	900	810	850
Coelastrum	1,80	1,900	1,500	1,300	1,260	1,300	1,100	1,320
Scenedesmus	18,650	17,750	17,250	17,400	12,100	11,850	15,470	15,300
Microspora	210	190	60	35	----	----	----	----
Ankistrodesmus	3,800	3650	3,200	3,300	2,100	2,150	2,140	2,220
Ceratium	590	550	460	450	-----	-----	240	220
Phacus	6,630	6,800	6,100	5,900	4890	4,850	5,250	5,400
Pediastrum	920	850	640	530	---	---	250	180
Melosira	3,20	4,100	3,850	3,780	2,450	2,260	3,100	3,350

Table 4.31 Zooplankton in Jamuna River

Zooplankton Genera	Number (individuals/L)							
	Station 1		Station 2 (Inlet)		Station 3 (Outlet)		Station 4	
	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B	Sample A	Sample B
Brachionus	7,660	7,580	6,220	6,300	4,430	4,225	5,850	5,780
Keratella	2,800	2,650	2,100	2,220	1,350	1,280	1,980	1,920
Philodina	1,320	1,350	250	240	---	---	---	---
Nauplius larvae	5,120	5,100	4,860	4,650	4,150	4,060	4,660	4,750
Cyclops	3,440	3,430	3,100	3,200	1,460	1,420	2,250	2,350
Bosmina	890	830	470	410	---	---	---	---
Moina	2,610	2700	2,850	2,810	2,120	2,100	2,320	2,310
Daphnia	3,100	3,140	3380	3,460	1,600	1,620	3,110	3,120
Cypris	910	940	320	250	---	---	---	---
Polyarthra	740	690	410	350	270	240	330	350
Diaptomus	60	80	---	---	---	---	---	---

The phytoplankton enumerated from the 4 duplicate samples include different species of Diatoms (5 species), cyanobacteria (3 species), green algae (8 species) and protozoa (1 species).

The zooplankton enumerated from the 4 duplicate samples include different species of rotifers (4 species), crustaceans (2 species), Copepods (2 species) and ostacods and cladoceras with single species. None of the species observed are of conservational significance.

Aquatic and Amphibious Plants

The plant species usually submerged or partially submerged/floating in the water recorded from the Project AOI are *Azolla* sp, *Eichornia crassipes, Ipomea alba, Hydrilla verticillata, Calocasia esculenta Rorippa indica, Oxalis corniculata, Marselia sp, Chenopodium album, Sphenoclea zeylanica* and *Ceratophyllum* sp. None of the species observed are of conservational significance.

Macro-invertebrate Fauna

Macroinvertebrate surveys were conducted in May-June 2015 survey. Macro invertebrate species such as water spiders (*Argyroneta aquatic*), Common Apple snail (*Pila globosa),* Disk Snail (*Macrochlamys sequax*), River Snail (*Bellamya begalensis*), Brotia Snail (*Brotia costula*), Lymneid Snail (*Lymnaea luteola*), Fresh water Mussels species such as (*Lamellidens corrianus*), (*Lamellidens marginalis*), (*Lamellidens jenkinsianus)* were observed in the study area. None of the species observed are of conservational significance.

Fish

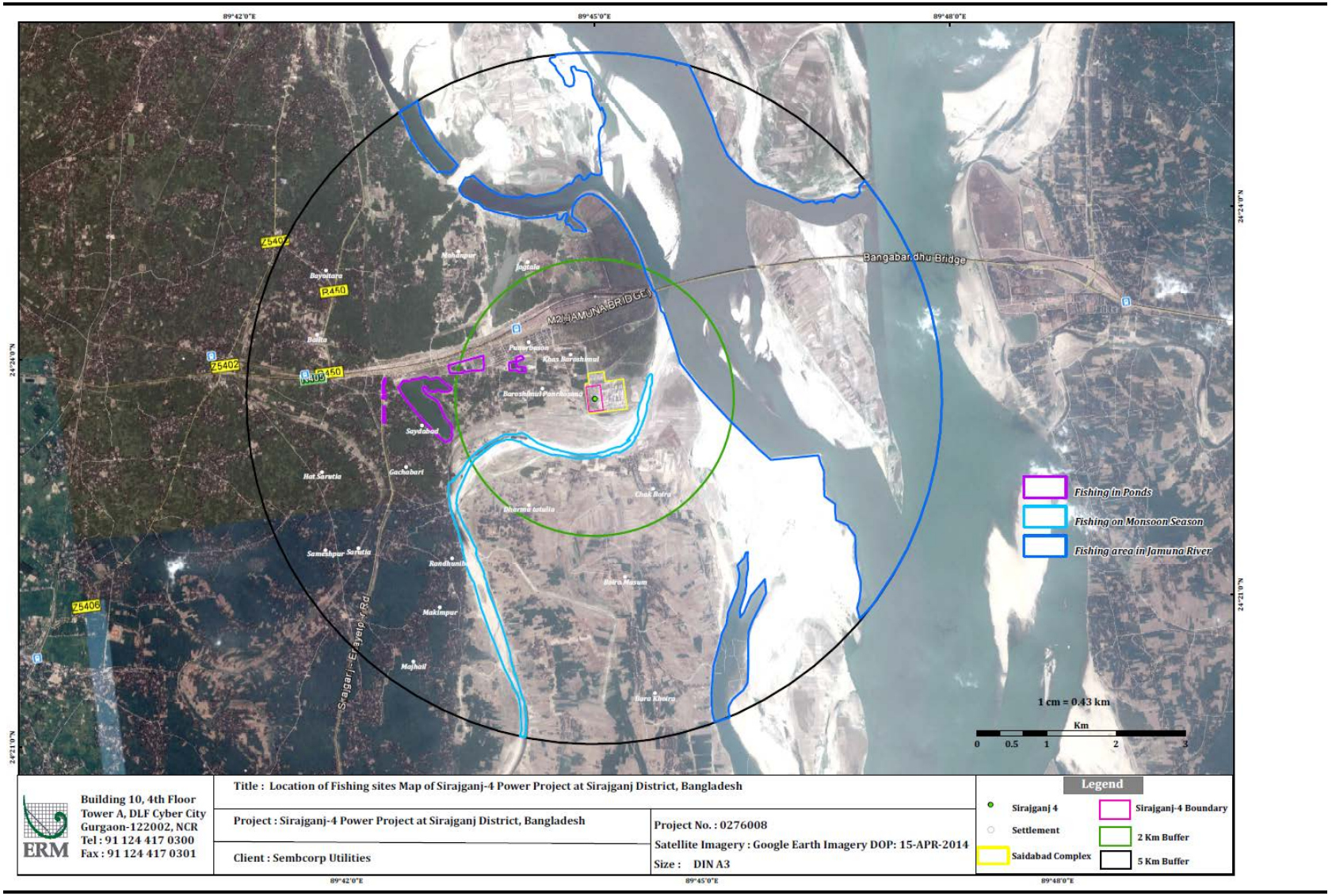
In order to get secondary information, various literatures were consulted. Data / information on the specific river/floodplain of the Project AOI were generally not available.

Primary Fish surveys were carried out long the Jamuna River and fish breeding area along the Dhaka Rajshahi Highway by consulting respective stakeholders such as fisherman, surveying fish landing centres, fish pond owners and operators and fish markets from the Project AOI. The details of the fishing areas are depicted in ***Figure 4.41.***

The Department of Fisheries, GoB has designated one pond as a fish breeding area. This pond is located about 2.10 km away to the west of the project site near the village of Purbo Radhunibari within the AOI. This is effectively used seasonally for increasing fish production during the monsoons for the user community in the vicinity.

In order to understand the fish culture status in ponds within the Project AOI, all the villages under Sirajganj Sadar and Belkuchi Upazilla within the project area of 5 km were surveyed. The details are provided in ***Table 4.32*** and details of fish species reported are listed in ***Table 4.33*** and represented in ***Figure 4.42.*** Fishing takes place along the entire Jamuna River in the AOI. It is noted however that fishing related activities are not allowed under the Bangbandhu Bridge due to security reasons related to the bridge. Boats were observed to be occasionally parked near the proposed temporary jetty area in a small water channel which is used by the local people for fishing when the water level of the river is high. When the river level is low the fisherman fish in the main river. These boats are also used by the people from the neighbouring villages for connectivity to the char lands, which are used for cultivation during non-flooding period. Some fishermen from the villages mentioned in ***Table 4.35*** were surveyed**.** The table provides the distance from the proposed project components. However these populations were not solely dependent on fishing for their livelihood as mentioned during surveys.

Figure 4.41 Fishing Areas within AOI



Source: Google Earth Pro (Imagery Date: 15 April 2014) and site reconnaissance survey (November 2012 and December 2012 and May and June 2015)

Table 4.32 Fishing pond status in Project AOI

Name of the pond owner	Study village	Union	Upazilla	No. of ponds	Pond size	Species cultured *	Culture practice	Culture period	Total fish production
Abdus Samad	Panchosona	Saidabad	Sirajganj Sadar	1 pond	16 decimal	Rui, Catla, Mrigal, Sarpunti, Tilapia, Grasscarp	Semi-intensive	15 years	250 kg/year
Samsu, Basher and Sayed	Punorbason	Saidabad	Sirajganj Sadar	1 pond	100 decimal	Rui, Catla, Common carp, Mrigel, Kalbaus	Semi-intensive	8 years	>2000 kg/year
Abul Kalam	Paschim Radhunibari	Rajapur	Belkuchi	1 pond	30 decimal	Rui, Catla, Common carp, Mrigel, Kalbaus, Sarputi	Semi-intensive	10 years	400 kg/ year

Source: Primary Survey Jan 2013

* Kindly refer to ***Table 4.33*** for scientific names

Figure 4.41 Fishing activity in the Jamuna River and Temporary Jetty area

Fishing Boat in Temporary Jetty Area

Army surveying in the Temporary Jetty Area

Fishing Boat in Temporary Jetty Area

Fishing mouth of Temporary Jetty

Fishing at the turning Point of Temporary Jetty

Fishing Inside Temporary Jetty area

Fishing in the main Jamuna River

Current Net near Temporary Jetty

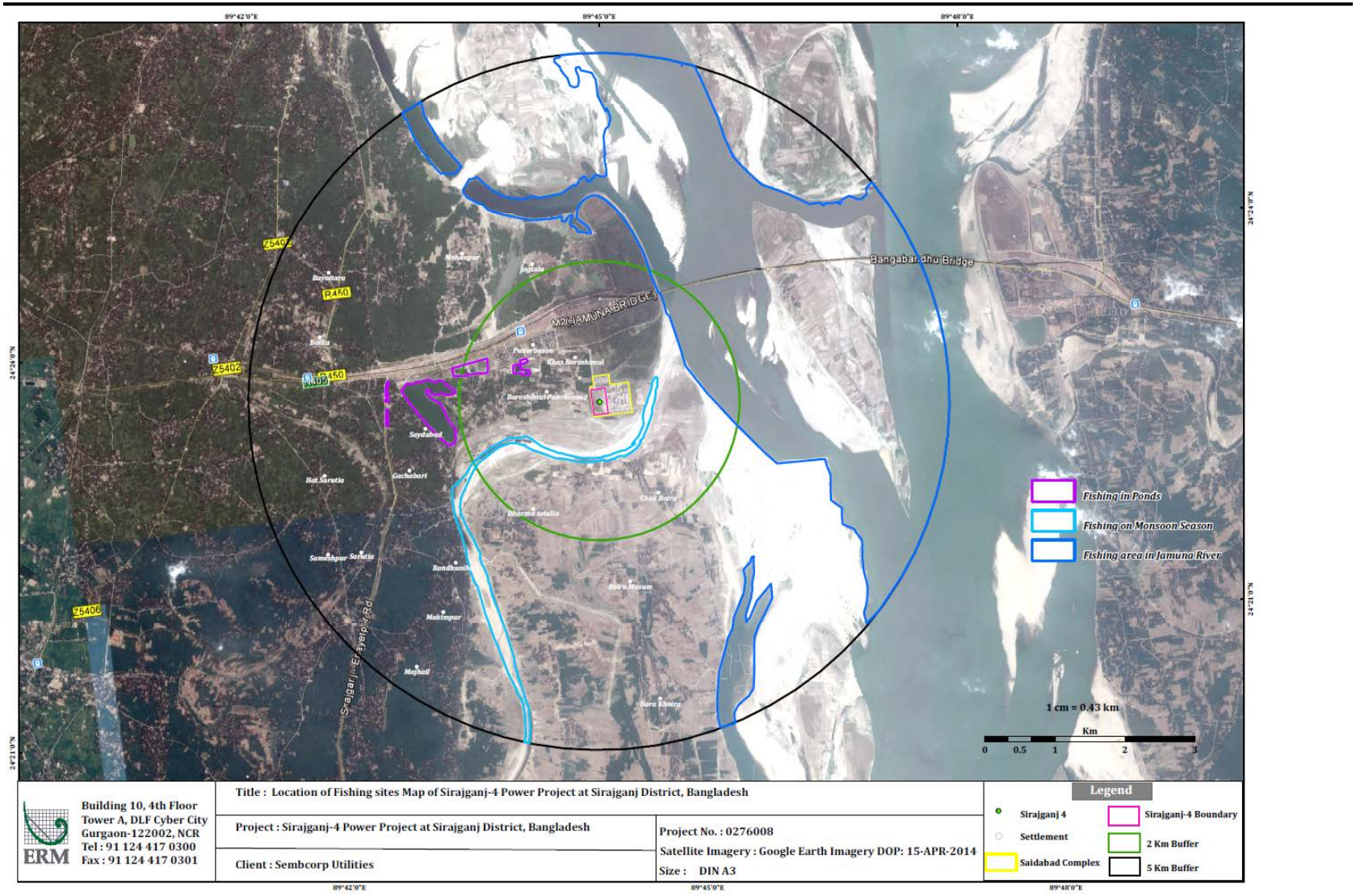
Fishing in the Jamuna River

Fisherman placing Current Net near Temporary Jetty

Consultation with Fisherman

Source: ERM Survey May-June 2015

Figure 4.42 Map showing Location of Fishing Ponds and Fishing Area in Jamuna River



Source: Google Earth Pro (Imagery Date: 15 April 2014) and site reconnaissance survey (November 2012 and December 2012, May-June 2015))

Table 4.33 Availability of Major Fish Species in the Project AOI with seasonal variation

Scientific name	Local name	IUCN Status	Migratory/ Endemic	Seasonal availability
Sperata aor	Ayre	LC	E	June-November
Eutropiichthyes vacha	Bacha	NA	E	March-November
Bagarius bagarius	Baghair	NT	E	June-November
Mastacembelus armetus	Baim	NA	E	May-February
Wallago attu	Boal	NT	E	May-August
Botia dario	Bou mach	LC	E	March-February
Chela laubuca	Chela	NA	E	March-November
Macrobrachium sp.	Chingri	NA	E	April-August
Chitala chitala	Chital	NT	E	June-October
Monopterus cuchia	Cuchia	LC	E	November-February
Tenualosa ilisha	Ilish	LC	E	March-November
Mystus cavasius	Kabashi tengra	LC	E	July-December
Corica soborna	Kachki	LC	E	March-November
Xenentodon cancila	Kaikka	LC	E	May-October
Labeo calbasu	Kalibaus	LC	E	March-November
Catla catla	Katal	NA	E	March-November
Channa punctatus	Lata, Taki	NA	E	March-November
Rita rita	Rita	LC	E	March-November
Labeo rohita	Rui	LC	E	March-November
Pangasius pangasius	Yellowtail catfish	LC	E	March-November
*Tor tor**	Mohashoul	NT	E	-
*Systomus sarana**	Shorpunti	LC	E	-

Source: Primary Survey Jan 2013(* Consultation with Fishery Department)
Notes: LC-Least Concern, NT-Near Threatened, NA-Not Assessed, E-Endemic to Indian Subcontinent

Most of the fish species were found in the rainy season while some major fish species like Hilsha (*Tenualosa ilisha*) were found in the early winter and also in the early monsoon. Small indigenous fish species were available especially in the post monsoon season. Such fish are It is an important protein source for the poor people and during discussion with the local fishermen fishing community it was revealed that most of the subsistence and part-time fishermen depend on these small fishes not only as a protein source in their diet but also a major part of their income comes is derived from the sale of these fish.

Fish Catch Assessment

The fish Catch Assessment surveyed included seasonal variation of fish catch, total number of fish and quantitative analysis of the landed caught fish in the Project AOI, fish landing centres, fish traders who buy fish in the river and the local fish market. The survey was conducted from morning to evening for close observation and in addition FGD were completed to get accurate information. Details of fish landing centers/fish markets are given in ***Table 4.34.***

Table 4.34 Derails of Surveyed Fish Landing Centres/ Fish Market

Name of the Fish markets/ Landing centres with GPS Locations	Number of Fish Traders/ commission Agent/ Aratdar	Average sale per day(kg)	Rate of Commission taken by the Commission Agent/Aratdar	Operational Duration of the Landing Centres /day
1. Saidabad market N 24˚23.383′ E 89˚42.890′	6-7	30-150	2-3%	7-10 am
2. Chok-mokimpur bazaar N 24˚21.832´ E 89˚ 43.193´	5-7	50 - 200	2-3%	7-10 am
3. Sirajganj Boro Bazar N 24˚27.396´ E 89˚ 41.370´	20-30	500-700	2-5	7 am-9 pm
Chala Bazar, Belkuchi N 24˚18.031´ E 89˚ 41.788´	3-5	25-80	1-2%	7-10 am
Railway Station Market, Sirajganj N 24˚27.080´ E 89˚ 42.130´	3-6	50-150	2-3%	4-8 pm

Survey of fish landing center/fish market enumerated various types of fish, their source and market price. These are given in ***Table 4.35.***

Table 4.35 Field Survey and Inspection on Fish Landing and Marketing Centres of the Project AOI

Sl. No.	Scientific name	Local name	Sources	Quantity (kg/day)	Price (BDT/kg)
1.	*Labeo rohita*	Rui	R, P	80-200	150-350
2.	*Catla catla*	Katal	P	50-100	150-350
3.	*Clarias batrachus*	Walking catfish	R, P	5-10	200-300
4.	*Wallago attu*	Boal	R,	25-70	250-800
5.	*Pangasius pangasius*	Yellowtail catfish	R, P	300-400	70-150
6.	*Eutropiichthyes vacha*	Bacha	R,	3-5	300-600
7.	*Rita rita*	Rita	R,	5-8	400-600
8.	*Sperata aor*	Ayre	R,	15-25	450-700
9.	*Mystus cavasius*	Kabashi tengra	R,	10-15	150-400
10.	*Bagarius bagarius*	Baghair	R	15-20	400-550
11.	*Chitala chitala*	Chital	R	7-12	450-700
12.	*Tenualosa ilisha*	Ilish	R	30-80	350-1200
13.	*Corica soborna*	Kachki	R	25-40	200-350
14.	*Mastacembelus armetus*	Baim	R,	15-20	250-350
15.	*Anabas testudineus*	Koi	P	50-80	150-300
16.	*Xenentodon cancila*	Kaikka		8-15	250-350
17.	*Channa striatus*	Shol	R	15-30	180-250
18.	*Channa punctatus*	Lata, Taki	R	30-50	150-250
19.	*Chela laubuca*	Chela		15-20	200-350
20.	*Labeo calbasu*	Kalibaus	R	50-100	220-350
21.	*Botia dario*	Bou mach	R	15-20	250-400
22.	*Heteropneustes fossilis*	Shing	R	20-30	200-300
23.	*Macrobrachium sp.*	Chingri	R,	50-100	200-350
24.	*Oreochromis mossambicus*	Tillapia	P	70-150	120-200
25.	*Puntius sarana*	Sarpunti	P	50-100	150-250
26.	*Hypophthalmichthys molitrix*	Karfu	P	70-150	180-250
27.	*Ctenopharyngodon idella*	Grass carp	P	100-150	150-200
28.	*Puntius puntio*	Punti fish	R	60-100	120-200
29.	*Awaous guamensis*	Baila	R	10-20	200-300
30.	*Neotropius atherinoides*	Batasi	R	15-20	250-350

Sl. No.	Scientific name	Local name	Sources	Quantity (kg/day)	Price (BDT/kg)
31.	*Ailia coila*	kajuli	R	8-10	250-400
32.	*Puntius sophore*	Bhadi puti	R,P	20-25	150-200
33.	*Gonialosa manmina*	Chapila	R	10-12	200-300
34.	*Ompok pabo*	Pabda	R	5-10	300-450

Source: Based on Sample Survey in three Fish Landing Centres
Note: R= River, P=Pond

The fish Catch Assessment Survey Study' undertaken in the aforesaid aquatic Project AOI, showed an average daily catch of about 2.25 kg of different fish species/day from the Jamuna river within the Project AOI. More than 90% of the fish were caught by using mostly 3 types of fishing gear/unit namely Current jal, Jhaki jal and Ber jal. Most commercial and dominant fish species were different types of Carps, Prawns, Boal, Pangas, Baga ayer, Catfishes, Hilsha, etc. Most of fishes were 0+ and 1+ year old. Hilsha fish were caught in the same water bodies, were 1+ years old. About 10% of the catches were 1+ and 2+ years old but 3+ age class fish was not found in this Project AOI during the study period.

There are no specific fisherman villages in Project AOI. There are some discrete fisherman households in three villages within 5 km study area. Three study villages consist of 39 fishermen household and all of these household were surveyed. The details are provided in Table 4.36**.**

Table 4.36 Details of the Fisherman Population in the Project AOI

Village	Distance, direction from jetty	Distance, direction from water intake	Total population (approx..)	Fishermen (full time and part time) (approx..)	Total Number of Fishermen Households	Total Number of Surveyed Households
Paschim Mohanpur	4.33 km/W	5.88 km/W	887	15	10	3
Khas Chtragachha	2.23 km/W	3.73 km/W	101	35	25	7
Purbo Radhunibari	3.69 km/SW	4.89 km/W	1972	7	4	3

Source: Based on Fisherman Survey in AOI

Aquatic Mammals

Based on a study conducted in 1995-96 (1) , South Asian river dolphin (*Platanista gangetica* –IUCN v 2015.2 EN) were recorded from the Project AOI. During this study, dolphins were observed in the Jamuna River at 0.13 sightings per kilometre and 1.5 sightings per hour.

(1) Brian D Smith, AKM Aminul Haque, M Shakhawat, Anisuzzaman Khan (1998)River Dolphins in Bangladesh: Conservation and the effects of water Development, Published by Springer Verlag New York Inc.323-35

Table 4.37 Aquatic Mammal

Scientific name	Local name	Seasonal availability
*Platanista gangetica**	South Asian river dolphin IUCN [1] EN Species	July-November

During the recent survey (May-June 2015), the Jamuna River within the AOI was surveyed twice for the South Asian River Dolphin and a total of three sightings occurred. The species is commonly spotted by the fishermen in the area during the pre-monsoon and monsoon period when the water level is high. The main sightings occurred at the turning point of the river for Temporary Jetty area, however with the rise of water in summer and monsoon the species can be seen in the temporary jetty area too..

Figure 4.43 Sighting of River Dolphin

Source: Google Earth Pro (Imagery Date: January 8 2015) and site reconnaissance survey May-June 2015

(1) Ref.: Smith, B.D. & Braulik, G.T. 2012. Platanista gangetica. The IUCN Red List of Threatened Species. Version 2015.1.

5 SOCIO-ECONOMIC ENVIRONMENT

5.1 THE SOCIO-ECONOMIC BASELINE

The baseline conditions define the cultural and human conditions that prevail in the Project Study Area. It includes information on all receptors and resources that were identified during the scoping stage of the Impact Assessment process as having the potential to be affected by the Project, as well as have an impact on the sustainability of the Project.

This section describes the socioeconomic baseline conditions in the Study Area (defined below). The analytical framework for the impact assessment is based on the sustainable livelihoods framework [(1)], which focuses on putting people at the center of development (refer ***Figure 4.1***). The baseline therefore describes the interrelated resources and receptors, which in the livelihoods framework are termed 'capital'. The five broad areas of resource and receptors on which livelihood depends are as follows:

- **Natural Capital –** natural resource stocks, which include *physical* (e.g. climate topography, land use), *terrestrial* (e.g. flora, fauna), and *aquatic* (e.g. benthos, fisheries);
- **Human Capital –** skills, knowledge, ability to labour and good health (e.g. population composition, technical skills, education and health status);
- **Social Capital** - networks, membership and trust (e.g. social networks, cultural practices and sites);
- **Financial Capital –** financial resources (e.g. sources of employment, wages and subsistence and other economic resources); and
- **Physical Capital –** basic infrastructure and producer of goods (e.g. utilities and services).

5.1.1 *Area of Influence*

Socio-economic/ Social

The AOI for social (including health) receptors was fixed to include 5 km radial zone which has been developed based on reconnaissance site visits and limited stakeholder consultations with the local community.

The AOI for development of the social baseline comprises of 55 villages, which according to the administrative structure falls in 38 Mauzas, 3 Unions and 2 Upazillas under Sirajganj District and covers a radial zone of 5 km. The AOI is largely spread within Saidabad and Kalia Haripur Unions of Sirajganj

(1) "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustained when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base." (UK Department for International Development – DFID)

Sadar Upazilla. However, only a small fraction (south of the plant location) falls under Rajapur Union in Belkuchi Upazilla. The composition of the AOI (in terms of geographical area, number of households, and population) vis-à-vis higher levels of administrative classifications is provided in ***Table 5.1.***

Table 5.1 Composition of Project AOI (5 km)

Admin Levels / Particulars	Zilla (Sirajganj)	Upazillas (Sirajganj Sadar+ Belkuchi)	Unions (Saidabad + Kalia Haripur+ Rajarpur)	Area of Influence (AOI)			
				Total	% of Zilla	% of Upazilla	% of Unions
Area in Acres	593,559	118,368	22,006	19,397	3.26	16.38	88.14
No of HHs	714,971	199,935	31,701	15,681	2.19	7.84	49.46
Population	3,097,489	907,990	146,322	73,721	2.38	8.11	50.38

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

The socio-economic information presented in this report has used information from different administrative levels, depending primarily on the availability of appropriate data. ***Figure 4.2*** shows areas with 5 km, 2 km and 1 km radius from the Project Site. The area within 1km radius falls in Saidabad Union is considered as the core zone. The Saidabad Union is comprised of 14 Mouzas and 24 Villages.

Project AOI covers part of the two districts of Sirajganj and Tangail. The western side of the AOI includes the Project site which falls under Sirajganj District, and the eastern part of the area falls under Tangail District. The AOI falling under Tangail District is mostly Jamuna River including char lands. South of the project AOI is also occupied by char "Boro Simul" and Makimpur.

5.2 NATURAL CAPITAL: LIVELIHOOD INTERFACE

5.2.1 Land Resources Use

Agriculture Land-Use

Sirajganj District falls within active Brahmaputra-Jamuna Floodplain (agro ecological zone) which comprises of unstable alluvial land where land is constantly being formed and eroded by shifting river channels. According to the most recent available agricultural statistics (Agriculture Census 2008 for Sirajganj District n.d.), the total cultivable land available within the district was observed to be 172439.79Ha. Out of this, the land under permanent crop cultivation was estimated at 1.67%, and under seasonal crop cultivation was estimated at 97.53%. The remaining area was registered as fallow land. The total cultivable land under irrigation was observed to be at 79.87%.

The primary crops grown within Sirajganj District are paddy, jute, wheat, mustard, sugarcane and a variety of pulses. The district is also a major

producer for variety of vegetables and fruits. Typical vegetables grown within the district are onion, garlic, potato, sweet potato, chilly and ground nut whereas the main fruits include mango, jackfruit, black berry, papaya, guava, coconut, palm, date, olive, bael, tamarind and banana. There are also a few varieties of crops that are reportedly extinct or nearing extinction within the district such as indigo, tobacco, local varieties of aus paddy, china, kaun, and some varieties of pulses. The ***Table 5.2*** highlights the area under cultivation for some of the key crops in Sirajganj District, Sirajganj Sadar and Belkuchi as per the (Agriculture Census 2008 for Sirajganj District n.d.).

Table 5.2 ***Area under cultivation (in acres) for various crops in Sirajganj District, Sirajganj Sadar and Belkuchi Upazilla***

District /Upazilla	Different varieties of Rice under cultivation												
	Local Aus	HYV Aus	Local Aman	HYV Aman	Local Boro	Hybrid Boro	HYV Boro	Wheat	Maize	Jute	Pulses	Oil Seeds	Sugarcane
Sirajganj	9499	9191	58284	29836	24354	64050	222402	7386	14132	27847	39864	192193	5645
Sirajganj Sadar	531	436	2344	1811	2347	5256	20231	1176	1438	4318	4720	14690	3472
Belkuchi	407	246	2447	627	1187	3868	11991	1844	83	2585	3988	15073	40

Source: *(Agriculture Census 2008 for Sirajganj District n.d.)*

Non-Agricultural and Industrial Land Use

Only the Preliminary Report on Economic Census 2013 is available at present. The preliminary report reports that more than half of the labour force in Bangladesh is engaged in economic activities outside the farm sector. This underscores the growing importance of the sector in supporting faster growth of the overall economy ((Bangladesh Bureau of Statistics Nov 2013, 53). Rajshahi division has recorded increase in total economic units. It is noteworthy that Sirajganj and Rajshahi division has received a targeted public investment and special credit programme to facilitate non-farm activities to address seasonal unemployment. According to the (Economic Census 2001 and 2003 Sirajganj District n.d.), the industrial landscape of Sirajganj is primarily marked by manufacturing industries and establishments. Manufacturing includes manufacturing of textiles, food products and beverages, local made wooden furniture, and fabrication of metallic and non-metallic products. The manufacturing industry is equally supported by wholesale retail and trade and community, social and personal services. More information on the industrial landscape of Sirajganj and within the AOI is provided in Economic Capital section.

5.2.2 *Water Resources*

Inland Fishery

Fishing is not a major commercial activity within Sirajganj District or Sirajganj Sadar or Belkuchi Upazilla. The local people undertake fishing in the river or local ponds in small scale for consumption and sale in local markets. Fish rearing in ponds and local water bodies is very limited.

Based on consultation with the fishing department of Sirajganj Sadar, it was reported that the department is trying to develop fishing resources within Sirajganj. The Department has initiated development of a 'fish breeding area' in Saidabad Union where various species of fishes are bred and released into the river.

Irrigation from Surface Water and Ground Water

The primary source of irrigation within Sirajganj District as per the (Agriculture Census 2008 for Sirajganj District n.d.) is shallow or deep tubewell. The other source for irrigation is motorized pumps. However, its prevalence is low due to higher running costs from the use of diesel. Surface water bodies like ponds and backwaters are also used by local people for irrigation. The ***Table 5.3*** provides a snapshot of the land under irrigation within Sirajganj District, Sirajganj Sadar and Belkuchi Upazillas respectively.

Table 5.3 Land under irrigation in Sirajganj District, Sirajganj Sadar and Belkuchi Upazillas

Classification	Net Cultivated Area	Total Irrigated Area (Ha)
	Area in (Ha)	
Sirajganj District		
All Holdings	370032	340311
Non-Farm	40	39
Farm	369991	340272
Sirajganj Sadar Upazilla		
All Holdings	37381	30529
Non-Farm	7	6
Farm	37374	30522
Belkuchi Upazilla		
All Holdings	20116	16212
Non-Farm	4	4
Farm	20008	16209

Source: (Agriculture Census 2008 for Sirajganj District n.d.)

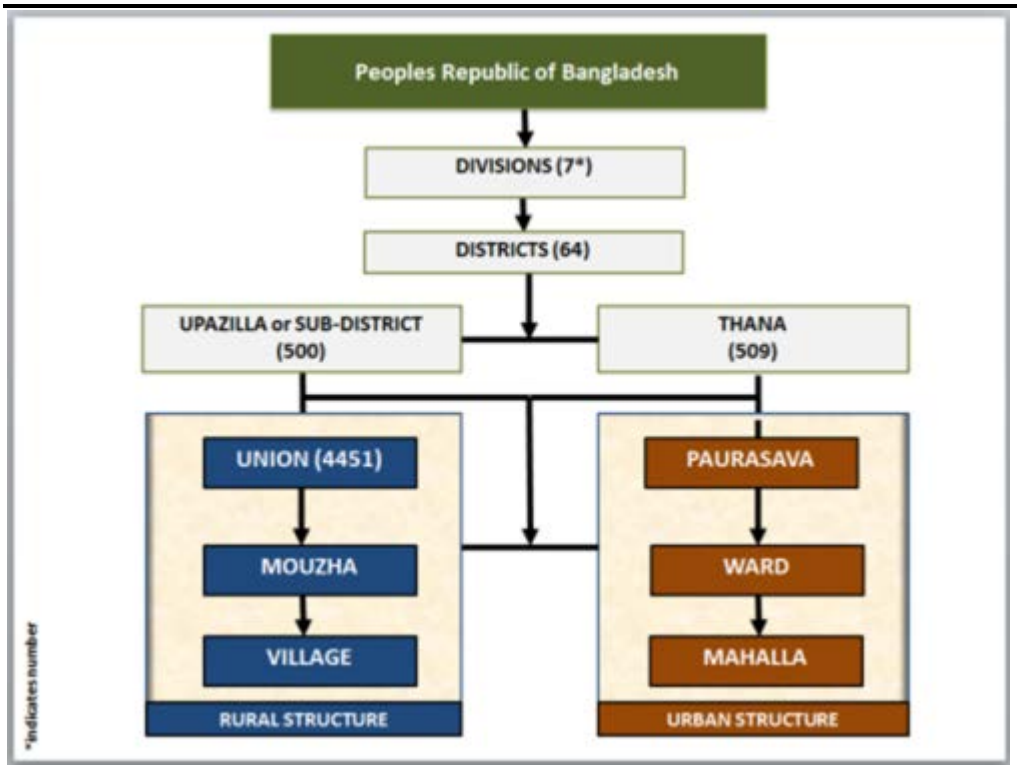
5.3 *HUMAN CAPITAL*

5.3.1 *Administrative Structure and Composition*

The administrative setup of Sirajganj District could be better understood from the ***Figure.5.1*** that explains the overall administrative setup of Bangladesh.

According to the (Census 2011 n.d.), the administrative setup of Sirajganj District comprises of nine (9) Upazillas, eighty-two (82) Unions, one thousand four hundred and seventy two (1472) Mauzas, two thousand one hundred and eighty (2180) Villages, sixty (60) Wards, hundred and seventeen (117) Mahallas and six (6) Paurasavas.

Figure.5.1 Governance Structure in Bangladesh



Source: Adopted from www.bangladesh.gov.bd

It can be observed from the above figure that the administrative setups for rural and urban areas are different. The rural area governance structure primarily comprises of unions, *mauzas* and villages. A *mauza* can be a single village but in most cases comprises of a no. of villages. The village is the lowest rural geographic unit. The urban structure of governance comprises of Paurasavas, wards, and Mahallas. The Paurasava is headed by an elected mayor who is the administrative head and is responsible for its overall functioning of the various wards and the Mahallas falling within it. Simultaneously, the union is headed by the union chairperson who is responsible for the administration of the union and the mauzas and villages falling within it.

The council of all union representatives within an Upazilla is termed as the council of unions or Union Parishad while the council comprising of all Paurasava representatives is termed as Paurasava Parishad. The two parishads functions under the governance of the sub-district or upazilla parishad. The upazilla can also be called as thanas in certain locations depending on the local administrative scenario. The overall administrative

head is the District or Zilla Parishad and more or less has a coordinating and supervisory role of the lower echelons of administrative governance.

5.3.2 Demography

As per Census of Bangladesh (2011), total population of Sirajganj District is estimated at 30,97,489 comprising of 7,14,971 households. The average annual increase in population since 2001 has been estimated at 1.38%. The following ***Table.5.4*** provides an overview on the population trends of Sirajganj District over a period of 10 years from 2001 to 2011.

Table.5.4 Population trends of Sirajganj District

Index	Population Details of Sirajganj District	
	2011	**2001**
Total Households	714971	562708
Total Population	3097489	2693814
Change in Population	403675	474111
Average Annual Increase	40367	47411
Annual rate of Growth over period of 10 years (%)	1.38	1.76
Average Household (HH) size	4.3	4.7

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

The populations of Sirajganj Sadar Upazilla and Belkuchi Upazilla are estimated at 5,55,155 and 3,52,835 respectively as per the 2011 census. Sirajganj Sadar Upazilla constitutes approximately 17.92% of the total population of Sirajganj District whereas Belkuchi comprises of approximately 11.39% of the population of Sirajganj District.

The total population of the AOI is estimated to be approximately 73, 721 and 15,681 households. Out of this, a total population of 32,895 under 6,863 households falls within Sirajganj Sadar Upazilla while the remaining population of 40,827 within 8,818 households falls under Belkuchi Upazilla. With respect to households, approximately 5.5% of the total households of Sirajganj Sadar and 11.8% of the total households of Belkuchi falls within the AOI. ***Table 5.5*** shows the d overview of the population indicators of the AOI .

Table 5.5 Detailed Overview of the Core Zone and AOI

Union Name	*Total House-holds*	*Population*
Saidabad Union (Sirajganj Sadar Upazilla)	**5968**	**27421**
Kalia Haripur Union (Sirajganj Sadar Upazilla)	**895**	**5474**
Rajapur Union (Belkuchi Upazilla)	**8818**	**40827**
Total	**15681**	**73721**

Source: Census 2011

The Saidabad Union is the immediate Union Parishad, hence is considered as the core zone of the AOI and Karlia Haripur and Rajarpur constitute the buffer zone. Saidabad Union is comprised of 14 Mouzas and 24 Villages. The

population size and number of households of these Mouzas and Villages in Saidabad Union is provided in the table below.

Table 5.6 Mouzas and Villages comprising Saidabad Union

Mouzas[1]	Villages	House-holds	Population
1. Dukhiabari	Purba Dukhiabari	87	353
	Paschim Dukhiabari	351	1569
2. Jamtail Khidirpur	Jamtail Khidirpur	203	873
	Dighir Char	269	1182
3. Jamtail Das	Uttar Porabari	337	1502
	Dakshin Porabari	263	1226
4. Jarila	Jarila	432	2003
	Maisura	82	398
	Jarila Madhyapara	200	879
	Jarila Digrir Char	89	400
5. Gachhabari	Purba Gachhabari	150	661
	Paschim Gachhabari	296	1430
6. Saidabad	Uttar Saidabad	629	2784
	Dakshin Saidabad	513	2444
	Kalibari	88	365
7. Purba Mohanpur	Purba Mohanpur	324	1537
	Paschim Mohanpur	194	877
8. Khas Chhatragachha	Khas Chhatragachha	101	431
9. Rehai Chhatagachha	Rehai Chhatagachha	86	387
10. Bara Shimul Panchosona	Bara Shimul Panchosona	782	3741
11. Khas Barashimul**	Khas Barashimul	128	698
12. Chak Boyra	Chak Boyra	109	528
13. Birhati	Birhati	93	478
14. Jamunabali	Jamunabali	162	675
		5968	27242

Source: Census 2011

The average household size within the core zone of Saidabad Union stands at 4.6 persons per household. The average household size within the AOI has been calculated at 4.7 persons per household. The ***Table.5.7*** provides comparison of the key demographic indicators of the AOI (both core and buffer zone) with indicators from the aforementioned Upazilla level as well as the district level.

Table.5.7 Comparison of Key Demographic Indicators

Mauza/Union/Sub-District/District	Total Population	Total Households	Average Household Size
AOI	73721	15681	4.7
Population within Saidabad Union (Core	27421	5968	4.6

(1) [1] The mouzhas within the 5km study area have been identified using revenue maps collected from local Revenue Department.

Mauza/Union/Sub-District/District	Total Population	Total Households	Average Household Size
Zone)			
Population within Kalia Haripur Union (Buffer Zone)	5474	895	6.1
Population within Rajapur Union ?(Buffer Zone)	40827	8818	4.6
Population in AOI, within Sirajganj Sadar Upazilla	32895	6863	4.8
Population in AOI. within Belkuchi Upazilla	40827	8818	4.6
Sirajganj Sadar Upazilla	555155	125485	4.4
Belkuchi Upazilla	352835	74450	4.7
Sirajganj (District)	3097489	714971	4.3

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

Saidabad Union, which for the purpose of this study has been identified as the core zone, has a total population of 27421, which is approximately 37% of the population in the AOI. Total population of the AOI is approximately 2.38% of the total population of the district and comprises of 2.19% of its total households.

Rural and Urban Population Distribution

The ***Table 5.8*** indicates the distribution of rural and urban population within Sirajganj District, Sirajganj Sadar Upazilla and Belkuchi Upazilla respectively.

Table 5.8 Dissemination of Rural and Urban Population

District/Upazilla	Rural/Urban	2011	2001	% Growth from 2001 figures	% of Sirajganj District (2011 Census)
Sirajganj District	Rural	2660912	2372561	12.51	-
	Urban	436577	321253	35.89	-
Sirajganj Sadar Upazilla	Rural	387955	349019	11.15	14.57
	Urban	167200	135151	23.71	38.29
Belkuchi Upazilla	Rural	277471	282350	(-)1.73	10.43
	Urban	75364	20328	270.73	17.26

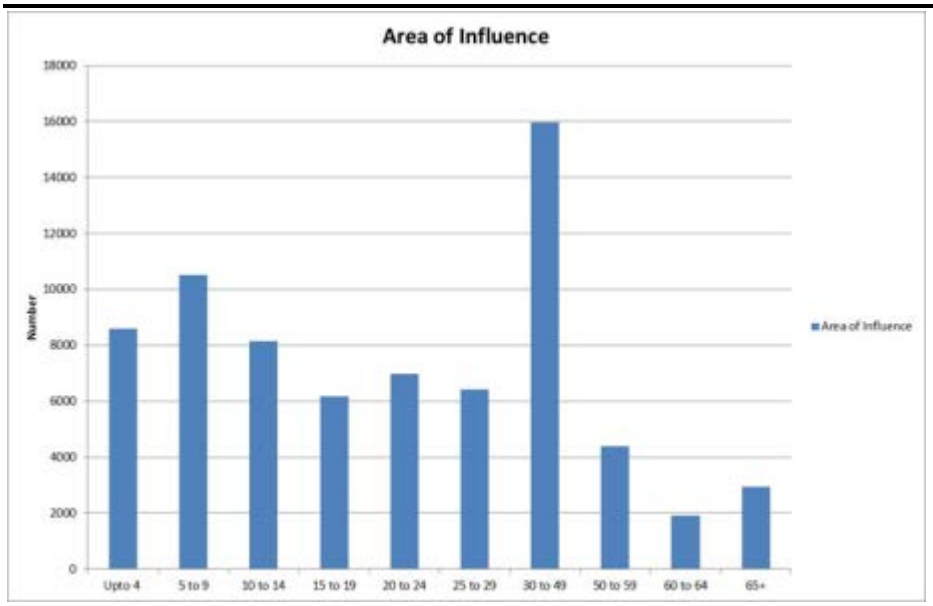
Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

It can be observed from the above figure that in all three cases, the rural population is greater than the urban population.. However, it can be seen that over two consecutive census period, the growth within the urban population has been significantly more as compared to rural population. The maximum growth has been observed in Belkuchi Upazilla where population has more than trebled within the ten year period.

5.3.3 *Age Structure*

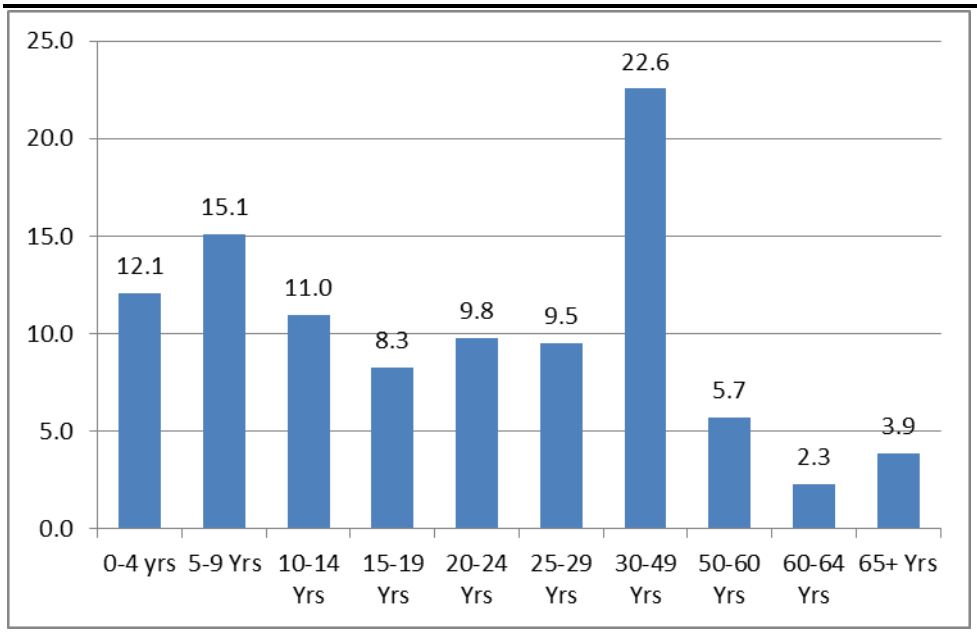
The census of Bangladesh divides the population age groups into ten (10) categories. These being, those below the age of 4, between 5 and 9, 10 to 14, 15 to 19, 20 to 24, 25 to 29, 30 to 49, 50 to 59, 60 to 64 and those above the age of 64 respectively. The following ***Figure. 5.2*** highlight the age-wise distribution of population within the AOI. ***Figure. 5.4*** highlight the comparative trend in the age-wise population distribution within the AOI with that of the overall district.

Figure. 5.2 Age-Wise Distribution within the AOI



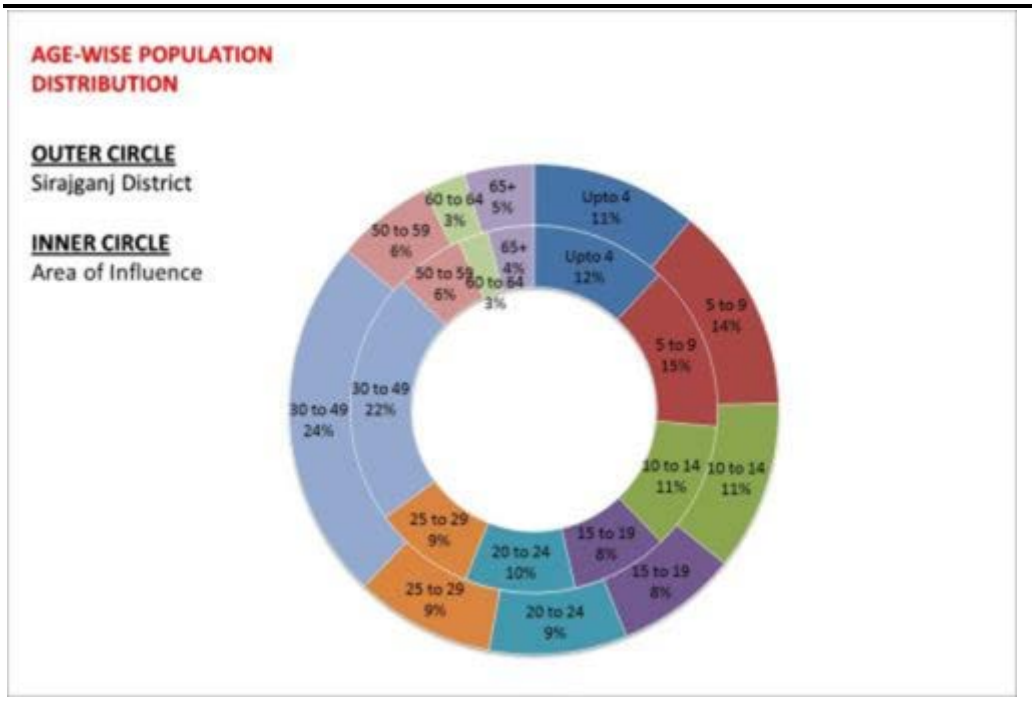
Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 5.3 Age Composition within Saidabad Union



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

Figure. 5.4 Comparison of Age Distribution within AOI and Sirajganj District



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

It can be observed from the above figure that the larger proportion of the population within the core zone and AOI falls within the age group of 30 to 49 years followed by population within the age group of 5 to 9 and upto 4 respectively. The trend is similar to that the district level where the larger percentages of population within Sirajganj District falls within the age group of 30 to 49 years followed by age group of 5 to 9.

5.3.4 Education

The literacy rates in Sirajganj Sadar Upazilla and Belkuchi Upazilla have been observed at 47.4% and 47% respectively. The overall literacy rate for the district has been estimated at 40.6%. The literacy rate within the AOI has been estimated at a low 34.12%. The literacy trends in all these locations were observed to be poor when compared to the national literacy rate for Bangladesh estimated at 56.75%. The graphical representation of literacy indicators are shown in ***Figure.5.6***.

Figure 5.5 Breakdown of AOI literacy rate- Core and Buffer Zone

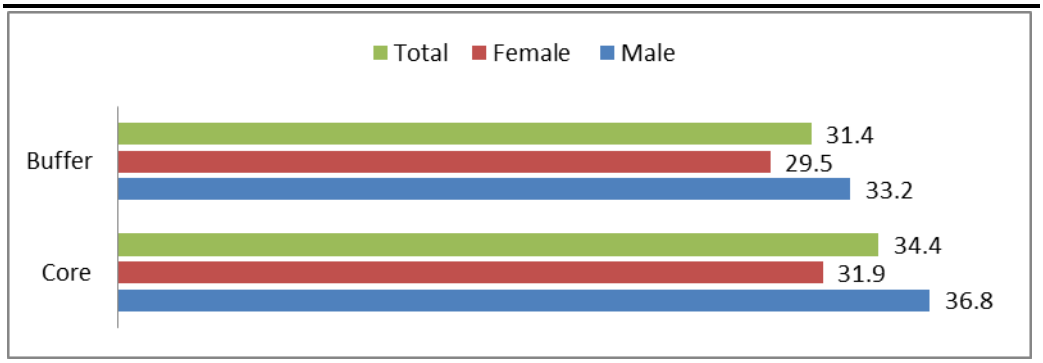
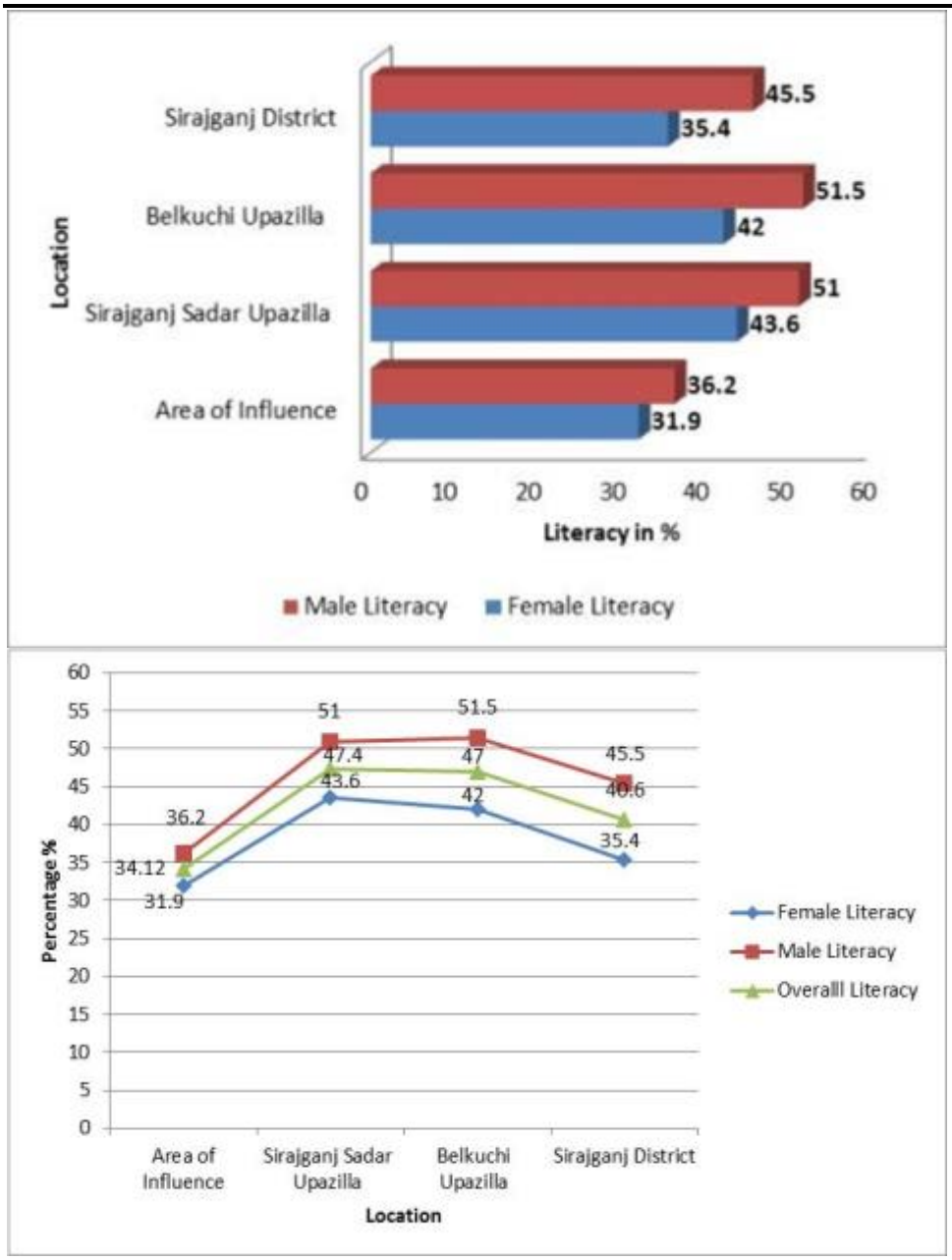


Figure.5.6 Literacy Profile



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

With respect to individual literacy trends amongst males and females, it can be observed that literacy amongst women is lower than their male counterparts. The difference registered was lowest within the AOI (4.31%) but gradually increases as one takes into account Sirajganj (7.4%) and Belkuchi (9.5%). The difference is the highest when the overall district is taken into context with 10.1% more men being considered literate in comparison to their women counterpart.

5.3.5 Health Profile

According to the available healthcare data from the sub-divisional health complex of Belkuchi Upazilla, the health profile for the area indicates that the most prevalent diseases within these locations and hence the AOI include Arsenicosis (due to arsenic poisoning), Tuberculosis, Pneumonia, and Diarrhoea. The ***Table 5.9*** indicates single year data from the sub-division health complex of Belkuchi.

Table 5.9 Disease data for sub-divisional health complex, Belkuchi Upazilla for 2011

Month	Cases of Diarrhoea	Cases of Tubercolosis	Cases of IMCI Patients
January	118	26	250
February	256	37	240
March	125	31	246
April	262	47	300
May	143	48	85
June	117	28	160
July	278	20	248
August	124	16	140
September	178	44	103
October	264	23	66
November	321	22	149
December	394	25	480
Total	2580	367	2467

Source: Sub-divisional health complex

The above table also indicates the cases of patients under the Integrated Management of Child Illness (IMCI) programme which looks after the overall healthcare issues rising amongst children.

5.3.6 Gender Equity

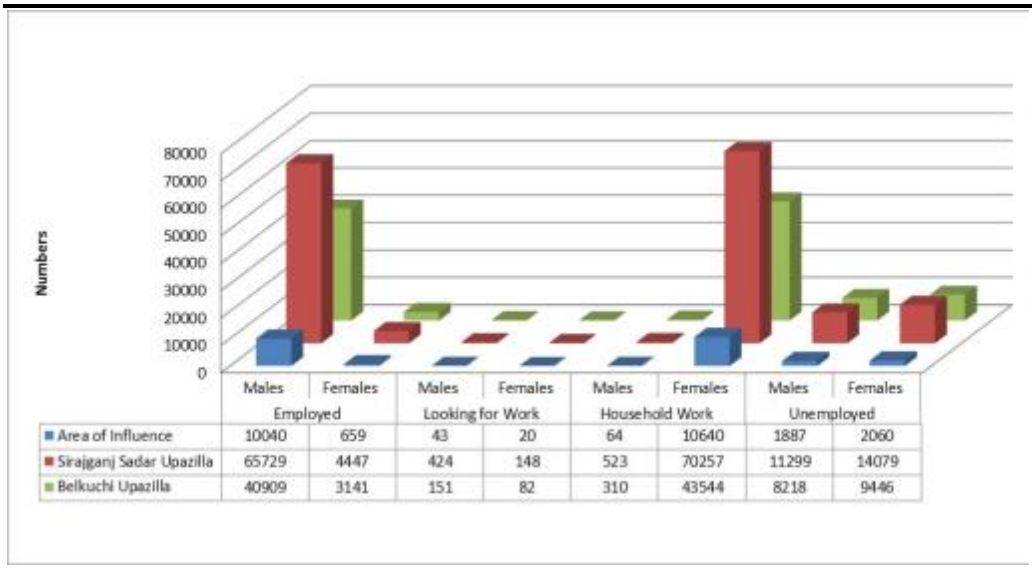
The male and female composition of the population is relatively equitable with only Belkuchi indicating a marginally higher male dominated population as compared to female population. The sex ratio[1] within the AOI has been determined at 105 as against 101 for Sirajganj Sadar Upazilla and 102 for Belkuchi Upazilla. The sex ratio for the overall Sirajganj District is 101

(2) [1]Sex Ratio is defined as Number of Males per 100 Females

If one assesses the sex ratio individually at the mauza level within the AOI, it is observed that the most skewed ratio is prevalent at Nakphata mauza with over 175 males for every 100 women and Mathpara with only 73 males for every 100 women, on both ranges of the spectrum.

The ***Figure.5.7*** provides an account of the employment status of men and women within the AOI, Sirajganj Sadar and Belkuchi Upazilla respectively.

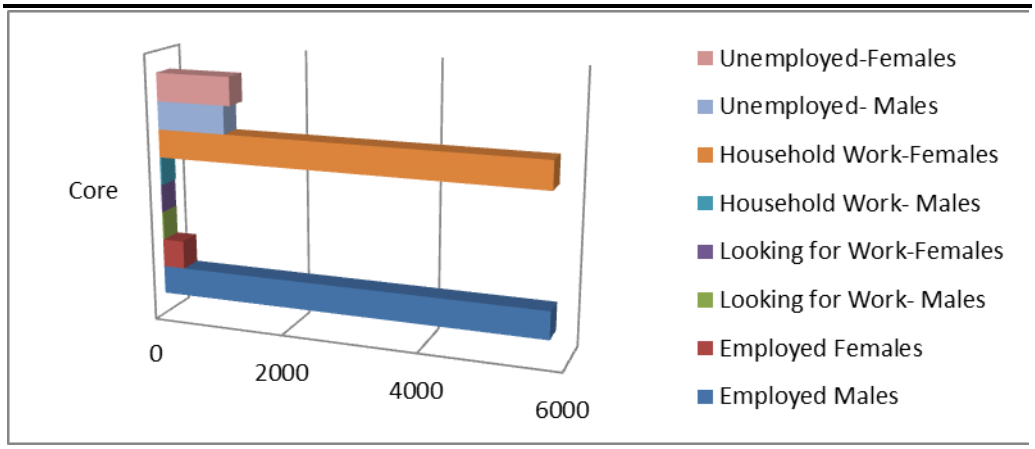
Figure.5.7 Employment Status among men and women



	Employed		Looking for Work		Household Work		Unemployed	
	Males	Females	Males	Females	Males	Females	Males	Females
Area of Influence	10040	659	43	20	64	10640	1887	2060
Sirajganj Sadar Upazilla	65729	4447	424	148	523	70257	11299	14079
Belkuchi Upazilla	40909	3141	151	82	310	43544	8218	9446

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

Figure 5.8 Employment Status among Males and Females



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

It can be observed from the above figure that the participation of women in the work force within the core zone, AOI as well as in the overall context of Sirajganj Sadar and Belkuchi is very low and restricted. In terms of participation ratio, the men outweigh the women with only one women being employed for every 15 men. The figures for Sirajganj and Belkuchi are 15 and 13 respectively. Also, in terms of unemployment rate, it is observed that

women have a higher unemployment rate as compared to men in all the three locations.

Box 5.1 Status of Women in Bangladesh

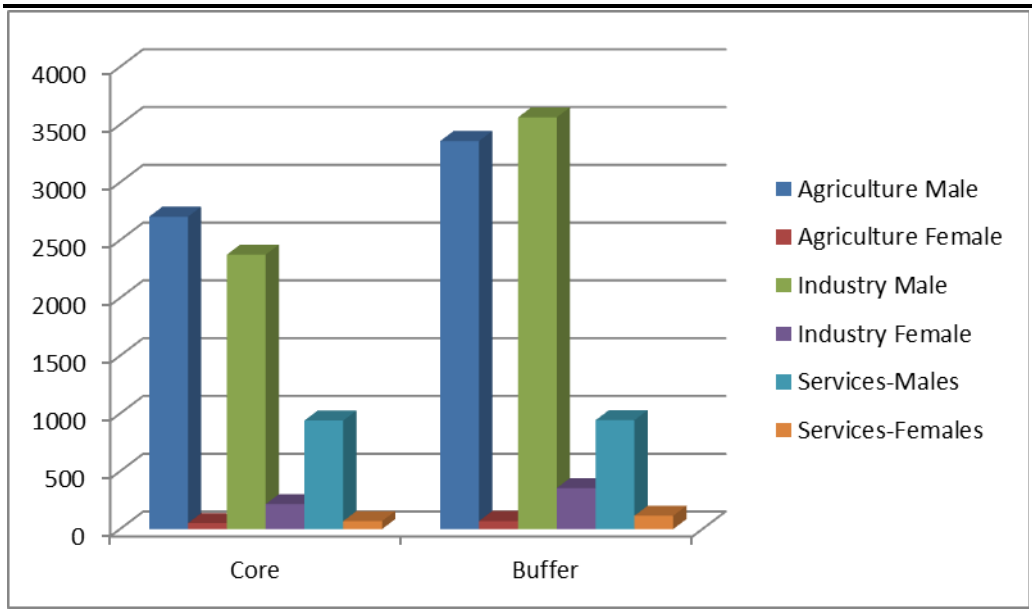
Women comprise approximately 49.56% of the total population within the project study area which more or less indicates a healthy sex ratio of approximately 105. This indicates a lower disparity for the girl child. However, women in Sirajganj Sadar may still be classified as vulnerable due to the fact that a large fraction of the same are not allowed to work or earn a living or pursue higher level education due to religious and cultural beliefs. They are mostly relegated to household level chores, raising families and domestic work like raising cattle and crop harvest. They are also occasionally attributed to social evils like child marriage, polygamy, and domestic violence. In particular, from stakeholder consultation it was noted that a large number of women have been victims of acid attacks in Sirajganj Sadar.

Due to the large NGO landscape in Sirajganj District and Sirajganj Sadar with a multitude of local and international NGO's working in the area, a large no. of women related empowerment and development programs are under implementation. Some of the key women centric programs that came to notice are Resilience through Economic Empowerment and Climate Adaptation, Leadership Learning (REECALL) funded by Oxfam-GB, Rural Employment Opportunities for Public Assets (REOPA) funded by UNDP & EC and Community Based Adaptation with Local Government in Bangladesh (CBA-LG) funded by Action Aid, Bangladesh amongst others. A broad understanding on these programs has been provided in the following sections.

Source: Manab Mukti Sangstha (Local NGO Working in Sirajganj Sadar and Belkuchi)

Female participation is primarily at the household level including domestic household activities and in minor agricultural practices such as livestock breeding, post-harvest work like thrashing of grains, etc. and this is clearly evident from the graph with over 166 women employed in domestic work for every one man. Women are rarely encouraged in gainful employment or service roles or allowed to travel far for employment.

Figure 5.9 Employment Sectors- Core & Buffer



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

5.3.7 Human Rights Context

According to the Section 2(f) of the National Human Rights Commission Act, 2009 of Bangladesh, "Human Rights" means Right to Life, Right to Liberty, Right to Equality and Right to Dignity of a person guaranteed by the constitution of the People's Republic of Bangladesh and such other human rights documents and ratified by the People's Republic of Bangladesh and enforceable by the existing laws of Bangladesh.

As per the (Annual Report 2011, National Human Rights Commission, Bangladesh 2011), the main complaints and cases that have been classified as human rights violation includes abductions, rapes, murders, custodial deaths, torture, human trafficking, domestic violence, enforced disappearance from homestead amongst others.

5.3.8 Labour and Employment

As per the Preliminary Report of Economic Census 2013 (Bangladesh Bureau of Statistics Nov 2013), the labour and persons engaged in economic activities are classified under following categories:

- ***Proprietor/Partner:*** is directly engaged in the economic activity of the establishment and has the right of ownership in the business;
- ***Full-time Employees:*** are workers who are paid regular salary and other emoluments for work for full hours are full time employees;
- ***Part-time workers:*** are those workers who work on a part time basis fall under this category. They are not usually entitled to full time salary or allowance;
- ***Irregular workers:*** workers who are employed irregularly for a special purpose or an emergency basis falls under this category; and
- ***Unpaid family workers:*** includes any family member of the proprietor or partners if works in the unit usually without salary or wage in return is an unpaid family worker.

The ***Table 5.10*** details the persons engaged as per type of employment and establishment in Sirajganj District and also the annual growth rate from 1986 onwards upto 2003[1].

[1] The Preliminary Report for Economic Survey 2013 only gives aggregate figures at Division level. The final report along with District and Upazilla level data is yet to be published by Bangladesh Beureau of Statistics.

Table 5.10 Persons engaged by working status and by type of establishment

Type/Working Status	Persons Engaged								Growth Rate
	1986				2001 and 03				
	Total	%	Male	Female	Total	%	Male	Female	
Permanent Establishment	**183,075**	**100**	**156,998**	**26,077**	**249,066**	**100**	**211,176**	**37890**	**1.9**
Working Proprietor	25,852	14.1	25,270	582	55,871	22.4	54,502	1,369	4.8
Unpaid family workers	19,768	10.8	14,098	5670	30,559	12.3	24,220	6,339	2.7
Full time workers	118,119	64.5	104,4083	14036	152,368	61.2	124,098	28,270	1.5
Part-time workers	19,336	10.6	13,547	5,789	10,268	4.1	8,356	1,912	-3.7
Temporary Establishments	**1,620**	**100**	**1,608**	**12**	**12,350**	**100**	**12,012**	**338**	**13**
Working Proprietor	1,296	80	1,293	3	6,996	56.6	6,924	72	10.7
Unpaid family workers	132	8.1	126	6	1,883	15.2	1,778	105	17.4
Full time workers	166	10.2	163	3	3173	25.7	3,041	132	19.5
Part-time workers	26	1.6	26	0	298	2.4	269	29	15.8
Household premise based establishments	**102,310**	**100**	**76,531**	**25,779**	**88,947**	**100**	**69,505**	**19,442**	**-0.8**
Working Proprietor	20,502	20	17,664	2,838	21,183	23.8	16,738	4,445	0.2
Unpaid family workers	21,367	20.9	10,916	10451	14,544	16.4	8,025	6,519	-2.3
Full time workers	50,352	49.2	41,964	8388	49,178	55.3	41,597	7,581	-0.1
Part-time workers	10089	9.9	5987	4,102	4,042	4.5	3,145	897	-5.4

Source: Sirajganj District Economic Census 2001 and 2003

As per the (Economic Census 2001 and 2003 Sirajganj District n.d.) skill and human capacity of the population engaged in any form of economic activity within Sirajganj District has been primarily defined on the basis of seventeen (17) types of mutually exclusive categories of work on the basis of which the skill set is derived. These seventeen categories are agriculture, hunting, forestry; fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale and retail trade; hotels and restaurants; transport, storage and communication; bank, insurance and financial institutions; real estate and renting; public administration and defence; education; health and social works; community social and personal services; household services; and services of international and extra-territorial bodies. A detailed understanding on the engagement status of the labour and workers engaged within these skill sets have been provided in Section 5.5.2.

5.4 SOCIAL CAPITAL

5.4.1 Historical and Political Overview

Sirajganj District was formerly a sub-division of Pabna District. It was made a full-fledged district as a part of up-gradation programme of Sub-divisions to Districts. During the reign of ***Nawab***[1] ***Alivardi Khan*** between 1740 and 1756 Sirajganj became the commercial centre of Bengal. He developed this commercial centre further to supply paper to different parts of the country by transferring a group of highly skilled people in making hand-made paper (generally known as ***Tulat kagas***) from central Asia to this place. Their descendants are still living in Kalia and Kandpara Mauzas adjacent to Sirajganj town. The place was named as "Sirajganj" after the name of Alivardi's grandson Sirajuddowla, the last independent Nawab of Bengal. (Census Handbook of 2011).

Sirajganj Sadar came into existence in 1988. As per the District Gazetteers it is learnt that the town was founded by a ***Zamindar*** or landlord by the name of Siraj Ali who founded the Sirajganj town. Belkuchi came into existence in 1983. It is believed that the name of the Upazilla was taken from that of an Englishman named Belkuchi who came for indigo plantation during British rule in this region

Box 5.2 Historical Events of Importance

In 1922, many people were killed and wounded when police opened fire on an assemblage of people gathered at Salanga Hat (as a part of the Khelafat and non-cooperation movement) under the leadership of Maulana Abdur Rashid Tarkabagish. This is known as the Salanga Movement or 'Salanga Genocide'.

In 1942 Mohammad Ali Jinnah came to Sirajganj to attend the All India Muslim League Conference; Mahatma Gandhi and Subhas Chandra Bose came to Sirajganj to attend the convention of the Brahmo Samaj in 1928.

The Hindu-Muslim Pact of the Swaraj Party, headed by Deshbandhu Chitta Ranjan Das, was adopted in the Conference of the All India Congress Party held in 1924 at Sirajganj.

National poet Kazi Nazrul Islam came to Sirajganj in 1932 to preside over the Conference of the Tarun Muslim. Ak Fazlul Huq laid the foundation stone of Sirajganj Degree College in 1940.

During the War of Liberation, a battle was fought between the freedom fighters and the Pak army at Naogaon of Tarash Upazilla in which the Pak army was defeated and about 150 members of the Pak army were killed. During 11 to 14 December a battle was fought between the Pak army and the freedom fighters at Shailabari in which Pak army was defeated. Sirajganj was liberated on 14 December 1971.

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

[1] Nawab was a pricely title used for the administrative or ruling heads in most parts of eastern India and Bangladesh prior to Independence.

5.4.2 *Ethnic Composition* [1]

Although the country has identified a total of twenty seven (27) ethnic population groups living within Bangladesh, almost 98% of the total population are Bengalis, native to the region of Bengal.

From the 2011 census data, approximately 0.6% of the total district population belong to the ethnic minority categories. The census records states that this population is largely from the *Orao* (5170), *Coach* (723), *Santhals* (621) and other (13258) ethnic communities within Sirajganj district.

It is significant to note that Sirajganj Sadar Upazilla registers an ethnic population of 36 whereas Belkuchi does not register any presence. Consultations with Saidabad Union president and local communities revealed that the core area of influence do not have any ethnic minority households.

5.4.3 *Religious Composition*

The religion followed by local community is Islam religion. As per the 2011 census, the population within the AOI primarily consists of Muslims, constituting 98% of the total population. The remaining 2% are mostly Hindus. There is no other religious minority such as Christianity or Buddhism within this area.

The ***Table 5.11*** indicates the population distribution from the various religions within the AOI as well as Sirajganj Sadar, Belkuchi and the district as a whole.

Table 5.11 Religion and Community Profile

S. No.	Mouzas/Union/Sub-District/District	Muslim		Hindu		Christian		Buddhist		Others	
		Pop.	% Tot. Pop.	Pop.	% Tot. Pop.	Pop.	% Tot. Pop.	Pop.	% Tot. Pop.	Pop.	% Tot. Pop.
1	AOI	69316	98.03	2779	1.98	1	<1	0	0	0	0
2	Sirajganj Sadar Upazilla (Sub-District)	534622	96.3	20490	3.69	23	<1	10	<1	10	<1
3	Belkuchi Upazilla	333735	94.6	18949	5.6	50	<1	8	<1	93	<1
4	Sirajganj (District)	2948505	95.2	147514	4.76	380	<1	24	<1	1066	<1

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

The Muslim communities are mostly from the ***Sunni*** sect of Islam with the ***Shia*** sect being in minority. The school of law followed by the Sunni sect is the ***Hanafi*** School of law.

According to (Heitzman and Worden, A Country Study: Bangladesh 1988) traditional Muslim class distinctions has had little importance in Bangladesh.

[1] Primary sources of information include CIA World Factbook, Census Handbook and Wikipedia

The proscription against marriage between individuals of high-born and low-born families, once an indicator of the social gap between the two groups, had long ago disappeared. Most matrimonial alliances were based on wealth and power and not on the ties of family distinction. Also, many so-called upper-class families, because of their traditional use of the Urdu language, had become alienated in independent Bangladesh.

According to (Heitzman and Worden, Social Classes and Stratification n.d.), Hindu society used to be formally stratified into caste categories, caste did not figure prominently in the Bangladeshi Hindu community. About 75 % of the Hindus in Bangladesh belonged to the lower castes, notably ***namasudras*** (lesser cultivators), and the remainder belonged primarily to outcaste or untouchable groups. Some members of higher castes belonged to the middle or professional class, but there was no Hindu upper class. With the increasing participation of the Hindus community in non-traditional professional mobility, the castes were able to interact in wider political and socioeconomic arenas, which caused some erosion of caste consciousness.

Family, Kinship and Marriage

Family and kinship ties form the core of social life in Bangladesh. A family resides in a ***bari*** (or "house") and functions as the basic economic unit (Heitzman and Worden, Family, Household, and Kinship n.d.). In the eyes of rural people, the ***chula*** (or "stove") defines the effective household, an extended family exploiting jointly-held property and being fed from a jointly operated kitchen. A bari might consist of one or more such functional households, depending on the circumstances of family relationship. Married sons generally live in their parents' household during the father's lifetime. However, families at different stages of the cycle display different configurations of household membership.

Inter-Community Relationship

Although Sirajganj has a majority Islamic population, the intercommunity relationship has been reportedly relatively stable based on mutual tolerance and harmony. Prior to partition, the district used to be a vital trading port, centre of business and literary exchange. This has led to a larger amalgamation of cultures within the society. Festivities such as Durga Puja and Id being still celebrated today with equal fervour amongst both communities as well as the similarity in the marriage events that take place are examples of that.

5.4.4 Vulnerable Social Groups and Households

Vulnerable groups include specific group of persons, households or a section of the community vulnerable to multiple stressors including abuse, social marginalization, social exclusion, domination or are under greater susceptibility to external influence.

Table 5.12 provides an account of some of the vulnerable groups identified above including widows, old aged and disabled within the AOI. It also provides an account of the total number of these individuals presently registered with the Department of Social Welfare under their Social Safety Net Program [1] as well as the Department of Disaster Management and Relief office, and receiving monetary aid from them.

Table 5.12 Status on Widows, Old Aged and Disabled within AOI

S No.	Parameter	Widow	Old Aged	Disabled
1.	Pop. in Saidabad Union*	1666	2142	2190
2.	Population in Kalia Haripur Union*	1612	1864	1260
3.	Pop. in Rajapur Union*	1594	1981	532
4.	Tot. members receiving grant from Safety Net Program in Sirajganj Sadar	2325	6856	818
5.	Tot. members receiving grant from Sirajganj Sadar Disaster Management and Relief Office	232	850	14

Source: Sirajganj Purosabha Office *Census 2001

Box 5.3 Community Opinion on Vulnerable households in Saidabad Union

The key vulnerable groups identified in discussion with the local stakeholders are those who are unemployed or with irregular incomes (including rickshaw pullers, fishermen, van drivers), beggars, physically handicapped, widows, at the individual levels. At the household level, these include households displaced by flooding, ***Char***[2] and low land dwellers, families solely dependent on Char cultivation, large families without any permanent source of income, women headed households, as well as households headed by chronically ill or disabled persons.

5.4.5 Language

The primary language of communication within Sirajganj as in most parts of Bangladesh is Bengali or Bangla. There are four main dialects of Bengali which are Chittagonian, Rangpuri, Noakhailla and Sylheti; of which the Noakhailla is the most spoken dialect within Sirajganj District. The other languages that are comprehended well within the society though not used in day to day communication are English (the second language of Bangladesh and mostly used within urban clusters) and Hindi. (Bangladesh: Ethonologue, UNESCO n.d.)

It was also reported by the community that the other language that is used but mostly restricted to a very niche group in society is the Urdu language. It is mostly used in religious scriptures, by the religious scholars as well as taught at *Madrasas* and religious schools.

[1] Discussed in future sections

[2] Char are large sand or silted land formations occurring within the river during the dry season. During monsoon, these Char lands get submerged and becomes inaccessible.

5.4.6 Civil Society Organizations

Sirajganj District is a major hotspot for a large number of Development Agencies, NGOs and welfare organizations working at the community level in order to address a variety of social issues including loss of life, loss of land, displacement and food shortages caused from frequent flooding during the monsoons, abject poverty and marginalization of lower income groups or families below the national poverty line, irregular or no employment, hunger, etc.. Some of the key amongst these agencies and the relevant schemes and programmes are as follows:

- **Department of Social Welfare, Government of Bangladesh***:* This is the primary social welfare agency under whose authority most of the government schemes and programmes are implemented at the ground level. Some of the key schemes implemented by this agency are:
  - Micro Credit Schemes for the poorest sections of the society;
    - Old age and Widow Pension schemes
    - Freedom Fighter Allowance
  - Schemes for highly marginalized sections of the society including Beggars, Handicapped and Destitute
  - Conducting awareness programs on Education, Healthcare, Family planning, etc.
- All local and international NGOs' working within Sirajganj are required to register with the Department of Social Service prior to implementing any community related work or service;
- **Aid Organizations:** Sirajganj sees active participation from a variety of major aid organizations including USAID, UNICEF, World Food Program (WFP), World Sanitation Program (WSP), Oxfam, Action Aid Bangladesh, and CARE Bangladesh amongst others. They are responsible for implementation of a variety of their schemes and programmes on poverty alleviation, hunger, disaster management, sanitation, literacy, immunization amongst others. These programs and services are implemented at the ground level through active local NGO's and Self Help Groups (SHG). Offices of most of these aid organizations are located at Sirajganj Sadar.

The well-known NGOs working in study area include BRAC, ASA, Proshika, Grameen Bank, JKS, NDP, SDS, Grameen Uddag, Ganasastha Kendra, Sirajganj Uttaran Mohila Sangstha and Social Work Centre. One of the most prominent amongst these and located very close to the project site is the ***Manab Mukti Sangstha (MMS).*** This organization is a local level NGO established back in 1984 at Chawli Upazilla in Sirajganj District. The organization obtained registration from the Department of Social Services in 1984 and NGO affairs bureau in 1990. It primarily works in Sirajganj, Tangail and Pabna District in the northern parts of Bangladesh.

Box 5.4 Rural Social Service (RSS) Programme - An Initiative by the Government of Bangladesh

The RSS project was launched as a pilot project in 1974 in 19 selected Thanas of 19 Districts in Bangladesh. In 1984, Upazilla Social Service Offices were established in all Upazillas. Under these offices, the RSS Programme was introduced all over the country.

The RSS Programme is particularly designed for the vast majority of by-passed groups to organise them and to build their capacity to fight against poverty, illiteracy, ill health, unemployment and population explosion. The direct target groups of the RSS are children, youth, women, landless families and other disadvantaged groups who do not directly get benefit from other development activities in the rural areas.

Some of the key salient features of this programme are as below:

- To identify the target people (the disadvantaged and by-passed community groups) through socio-economic survey with a view to bring them within the orbit of development activities of the Programme,
- Creating self-employment and increase income by giving interest free micro-credit at the rate of TK 2000 to 5000[1], for income generating economically profitable activities
- Providing informal education on health, nutrition, mother and child care, sanitation, use of safe drinking water, motivation on family planning, social a-forestation, literacy etc. for the improvement of the basic living standard of the people
- Establishing democratically functioning Village Based Institutions (VBI) of different target population and form Project Village Committee (PVC) and Village Executive Committees to identify key problems, needs and resources of the village and plan and implement development activities to improve their socio-economic conditions
- Providing skill training for increasing the income capabilities and productivity of unemployed and underemployed persons
- Awareness on family planning practices

Source: www.dss.gov.bd

5.5 ECONOMIC CAPITAL

5.5.1 Fixed Assets (Land & Property) Ownership

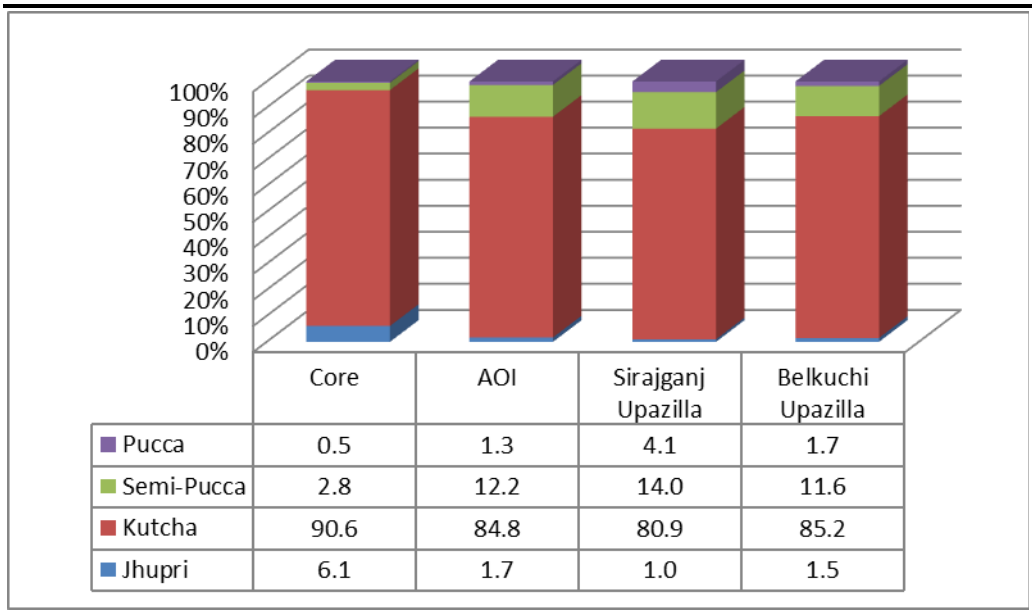
Land ownership pattern for a total of 179964.02 hectares in Sirajganj District suggests that out of the total land holding, 21.85% is controlled by the landless cultivators and agricultural labourers, 22.41% marginal farmers, 32.37% small farmers, 17.58% intermediate farmers, and 5.79% large farmers. The total cultivable land per head of the population as per the 2001 census figure has been estimated at only 0.07 hectare.

As per the census data, majority of the population within the AOI lives in *kuchcha* structures. The material used for construction of houses includes mud, bamboo, home baked bricks or tin sheets. Tin sheets are the most commonly used material especially those living closer to the river bank as it allows the household to dismantle the structure quickly in case of flooding during monsoons and relocate and reconstruct their homes at higher grounds. The situation is similar in the rest of the study area where 84% of the houses are

(1) [1] Figure subjected to change

kutcha The ***Figure 5.10*** indicates the housing structures within the AOI. It can be observed from the above graph that the total pucca and semi-pucca houses within the AOI are relatively less in comparison to kuchcha houses.

Figure 5.10 Type of Housing Structure in Core, AOI and Upazillas.

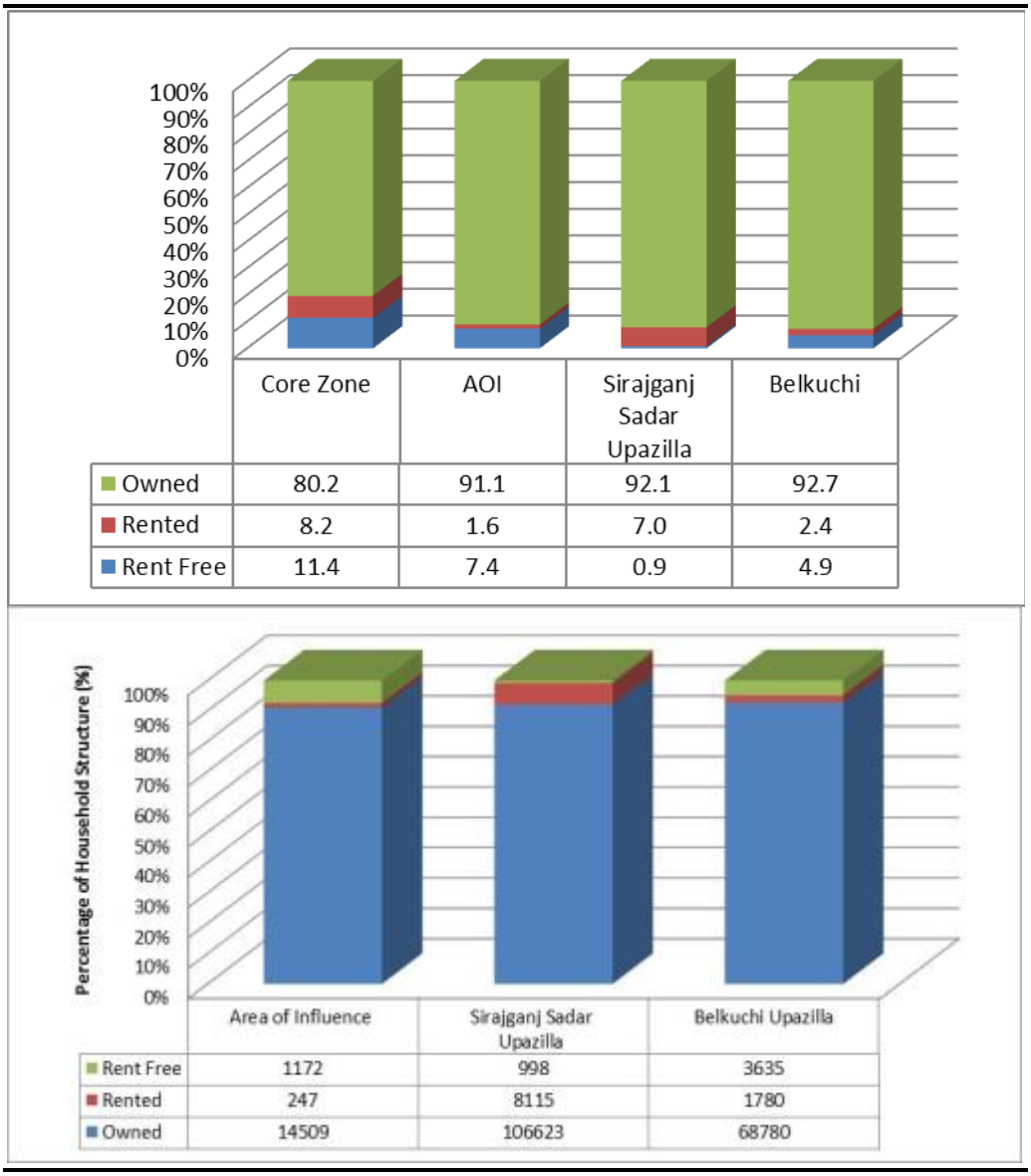


	Core	AOI	Sirajganj Upazilla	Belkuchi Upazilla
Pucca	0.5	1.3	4.1	1.7
Semi-Pucca	2.8	12.2	14.0	11.6
Kutcha	90.6	84.8	80.9	85.2
Jhupri	6.1	1.7	1.0	1.5

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

With respect to ownership pattern within the AOI, the majority of the houses are self-owned in comparison to houses being rented out or under rent-free occupation. The ***Figure 5.11*** indicates the ownership pattern amongst households within the AOI.

Figure 5.11 Property ownership



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

5.5.2 *Employment and Local Enterprises*

It can be observed from (Economic Census 2001 & 2003 Sirajganj District n.d.) data that the majority of the population within Sirajganj District are employed in the manufacturing sector with over 201052 persons engaged in over 22867 establishments. The manufacturing sector in Sirajganj primarily comprises of handlooms, textile mills, jute mills, cement factory, manufacturing of food and agro based products, and handicrafts amongst others (refer Table 41.445). Also, the population observed to be in manufacturing were primarily from the rural areas as compared to urban sections. The manufacturing industries also contribute significantly to export demand for products such as Jute products, molasses, flour, cotton sarees, and lungi, amongst others.

The next sector that employed the most personnel was the wholesale and retail trade with over 91069 persons employed in over 42817 establishments.

This primarily includes local produce sellers and vendors, commodity traders, retails shops and establishments, exporters amongst others. Here again, the majority of the population employed came from the rural clusters.

Table 5.13 Sectors of Employment in Sirajganj District

Type of Employment	Establishments	Persons Engaged					Average Establishment size
		Total	Male	Female	Urban	Rural	
Mining and Quarrying	0	0	0	0	0	0	0
Manufacturing	22867	201052	152394	48658	11194	189858	8.8
Electricity, gas and water supply	15	384	378	6	7	377	25.6
Construction	45	576	574	2	203	373	12.8
Wholesale and retail trade	42817	91069	88330	2739	23001	68068	2.1
Hotels and restaurants	2443	7253	7103	150	2528	4725	3
Transport, storage and communication	2232	4365	4162	203	755	3610	2
Bank, insurance and financial institution	315	3207	2396	811	1959	1248	10.2
Real estate and renting	483	1179	1160	19	598	581	2.4
Public administration and defence	360	3421	3131	290	2698	723	9.5
Education	3073	17794	15353	2441	2057	15737	5.8
Health and Social works	964	3050	2573	477	1101	1949	3.2
Community, social and personal services	8435	17013	15139	1874	3240	13773	2
Total	**84049**	**350363**	**292693**	**57670**	**49341**	**301022**	**4.2**

Source: Economic census of Sirajganj 2003

The Bangladesh economy has grown at the rate of 6 to 7% per annum in the last few years. More than half of the GDP is generated by the service sector, while merely half of the total population is employed in the agricultural sector.

According to the Economic Census 2003 for Sirajganj District, most of the manufactured material (81.2%) meets the local demand with only about 0.8% being exported. It is significant to note that the textile export in Bangladesh over past years has shown significant growth. However, the contribution of Sirajganj District to textile exports is limited. Hence, the Government of Bangladesh is developing a Special Export Zone (SEZ) close to the Saidabad Power Generation Complex to provide better access to international textile markets and optimize the regional potential of the existing textile sector in Sirajganj.

According to the (Economic Census 2001 & 2003 Sirajganj District n.d.), 22.9% of the total establishments catering to the various economic activities within Sirajganj District are established in household based premises. Out of these, over 12.5% of the industries are from the manufacturing category followed by wholesale and retail trade. The household industries in this district primarily includes home based handlooms, weaving bamboo and cane work jute and jute goods, goldsmiths, handicrafts, blacksmiths, potteries, wood works, mat

and pati making. Most of the produce is either sold in the local market or exported out to the neighbouring district of Tangail or as far as Dhaka.

The micro establishments mostly constitute of the household level enterprises while the macro establishments are larger human capital engaging enterprises. The table below provides an overview of the macro and micro level establishments within Sirajganj District.

Table 5.14 Macro and Micro level establishments within Sirajganj District

Type of Establishment	Total Micro Permanent Establishments	Macro Permanent Establishment			
		Total	Small	Medium	Large
Mining and Quarrying	0	0	0	0	0
Manufacturing	8626	85403	63900	7795	13708
Electricity, gas and water supply	12	322	15	93	214
Construction	15	475	45	68	362
Wholesale and retail trade	31428	1420	1420	0	0
Hotels and restaurants	1928	238	238	0	0
Transport, storage and communication	801	106	106	0	0
Bank, insurance and financial institution	194	1456	1401	55	0
Real estate and renting	427	0	0	0	0
Public administration and defence	267	2072	1641	211	220
Education	2524	8010	7523	487	0
Health and Social works	824	1009	419	152	438
Community, social and personal services	6613	638	637	0	0
Sirajganj District	53659	101149	77346	8861	14942

Source: (Economic Census 2001 & 2003 Sirajganj District n.d.)

It is again evident from the above table that manufacturing alone is the most significant and primary employment activity followed widely across Sirajganj District. In Saidabad Union, it was noticed that household based industries particularly the handloom sector is an important avenue for employment and income for people. Many of them also reported to work in the wholesale trading companies operating from Sirajganj Sadar. The trend for going abroad to work as wage labours is also reported to be a popular option for the youths.

Box 5.5 Proposed Industrial Park in Sirajganj Sadar

In order to bolster the local economy of Sirajganj, an industrial park close to the Bangabandhu Bridge is being proposed by the Government of Bangladesh. The industrial park would be spread over an area of over 400 acres and would come along the banks of river Jamuna. The park will primarily house chemical based dye manufacturers as well as agro based packaging and retailing industries. The output from these industries would be primarily catered to the growing textile and agro related export market which is a major source of foreign exchange for the Bangladesh Government.

Source: Stakeholder Consultation

5.5.3 *Access to Finance*

According to the Central Bank of Bangladesh[1], the financial system prevalent within the country is comprised of three broad fragmented sectors, i.e. formal, semi-formal, and informal sector. Access to various financial sectors in Sirajganj District varies in urban and rural clusters. Based on discussion with the individual stakeholders such as MMS, BRAC, Department of Social Welfare, as well as the overall community within the AOI, it was reported that, the formal and the semi-formal sectors mostly catered to the urban populations within the paurasavas, wards and municipalities, etc. while the semi-formal and most of the informal sectors catered to the financial requirements of the rural population. Some of the key microfinance agencies and NGOs that represent the semi-formal agencies within the AOI include MMS, Grameen Bank, BRAC, and Buro Bangla amongst others.

Box 5.6 Overview of Grameen Bank, one of the largest microfinance institutions of Bangladesh

The *Grameen Bank* is a Nobel Peace Prize winning microfinance organization and community development bank started in Bangladesh that makes small loans (known as microcredit or "*grameen* credit") to the impoverished without requiring collateral. The name *Grameen* is derived from the word "*gram*" which means "rural" or "village" in the Bengali language.

The system of this bank is based on the idea that the poor have skills that are under-utilized. A group-based credit approach is applied which utilizes the peer-pressure within the group to ensure the borrowers follow through and use caution in conducting their financial affairs with strict discipline, ensuring repayment eventually and allowing the borrowers to develop good credit standing. The bank also accepts deposits, provides other services, and runs several development-oriented businesses including fabric, telephone and energy companies. Another distinctive feature of the bank's credit program is that the overwhelming majority (98%) of its borrowers are women

Source: http://www.grameen-info.org/

5.6 *PHYSICAL CAPITAL: DEVELOPMENT INFRASTRUCTURE*

5.6.1 *Health Service Infrastructure*

The primary centres for immediate medical assistance in Sirajganj are the private or government clinics and the health complex located at the upazilla and the union levels respectively. However, these clinics and health complexes are mostly for diagnosis of minor medical conditions and are not equipped to handle any serious medical conditions or surgical procedures. Assistance in those regards is provided at either district level hospital or private hospitals.

[1] Bangladesh Bank (http://www.bb.org.bd/fnansys/index.php)

Table 5.15 provides an overview of the medical and healthcare infrastructure within Sirajganj District as per the 2007 statistics of the Bangladesh Bureau of Statistics.

Table 5.15 Healthcare Infrastructure Statistics for Sirajganj District

Healthcare Facility	Doctors	Nurses	Total Number of Beds
Clinics	18	32	48
Family Welfare Centre	27	370	7
Primary Health Centres	5	5	0
Maternity Centres	5	11	28
Hospitals	98	222	372

Source: http://www.bbs.gov.bd/RptZillaProfile.aspx

The following ***Table 5.16*** provides an overview of the healthcare infrastructure within Sirajganj Sadar as per 2007 statistics.

Table 5.16 Healthcare Infrastructure Statistics for Sirajganj Sadar

Healthcare Facility	Doctors	Nurses	Total Number of Beds
Clinics	13	28	38
Family Welfare Centre	7	10	7
Primary Health Centres	5	5	0
Maternity Centres	1	5	10
Hospitals	52	73	141

Source: http://www.bbs.gov.bd/RptZillaProfile.aspx

However, the situation was observed to be very poor in Belkuchi Upazilla with only nine (9) doctors, forty nine (49) nurses available catering to a mere 31 beds.

It can be observed from the above statistics that the healthcare services within the district with respect to infrastructure and access is limited. Based on these available statistics, there is only one clinic or hospital bed for every 7,375 persons in context of the entire district. The situation is better within Sirajganj Sadar with one bed for every 3,101 persons. However, it is worse for Belkuchi with one bed for every 11,382 persons.

5.6.2 Roads and Transport

Roads

Sirajganj District has a total road network of 2808 km. Out of this the total pucca network or concreted road with bituminous top is for 324 km, the total semi-pucca or only concreted road is for 91 km and kuchcha or mud road is 2393 km.

The internal roads within the AOI are primarily kuchcha in nature. The major road closest to the project site is the national highway number 405 connecting Dhaka to Rajshahi which is located approximately 1.4kms towards North.

The total navigable waterway that has been estimated within Sirajganj District is 175 nautical miles. The waterway is primarily used by small trawlers, transportation boats and ferries. Due to frequent siltation in the Jamuna River during the dry season, the waterway is not used by larger ships or boats in and around Sirajganj District.

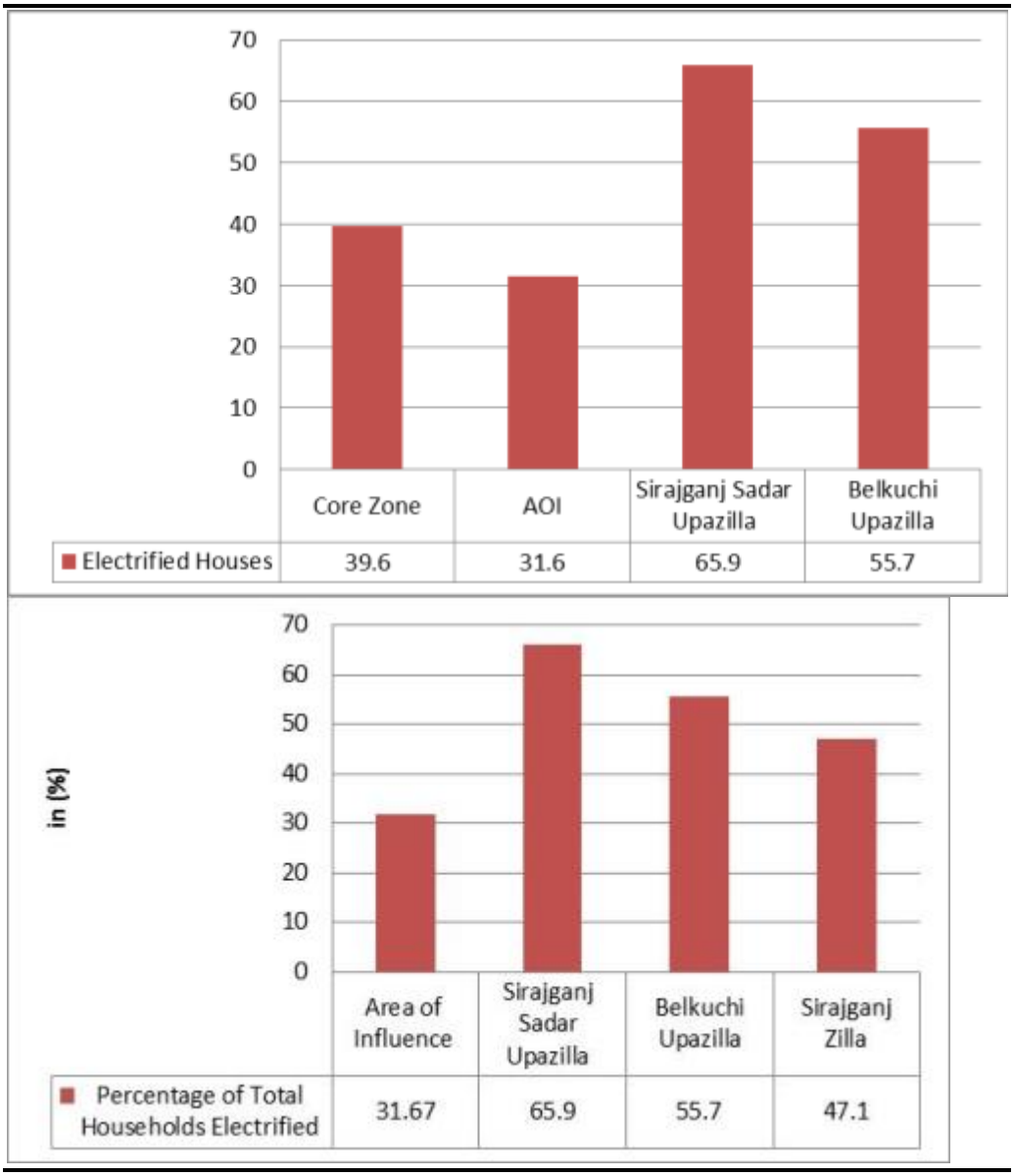
There are a total of three (3) railway stations and the busiest station is Sirajganj Sadar. The closest railway station to the project site is the ***Bangabandhu West*** railway station located at an approximate distance of 1.4km. The station will be utilized for project related transportation purposes.

5.6.3 Electricity

Based on stakeholder consultation with the local community within the AOI, it was reported that although a power plant complex has been established within the area and is functional, access to electricity was still a major problem. This observation was also supported by the census information which indicates that only about 31.67% of the total households within the AOI have access to power. However, the scenario is better in Sirajganj Sadar or Belkuchi Upazilla level. The access to power within Sirajganj Sadar and Belkuchi were observed to be 65.9% and 55.7% of households respectively.

The following ***Figure 5.12*** shows the percentage of households electrified within the various locations.

Figure 5.12 Household level electrification



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

Overall, if one observes the overall electrification scenario within the entire district, it may be inferred to be very low with only 47.1% of the total households having any form of access to electricity. In the core zone and overall AOI, less than 40% of the houses are electrified.

The lower percentage of electrification indicates reliance on other sources of energy to meet the domestic demand for heat and lighting. It also can be taken as a proxy indicator for quality of life of most of the people as lack of electricity impedes use of modern equipment.

5.6.4 Education

Table 5.17 provides an overview of the educational institutions available within Sirajganj District. It also provides data on the educational institutions within Sirajganj Sadar Upazilla[1].

Table 5.17 Educational Institutions within Sirajganj District

Educational Institutions	Total Number in Sirajganj District	Total Number in Sirajganj Sadar Upazilla
Government Primary Schools	880	151
Non-Government Primary Schools	503	5
Junior High Schools	43	
Government High Schools	3	2
Non-Government High Schools	245	61
Madrasas	249	26
Community Schools	2	
Kindergartens	2	
Government Colleges	5	3
Non- Government Colleges	75	14

Source: Banglapedia

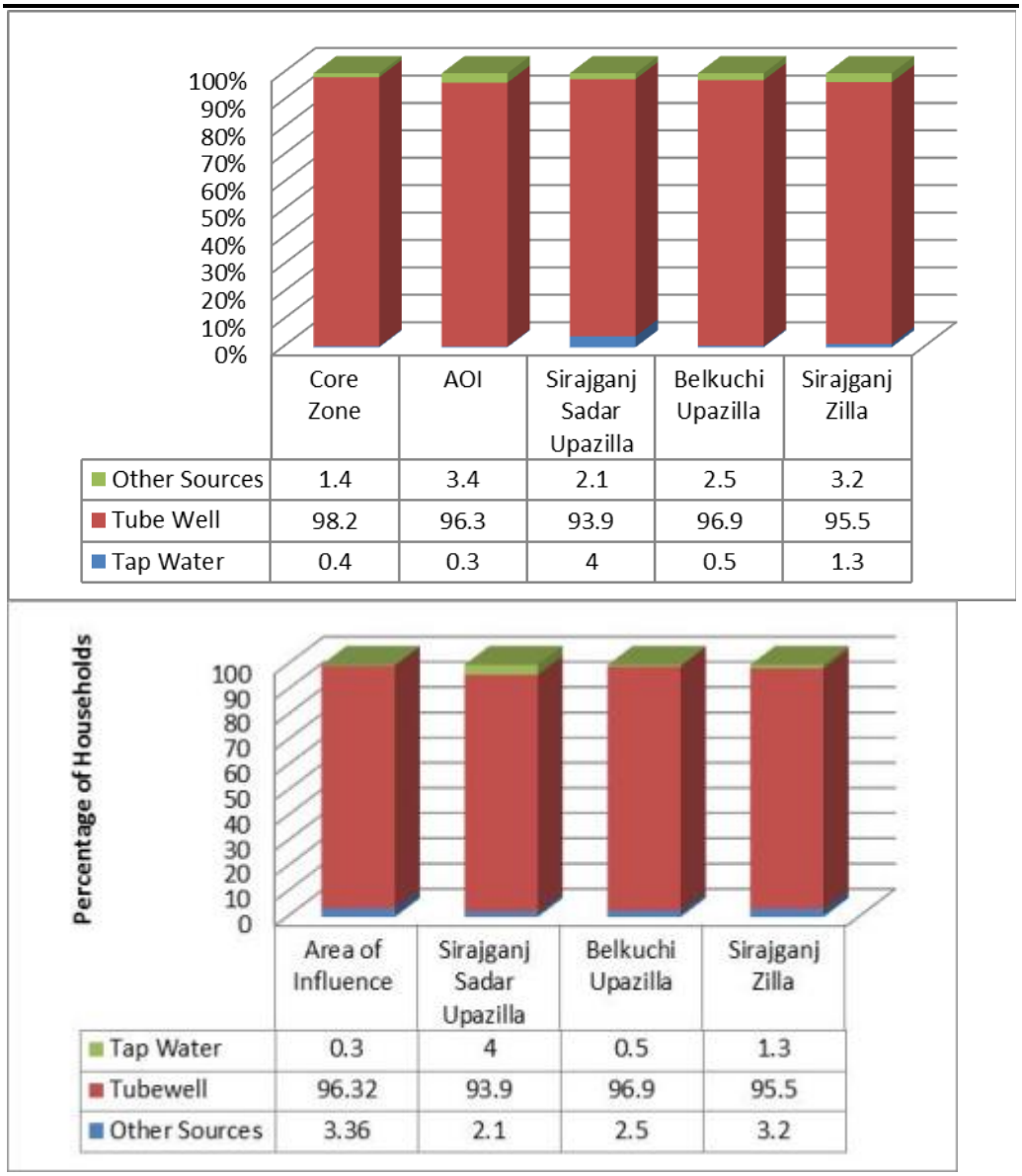
Some of the noted educational institutions within the district are the Islamia College (formerly Senior Madrasa (dated 1887), Gayanadayeni High School (1884), BL High School (1869), Sirajganj Government University College (1940), Pakrashi Primary School (1856, Chauhali), and Ullahpata Merchants Pilot Multilateral High School (1906) amongst others.

5.6.5 Water Supply Infrastructure

The primary source of water used for drinking and sustaining household level domestic water is tube wells. More than 95% of the total households within the district are dependent on tube wells for their water consumption or usage. Tap water usage was observed to be relatively high only within Sirajganj Sadar and mostly restricted to paurasavas or urban areas. Other sources of water that were used by a minority include river (primarily used by char dwellers), pond and riverine within the inland areas.

[1] Data for Belkuchi Upazilla was not available

Figure 5.13 Distribution of Households (%) by source of drinking water



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

In Saidabad Union, the tube well water is primarily used for drinking water for most other domestic purposes such as cattle washing, clothes and utensil washing etc. is sourced from tube well water or nearby surface water.

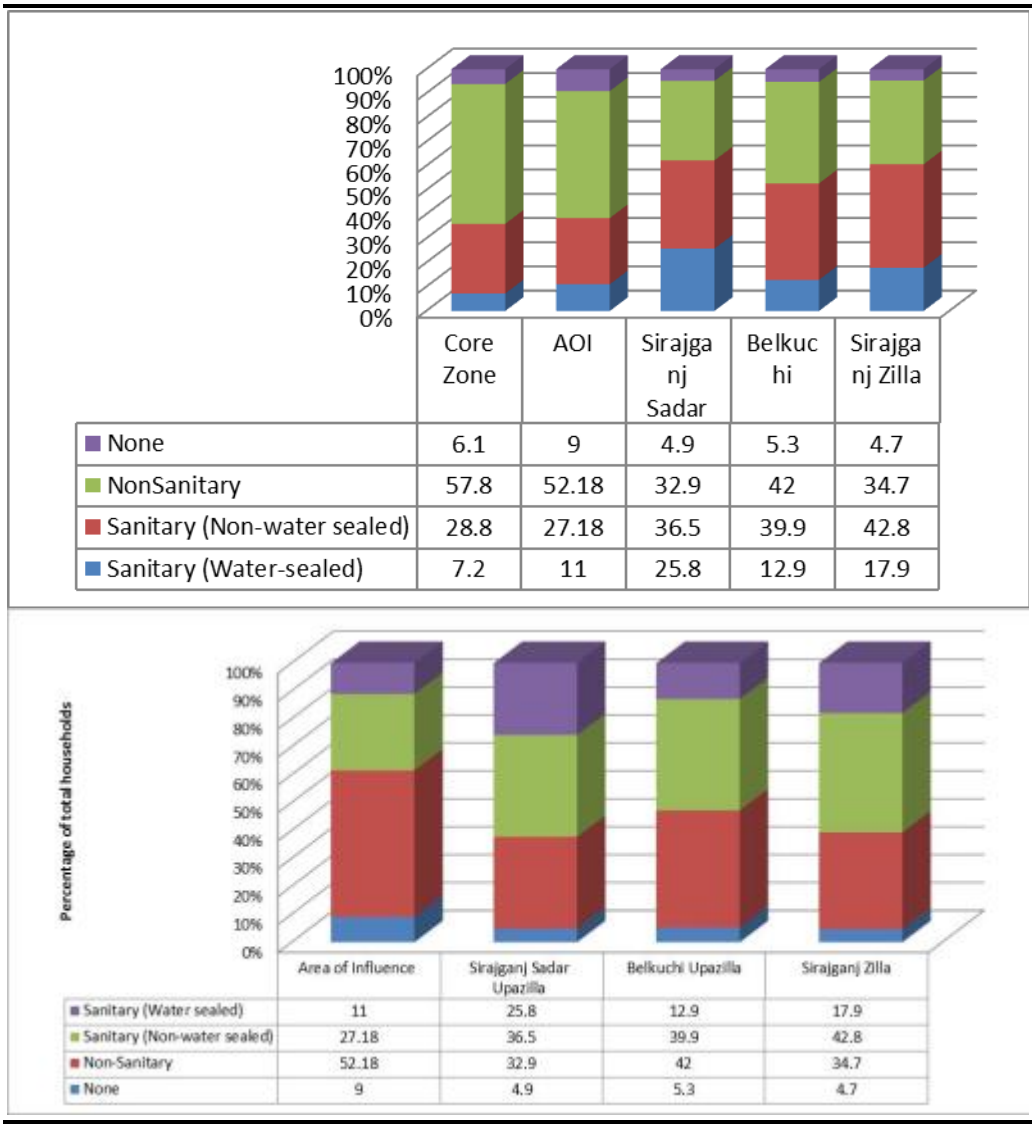
According to census data (Agriculture Census 2008 for Sirajganj District n.d.), apart from rain-fed irrigation, the primary sources of irrigation in Sirajganj has been identified as deep tube wells, shallow tube wells and power driven pump irrigation.

5.6.6 Sanitation and Waste Management

According to the census information, the sanitation facilities within the AOI comprises mostly of pit latrines with dry disposal without any sanitary hardware. The pit latrine facility was observed to be prevalent in more than 50% of the households. A smaller fraction of the households were observed to

be using sanitary hardware without any water based flushing. Proper sanitation facilities with water sealed latrines were observed only in 11% of the households, mostly within urban clusters and municipalities. Open defecation or absence of any form of sanitation facilities was observed in 9% of the households. Graphical representation of distribution of sanitation facilities is shown in ***Figure 5.14***.

Figure 5.14 Distribution of Households according to the type of sanitation facilities used



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

The trend is similar when compared to that of the district, with more than 77.5% of the population being dependant on the dry pit latrines or sanitary hardware without water based disposal system. Only 17.9% of the total population has access to proper latrine systems.

6 IMPACT ASSESSMENT & MITIGATION/ENHANCEMENT MEASURES

6.1 INTRODUCTION

This section assesses the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. This has been organized as per the various stages of the project lifecycle to understand the risks and impacts associated with each of these individual stages.

The Project does not envisage any significant environmental/ social impact in the pre-construction phase, which primarily involves feasibility study and possession of land for development of the power plant, as there is no land acquisition and resettlement involved, which is typically the social issue in pre-construction phase. Hence, the environmental and social impacts due to the Project activities are considered in three distinct stages of the Project life cycle: (a) construction of the Plant (Construction Phase); (b) operation and maintenance of the Plant (Operation Phase) and (c) closure of the Plant (Decommissioning Phase) [1].

6.2 SCOPE OF THE ASSESSMENT

The scope of the assessment captures the understanding on 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.

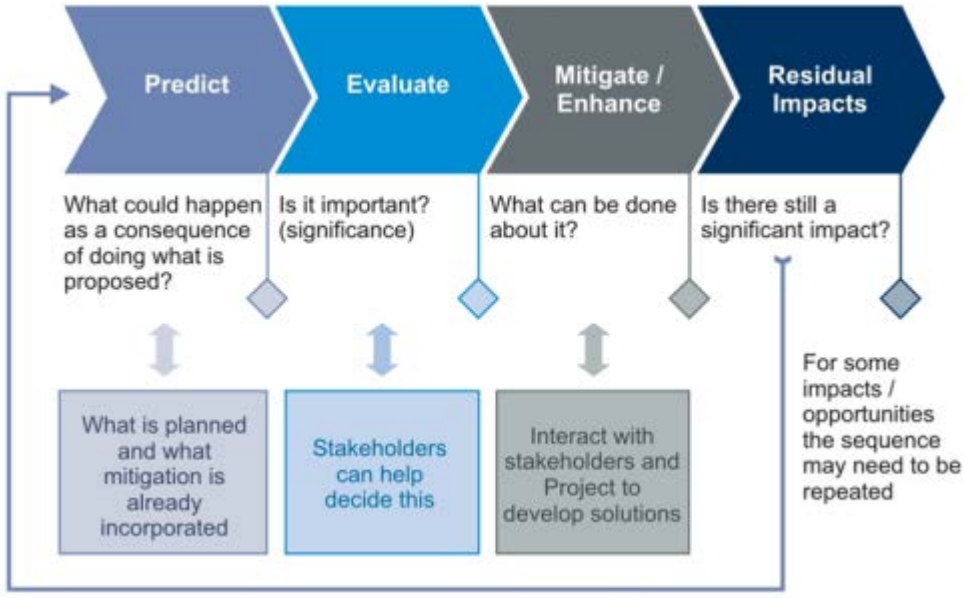
6.3 ASSESSMENT METHODOLOGY

Impact identification and assessment starts with scoping and continues through the remainder of the IA Process. The principal IA steps are summarized in Figure 6.1 and comprises of:

[1] Environmental and social impacts during decommissioning of the Plant have not been considered in the impact assessment, as these will depend on the options available at the time of expiry of the power purchase agreement between Sembcorp and BPDB/NWPGCL. The design life of the power plant is estimated to be 30 years, which is almost 8 years longer than the Power Purchase Agreement term. If the Power Purchase Agreement, Land Lease 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 that the required retrofits and new emission rates meet the applicable standards and guidelines. If retrofitting is not a feasible option, 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.

- **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 measures.

Figure 6.1 Impact Assessment Process



Prediction of Impacts

Prediction of impacts was carried out with an objective to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors were elaborated and evaluated.

Evaluation of Impacts

Each impact was described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The terminology used to describe impact characteristics is shown in Table 6.1**.**

Table 6.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect)	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.)	Local National Global
Duration	The time period over which a resource/ receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value or a qualitative description of "intensity"]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

The definitions for the *type* designations are given in Table 6.2**.** Definitions for the other designations are resource/receptor-specific.

Table 6.2 Impact Type Definitions

Type	Definition
Direct	Impacts that result from a direct interaction between the Project and a resource/ receptor
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project.

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains only to unplanned events is likelihood. The likelihood of an unplanned event occurring was designated using a qualitative scale, as described in Table 6.3**.**

Table 6.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions (probability less than 20%)
Possible	The event is likely to occur at some time during normal operating conditions (probability greater than 20% and less than 50%)
Likely	The event will occur during normal operating conditions (probability greater than 50% and less than 90%)
Certainly	Greater than 90%

Once an impact's characteristics were defined, each impact was assigned a 'magnitude'. Magnitude is typically a function of a combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent
- Duration
- Scale
- Frequency

In case of unplanned events only, magnitude incorporates the 'likelihood' factor discussed above.

Magnitude essentially describes the intensity of the change that was predicted to occur in the resource/receptor as a result of the impact. As discussed above, the magnitude designations themselves are universally consistent, but the descriptions for these designations vary on a resource/receptor-by-resource/receptor basis. The universal magnitude designations are:

- Positive
- Negligible
- Small
- Medium
- Large

In the case of a positive impact, no magnitude designation (aside from 'positive') was assigned. It was considered sufficient for the purpose of the IA to indicate that the Project was expected to result in a positive impact, without characterising the exact degree of positive change likely to occur.

In the case of impacts resulting from unplanned events, the same resource/ receptor-specific approach to concluding a magnitude designation was followed, but the 'likelihood' factor was considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step was definition of the sensitivity/ vulnerability/ importance of the impacted resource/receptor. There are a range of factors that was taken into account when defining the sensitivity/ vulnerability/ importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors were also considered when characterising sensitivity/ vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value. The sensitivity/ vulnerability/importance designations used herein for all resources/receptors are:

- Low
- Medium
- High

Once magnitude of impact and sensitivity/ vulnerability/ importance of resource/ receptor have been characterised, the significance was assigned for each impact. Impact significance is designated using the matrix shown in Figure 6.2.

Figure 6.2 Impact Significance

		Sensitivity/Vulnerability/importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/ vulnerability/ importance designations that enter into the matrix. ***Box 5.1*** provides a context of what the various impact significance ratings imply.

Box 6.1 Context of Impact Significances

An impact of **negligible** significance is one where a resource/ receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/ receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards/ guidelines.

An impact of **moderate** significance has an impact magnitude that is within applicable standards/guidelines, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

It is important to note that impact prediction and evaluation takes into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the IA Process).

Identification of Mitigation and Enhancement Measures

Once the significance of an impact has been characterised, the next step was to evaluate what mitigation and enhancement measures are warranted. For the purposes of this IA, ERM adopted the following Mitigation Hierarchy:

- **Avoid at Source, Reduce at Source:** avoiding or reducing at source through the design of the Project.
- **Abate on Site:** add something to the design to abate the impact.
- **Abate at Receptor:** if an impact cannot be abated on-site then control measures can be implemented off-site.
- **Repair or Remedy:** some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, work camps or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures.
- **Compensate in Kind, Compensate Through Other Means:** where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries, access, recreation and amenity space).

The priority in mitigation was to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Management and Monitoring

The final stage in the IA Process was the definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards/ guidelines; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted. This is covered in ***Chapter 9*** under environmental and social management plan (ESMP)

An activity – impact interaction matrix for construction and operation phases of the Project is presented in Table 6.4, which has been further used to assess the impact significance at activity levels on environmental, ecological and social resources**.**

Table 6.4 Activity-Impact Interaction Matrix for Construction and Operation Phases of the Project

Project Activity/ Hazards	Environmental Resources													Social Resources								
	Land Forms/ Profile	Soil/ Sediment Quality	Land Use	Air Quality	Climate Change	Drainage Pattern	Surface Water Quantity/Quality	Ground Water Quality	Ambient Noise Levels	Vibration	Occupational Health & Safety	Terrestrial Ecology	Aquatic Flora/ Fauna (Biodiversity)	Demographics (i.e. Displacement)	Economy & Livelihoods	Social & Cultural Structures	Land Use (Inc. Economic Displacement)	Infrastructure & Services	Cultural Resources	Community Health & Safety	Vulnerable Groups	Social/ Community Cohesion
Construction Phase																						
Site Clearing/ Levelling		▒		▒		▒			▒			▒										
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		▒				▒																
Operation Phase																						
Air emissions from stacks of the plant				■							▒									▒		

Project Activity/ Hazards	Environmental Resources													Social Resources								
	Land Forms/ Profile	Soil/ Sediment Quality	Land Use	Air Quality	Climate Change	Drainage Pattern	Surface Water Quantity/Quality	Ground Water Quality	Ambient Noise Levels	Vibration	Occupational Health & Safety	Terrestrial Ecology	Aquatic Flora/ Fauna (Biodiversity)	Demographics (i.e. Displacement)	Economy & Livelihoods	Social & Cultural Structures	Land Use (Inc. Economic Displacement)	Infrastructure & Services	Cultural Resources	Community Health & Safety	Vulnerable Groups	Social/ Community Cohesion
GHG emissions					■										■					■		
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																				■		
HSD transportation by pipeline		■						■			■									■		
Transportation of personnel, raw material/s and disposal of wastes																				■		
Employment															■							
Operation of Sirajganj 1, 2, 3 and 4 Projects (Cumulative)																						
Water Demand for plant operations							■	■					■		■							
Wastewater discharge/ disposal							■	■							■					■		
Air emissions from stacks of the plants				■							■									■		
GHG emissions					■										■					■		
Noise generation due to operation of plants and auxiliaries									■	■	■											

= Represents "no" interactions is reasonably expected
= Represents interactions reasonably possible but none of the outcomes will lead to significant impact
= Represents interactions reasonably possible where any of the outcomes may lead to potential significant impact

6.4 ASSESSMENT OF ENVIRONMENTAL IMPACTS - CONSTRUCTION PHASE

Construction of the power plant will be carried out by the construction contractor appointed by Sembcorp. The construction phase for the Project will comprise of primarily two distinct phases: (a) civil construction work that would require a minimum of one year for completion; and (b) mechanical and electrical work for Plant commissioning. The entire construction phase is expected to continue for 30 months. The approximate number of workers for both civil and mechanical works is expected to be around 1500 (during peak construction). The workers will be sourced both locally as well as from outside. A summary of the activities with the potential to cause impacts to the surrounding environment and human receptors is presented below.

- **Site preparation**: include clearance of vegetation and site levelling.
- **Civil work for power plant:** Construction of Lay down areas and construction workers camp (outside the power generation complex), internal roads, site drainage, excavation for foundations work, buildings, etc.;
- **Construction of a temporary jetty:** to receive heavy power plant equipment;
- **Procurement and transportation of power plant equipment:** will include Transportation of construction materials, construction machinery and equipment for the power plant through the existing access road and the temporary jetty via Jamuna River ;
- **Installation of power plant equipment:** will include installation of GTG, HRSG, STG, cooling tower, transformer, switch yard, etc.
- **Installation of gas pipeline:** 1.5 km long gas pipeline will be constructed from the GTCL value station to the site.
- **Installation of water pipeline:** about 2.0 km long raw water pipeline from River Jamuna to the project site.
- **Construction of on-site and off-site work facilities:** including site office, sanitation and labour accommodation

6.4.1 *Soil and Sediment Quality*

Potential sources of impacts to soil and sediment quality due to the construction phase activities include:

- Clearance of vegetation from the project site and ancillary areas within the power generation complex and laydown areas outside the power generation complex;
- Civil work activities;
- Transportation of construction material, equipment and personnel;
- Storage of construction materials including hazardous material;
- Storage, handling and disposal of wastes generated from site clearance, site excavation and formation, civil works and activities of construction workers (general waste and sewage).
- Erection of Power Plant Building

Criteria

For the assessment of soil and sediment quality, the sensitivity and magnitude criteria outlined in ***Table 6.5*** and ***Table 6.6***, respectively have been used.

Table 6.5 Sensitivity Assessment Criteria for Soil and Sediment quality (compaction, erosion and contamination) and Landuse

Sensitivity Criteria	Contributing Criteria	
	Environment	*Social*
Soil and sediment Quality related criteria as compaction, erosion and contamination and Landuse change	The extent to which the soil and sediment quality plays an ecosystem role in terms of supporting biodiversity. This includes its role as in supporting a lifecycle stage	The extent to which the soil and sediment quality provides a use (agricultural use, fishing) to the local communities and businesses, or is important in terms of national resource protection objectives, targets and legislation
Low	• The soil quality does not support diverse habitat or populations and/or supports habitat or population of low quality. • The sediment quality does not support diverse aquatic habitat or populations and and/or supports aquatic habitat or population of low quality.	• The soil and sediment quality has little or no role in provisioning of services as agricultural uses for the local community.
	• Designated area, No change or negligible Change from designated Landuse. • Minor Visual Change.	• Landuse not of relevant use by Community.
Medium	• The soil quality supports diverse habitat or population of flora and fauna and supports habitats commonly available in the Project AoI. • The sediment quality does not support diverse aquatic habitat and supports habitats commonly available in the Jamuna river across the Project AoI.	• The soil and sediment has local importance in terms of provisioning services as agricultural services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality i.e. ready availability across the AoI.
	• Perceived change from designated landuse. • Visual Change but common feature in Project AoI.	• Landuse of important local use by communities.
High	• The soil quality supports economically important or biologically unique species or provides essential habitat for such species. • The sediment quality supports economically important or biologically unique aquatic species or provides essential habitat for such species.	• The soil and sediment is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional level for provisioning services.

	• Major change in Landuse. • Visual Change aesthetically affecting locals.	• Landuse of regional importance. Change would impact Landuse classification of the area.

Table 6.6 Criteria for Impact Magnitude for Assessment of Impact to Soil and Sediment Quality and Landuse

Magnitude Criteria	Negligible	Small	medium	Large
Soil compaction and erosion	• Qualitative-No perceptible or readily measurable change from baseline conditions • Scale-Localized area as Particular activity areas • Time-Short duration (few days) or one time as temporary	• Perceptible change from baseline conditions but likely to easily revert back to earlier stage with mitigation • Scale- -Project site, activity areas and immediate vicinity not impacting any sensitive receptor • Sort term-Only during particular activities or phase of the project lifecycle as civil works or construction phase (few months)	• Clearly evident (e.g. perceptible and readily measurable) change from baseline conditions and/or likely take time to revert back to earlier stage with mitigation • Scale- Project site, activity areas and immediate vicinity impacting sensitive receptor/s • Long term-Spread across several phases of the project lifecycle (few years)	• Major (e.g. order of magnitude) change in comparison to baseline conditions and/or likely difficult or may not to revert back to earlier stage with mitigation • Scale- Regional or international; • Permanent change
Soil and sediment contamination	Well within Dutch standard[1] (refer Section 2.9 for Dutch guidelines)	Well within Dutch standard[2]	Exceeds Target Value but well within Interventional Value (Refer Table 2.11)	Exceeds Interventional Value and needs intervention. (Refer Table 2.11)

[1] Dutch Target and Intervention Values (Soil remediation Circular 2009-2012 Revision), https://zoek.officielebekendmakingen.nl/stcrt-2012-6563.pdf.
The assessment of potential impacts to soil and sediment has been considered as per the Dutch Standard as Bangladesh does not have any local standards for soil or sediment quality.

[2] Dutch Target and Intervention Values (Soil remediation Circular 2009-2012 Revision), https://zoek.officielebekendmakingen.nl/stcrt-2012-6563.pdf.
The assessment of potential impacts to soil and sediment has been considered as per the Dutch Standard as Bangladesh does not have any local standards for soil or sediment quality.

Magnitude Criteria	Negligible	Small	medium	Large
Land use	No change	Temporary	Permanent but no visual and use impact	Permanent with visual and use impact

Receptors

The analysis of soil and sediment sampling in the Project area indicate that the soils are mainly sandy loam to silty clay loam and sediments from the Jamuna River were of the silty clay loam type. Soil samples were found to be slightly alkaline in nature (i.e. pH between 7.31 and 7.8) while the pH of sediment samples from Jamuna River was found to be neutral.

The soil at the project site contains sand depositions from the Jamuna River used for filling. It does not support any diverse habitat or species and agricultural activities. Furthermore, soil of the areas identified for laydown, construction workers camp, temporary jetty and water and gas pipeline and pump house are also not having any agricultural activities. The same was observed with the sediment and hence soil and sediment was considered as low under sensitivity assessment criteria.

Impact Significance

Soil Compaction

The Project site contains sand depositions from the Jamuna River used for filling to raise the height of the entire Saidabad Power Generation Complex above the highest flood level recorded. However soil outside the project site will be compacted during the establishment of laydown areas, gas pipeline and installation of equipment to ensure soil stability. Movement of heavy vehicles and heavy construction machinery will also cause soil compaction however a permanent access road to the Project site is already in place and being used by the existing NWPGCL power plant. Soil compaction and possible damage to the soil structure due to heavy vehicular movement will only be limited to the vicinity of temporary jetty, gas pipeline route, water pipeline route and Project site. The pipeline routes are not involving any agricultural activities and are part of the government non-agricultural khas land or BBA land. The area identified for temporary jetty was already being used in the past by NWPGCL for unloading and transportation of heavy lifts during the commissioning of Sirajganj 1 (225 MW) power plant, located with the same complex and there is an existing road of BBA, which connects this jetty location to the national highway. Based on the impact magnitude assessment criteria as given in ***Table 6.6*** the impact was assessed as **negligible.**

Impact	*Soil Compaction*			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent

Impact Extent	Local		Regional		International
Impact Scale	Limited to Project Site, gas and water pipeline RoW and temporary jetty site vicinity as well as areas identified for laydown and construction workers camp. Approach road and access to temporary jetty location, GTCL valve station and water intake location already exist.				
Frequency	Primarily during Civil work				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium		High
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Soil erosion

The project AOI is prone to soil erosion due to nature of soil enhanced by heavy rains and flooding in the area. As mentioned earlier, the project site within the power complex is already raised and compacted with filled sand. This is also having embankment for safety from flood induced erosion. However soil erosion may occur in vicinity of the temporary jetty, during the laying of gas pipeline, water pipeline and laydown areas due to clearance activities, transportation of materials and excavation. Soil erosion will typically be worse during the monsoon months however no construction activities will be taking place during this period. Further it will be proposed in the specification manual for EPC contractors that:

- All areas of excavation will be closed and compacted before the monsoon season to prevent soil erosion.
- Storm water is properly channelized to settling tanks for controlling soil erosion.

Based on the impact magnitude assessment criteria as given in ***Table 6.6*** the impact was assessed as **negligible.**

Impact	*Soil Erosion*				
Impact Nature	Negative		Positive		Neutral
Impact Type	Direct		Indirect		Induced
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local		Regional		International
Impact Scale	Limited to gas and water pipeline RoW, temporary jetty and laydown areas vicinity.				
Frequency	Primarily during Civil work				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium		High
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Soil and Sediment Contamination (Spills and Leaks)

Soil contamination during the construction phase may result from leaks and spills of oil, lubricants, fuel from heavy equipment or leakage from

chemical/fuel storage. Sediment contamination may take place during the construction of the temporary jetty north of Bangabandhu Bridge on Jamuna River and unloading of heavy equipment. Such spills can have long-term impact on soil and sediment quality, but are expected to be localised in nature. While the risk of accidental spillage of potentially hazardous substances is low, proper handling and disposal of contaminated materials will further reduce the risk if such event does take place. The following prevention and mitigation measures will be proposed in the Specification Manual for EPC Contractors:

- The Contractor will prepare unloading and loading protocols for the temporary jetty 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

Soil and sediment samples analysis indicates that the soil/fill material at the Project site and Jamuna River 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. Loaders to be used near the temporary jetty will be checked for lubricant leaks and workers trained not to dispose of waste in the area. Liquid effluents arising from construction activities will be treated to the standards specified in *Schedule 9 and 10 of ECR, 1997 of the GOB (**Table 2.8*** and ***Table 2.9**)*;. Therefore, the likelihood of unplanned events (i.e. spills and leaks) leading to soil and sediment contamination is considered likely. Based on the impact magnitude assessment criteria as given in ***Table 6.6*** and impact has been considered as **minor.**

Impact	*Soil and Sediment contamination from spills and leaks*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Project Site and temporary jetty				
Frequency	Limited to construction Phase primarily during transportation, handling and storage of materials, waste and equipment installation				
Likelihood	Likely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Soil Contamination from Waste Handling

Soil may become contaminated due to improper handling and storage of waste. The majority of the generated wastes will be non-hazardous. General construction waste will comprise of surplus or off-specification materials such

as concrete, steel cuttings/filings, wooden planks, packaging paper or plastic, wood, plastic pipes, metals, etc. During the construction phase of the Project, solid waste generation will mainly be concrete waste and bitumen. It is estimated that approximately 100 – 150 m^3 of such waste will be produced. The inert wastes will be stored near the batching plant (which is planned to be located within the power generation complex in an area of about 2 acres to be provided by NWPGCL) and will be reused under floors or under road to increase the California Bearing Ratio (CBR)[1] value. Bitumen or any hazardous wastes will be disposed off to licensed contractors. Domestic wastes consisting of food waste, plastic, glass, aluminium cans and waste packages 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 solvents from equipment cleaning activities; and
- Spent batteries or spent acid/alkali from the maintenance of machinery on site.

If improperly managed, hazardous waste may create impacts on land. 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 100 litres per month. The construction contractor will handle, store and dispose of all waste in accordance with applicable GOB guidelines. Concrete waste of inert nature will be stored near the concrete batching plant and will be reused under floors or internal roads. Any bitumen waste will be stored separately in lined areas to be disposed-off to licensed contractors. There is a potential for direct, long-term negative impacts to soil quality from improper waste handling; however, with the implementation of the mitigation measures discussed above the impacts to soil quality as discussed in ***Table 6.6*** is assessed to be **negligible.**

Impact	*Soil Contamination from Waste Handling*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Project Site				
Frequency	Limited to construction Phase primarily during transportation, handling and storage of waste				
Likelihood	Likely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large

[1] The **California Bearing Ratio** (**CBR**) is a penetration test for evaluation of the mechanical strength of road subgrades and base courses.

Resource/ Receptor Sensitivity	Low		Medium		High	
Impact Significance	Negligible	Minor		Moderate		Major
	Significance of impact is considered **negligible.**					

Mitigation Measures

Potential impacts to soil and sediment during the construction phase are attributed to soil compaction, erosion and soil /sediment contamination from spills and leaks and wastes.

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

- 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 and
- Building small bunds in areas with slope to prevent soil erosion.

The following measures will be implemented for the storage and handling of chemicals and to minimise impacts to soil/sediment:

- Fuel tanks and chemical storage areas will be sited on sealed areas and provided with locks to prevent unauthorized entry;
- 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 percolating into the ground or reaching the receiving waters;
- The Contractor will prepare unloading and loading protocols for the temporary jetty 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; and
- The construction contractor will implement a training program to familiarise staff with emergency procedures and practices related to contamination events.

The measures in place to properly manage waste and thereby minimize any impacts to soil and sediment quality are:

- Design processes to prevent/minimise quantities of wastes generated and hazards associated with the waste generated;
- Training labourers for waste disposal in designated areas and use of sanitation facilities;

- Proper storage of the construction materials and wastes to minimise the potential damage or contamination of the materials; and
- Implementation of construction materials inventory management system to minimise 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 minimise odour 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Remark
Soil and Sediment contamination from spills and leaks			
Residual Impact	Minor	Negligible	With implementation of the precautionary and the mitigation measures mentioned for the storage and handling of chemicals and to avoid /minimise impacts to soil/sediment the residual impact would be negligible.

6.4.2 *Water Resources*

The potential sources of impact to surface and ground water resources are:

- Excavation activities at the Project site and for gas and water pipeline RoW may increase the erosion, especially during rainfall, which may increase the suspended sediment concentrations and pollute water sources. Similar impacts are possible from construction of the temporary jetty north of Bangabandhu Bridge for receiving heavy equipment;
- Sewage generated from the construction workforce (toilets). Liquid effluents will be generated from washing of construction equipment and vehicles;
- Commissioning phase testing of pipelines and wastewater generation; and
- Inappropriate storage of waste leading to water quality impacts from runoff entering the adjoining channel to the Project site or seepage to ground water.

Criteria

For the assessment of water resources, the sensitivity and magnitude criteria outlined in Table 6.7 and Table 6.8 have been used respectively.

Table 6.7: Sensitivity Assessment Criteria for Water Resources (Surface water and Ground water)

Sensitivity Criteria	Contributing Criteria	
	Environment	*Social*
Water Resources -Surface water and ground water (quality/quantity related criteria)	The extent to which the water resource plays an ecosystem or amenity role in terms of supporting biodiversity either directly or indirectly, particularly with respect to dependent ecosystems.	The extent to which the water resource provides or could provide a use (drinking water, agricultural uses, washing and other domestic or industrial, use as waterways) to the local communities and businesses, or is important in terms of national resource protection objectives, targets and legislation.
Low	The water resource does not support diverse aquatic habitat or populations, or supports aquatic habitat or population that is of low quality.	The water resource has little or no role in terms of provisioning services as agricultural water source, other domestic uses as washing, bathing, industrial use and waterways for the local community. The groundwater resource is not currently abstracted and used in the vicinity of the Project, but is of sufficient quality and yield to be used for that purpose in the future (and there is a reasonable potential for future use).
Medium	The water resource supports diverse populations of flora and / or fauna but available in the surface water bodies in the region.	The surface water resources have local importance in terms of provisioning services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality. The groundwater resource is an important water supply, and is currently used, but there is capacity and / or adequate opportunity for alternative sources of comparable quality.
High	The water resource supports economically important or biologically unique aquatic species or provides essential habitat for such species	The surface water resources are wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or transboundary watershed level for provisioning services

Sensitivity Criteria	Contributing Criteria
	The groundwater resource is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or national level for water supply or contribution to groundwater dependent ecosystems (e.g. transboundary rivers).

Table 6.8 ***Criteria for Impact Magnitude for Assessment of Impact to Surface and Ground water Resources***

Magnitude Criteria	Negligible	Small	Medium	Large
General Criteria	No perceptible or readily measurable change from baseline conditions.	Perceptible change from baseline conditions but likely to be within applicable norms and standards for mode of use.	Clearly evident (e.g. perceptible and readily measurable) change from baseline conditions and / or likely to approach and even occasionally exceed applicable norms and standards for mode of use.	Major changes in comparison to baseline conditions and / or likely to regularly or continually exceed applicable norms and standards for mode of use.
Water Quality	Discharges are expected to be well within statutory limits*	Discharges are expected to be within statutory limits*	Occasional breach(es) of statutory discharge limits (limited periods) expected*	Repeated breaches of statutory discharge limits (over extended periods) expected*
	Groundwater quality be well within ambient levels or allowable criteria** Abstractions from or discharge to aquifer(s) are unlikely to cause water quality issues.	Groundwater quality be within ambient levels or allowable criteria** or may exceed for 1-2 parameters which is common occurrence due to geological regime of the area. Abstraction or discharge to aquifer(s) may cause small but local changes in water quality in the aquifer system. These can	Groundwater quality exceeds ambient levels or allowable criteria** for key parameters. Abstraction or discharge to aquifer(s) are expected to cause potential localized effects on groundwater quality which are likely to be fairly long lasting and / or give rise to indirect ecological and /	Groundwater quality exceeds ambient levels or allowable criteria**. Abstractions or discharge to aquifer(s) are expected to cause potentially severe effects on groundwater quality which are likely to be long-lasting (e.g. years or permanent) and / or give rise to indirect ecological and /

Magnitude Criteria	Negligible	Small	Medium	Large
		be considered potential short-term localized effects on groundwater quality which is likely to return to equilibrium conditions within a short (months) timeframe.	or socio-economic impacts.	or socio-economic impacts.
Water Quantity	There is likely to be negligible (less than 1% of lean season flow) or no consumption of surface water by the Project at any time	The Project will consume surface water, but the amounts abstracted are likely to be relatively small in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)	The Project will consume surface water, and the amounts abstracted are likely to be significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)	The Project will consume surface water, and the amounts abstracted are likely to be very significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)
	There is likely to be negligible or no abstraction, use of or discharge to the groundwater by the Project at any time.	The Project will consume groundwater or deliver discharge to groundwater, but the amounts abstracted / discharged are likely to be relatively small in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation).	The Project will consume groundwater or discharge to groundwater, and the amounts abstracted / discharged are likely to be significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation).	The Project will consume groundwater or discharge to groundwater, and the amounts abstracted / discharged are likely to be very significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation).

*The quality assessment of potential impacts to surface water has considered according to Schedule 9 of ECR, 1997 of the GOB (refer to ***Table 2.9***).
**The quality of groundwater was compared with Schedule 3 (B) (Standards for drinking water) of ECR 1997 of the GOB.

Receptors

The major surface water body adjacent to the southern boundary of the Project site is an adjacent channel located about 200 m from the boundary of the Saidabad Power Generation Complex and east of the Saidabad Power Generation Complex is the main Jamuna River, which is located at a distance of about 1.2 km. The adjacent channel is seasonal and runs dry during the non-rainy season with water left only in depressions. The main Jamuna River will be used as means of transport for heavy equipment and temporary jetty constructed on it. Details of the hydrology and drainage pattern in the AOI are discussed in ***Section 4.3.5.***

Based on the sensitivity assessment criteria described in Table 6.7 both surface and ground water resource was found to be medium. However at places where discharge is to the channel when it is dry, the sensitivity assessment criteria for soil and sediment quality described in ***Table 6.5*** was used and the receptor assessed as of low sensitivity.

Impact Significance

Wastewater Discharge

Wastewater will be generated from washing of equipment and machinery on site. This 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* 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. The contractor will be responsible for ensuring that any wastewater discharges meet the standards stipulated in *Schedule 9 of ECR, 1997* (refer to ***Table 2.8*** and ***Table 2.9***) prior to discharge of such wastewater if required. Potential impacts are expected to be short-term and localised in nature. Based on the above discussion and referring to the magnitude criteria in Table 6.8, the impact to surface water from wastewater discharges during construction is assessed to be **negligible.**

Impact	*Wastewater discharge*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to on land discharge outside the southern boundary of the power generation complex				
Frequency	Limited to construction Phase –washing of machinery, equipment, use of sanitation facilities, cleaning of pipelines				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Groundwater Contamination

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 laydown 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* 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, impact to ground water would be limited. Based on the above discussion and referring to the magnitude criteria in Table 6.8, the impact to groundwater from spills and leaks is assessed to be **minor**.

Impact	*Ground water contamination*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Project site, ancillary areas and jetty site				
Frequency	Limited to construction Phase and unplanned events as leaks, spills, sewage discharge				
Likelihood	Likely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Mitigation Measures

The following measures will be implemented to reduce impacts to surface water and groundwater:

- Vehicle servicing areas and wash bays will, as far as practical, be located within roofed and cemented areas. The drainage in these covered areas will be connected to oil/water separator and channelized properly to the land/inland waters ;
- Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal;
- Oil and grease separator shall be used for wastewater generated from cleaning activities;
- Any surplus wastewater from the concrete batching will be treated to comply with discharge standards before it is discharged to the Jamuna River;
- Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce;
- Workers will be trained in the use of designated areas/bins for waste disposal and encouraged to use toilets.
- Septic tanks will be provided to treat sanitary wastewater; and
  All sewage and liquid effluent will be treated to meet the standards specified in *Schedules 9* and *10 of the ECR, 1997* respectively prior to discharge to land/inland waters.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Groundwater contamination			
Residual Impact	Minor	Negligible	With implementation of the precautionary and the mitigation measures mentioned for prevention of groundwater contamination the residual impacts would be negligible.

6.4.3 *Air Quality*

Sources of Impact

The potential sources of impacts to air quality are as follows:

- Site preparation and levelling;
- Excavation of soil to create building and equipment foundations;
- Pile driving for the equipment foundation;
- Exhaust emission from movement of heavy equipment by barge, heavy loaders, trucks;
- Loading and unloading of materials,
- Installation of gas pipeline;
- Concreting works, including operation of concrete batching plant, which will be located away from sensitive receptors and additional net fencing on section of boundary wall facing the residential receptors to reduce dust transport;
- Operation of diesel generators and other diesel based construction machineries.
- Dust generated from stockpiles of materials, waste, loose earth, handling and moving excavated material and transporting wastes on vehicles.

Dust generated from many of these activities will increase the particulate matter levels in ambient air. Vehicles and equipment exhaust emissions can lead to increases in levels of nitrogen oxides (NO_x), sulphur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), volatile petroleum hydrocarbon constituents and carbon monoxide (CO), which are key pollutants of concern with respect to human health.

Criteria

For the assessment of air quality, the sensitivity and magnitude criteria outlined in Table 6.9 and Table 6.10 respectively have been used.
The standards considered for assessment of potential impacts to air quality, are *Schedule 11 ECR, 1997 of the GOB* (***Table 2.7***). The air quality impacts associated with the construction activities have been assessed qualitatively, using professional judgement and based on past experience from similar projects.

Table 6.9 Sensitivity Criteria for Air quality

Sensitivity Criteria	Contributing Criteria	
	Human Receptors	*Ecological Receptors*
Low	Locations where human exposure is transient.[1]	Locally designated sites; and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team).
Medium	Locations where the people exposed are workers [2], and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day[3].	Nationally designated sites.
High	Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).	Internationally designated sites.

Table 6.10 Criteria for Impact Magnitude for Assessment of Impact to Air Quality (Construction Phase)

Magnitude Criteria	Negligible	Small	medium	Large
Air Quality	• Total site area < 500 m^2; • Soil type with large grain size (e.g. sand); and/or • Total material moved < 5,000 tonnes.	• Total site area 500 m2 to 2,500 m2; • Soil type with large grain size (e.g. sand); and/or • Total material moved 5,000 to 20,000 tonnes.	• Total site area 2,500 m^2 to 10,000 m^2; • Moderately dusty soil type (e.g. silt); and/or • Total material moved 20,000 tonnes to 100,000 tonnes.	• Total site area > 10,000 m^2; • potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size); and

[1] As per the GOB, there are no standards that apply to short –term exposure, eg one or two hours, but there is still a risk of health impacts, albeit less certain.

[2] Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM10. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers are included in the medium sensitivity category.

[3] *Schedule 11 ECR, 1997 of the GOB* (***Table* 2.7**).

Magnitude Criteria	Negligible	Small	medium	Large
				• Total material moved 100,000 tonnes.

Receptors

From the landuse analysis and field study, it is clear that most of the land surrounding the Project site is agricultural/fallow land on the north and west sides and plantations done by the BBA on their land on the north eastern side. On the immediate east exists vacant land for two proposed 225 MW dual fuel based combined cycle power plant (Sirajganj 2 and Sirajganj 3) and existing 225 MW NWPGCL power plant (Sirajganj 1) followed by a Channel, char lands and Jamuna River. The immediate south of the Project site has barren land followed by a dried channel and char/waste lands. A few (3-4) scattered huts are located on the west side about 200-220 m from the Project site boundary and few settlements are located along the access road. The main village settlements (Panchosona and Khas Bara Shimul) start at about 400 m away from the Project site boundary on the west and north-west side. The laydown area has also been selected away from the settlements of Khas Bara Shimul and Punorbason village. It has further been noted that the area on the western and southern part of the Saidabad Power Generation Complex is currently being acquired for development of an export processing zone (EPZ) by the Government of Bangladesh. However, details of type of industries planned were not available at the time of this assessment.

As can be referred from Table 6.9 and above discussion, the human receptors were assessed to be of Medium sensitivity, whereas ecological receptors were considered as of Low sensitivity.

Impact Significance

Dust Generation

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 conditions will reduce this impact. Construction dust dispersion is expected to be localised 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 will be practiced, the main receptors would be workers on site and neighbouring plant and people living near the access road.

On the basis of the above factors and the magnitude criteria described in Table 6.10, and considering the high levels of SPM and PM_{10} recorded during the baseline monitoring in the surrounding areas, 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 **moderate**.

Impact	*Air quality degradation due to dust generation*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Within 100 m from project boundary and within 100 m from access road				
Frequency	Limited to civil works in Construction Phase and transportation of material to site				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate.**				

Exhaust Emissions

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 10-15 heavy trucks and other transport vehicles per hour during daytime 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 minimise adverse air quality impacts. Based on the above discussion and Table 6.10, the air quality impacts associated with the vehicular and equipment emissions during construction activities are assessed to be of **minor** potential significance.

Impact	*Air quality degradation due to exhaust emissions*

Impact Nature	Negative		Positive		Neutral
Impact Type	Direct		Indirect		Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local		Regional		International
Impact Scale	Within 100 m from project boundary and within 100 m from access road				
Frequency	Limited to Construction Phase primarily due to transportation of material and use of heavy machinery and DG sets				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium	High	
Impact Significance	Negligible	Minor		Moderate	Major
	Significance of impact is considered **minor.**				

Mitigation Measures

The mitigation measures listed below will be implemented to ensure that air quality impacts during the construction phase are as low as reasonably practicable.

To reduce dust impacts, the following measures will be put in place:

- Implementation of a regular watering and sprinkling dust suppression regime, during the dry season;
- Concrete batching plant will be located within the power generation complex to keep it away from sensitive receptor/s;
- Stockpiles will be maintained at site only, which is a fenced area. No stockpiles will maintained outside, and maximum possible distance between the stockpiles and receptors will be maintained;
- Covering and/or watering of all stockpiles of dusty materials such as excavated spoils to avoid fugitive dust emissions;
- 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.

Exhaust emissions will be minimized as follows:

- The movement of construction vehicles will be minimised 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 minimise emissions;
- Low sulphur diesel (S<0.5%) will be used in diesel powered equipment in collaboration with best management practices;
- 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Air Quality Degradation due to dust generation			
Residual Impact	Moderate	Minor	With implementation of the precautionary and the mitigation measures mentioned for prevention/reduction of dust generation the residual impacts would be minor.
Exhaust Emissions			
Residual Impact	Minor	Negligible	With implementation of the precautionary and the mitigation measures mentioned for minimizing exhaust emissions the residual impacts would be negligible.

6.4.4 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 major plant and buildings. There is expected to be an increase in traffic and thereby in traffic noise impacts to receptors near the existing access road from the transportation of equipment, construction materials and workers. To minimise 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 30 months. As per the *Master Specifications*, the Contractor is required to seek permission from the authorities to carry out construction works at night (2100 to 0600) on weekdays.

The detailed breakdown of activities is not available at this stage, and as the Contractor has not yet been appointed, no construction plant inventory is available at the time of assessment. Therefore, an assumed plant inventory is provided in Table 6.11. Assumptions have made regarding the type, number and Sound Power Levels (SPLs) of construction plant, based on similar projects and publicly available data. It has been assumed that only one of each type of plant will be on-site during any day or night period. Re-assessment of noise levels may be required if the actual plant inventory and SPL vary from the assumed list.

Table 6.11 Assumed Construction Equipment Sound Pressure Level Inventory

Construction Equipment	SPL, dB(A)
Bulldozer	115

Construction Equipment	SPL, dB(A)
Backhoe	96
Impact pile driver	101
Loaders	108
Vibratory roller	102
Fuel truck	104
Welding machine	101
Cranes	106
Dump truck	105
Grader	114
Fork lifts	112
Compressors	104
Generators	93

Source: The SPLs of the construction equipment have been taken from DEFRA Construction Noise database for prediction of noise on construction and open sites, July 2006 and ERM's internal database

Although construction equipment and materials will be delivered by road from the nearby railway station/ temporary jetty, which will result in slight increase in heavy traffic movement and thereby in traffic noise impacts to receptors near the access road. To minimise these impacts, only those vehicles meeting the standards stipulated in *Schedule 5* of the *Environmental Conservation Rules, 1997* will be used.

Criteria

The noise impact assessment was conducted with reference to Bangladesh *Environmental Conservation Rules, 1997*. Details of the standards are presented in ***Table 2.10.*** Furthermore, for the assessment of ambient noise, the sensitivity and magnitude criteria outlined in Table 6.12 and Table 6.13respectively have been used:

Table 6.12 Sensitivity Assessment Criteria for Ambient Noise Impacts

Sensitivity Criteria	Contributing Criteria	
Ambient Noise	Human receptor	Ecological Receptor
Low	Industrial Use	Locally designated sites; and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team).
Medium	Residential and Recreational Space	Nationally designated sites.
High	Educational/ Religious/ Medical Facilities	Internationally designated sites.

Table 6.13 Magnitude Assessment Criteria for Ambient Noise Impacts

Magnitude Criteria	Negligible	Small	medium	Large
Noise	• Predicted noise levels are at or less than 3 dB (A)	• Predicted noise levels are 3 to less than 5 dB (A)	• Predicted noise levels are between 5 and 10 dB (A)	• Predicted noise levels are more than 10 dB (A)

Magnitude Criteria	Negligible	Small	medium	Large
	above the relevant limits / thresholds*. • Short term exposure (Few hours in a day and not continuous)	above the relevant limits / thresholds*. • Short term exposure (< 1 month)	above the relevant limits / thresholds*. • Medium Term Exposure (1 to 6 months)	above the relevant limits / thresholds*. • Long term exposure (> 6 months)

*Note: reference to Bangladesh Environmental Conservation Rules, 1997 presented in Table 2.10.

Receptors

Baseline noise monitoring was carried out at twenty locations, including eight locations within or just outside the power generation complex. The results of baseline monitoring indicated that ambient noise levels at all locations except near highway connecting the access road and a location near to the project site are within the limits of applicable standards. The nearest receptor is located at 220 m from the Project boundary at Panchosona Village, which will be exposed to noise from construction activities. Apart from this the receptors located close to the access road of Khas Bara Shimul and Punorbason villages will also be affected due to the movement of vehicles.

As can be referred from Table 6.12 and above discussion, the receptors within the Saidabad Power Generation Complex as well as the ecological receptors were assessed to be of Low sensitivity, whereas the human settlements in the surrounding areas (residential areas) were assessed to be of Medium sensitivity.

Impact Significance

Methodology: The environmental noise prediction model SoundPLAN 7.2 was used for modelling noise emissions from the construction equipment. The operation of construction equipment with 50% usage scenario was modelled to cover the construction phase. 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 construction equipment was assumed to be operating simultaneously. Attenuation due to the boundary wall of the power generation complex that has already been constructed has been considered in the modelling.

Predicted Noise Levels at Receptors: The predicted noise levels within the Project AOI during day and night time are presented in Figure 6.3 and Figure 6.4, respectively. Predicted noise levels at 20 receptors (where baseline noise levels were also monitored) have been presented in Table 6.14. It is evident from the predicted results that in the worst case scenario, the nearest receptor

– Khas Bara Shimul (220 m from the western boundary of the Project site) will have a daytime noise level of 53.4 dB(A) during the construction phase.

Figure 6.3 Predicted Construction Noise Levels during Daytime (Leq $_{day}$)

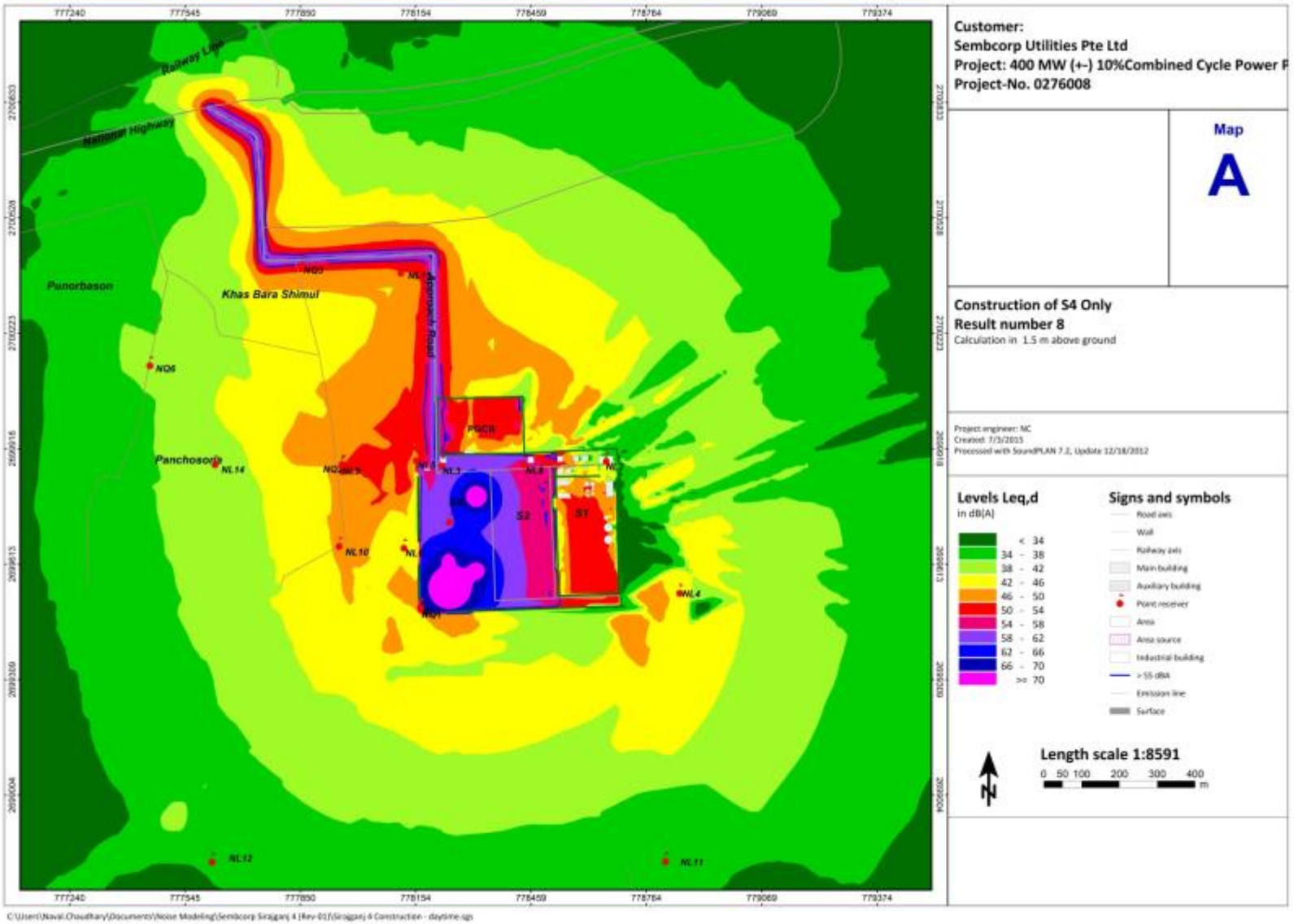


Figure 6.4 Predicted Construction Noise Levels during Night-time (Leq $_{night}$)

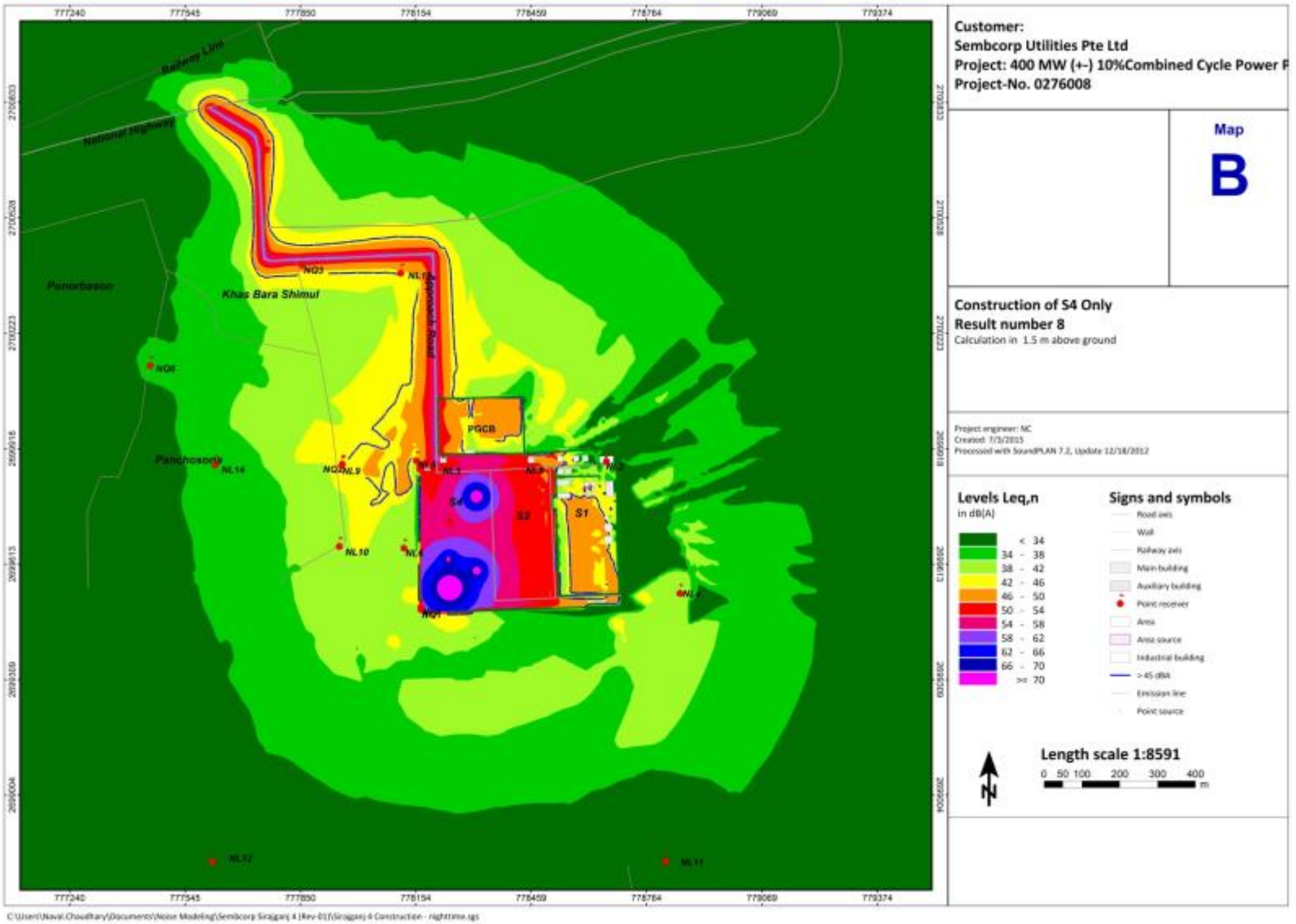


Table 6.14 Predicted Noise Levels at Noise Receptors during Construction Phase

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	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] [3] as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$
NQ1	Project Site Boundary	0 (-)	48.2	48.9	65.2	60.1	**65.3**	**60.4**	***70***	***70***
NQ2	Khas Bara Shimul	220 (W)	48.9	42.5	49.6	44.5	**52.3**	**46.6**	***55***	***45***
NQ3	Near Access Road (MMS Office)	665 (WNW)	47.0	42.4	54	50	**54.8**	**50.7**	***55***	***45***
NQ4	Access Road near National Highway	945 (WNW)	54.5	55.3	53.1	49.2	**56.9**	**56.3**	***55***	***45***
NQ5	Makimpur village	3000 (SW)	52.8	42.6	32.9	28.2	**52.8**	**42.8**	***55***	***45***
NQ6	Punorbason Village	760 m (NW)	50.4	42.4	38.5	33.6	**50.7**	**42.9**	***55***	***45***
NL1	Center of the Project area	0 (-)	40.7	32.4	61.2	56.2	**61.2**	**56.2**	***85***	***85***
NL2	North-East Corner	0 (-)	45.9	46.9	47.6	42.6	**49.8**	**48.3**	***70***	***70***
NL3	South side of the Mosque	0 (-)	40.2	24.8	58.9	53.9	**59.0**	**53.9**	***70***	***70***
NL4	NWPGCL Jetty	140 m (E)	40.2	47.6	44.9	39.9	**46.2**	**48.3**	***70***	***70***
NL5	North-west corner of the boundary	0 (-)	47.7	44.5	48.3	44.1	**51.0**	**47.3**	***70***	***70***
NL6	Middle point of the west side boundary (outside)	30 m (W)	48.0	45.1	45.5	40.5	**49.9**	**46.4**	***70***	***70***
NL7	South west corner of the boundary	0 (-)	39.5	40.6	65.2	60.2	**65.2**	**60.2**	***70***	***70***

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	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] [3] as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$
NL8	In front of the GTCL's quarter	0 (-)	46.8	47.5	56.8	51.7	**57.2**	**53.1**	***70***	***70***
NL9	Khas Bara Shimul village	220 m (W)	55.6	45.2	49.5	44.5	**56.6**	**47.9**	***55***	***45***
NL10	Khas Bara Shimul village	220 m (W)	47.3	43.5	46.3	41.3	**49.8**	**45.5**	***55***	***45***
NL11	Chak Boira Village	680 m (S)	46.5	40.7	34.5	29.5	**46.8**	**41.0**	***55***	***45***
NL12	Chak Boira Village	840 m (SW)	46.4	40.8	34.2	29.3	**46.7**	**41.1**	***55***	***45***
NL13	Bara Shimul village	490 m (N)	44.6	42.6	49.5	45.3	**50.7**	**47.2**	***55***	***45***
NL14	Panchosona village	560 m (W)	50.8	44.2	40.1	35.2	**51.2**	**44.7**	***55***	***45***

[1] Ambient noise levels as monitored during the baseline survey

[2] Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

It is evident from Table 6.14 that ambient noise levels due to construction activities will be well within the applicable standard during day time at 18 receptors and night time at 14 receptors, out of total 20 receptors considered in the study. However, noise levels will be slightly higher from applicable standard (with < 3 dBA increase from the applicable standard) at 2 locations during daytime, which are located close to the national highway and the project site). The higher levels at these locations primarily due to the background noise levels recorded during the baseline study and not a result of project induced noise. The noise impact from construction activity during day time is expected to be **negligible** to **minor**. Furthermore, noise levels at night time will be slightly higher than the applicable standard (with < 5 dBA increase from the applicable standard) at 6 locations. Due to this the noise impact from construction activity during night time is expected to be **minor** to **moderate.**

Impact	*Noise from Construction Activities and transportation of man/ material (Daytime)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Within 500 m of Project site and 100 m along the access road				
Frequency	Limited to construction Phase and noise generating construction activities				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible** to **minor.**				

Impact	*Noise from Construction Activities and transportation of man/ material (Night time)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Within 500 m of Project site and 100 m along the access road				
Frequency	Limited to construction Phase and noise generating construction activities				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor** to **moderate.**				

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 Monday to Sunday. 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Change in Ambient Noise Levels during daytime			
Residual Impact	Negligible to Minor	Negligible	With implementation of the precautionary and the mitigation measures mentioned for prevention/reduction in noise generation at source impacts would be negligible.
Change in Ambient Noise Levels during night time			
Residual Impact	Minor to Moderate	Negligible to Minor	With implementation of the precautionary and the mitigation measures mentioned for minimizing the noisy activities at night time and limiting the construction activities upto suggested time span, the residual impacts would be negligible to Minor.

6.4.5 Terrestrial Flora & Fauna

Potential sources of impacts of construction phase to terrestrial flora and fauna at the project site and project AOI includes:

- Clearance of vegetation at the project site;
- Clearance of vegetation within the ROW for the Intake and outfall water pipeline and intake structure;
- Clearance of vegetation at the temporary jetty location for unloading the heavy equipment and clearance of vegetation in the transportation routes to the project site; and
- Excavation for gas and water pipeline laying

Criteria

The assessment of the potential impacts to the flora and fauna has considered the Sch. I-III of Bangladesh Wildlife Prevention Order, 1973 and IUCN category for conservation status of flora and fauna to determine their rare, endangered and threatened status. Furthermore, for the assessment of impacts, the significance of effects on habitats and on species have been assessed by using the sensitivity and magnitude criteria, as outlined in Table 6.15 and Table 6.16, respectively.

Table 6.15 Significance of Effects on Habitats

Baseline Habitat Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	Small	Medium	Large
		Effect is within the normal range of natural variation	*Affects only a small area of habitat, such that there is no loss of viability / function of the habitat*	*Affects part of the habitat, but does not threaten the long-term viability / function of the habitat.*	*Affects the entire habitat, or a significant proportion of it, and the long-term viability / function of the habitat is threatened.*
Negligible	Habitats with negligible interest for biodiversity.	Not significant	Not significant	Not significant	Not significant
Low	Habitats with no, or only a local designation / recognition, habitats of significance for species listed as of Least Concern (LC) on IUCN Red List of Threatened Species, habitats which are common and widespread within the region, or with low conservation interest based on expert opinion.	Not significant	Not significant	Minor	Moderate
Medium	Habitats within nationally designated or recognised areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value.	Not significant	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) species, habitats of significant importance to endemic and/or globally restricted-range species, habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.	Not significant	Moderate	Major	Critical

Table 6.16 Significance of Effects on Species

Baseline Species Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of variation for the population of the species.	*Effect does not cause a substantial change in the population of the species, or other species dependent on it.*	*Effect causes a substantial change in abundance and / or reduction in distribution of a population over one, or more generations, but does not threaten the long term viability / function of that population, or any population dependent on it.*	*Affects entire population, or a significant part of it causing a substantial decline in abundance and / or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment (reproduction, immigration from unaffected areas).*
Negligible	Species with no specific value or importance attached to them.	Not significant	Not significant	Not significant	Not significant
Low	Species and sub-species of LC on the IUCN Red List, or not meeting criteria for medium or high value.	Not significant	Not significant	Minor	Moderate
Medium	Species on IUCN Red List as VU, NT, or DD, species protected under national legislation, nationally restricted range species, nationally important numbers of migratory, or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species.	Not significant	Minor	Moderate	Major
High	Species on IUCN Red List as CR, or EN. Species having a globally restricted range (i.e. plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km2), internationally important numbers of migratory, or congregatory species, key evolutionary species, and species vital to the survival of a high value species.	Not significant	Moderate	Major	Critical

Receptors

The receptors of various impacts identified are discussed in subsequent sections;

Impact Significance

Clearance of vegetation at project site

The project site is devoid of any large trees, but a variety of grasses, herbs and shrubs occurring within the site. The shrubs, herbs, weeds & and grasses (as listed in the ***Annex L***) germinate during monsoon when water is available and form the ground cover. By the end of January they start drying up due to water scarcity and are usually burnt at site for vegetation clearance as shown in ***Figure 6.5***. These plant species will be cleared for site preparation and levelling before the start of construction. No plant species occurring within the project site were identified as having conservation significance.

Various avifaunal species such as Black Drongo, Long tailed Shrike, Black Kite, Spotted Dove, Common Myna and Red Wattled Lapwing frequently visit the project site and are dependent on the insects dwelling in this vegetation. However none of these are threatened species though protected by Sch-III of the Bangladesh Wildlife Prevention Order, 1973. Removal of vegetation and site clearance will lead to movement of these open grassland avifauna to nearby similar habitats which is easily available within project AOI. Based on the criteria defined in Table 6.15 the impact significance has been considered as **Negligible**.

Impact	*Clearance of vegetation at the Project Site*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to project site				
Frequency	Limited to Construction Phase, site preparation and clearing				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (**Species**)	Low	Medium	High		
Resource/ Receptor Sensitivity (**Habitat**)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Negligible** for species and habitats.				

Figure 6.5 Overview of the Project Site Area

Vegetation within Right of Way (RoW) of Water Pipeline & Water Intake Structure

The water intake pipeline passes through the BBA plantation area. Cutting of trees and shrubs within the RoW will not be required, as the required RoW of 2m width is available between the plantation patch along the south fence of the BBA land and the internal BBA road connected to the West Guide Bund as shown in ***Figure 6.7.*** About 2.57 acres of land is required for RoW for the water intake. No trees were identified falling within the water intake pipeline RoW. The pipeline route passes within the fenced area of the BBA and sufficient space is available for pipeline lying without disturbing the surrounding vegetation. The pump house is also planned within the fenced area and does not require any tree cutting, as sufficient open area is available at the end of West Guide Bund.

No Turtle/terrapin nesting and egg laying sites were reported near the southern forest plantation (or water pipeline RoW). The area is also frequently visited by the fisherman and people living in the char lands as it provides easy access to the highway (N405) for commuting. Human activity inside these plantation areas includes the collection of non-timber forest produce such as leaf and twigs from the areas by the women of nearby settlements (Figure 6.6**).** This activity is quite common in winter months when the deciduous forest

floor is covered with leaves. These leaves are collected from the forest floor on a regular basis and dried for use as kitchen fuel. This activity results in disturbance of the mammalian habitat residing in this plantation. It also leads to disturbance of the natural forest function of composting which adds to the nutrient value of soil. The RoW for water pipeline and pump house areas are depicted in ***Figure 6.8.*** Based on the criteria defined in Table 6.15, the impact significance within the RoW of water pipeline and water intake structure has been assessed as **negligible**.

Impact	*Clearance of vegetation at the Right of way of Water Pipeline Route & Water Intake Structure*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to water pipeline RoW and Water Intake Structure				
Frequency	Limited to Construction Phase laying of pipelines, clearance at Intake Structure and Pump house site				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Resource/ Receptor Sensitivity (Habitat)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Negligible** for species and habitats.				

Figure 6.6 ***Human Activity inside the BBA Plantation Area***

Figure 6.7 Map showing the water pipeline route

Source: Developed based on reconnaissance survey on Google Earth Pro (Imagery Date: 15 April 2014)

Figure 6.8 Vegetation in the Water Pipeline Right of Way (RoW)

Open Area of Pump House Location

End Point of West Guide Bund

West Guide Bund (Water Pipeline will be above ground upto end of WGB)

BBA Internal Road and Southern Fence (2 m wide RoW will be used from Fence for underground water pipeline)

BBA Internal Road and Southern Fence

Culvert, BBA Internal Road and Southern Fence

BBA Internal Road and Southern Fence

Culvert, BBA Internal Road and Southern Fence

Clearance of Vegetation at the Jetty Location & Transportation Route

The vegetation at the temporary jetty location does not bear any major tree vegetation. The location has been previously used for unloading of heavy equipment for the existing power plant. However, the transportation route passes through the Jamuna Ecopark and the plantation area to the south of Bangabandhu Multipurpose Bridge (***Figure 6.9***). The vegetation clearance may be envisaged in the transportation route due to the movement of heavy lifts from this area. During discussion with the BBA official it was identified that the existing road were used for the transportation of heavy equipment for the existing plant and in the process 12-15 trees were cut. As a part of the compensatory afforestation 80-100 trees were planted in the BBA area. The desired width of the trailer for transportation of offloaded equipment and machinery is 5.1 m. The road width at the transportation route varies from 4.2 m to 7.0 m. Based on the recent survey in May-June 2015 (refer to ***Figure 6.10***), a total of 45 individuals of newly raised (4-5 years old) ornamental trees such as *Ficus benjamina*- 41 individuals, *Bahunia varigata*-2 individuals, *Aphanamixis polystachya*-2 individuals with girth size 10 cm to 40 cm were identified to be removed/replanted from the road inside Ecopark near Jetty area and along the fence area of Jamuna Eco Park. Along with these tree species certain shrub species which were planted along the fence also need to be removed. The majority of these ornamental shrubs are *Thuja standishii.* None of the species falling within the transportation route were identified as species of conservational significance as per IUCN Red Data List (2015. Ver 2).

The area marked for trees and shrubs removals are presented in Figure 6.11. Based on the matrix below the impact significance has been considered as **Negligible**.

Impact	*Clearance of vegetation at the Jetty Location and Transportation Route*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to temporary jetty and transportation route				
Frequency	Limited to Construction Phase laying of pipelines, clearance at jetty site				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Negligible** for Species & Habitats				

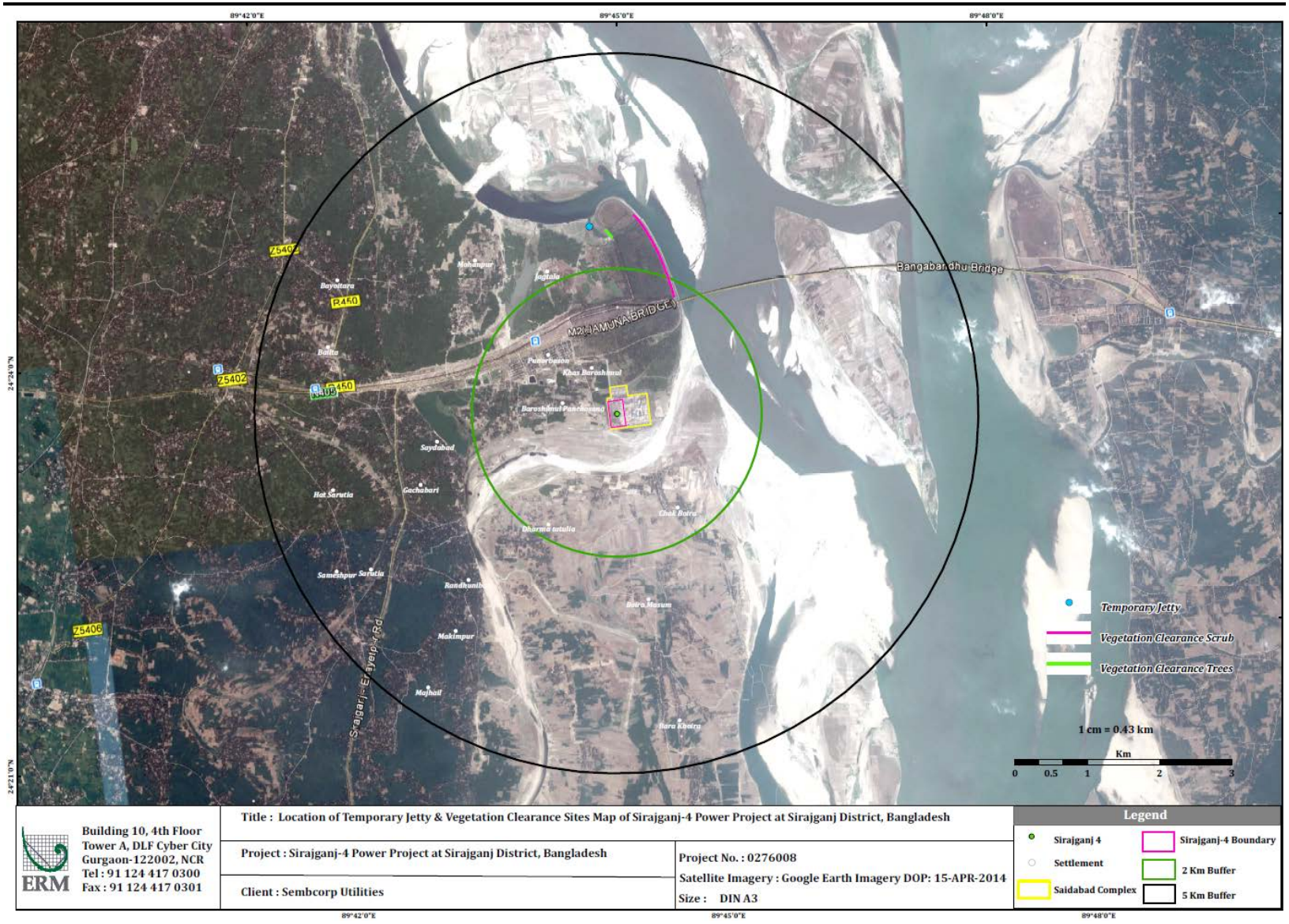
Figure 6.9 ***Map showing the Temporary Jetty Location and Transportation Route***

Source: Developed based on reconnaissance survey on Google Earth Pro (Imagery Date: 15 April 2014)

Figure 6.10 Trees and shrub removal along the Temporary Jetty transportation route

Source: ERM Survey May-June 2015

Figure 6.11 Tree and Shrub clearance area in Heavy Lift Transportation Route



Source: Google Earth Pro (Imagery Date: January 8, 2015) and site reconnaissance survey (May and June 2015)

The areas of temporary jetty, transportation route through Eco Park, water intake structures and pipeline routes does not bear any species of flora and fauna of conservational significance. Hence the sensitivity is low.

Excavation for Fuel Pipelines Laying

HSD supply pipeline facility will be on sharing basis with the existing power plant under common arrangements. The HSD supply pipeline is within the RoW of National Highway (Dhaka-Rajshahi) up to GTCL Valve Station and after that follows the gas pipeline RoW. Hence, additional impact on the vegetation clearance is not envisaged.

The natural gas pipeline will be laid within the RoW designated for the gas pipeline of existing power plant. Excavation for pipeline laying will not involve removal of vegetation, as there is no vegetation in the current RoW. Based on the matrix below the impact significance has been considered as **negligible**.

Impact	*Excavation for laying fuel pipelines*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to RoW of Fuel Pipeline route				
Frequency	Limited to Construction Phase during pipeline laying				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible** for Habitats and Species.				

Mitigation Measures for Terrestrial Flora and Fauna

Mitigation measures to minimize impacts on the terrestrial ecology due to construction activities will be as follows:

- Pre-construction surveys will be conducted by qualified ecologist hired by project developer to identify the floral and faunal species of conservational significance. The location of CR/EN species (if chance found) will be marked in advance and the area will be avoided;
- If tree removal cannot be avoided, adequate compensatory afforestation including conservation of EN species in consultation with Forest Department shall be undertaken;

- Efforts to be taken to replant the species nearby where no disturbance due to project activity is envisaged;
- Vegetation clearing will be kept to the minimum extent practicable for the project site, temporary jetty, transportation route through Jamuna eco park, water and gas pipeline;
- 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/ encouraged in order to reduce the impacts on vegetation from the vicinity of the Project site;
- Construction workers will be given conservation and awareness training to promote sustainable resource use; and
- Improved management of eco-park needs to be supported by the project to reduce impacts during the construction phase of the project.

6.4.6 Aquatic Flora and Fauna

Only 100 m^3/day of water is required for the construction phase, which shall be sourced from Jamuna River. The water requirement for the construction phase is too small for impact on the aquatic fauna and riverine flora minimum flow quantity in the river in last fourteen years has been 2036.82 m^3/sec as observed at Bahdurabad Transit Station as per data collected from BWDB) and about 745 m^3/s at the right channel near West Guide Bund.

Criteria

The assessment of the potential impacts to the flora and fauna has considered the Sch. I-III of Bangladesh Wildlife Prevention Order, 1973 and IUCN category for conservation status of flora and fauna to determine their rare, endangered and threatened status. Furthermore, for the assessment of impacts, the significance of effects on habitats and on species have been assessed by using the sensitivity and magnitude criteria, as outlined in Table 6.15 and Table 6.16, respectively.

Receptor

A total of 21 species of flora, one species of mammal, 7 species of birds, 3 species of reptiles of aquatic and riverine nature were recorded from the Jamuna River. Impact of the activities envisaged will be confined to the intake point on the land side. List of riverine and aquatic species enjoying protection by national law and international conventions are listed in ***Table 6.17.***

Table 6.17 List of Aquatic and Riverine Fauna under Conservation Status

Common Name	Scientific Name	Bangladesh Wildlife Prevention Order,1973	IUCN Category	Dist./Dire. From Project Site
Mammals				
Indian Grey Mongoose	*Herpestes edwardsi*	Sch.-III	LC	2.6 km/NE
Aquatic & Riverine Birds				
Pied Kingfisher	*Ceryle rudis*	Sch-III	LC	Project Site
Red Wattled Lapwing	*Vanellus indicus*	Sch-III	LC	2.6 km/NE
Reptiles				
Ganges Soft Shell*	*Nilssonia gangetica*	Sch III	VU	2.25 km/NE
River Terrapin*	*Batagur baska*		CR	3.64 km/NE
Striped Roof Turtle*	*Kachuga dhongoka*		EN	2.16 km/W
South Asian River Dolphin	*Platistina gangeticus*	Sch.III	EN	All along the Jamuna river

Note: LC: Least Concern; VU: Vulnerable; CR: Critically Endangered; EN: Endangered
** Further consultation with IUCN Bangladesh and a recent study conducted by IUCN (EIA of the River Management Improvement Programme (Bangladesh Water Board, Ministry of Water Resources, May 2015) revealed that major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore despite a report by fishermen, it is unlikely that these species are found here. Fishermen reports tend to be through memory and therefore reports of the species may have been due to sightings further north. Species presence in this area is very unlikely.*

Submerged aquatic flora and fauna including phytoplankton enumerated from the 4 duplicate samples includes different species of Diatoms (5 species), cyanobacteria (3 species), green algae (8 species) and protozoa (1 species).

The zooplankton enumerated from the 4 duplicate samples included species of rotifers (4 species), crustaceans (2 species), copepods (2 species) and ostracods and cladoceras (a single species each).

Twenty species of fish were reported by primary survey and secondary information from the Jamuna River. None of the species listed are protected by law. Based on a study conducted in 1995-96 the South Asian Dolphins (*Platanista gangetica* -IUCN EN) were studied in Jamuna River at the rate of 0.13 sightings per kilometre and 1.5 sightings per hour. The current survey (May-June 2015) spotted 3 individuals in Jamuna River near Temporary Jetty area. Consultation with the fishermen confirmed their presence in the Jamuna River all through the year.

Sensitivity

The areas of water intake structures and pipeline routes may disturb the movement path of the South Asian River Dolphin (*Platanista gangetica* IUCN EN*)* however, considering the wide river sufficient space is available for their movement; hence the sensitivity from the same will be low.

Impact Significance

Leakage and Discharges from River Transportation

Jamuna River is the main water body in the project AOI and is also a main source of transportation of heavy equipment from their source to the temporary jetty to be constructed for the Project. Transportation will be undertaken with the help of barges/trawlers. There is a likelihood of leakage of fuels and other contaminants from barges/trawlers to Jamuna River. Three species of aquatic reptiles reported from the Jamuna River fall under the Critically Endangered, Endangered or Vulnerable category of IUCN Red List. Though the current survey and consultation has indicated that the reported habitat of these species is away from the water intake and temporary jetty location (refer Figure 4.38); however, since the spillage may affect their habitat and egg laying sites hence, due care should be exercised to avoid any leakages and ballast water discharge near the temporary jetty area. Based on the matrix below the impact has been considered as **moderate**.

Impact	*Leakages/ spillage from Transportation Vessels*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Equipment unloading site				
Frequency	Limited to Construction Phase for unloading of heavy lifts at Temporary Jetty				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate** for Species & Habitats**.**				

Mitigation Measures

Mitigation measures to minimize impacts to the aquatic ecology due to construction activities will be as follows:

- Herpetofaunal experts will be appointed to understand the usage of the proposed temporary jetty area by turtle and terrapin of conservational significance prior to start of construction activities for identification of egg laying sites of aquatic reptiles at the equipment loading sites for avoidance.
- Conservation training will be given and a ban on capture of species or its eggs with any contractor/subcontractor/construction worker working on

water pipeline, jetty area including logistics contractor not complying being immediately removed from the project;
- Proper maintenance for avoidance of any leakage of fuels and other contaminants from barges/trawlers to Jamuna River;
- During transportation of equipment's the vessel speed should be regulated and observer for the Dolphin movement should be appointed to guide the vessel to the temporary jetty area. Ballast discharge to be regulated near the AOI; and
- Trawlers/barges with valid requisite licenses and emergency handling capacity or tie-ups shall only be engaged.

Habitat Disturbance due to construction of Temporary Jetty and Dredging

The requirement for a temporary jetty is primarily for receiving the heavy equipment (GT, ST, HRSG, Transformer, etc.), which could not be able to transport by road/ rail. The requirement of the temporary jetty will be for a period of about 6 to 9 months, depending upon the receipt of shipment and will be required after 15 months from receipt of the limited notice to proceed (LNTP) from the BPDB. The temporary jetty will be constructed at the same location, which was earlier used by the NWPGCL at the time of Sirajganj 1 project construction. The temporary jetty will be constructed by using layers of sand and sand bags and these will be arranged so as to provide compaction and strength. Small compaction units will be used throughout the erection process to ensure that the ground is solid and suitable for the off-loading of the heavy lifts. Heavy lifts will be jacked up on the barges and a modular trailer placed under it. The modular trailer shall then lift the cargo from barge and transport it to the site location approximately 4 km from the offloading site.

Dredging may be required near the temporary jetty in order to provide sufficient draft for the incoming barges carrying heavy lifts. However, the magnitude of dredging will depend on the bathymetry of the channel connecting with the main river and the water level at the time of heavy lifts transportation. However, it has been observed during the survey of the temporary jetty location that dredging on the River Jamuna is being carried out by the Bangladesh Water Development Board in order to remove silt from the main channel as well as for river bank erosion control. Currently, BWDB is carrying out dredging activity on the north or the Jamuna Bridge and a channel on the north-west to the temporary jetty location has been closed in order to provide additional protection to Sirajganj town as well as to the west guide bund (refer Figure 6.12). Further dredging is also being carried out on the north-eastern and eastern part of the temporary jetty by BWDB (refer to ***Figure 6.12*** and Figure 6.13).

Figure 6.12 Locations of Closures and Dredging Alignments in the Jamuna River

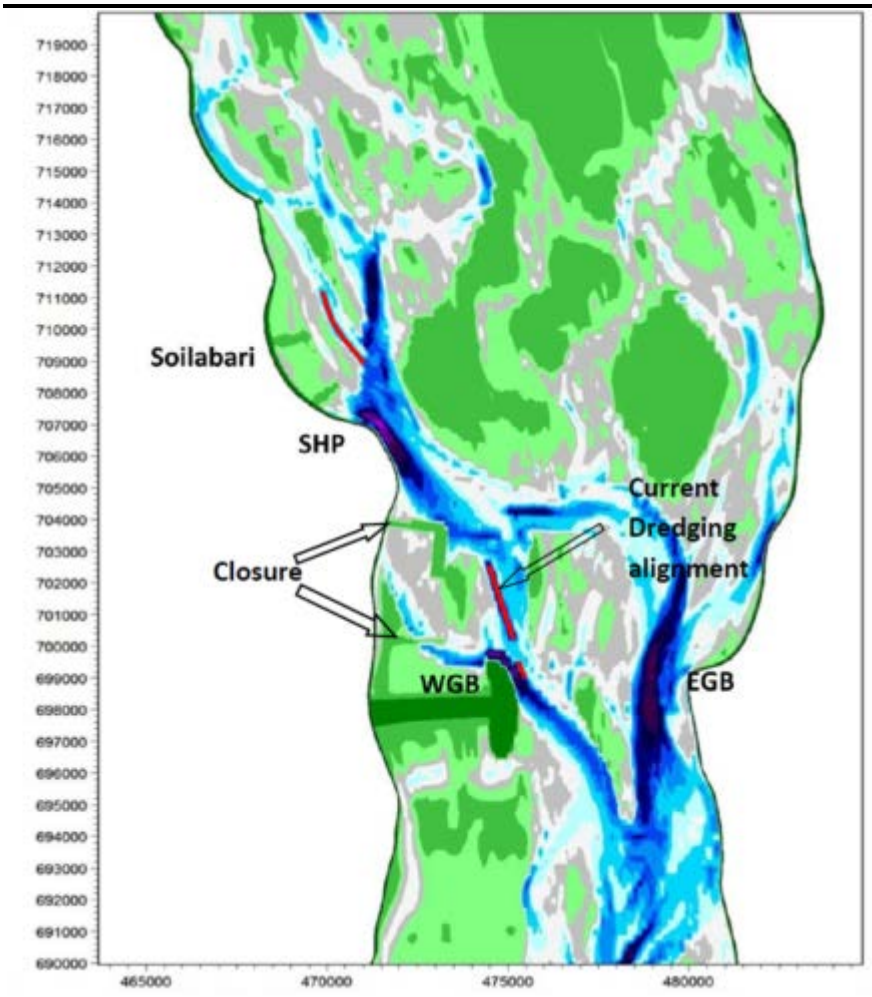


Figure 6.13 Dredging activities in the Area

Dredging activities in middle of river

Dredging of sand for China Bund

Dredging near China Bund

	
Bund making in upstream of Jamuna River	Sand collection from Char lands

Considering the on-going dredging activities near to the temporary jetty location as well as construction of closures in the upstream of the temporary jetty, the impact of limited dredging during the transportation of heavy lifts is not significant.

Sensitivity

The dredging will be involved for movement of vessel from Jamuna river to temporary jetty location. There could be presence of IUCN CR/EN species in these areas however, pre-construction surveys will be undertaken to identify the habitat (nesting areas) if any near to the temporary jetty area.

Receptors

The possible receptors are mentioned in ***Table 6.17*** River Terrapin (*Batagur baska)* IUCN 2015.2 CR, Striped Roof Turtle (*Kachuga dhongoka*) IUCN 2015.2 EN and South Asian River Dolphin (*Platistina gangeticus)* IUCN 2015.2 EN are species likely to be affected[1].

Impact	*Construction of Temporary Jetty and Dredging*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Temporary jetty area and about 200 m of channel connecting with the main river.				
Frequency	Limited to transportation of heavy lifts during construction stage (6 to 9 month usage)				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		

[1] Though turtles and terrapins were only reported during some fishermen consultations, d these were not confirmed during the consultation with IUCN as well as in the recent report of IUCN. This impact assessment is entirely preacautionary.

Impact Significance	Negligible	Minor	Moderate	Major
	Significance of impact is considered **moderate** for Species & Habitats**.**			

Mitigation measures

The mitigation measure for the species likely to be affected is discussed in ***Box 5.2.***

Box 6.2 Mitigation measure for species of conservational significance

Mammals: South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica*
Impact Significance : Moderate
Mitigation Measures

Monitoring of Species: The species occurs in the Jamuna River during the post monsoon season when the water level in the river rises based on information provided by fishermen. Movement of vessels in the Jamuna River to temporary jetty area will require vessel patrols or deck monitoring for detecting movement of South Asian River Dolphin. If such movement is observed, the vessel should be stopped until the species moves out of the path of the vessel. Vessel patrols and deck monitoring should organize or enforced/ supervised by the site security.

6.4.7 Critical Habitat Assessment

In order to obtain an understanding of habitats and their species composition occurring in AOI, to assess possible triggers of critical habitat as defined in IFC's Performance Standard (PS) 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012a) and the associated guidance note (IFC, 2012b), the baseline data on habitats and species described was assessed as described in the following sections.

Species listed in ***Table 6.18*** are considered for possible triggers of critical habitats.

Table 6.18 Possible Species triggers for Critical Habitat

Species	IUCN 2015. V 2. Classification
Birds	
White-rumped vulture (*Gyps bengalensis*)	CR
Reptiles	
River Terrapin (*Batagur baska*)	CR
Striped Roof Turtle (*Kachuga dhongo*)	EN
Mammals	
South Asian river Dolphin (Plat*anista gangetica*)	EN
Plants	
Garjan (*Dipterocarpus turbinatus*)	CR
Small-leaved Mahogany (*Swietenia mahagoni*)	EN

Habitat Analysis

The AOI bears 38% of agricultural land (agricultural lands, homestead plantations and fallow lands), 28% of waterbodies including the Jamuna

River, 19% of waste land (including grasslands, riverine habitats and char lands[1]), 9% of miscellaneous areas, 3% of plantation (including the Jamuna Eco park and surrounding plantation areas) and 3% of built up area (including the Saidabad Complex).

Classification of Habitats

The IFC Performance Standard 6 classifies habitats into three major categories;

- **Natural Habitats**: Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.
- **Modified Habitats**: Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. Definition of the modified habitat also includes significant biodiversity value, as determined by the risks and impacts identification process required in Performance Standard 1. The client should minimize impacts on such biodiversity and implement mitigation measures as appropriate.
- **Critical Habitats**: IFC PS 6 identifies critical habitats as areas with high biodiversity value, including (i.) habitat of significant importance to Critically Endangered and/or Endangered species; (ii.) habitat of significant importance to endemic and/or restricted-range species; (iii.) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv.) highly threatened and/or unique ecosystems; and/or (v.) areas associated with key evolutionary processes.

Table 6.19 Habitat Identification as per IFC 2012 PS 6

Land Use Class.	Attributes	Habitat Type (IFC PS6, 2012)	Rationale
Forest plantation	Major plant species planted are *Terminalia arjuna*, *Dalbergia sisso*, *Eucalyptus citiodora*, *Albizia lebbeck*. Planting includes fruit trees, medicinal plants, timber yielding trees, ornamental trees and revenue trees. The plantation also includes 2 species of trees, *Dipterocarpus turbinatus* and	MODIFIED	Most trees within the plantation, established in 1998-1999, are introduced. These include the threatened

[1] Char lands are created by the constantly shifting coastline in Bangladesh. In many case these lands are settled with communities that live of the surrounding natural resources.

Land Use Class.	Attributes	Habitat Type (IFC PS6, 2012)	Rationale
	Hopea odorata which are CR and VU respectively (IUCN v2015.2)		species. There is no reason to expect that this plantation has the attributes of a natural forest.
Homestead Plantation	Twenty six (26) species of fruit and vegetable bearing trees were recorded in the homestead plantations. These included Cocos *nucifera, Eucalyptus citriodora, Mangifera indica, Psidium guajava, Ricinus cummunis, Lichi chinensis, Ziziphus mauritiana, Carica papaya, Lannea coramandelica, Moringa oleifera, Citrus aurantifolia, Sweitenia mahagoni, Musa sapientum, Musa paradisiac, Atrocarpus heterophyllus, Ficus hispida* and *Syzygium cumunii. Sweitenia mahagoni* is EN as per IUCN (2015 v 2).	MODIFIED	All trees planted are for domestic use and no parts of the homestead plantations have succeeded into natural forest. The EN species, *Sweitenia mahagoni* is introduced.
Fallow Land	Fallow lands were dominated by herbs species of *Xanthium indicum, Alternanthera sesilis, Lipia ciliate, Cyperus rotundus, Persicaria praetermissa, Croton caudatus and Desmodium triflorum. Shrub species of Anisomeles indica, Cassia tora* and *Crotalaria pallida*	MODIFIED	Succession is relatively minimal and therefore no components of fallow lands can be considered natural habitat.
Riverine Habitat (includes char lands).	20 genera were recorded in the riverine habitats. These included *Linderina ciliate, Cyperus rotundus, Saccharum spontaneum, Alternanthera sesilis, Lippia alba, Cynodon dactylon, Fimbristylis* sp., *Amania* sp., *Ludwigia decurrens, Grangia* sp., *Rananculus* sp., *Rumax* sp., *Hydrocotyl asiatica, Centella asiatica* and *Dentella* sp	MODIFIED	As most species recorded were natural grasses the habitat could be considered natural. However there are several communities settled on riverine habitats causing degradation and perhaps modification of habitats. Because of these impacts the habitat is considered modified.
Grasslands	A total of 29 species belonging to 25 genera of 13 families were recorded from grasslands of the AOI. Seven (07) species of grasses were identified. Among them *Sparobollus diander, Saccharum pontaneum* and *Imperata cylinderica* were found most commonly occurring. Herbs were represented by	NATURAL	As most species recorded were natural grasses and herbs the habitat is considered natural.

Land Use Class.	Attributes	Habitat Type (IFC PS6, 2012)	Rationale
	19 species dominated by *Euphorbia hirta, Solanum xanthocarpum, Desmodium trifolium* and *Triumfetta rhomboidea*		
Jamuna River	Includes entire natural area encompassing the water of the river	NATURAL	The river is confined within natural banks and habitats, with no man made alteration such as concrete banks etc. Furthermore there are no manmade canals leading from the river thereby altering its habitat.

Note: We considered the Shannon Weaver's diversity index (H') during classification of natural and modified habitat. However due to diversity varying as a function of species introduced (and land use) and complexities due to the successional stages the habitats were in, interpretation of these indices were not useful. Diversity indices were therefore ultimately not used for the classification.

Based on the definitions given above and the rationale provided in ***Table 6.19*** habitats such as built up areas, all types agricultural lands which include homestead plantations and fallow lands riverine habitats that include char lands the Jamuna Eco Park plantation (a forest plantation) and homestead plantation areas can be considered as modified habitats within the AOI, while the Jamuna River, due its relatively unaltered state, qualifies as natural habitat.

Screening of Potential Critical Habitat

IFC PS 6 identifies critical habitats as areas with high biodiversity value, including

(i.) Habitat of significant importance to Critically Endangered and/or Endangered(1) species;

(ii.) Habitat of significant importance to endemic and/or restricted-range species;

(iii.) Habitat supporting globally significant concentrations of migratory species and/or congregatory species;

(iv.) Highly threatened and/or unique ecosystems; and/or

(1) As listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. The determination of critical habitat based on other listings is as follows: (i) If the species is listed nationally / regionally as as critically endangered or endangered, in countries that have adhered to IUCN guidance, the critical habitat determination will be made on a project by project basis in consultation with competent professionals; and (ii) in instances where nationally or regionally listed species' categorizations do not correspond well to those of the IUCN (e.g., some countries more generally list species as "protected" or "restricted"), an assessment will be conducted to determine the rationale and purpose of the listing. In this case, the critical habitat determination will be based on such an assessment.

(v.) Areas associated with key evolutionary processes.

The criteria for critical habitats as defined in PS6 Guidance Notes (GN6) (IFC 2012b) is shown in ***Table 6.20***.

Table 6.20 Critical Habitat Criteria

Criteria	Tier 1[1]	Tier 2[1]
Criteria 1: Critically Endangered(CR)/Endangered (EN) Species	a) Habitat required to sustain ≥ 10 percent of the global population of an IUCN Red-listed CR or EN species where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species. b) Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.	a) Habitat that supports the regular occurrence of a single individual of an IUCN Red-listed CR species and/or habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species. b) Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. c) As appropriate, habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent national/regional listing.
Criterion 2: Endemic and Restricted-range Species	a) An endemic species is defined as one that has ≥ 95 percent of its global range inside the country or region of analysis.	a) Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment.
Criterion 3: Migratory and Congregatory Species	a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' life-cycle where that habitat could be considered a discrete management unit for that species.	a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' life-cycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment. b) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance.

Criteria	Tier 1[1]	Tier 2[1]
		c) For species with large but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species. d) Source sites that contribute ≥ 1 percent of the global population of recruits.
Criterion 4: Highly Threatened and/or Unique Ecosystems	No Tiered system is prescribed a) that are at risk of significantly decreasing in area or quality; b) with a small spatial extent; and/or c) containing unique assemblages of species including assemblages or concentrations of biome-restricted species. Highly threatened or unique ecosystems are defined by a combination of factors which may include long term trend, rarity, ecological condition, and threat	
Criterion 5: Key Evolutionary Processes	The criteria is defined by a) Isolated areas (e.g., islands, mountaintops, lakes) are associated with populations that are phylogenetically distinct. b) Areas of high endemism often contain flora and/or fauna with unique evolutionary histories (note overlap with Criterion 2, endemic and restricted-range species). c) Landscapes with high spatial heterogeneity are a driving force in speciation as species are naturally selected on their ability to adapt and diversify. d) Environmental gradients, also known as ecotones, produce transitional habitat which has been associated with the process of speciation and high species and genetic diversity. e) Edaphic interfaces are specific juxtapositions of soil types (e.g., serpentine outcrops, limestone and gypsum deposits), which have led to the formation of unique plant communities characterized by both rarity and endemism. f) Connectivity between habitats (e.g., biological corridors) ensures species migration and gene flow, which is especially important in fragmented habitats and for the conservation of metapopulations. This also includes biological corridors across altitudinal and climatic gradients and from "crest to coast." g) Sites of demonstrated importance to climate change adaptation for either species or ecosystems are also included within this criterion.	

Note [1] No tier system is in place for Criteria 4 and Criteria 5.

The IFC PS-6 also suggests that, "In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and

- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program."

Table 6.21 provides the species that were recorded in the area either through direct observations or through consultations with local communities. The screening for potential critical habitat species has been carried out against Criteria 1 to 3 which are

1. Habitat of significant importance to Critically Endangered (CR) and/or Endangered(EN) species;
2. Habitat of significant importance to endemic and/or restricted-range species;
3. Habitat supporting globally significant concentrations of migratory species and/or congregatory species

On 3 despite a small portion of on IBA overlapping with the project area, the IBA does not support globally significant concentrations of migratory and/or congregatory species and neither the habitat, nor the species within, is considered potential critical habitat triggers except for the white-rumped vulture which is included in the critical habitat screening.

With respect to Criteria 4 and 5

4. Highly threatened and/or unique ecosystems
5. Areas associated with key evolutionary processes

The baseline assessment has not identified any highly threatened and/or unique ecosystems. Natural habitats within the Jamuna River are neither unique nor threatened as they are common in the biogeographical region.

Even though the highly dynamic char lands could be considered as catalysts for evolutionary processes, there is no scientific documentation of these processes. Furthermore char lands are common along the Jamuna River so if such evolutionary processes do occur they are not unique to the project AOI. Furthermore char lands are also not impacted by the project activities.

Table 6.21 Project Area Critical Habitat Screening Assessment – Criteria 1 and 2 Critically Endangered or Endangered Species and Endemic and/or Restricted-range species

Species Name	Common Name	Criteria 1 CR or EN Species	Criteria 2 Endemic / Restricted Range	Criteria 3 Migratory / Congregatory	Critical Habitat Tier 1	Critical Habitat Tier 2	Rationale	Information
Birds								
Gyps bengalensis **(**White rumped vulture)		CR				√	Criteria 1Tier 2e	The White-rumped Vulture was once widely distributed in Bangladesh but is now considered as rare and thinly distributed with a population of less than 1,000 individuals. During the last decade, it has been scientifically proven beyond doubt that the use of Diclofenac (A non-steroidal anti-inflammatory drug) in animals especially in cattle has led to massive mortality and a sharp decline in the vulture population. The mechanism which causes the death is renal failure, a known side effect of Diclofenac. The species features on the list of bird species found in the IBA and overlapping marginally with AOI.
Mammals								
Platanista gangetica	South Asian river Dolphin (Jamuna Dolphin)	EN	-	-	-	√	***Criteria 1Tier 2e*** • The presence of species was confirmed by sightings of 3 individuals in the Jamuna River within AOI. • Local fisherman confirm its presence frequently in post monsoon season; • It is under threat from the accidental	• The species is present in Ganges, Brahmaputra (Jamuna in Bangladesh), Meghna, Karnaphuli and Sangu river system in India, Bangladesh and Nepal. A total of world population of 4000-5000 is estimated. A study in 1998 (1)

Species Name	Common Name	Criteria 1 CR or EN Species	Criteria 2 Endemic / Restricted Range	Criteria 3 Migratory / Congregatory	Critical Habitat Tier 1	Critical Habitat Tier 2	Rationale	Information
							catch in the Sirajganj Area	estimated 38-58 (1.16%) of individuals of species in Jamuna river of Bangladesh in (190 km) stretch. ***Ref*:** (1)Smith, B.D., Aminul Haque, A.K.M., Hossain, M.S., and Khan, A. 1998. River dolphins in Bangladesh: conservation and the effects of water development. ***Environmental Management*** 22, 323–335.
Reptiles								
Batagur baska	River Terrapin	CR	-	-	-	√	Criteria1 ***Tier*** 2e The species is reported from Jamuna River during consultation of villagers during fisherman survey. The species was not physically seen during both the surveys. According to IUCN (EIA of the River Management Improvement Programme (Bangladesh Water Board, Ministry of Water Resources, May 2015) major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore it is unlikely that despite a report by fishermen the species is found here. Fishermen reports tend to be through memory and therefore report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.	The species is considered as Critically Endangered in Bangladesh and India because the subpopulations are all very small and declining. There are no recent data and it is therefore presumed to be Extinct in Myanmar, Vietnam and Singapore.
Kachuga dhongo	Striped Roof Turtle	EN	-	-	-	√	Criteria1 ***Tier*** 2e The species is reported from Jamuna River during consultation of villagers during	The species is considered as Critically Endangered in Bangladesh

Species Name	Common Name	Criteria 1 CR or EN Species	Criteria 2 Endemic / Restricted Range	Criteria 3 Migratory / Congregatory	Critical Habitat Tier 1	Critical Habitat Tier 2	Rationale	Information
							fisherman survey.. The species was not physically seen during both the surveys. According to IUCN (**Ref**. EIA of the River Management Improvement Programme (Bangladesh Water Board, Ministry of Water Resources, May 2015) Major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore it is unlikely that despite a report by fishermen the species is found here. Fishermen reports tend to be through memory and therefore report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.	
Flora								
Dipterocarpus turbinatus	Garjan,	CR	-	-	-	-	The species has been reported in primary survey. Its presence has been confirmed from Jamuna Eco Park Forest plantation area. These species are introduced into plantation hence the criteria as per PS6 is not relevant	• *Dipterocarpus turbinatus* is generally found in the tropical semi evergreen, tropical wet evergreen, and tropical moist deciduous forests of Bangladesh; • In Bangladesh the species is scattered in the tropical wet evergreen forests and tropical semi-evergreen forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar, and Sylhet.
Swietenia mahagoni	Small-leaved Mahogany	EN	-	-	-	-	The species has been reported from Homestead plantation of Khas Barashimul and Jagtala villages. These species are introduced into plantation hence the criteria as per PS6 is not relevant	*Swietenia mahagoni* is exotic to Bangladesh. The species is present in plantation areas in Bangladesh.

As part of the Critical Habitat Assessment and in order for appropriate mitigation to be applied, a high level impact assessment has been completed whereby the impacts of the proposed project activities were assessed against habitats and species identified in the AOI.

The assessment has been completed using ERM standard impact assessment criteria as outlined in Table 6.22 and Table 6.23 Focus has been placed on species identified through the critical habitat assessment as potential trigger species.

Table 6.22 Habitat-Impact Assessment Criteria

Habitat Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of natural variation	*Affects only a small area of habitat, such that there is no loss of viability / function of the habitat*	*Affects part of the habitat, but does not threaten the long-term viability / function of the habitat.*	*Affects the entire habitat, or a significant proportion of it, and the long-term viability / function of the habitat is threatened.*
Negligible	Habitats with negligible interest for biodiversity.	**Not significant**	**Not significant**	**Not significant**	**Not significant**
Low	Habitats with no, or only a local designation / recognition, habitats of significance for species listed as of Least Concern (LC) on IUCN Red List of Threatened Species, habitats which are common and widespread within the region, or with low conservation interest based on expert opinion.	**Not significant**	**Not significant**	**Minor**	**Moderate**
Medium	Habitats within nationally designated or recognised areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value.	**Not significant**	**Minor**	**Moderate**	**Major**

Habitat Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	Small	Medium	Large
High	Habitats within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) species, habitats of significant importance to endemic and/or globally restricted-range species, habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.	**Not significant**	**Moderate**	**Major**	**Critical**

Table 6.23 Species-Impact Assessment Criteria

Baseline Species Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	Small	Medium	Large
		Effect is within the normal range of variation for the population of the species.	*Effect does not cause a substantial change in the population of the species, or other species dependent on it.*	*Effect causes a substantial change in abundance and / or reduction in distribution of a population over one, or more generations, but does not threaten the long term viability / function of that population, or any population dependent on it.*	*Affects entire population, or a significant part of it causing a substantial decline in abundance and / or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment (reproduction, immigration from unaffected areas).*
Negligible	Species with no specific value or importance attached to them.	**Not significant**	**Not significant**	**Not significant**	**Not significant**
Low	Species and sub-species of LC on the IUCN Red List, or not meeting criteria for medium or high value.	**Not significant**	**Not significant**	**Minor**	**Moderate**
Medium	Species on IUCN Red List as VU, NT, or DD, species protected under national legislation, nationally restricted range species, nationally important numbers of migratory,	**Not significant**	**Minor**	**Moderate**	**Major**

Baseline Species Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	Small	Medium	Large
	or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species.	Not significant			
High	Species on IUCN Red List as CR, or EN. Species having a globally restricted range (i.e. plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km2), internationally important numbers of migratory, or congregatory species, key evolutionary species, and species vital to the survival of a high value species.		Moderate	Major	Critical

A description of the specific habitat values within the project site and surrounding areas within AOI which are of relevance to each species of conservational significance is provided in Table 6.24. Here agricultural lands and built up areas are not included in the assessment as they are negligible interest for biodiversity conservation as determined by the baseline assessment. Char lands and other riverine habitats lie outside the AOI and are therefore not included in the impact assessment. Due to the presence of threatened species the Jamuna Ecopark, the homestead plantations and the Jamuna River are ultimately considered for the assessment.

Table 6.24 Habitat Impact Assessment

Habitat Description	Associated Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
Jamuna River (Natural Waterbody)	South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica* IUCN-EN	1. Movement of vessel in Jamuna River for offloading the machineries and equipment's to Temporary Jetty Site in Construction Phase can cause hydrocarbon spills and leaks, contaminating natural habitats in the Jamuna river.	Presence of endangered species was observed and reported in Jamuna River within AOI-**HIGH**	a. Water contamination from accidental hydrocarbon spillage and leaks is likely to be low due to large volume of water flowing in the river. Effect is also likely to be temporary- **SMALL**	**MODERATE**

Habitat Description	Associated Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
Jamuna Eco Park (Forest Plantation)	*Dipterocarpus turbinatus* IUCN-CR and *Hopea odorata* IUCN-VU	Transportation of machineries and equipment's from Temporary Jetty Site to Project site may involve clearance of road side vegetation	Presence of Dipterocarpus turbinatus IUCN-CR and Hopea odorata IUCN-VU-**HIGH**	Roadside vegetation removal is envisaged for road widening in some places for transportation vehicle. However none of the IUCN threatened species will be impacted and all removal will target ornamental/plantation tree and shrub species-**NEGLIGIBLE**	**NEGLIGIBLE**
Homestead Plantation	*Swietenia mahagoni* IUCN EN	The project does not have any activity in the areas where homestead plantation is occurring.	The species observed in AOI are situated far from the project activity area-**HIGH**		**NEGLIGIBLE**

Table 6.25 ***Species - Impact Assessment***

Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
Fauna species **White rumped Vulture (*Gyps bengalensis*)**  	The species has been reported from the IBA overlapping the AOI. There is a chance of the species flying over the AOI or nesting within the AOI on any tall trees found in the area. There are no impacts envisaged by flying over the project site but possible, though very unlikely impacts from felling of nesting trees within the project site. The threat of poisoning by diclofenac is very unlikely due to the absence or very low presence of live-stock in the site area especially when the project is operational	**HIGH:** The species is critically endangered in the IUCN red list and Schedule III of Bangladesh Wildlife Prevention Order, 1973.	**SMALL**	**MODERATE**
Ganges Soft Shell Turtle *Nilssonia gangetica* Distribution Map:	The species has been reported from char lands in the middle of the river but could travel to other sections of the river. The project activity does not extend up to char lands and is confined to west bank of the Jamuna River. The char lands	**MEDIUM:** The species is listed as Vulnerable in IUCN Red list and Sch. III of Bangladesh	**NEGLIGIBLE**	**NEGLIGIBLE**

Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
 Ref.: Asian Turtle Trade Working Group 2000. *Nilssonia gangetica*. The IUCN Red List of Threatened Species. Version 2015.1	are known to be potential nesting sites of these turtle species. According to IUCN (**Ref**. EIA of the River Management Improvement Programme Bangladesh Water Board, Ministry of Water Resources, May 2015) Major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore it is unlikely that despite a report by fishermen, the species is found here. Fishermen reports tend to be through memory and therefore report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.	Wildlife Prevention Order, 1973. Locally it is considered as Endangered in Bangladesh and Vulnerable in India, its main range state. Traded in East Asian markets at volumes of 30–40 tons per week. It is listed on CITES Appendix I.		
River Terrapin *Batagur baska*  Ref.: Asian Turtle Trade Working Group 2000. *Batagur baska*. The IUCN Red List of Threatened Species. Version 2015.1.	The species has been reported from char lands in the middle of the river but could travel to other sections of the river. The project activity does not extend upto char lands and are confined to west bank of the Jamuna River. According to IUCN (**Ref.** EIA of the River Management Improvement Programme Bangladesh Water Board, Ministry of Water Resources, May 2015) Major turtle habitat lienorth of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore it is unlikely that despite a report by fishermen, the species is found here. Fisherman reports tend to be through memory and therefore report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.	**HIGH** : It is considered as Critically Endangered in Bangladesh and India because the subpopulations are all very small and declining. and Sch. III of Bangladesh Wildlife Prevention Order, 1973	**NEGLIGIBLE**	**NEGLIGIBLE**
Striped Roof Turtle *Baagur dhongoka*	The project activity outside the project site including water intake structures and pipelines and temporary jetty area do not has any nesting sites for these turtle species. According to IUCN (Ref. EIA of the River Management Improvement Programme Bangladesh Water Board, Ministry of Water Resources, May 2015) Major turtle habitats lie north of the area of influence of this project, therefore it is unlikely that despite a report by fishermen, the species is found here. Fishermen reports tend to be through memory and therefore	**HIGH:** It is uncommon in Bangladesh and listed as Endangered as per IUCN Red List.	**NEGLIGIBLE**	**NEGLEGIBLE**

Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
 Ref.: Asian Turtle Trade Working Group 2000. *Batagur dhongoka*. The IUCN Red List of Threatened Species. Version 2015.1.	report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.			
South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica*  Ref.: Smith, B.D. & Braulik, G.T. 2012. *Platanista gangetica*. The IUCN Red List of Threatened Species. Version 2015.1.	The project activities such as water intake structures does not impact the species , However, there is a likelihood of impact due to the vessel movement to temporary jetty area for transportation of material and dredging activities, through their propellers causing injury or death.	**HIGH:** It is listed as Endangered as per IUCN red list for Threatened Species. International trade is prohibited by the listing of the South Asian river dolphin on Appendix I of the Convention on International Trade in Endangered Species (CITES). The species is listed on Appendix I and Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS).	**SMALL**	**MODERATE**
Floral Species *Dipterocarpus turbinatus* ***Ref:*** Ashton, P. 1998. *Dipterocarpus turbinatus*. The IUCN Red List of	The project activity such as water intake system and temporary jetty do not impact the species. The species was observed inside the plantation area (at least 50 m from the road) and is not affected by removal of plantation trees due to	**HIGH:** The conservation status is based on rate of habitat loss. It is listed as	**NEGLIGIBLE**	**NOT SIGNIFICANT**

Species	Impact Description	Sensitivity	Magnitude of Effect	Significance
Threatened Species. Version 2015.2. <www.iucnredlist.org>. Downloaded on 05 July 2015.	strengthening of the Eco Park Road from Temporary Jetty to Project site.	Critically Endangered as per IUCN.		
Hopea odorata *Ref:* Ashton, P. 1998. *Hopea odorata*. The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>. Downloaded on 05 July 2015.	The project activity such as water intake system and temporary jetty do not impact. The species was observed inside the plantation area (at least 50 m from the road) and is not affected due to removal of plantation due to strengthening of the Eco Park Road from Temporary Jetty to Project site.	**MEDIUM:** The conservation status is Vulnerable based on rate of habitat loss. It is listed as Vulnerable as per IUCN.	**NEGLIGIBLE**	**NOT SIGNIFICANT**
Swietenia mahagoni ***Ref:*** Americas Regional Workshop (Conservation & Sustainable Management of Trees, Costa Rica, November 1996) 1998. *Swietenia mahagoni*. The IUCN Red List of Threatened Species. Version 2015.2. <www.iucnredlist.org>. Downloaded on 05 July 2015.	The project activity such as water intake system and temporary jetty do not impact. The species was observed inside the plantation area (at least 50 m from the road) and is not affected due to removal of plantation due to strengthening of the Eco Park Road from Temporary Jetty to Project site	**HIGH**: The conservation status is based on rate of habitat loss. It is listed as Endangered as per IUCN. Small quantities of timber from plantations are occasionally available on the international market. The species is listed in Appendix II of CITES	**NEGLIGIBLE**	**NOT SIGNIFICANT**

Preliminary CH Assessment

Criteria 1: One mammal (South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica* EN, *one bird, White-rumped vulture (Gyps bengalensis),* two reptiles River Terrapin *Batagur baska* CR and *Batagur dhongoka* EN and two floral species species *Dipterocarpus turbinatus* CR and *Swietenia mahagoni* EN were screened for potential critical habitat triggering against Criteria 1 and 2. It was assessed that criteria 3, 4 and 5 were not relevant for the screening process.

Conclusion

In this assessment we conclude that the three threatened plant species *Dipterocarpus turbinatu, Hopea odorata* and *Swietenia mahagoni*, are not impacted by the project activities and therefore do not result in triggering of critical habitats.

The White-rumped vulture (*Gyps bengalensis*) has been considered a possible candidate for critical habitats. However due to the very low likelihood of nesting trees within the AOI and the chance of poisoning by cattle contaminated by dicloefenac, the impacts are considered small though requiring some mitigation. Therefore given the highly threatened status of the species, the impact significance is considered moderate.

The two turtles and terrapin species have not been observed directly during the survey but have been reported by fishermen through identification from field guides. They have also indicated the location of nesting sites. According to IUCN (**Ref**. EIA of the River Management Improvement Programme Bangladesh Water Board, Ministry of Water Resources, May 2015) Major turtle habitats lie north of the area of influence of this project (i.e. near Shreepur, which is about 30 km north), therefore it is unlikely that despite a report by fishermen the species is found here. Fishermen reports tend to be through memory and therefore report s of the species may have been due to sightings further north. Species presence in this area is very unlikely.

There are no nesting sites within the area of influence and therefore impacts to possible congregations/aggregations of these species (e.g. as a consequence of migration) are unlikely.

The natural habitats within the Jamuna river are therefore assessed as either being of high or medium significance with the magnitude of impacts to the habitats considered small due to their limited spatial extent and inability to affect habitat function or viability. The threats to the species are considered small as the impacts are unlikely to cause a change in the species population or populations of other species dependent on them. Critical habitats are therefore not triggered for either the Striped Roof Turtle or the River terrapin or their habitats.

The South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica* has been recorded during the survey and from consultations with villagers. The species falls within Criteria 1, Tier 2e due to the presence in the Jamuna River being of considerable national significance and its threatened conservation status in Bangladesh (Table 6.18).

The impacts from project activities identified are

i. Accidental injury or death by propellers from boats plying the river for transportation of material for jetty construction and later use or dredging.

As discussed above the natural habitats within the Jamuna River are assessed as being of high significance due to the presence of this endangered species with the magnitude of impacts to the habitat considered small, due to their limited spatial extent and inability to affect habitat function or viability. The threats to the species are also considered small as the impacts are unlikely to cause a change in the species population or populations of other species dependent on it. Critical habitats are therefore not triggered for the South Asian river dolphin or its habitats.

Mitigation

Mitigation measures for habit are suggested in Table 6.26 and for species are suggested in Table 6.27. The mitigation methods recommended attempt to reduce impacts of project activities. They do not necessarily reduce impacts already of activities existing within the AOI prior to commencement of the project e.g. impacts from river vessels used for fishing or other river based activities and unconnected with the project activities or background sources of pollution within the river.

Table 6.26 Habitats -Mitigation Measures

Significance Ranking	Mitigation Hierarchy	Mitigation (Description)	Mitigation Area
Jamuna River			
Moderate	Minimisation	All vessels plying the river are to be properly maintained with oil seals etc. regularly checked for oil leaks etc. All containers used for hydrocarbons storage (vessels and jetty area) should be sealed tightly and secured to prevent accidental spillage or leaks into the river. Vessels plying the river and on shore facilities should be routinely inspected by the site security to ensure compliance to these principles. Any turtle or terrapin habitat identified during pre-construction surveys should be protected or if impacts cannot be avoided, restored to near natural conditions.	All across the Jamuna river to the temporary Jetty site and their return.

Significance Ranking	Mitigation Hierarchy	Mitigation (Description)	Mitigation Area
Jamuna Eco Park Minor	Minimisation	Species of conservational significance introduced into the Jamuna Eco Park are usually planted in the center of the plantation area. A survey of transportation route within the Jamuna Eco Park concludes that no such species are likely to be impacted. However, prior to the vegetation clearance for widening of the route, identification of all tree species to be removed by a qualified ecologist should occur as a precaution. Efforts should be made to replant the species within the Eco Park area. There is a likelihood of introduction of invasive species due to movement of Vehicles in the Jamuna Eco Park. All vehicles tyres should be properly washed before entering Jamuna Eco Park.	Transportation routes within Jamuna Eco Park

Table 6.27 Species -Mitigation Measures

Species	Significance Ranking	Mitigation (Description)
Birds:		
White-rumped vulture *Gyps bengalensis*	Minor	Identification of any trees where vultures nest on in the AOI and protection of these trees with a surrounding buffer area. Exclusion of cattle from project area by site security to reduce risks of carcasses contaminated by diclofenac being consumed by vultures.
Mammals: South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica*	Moderate	*Monitoring of Species*: The species occurs in the Jamuna River during the post monsoon season when the water level in the river rises based on information provided by fishermen. Movement of vessels in the Jamuna river to temporary jetty area will require vessel patrols or deck monitoring for detecting movement of South Asian River Dolphin. If such movement is observed, the vessel should be stopped until the species moves out of the path of the vessel. Vessel patrols and deck monitoring should be organized or enforced/ supervised by the site security. We also suggest that the company partners within an NGO with river dolphin conservation experience. The NGO can provide assistance for i. State of art training to site security for vessel patrol and monitoring (e.g. detecting signs of dolphin presence through early warning indicators). ii. Emergency response and medical care for any dolphins which are injured, using specialized veterinary experience.

Residual Impacts

Residual impacts have been provided in this section taking into account mitigation activities that will be carried out and avoidance/minimisation measures. Table 6.28 outlines the residual impacts on species. The main impacts relate to residual impacts caused by habitat loss for CR and EN listed species.

Table 6.28 Species Residual Impacts

Species	Pre-mitigation Impact Assessment	Description of value lost	Residual Impact
Birds: White-rumped vulture *(Gyps bengalensis)*	Minor	Given the very low population of the species in Bangladesh any mortality could impact the status within the country and should be actively avoided	Negligible: Actions suggested against the unlikely impacts are adequate to avoid mortality
Mammals: South Asian river dolphin (Jamuna Dolphin) *Platanista gangetica*	Moderate	The population in Jamuna river is assumed to be 38-58 individuals any mortality through accidents with river vessels could reduce the species numbers nationally, despite this impact being considered small. From the viewpoint of public opinion these threats should be actively minimized.	Minor-Mitigation suggested along with concerted, NGO assistance , is likely to reduce mortality to near zero levels ,

Table 6.28 outlines the residual impacts on species. The main impacts relate to residual impacts caused by habitat loss for CR and EN listed species, in particular. If impacts have been identified on critical habitats, the mitigation outcomes as outlined in IFC PS6 require a net gain in biodiversity values. However in this case, consequent to mitigation action, we perceive no or very minimal impacts on critical habitats. We surmise that with these actions, focussing on minimizing impacts, a no net loss balance will be maintained effectively with the AOI of the project. Mitigation action to achieve a net gain, such as designing and implementing biodiversity offsets [1] will not be required in this context.

6.4.8 Road network

During the construction phase of the Project additional soil materials along with construction material such as gravel, sand, steel and cement as well as plant equipment, construction equipment and machinery will be transported to the site. Further, excavation of earth and disposal of unsuitable soil from the project site will also be required. Sand and gravel for concrete will be transported from Jamuna Delta, which will be procured from licenced contractors. An increase in local traffic is expected as a result of the vehicles carrying construction material, machinery and equipment.

[1] Business and Biodiversity Offsets Programme (BBOP). 2012. Standard on Biodiversity Offsets. BBOP, Washington, D.C.

From the baseline surveys it is clear that access road connecting the Project site from the National Highway is about 6 m in RoW built on 1.5 m raised embankment. Though it was built for the sole purpose of providing connectivity to the Power Generation Complex, the villagers of Punorbason, Boro Simul and Panchosona also use this road. The majority of the vehicles on this road are non-motorized followed by motorcycles. The road is not a busy road. Due to the use of the approach road by the local villagers, the receptor sensitivity is considered as medium. A maximum of 12% of average daily traffic flow is recorded during the peak hour. When the construction for Sirajganj 4 power plant will start, there is likelihood that at the same time, Sirajganj 2 project will also be in the construction phase and due to increased no. of heavy vehicles on this road, the overall impact on the road network (i.e. access road) has been considered as small.

Based on the above, the impact is assessed as of ***minor*** significance.

Impact	*Traffic Impact on Road network (Construction Phase)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Access Road				
Frequency	Limited to Construction Phase and primarily material and personnel transport				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Mitigation Measures

The following mitigation measures will be put in place to reduce impacts to road networks in vicinity of the Project site to As Low as Reasonably Practicable:

- Avoiding peak hours for heavy vehicles movement where possible;
- During transportation of heavy equipment from the temporary jetty inside the ecopark to the main road a speed limit of 10 km/hr needs to be maintained by all heavy vehicles;
- 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Traffic impact on road network			
Residual Impact	Minor	Negligible	With implementation of the precautionary and the mitigation measures impact on road network would be negligible.

6.4.9 *Community Health and Safety*

Possible sources of impacts to 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; and
- Heavy traffic movement.

Criteria

The community health and safety impact assessment has been carried out with reference to the relevant national and international criteria and legislation, as outlined in *Section 2*. The sensitivity and magnitude criteria for community health and safety have been outlined in the ***Table 6.29*** and ***Table 6.30*** respectively.

Table 6.29 Sensitivity Assessment Criteria for Community Health and Safety

Sensitivity Criteria	Contributing Criteria
Community Health and Safety risk due to changes in environmental quality due to construction activities, increased prevalence of disease arising from the influx of construction workers Heavy traffic movement	
Low	The local community is not located in AOI and thus would not be exposed to health and safety risks from the project
Medium	The local community is located in close proximity to the project site or its associated facilities, including labour camp or access roads used
High	The local community is located in immediate vicinity of the project site and associated facilities and will have regular interaction with project activities, traffic movement and migrant labour for the project

Table 6.30 Criteria for Impact Magnitude for Assessment of Impact to Community Health and Safety

Magnitude Criteria	Negligible	Small	Medium	Large
• Changes in environmental quality due to construction activities • increased prevalence of disease arising from the influx of construction workers • Heavy Traffic Movement	• Qualitative: no perceptible or readily measurable change from baseline conditions • Scale: Localized area as particular activity areas • Time- Short Duration (few days) or one time as temporary	• Qualitative: perceptible change from baseline conditions but likely to easily revert back to pre-project conditions without mitigation • Scale: impacts restricted to project site, activity areas and their immediate vicinity • Time: only during the particular activities or project phase	• Qualitative: clearly evident and measurable changes from the baseline conditions which would take time to revert back to pre-project stage with mitigation • Scale: impacts restricted to activity areas and immediate vicinity. • Time: long term, spread across several phases of the project lifecycle	• Qualitative: major change in comparison to baseline conditions and may not revert back to earlier stage even with mitigation • Scale: impacts beyond AoI, at regional or international level • Time: Permanent Change

Receptors

Project site workers, settlements in close proximity to the Project site (within 500 m) and along the access road (with 100 m) are potential receptors of health impacts from construction related activities.

Impact Significance and Mitigation Measures

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 6.4.3*** and ***Section 6.4.4.***

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 6.4.1***and ***Section 6.4.2***.

The discharge of domestic waste effluent from sanitary facilities for construction workers may have the potential to cause contamination of surface water and groundwater in this area. A detailed assessment of this is presented in ***Section 6.4.2***.

The impacts to the workers on site and involved in transportation activities have been covered under Labour Welfare.

There is no community in the immediate vicinity of the project site, however the site identified for the labour camp is located in close proximity of Punorbason village, as discussed in ***Section 6.4.10***. The potential health impacts due to a change in the environmental conditions are expected to be of a temporary nature, restricted to the project site and their immediate vicinity. Keeping this in mind, the health and safety impact associated with changes in environmental quality is considered to have ***moderate*** significance when assessed against the receptors location and the various mitigation measures in place.

Impact	*Community health from changes in environmental conditions*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Project site and access road vicinity				
Frequency	Limited to Construction Phase and primarily covering dust, noise , waste generating activities and transportation				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate**				

Mitigation Measures

The following mitigation measures will be put in place to reduce impacts on community receptors:

- Barriers will be provided to prevent ingress 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 labour camps and surrounding areas; and
- Educating area residents and workers on risks, prevention, and available treatment for vector-borne diseases.

Increased prevalence of Disease

A total of up to 1,500 workers, during peak construction, 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 Arsenicosis, Tuberculosis, Pneumonia, 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. The proximity of the camp location with the nearby settlements (i.e. Punorbason and Khas Bara Shimul) also increases the risk in case of improper management of sanitary and other wastes.

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 labour camps will be implemented.

The community health and safety impacts from an increased prevalence of diseases are likely to be restricted to the local community in the immediate vicinity of the labour camp and within the construction phase of the project. Furthermore, the impacts should be such that can be mitigated with proper mitigation measures. Keeping this in mind, the impact to public health and safety is evaluated to be of **moderate** significance.

Impact	*Increased Prevalence of Diseases*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Settlement's around the Project site, Labour camps				
Frequency	Limited to Construction Phase primarily duration of labour stay				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate.**				

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;
- Prevention of larval and adult mosquito propagation through sanitary improvements and elimination of breeding habitats close to human settlements in the close vicinity of Project site;
- 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.

Heavy Traffic Movement

An increase in local traffic is expected as a result of the construction activities which may create public safety issues for local residents, especially along the access road.

From the baseline surveys it is clear that access road connecting the Project site from the National Highway is about 6 m in RoW built on 1.5 m raised embankment. Though it was built for the sole purpose of providing connectivity to the Power Generation Complex, the villagers of Punorbason, Boro Simul and Panchosona also use this road. The majority of the vehicles on this road are non-motorized followed by motorcycles. The road is not a busy road. A maximum of 12% of average daily traffic flow is recorded during the peak hour.

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; built on a raised embankment of 1.5 m and does not provide direct access to the villages. Furthermore, the impacts from traffic movement are expected to be restricted to the local community in the immediate vicinity and should be manageable with adequate mitigation measures, such as implementation of speed controls (20 km/hr). Thus, the potential impact to communities from heavy vehicular movement is assessed of **moderate** significance during the construction phase.

Impact	*Traffic Safety (Construction Phase)*			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	Access Road			
Frequency	Limited to Construction Phase primarily material transport			
Likelihood	Possible			

Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate**				

Mitigation Measures

The following mitigation measures will be put in place to reduce impacts to community to As Low as Reasonably Practicable:

- Road safety initiatives will be implemented to minimise risks to other users, including:
  - 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Community health impacts associated with environmental conditions			
Residual Impact	Moderate	Minor	With implementation of the precautionary and the mitigation measures mentioned for prevention/reduction of impact magnitude, impacts would be minor.
Increased Prevalence of Diseases			
Residual Impact			With implementation of the precautionary and the mitigation measures mentioned for prevention/reduction of impact magnitude, impacts would be minor.
Traffic safety due to heavy traffic movement			
Residual Impact			With implementation of the precautionary and the mitigation measures mentioned for prevention/reduction of impact magnitude, impacts would be minor.

6.4.10 Social Impacts

Criteria

For the assessment of the social impacts, the sensitivity and magnitude criteria outlined

Table 6.31 Sensitivity Assessment Criteria for Social Impacts

Sensitivity Criteria	Contributing Criteria
Employment generation, Benefit to Local Enterprises Impact on Fishing Households Labour Influx and Construction workers accommodation	
Low	The local community is not located in AOI and thus would not be impacted by the presence of the project
Medium	The local community is located in the AoI but not in close proximity to the project site or its associated facilities, including labour camp, jetty or access roads used
High	The local community is located in close proximity of the project site and associated facilities and will have regular interaction with project activities, traffic movement and migrant labour for the project

Table 6.32 Criteria for Impact Magnitude for Assessment of Social Impact

Magnitude Criteria	Negligible	Small	Medium	Large
• Changes in environmental quality due to construction activities • increased prevalence of disease arising from the influx of construction workers • Heavy Traffic Movement	• Qualitative: no perceptible or readily measurable change from baseline conditions • Scale: Localized area as particular activity areas • Time- Short Duration (few days) or one time as temporary	• Qualitative: perceptible change from baseline conditions but likely to easily revert back to pre-project conditions without mitigation • Scale: impacts restricted to project site, activity areas and their immediate vicinity • Time: only during the particular activities or project phase	• Qualitative: clearly evident and measurable changes from the baseline conditions which would take time to revert back to pre-project stage with mitigation • Scale: impacts restricted to activity areas and immediate vicinity. • Time: long term, spread across several phases of the project lifecycle	• Qualitative: major change in comparison to baseline conditions and may not revert back to earlier stage even with mitigation • Scale: impacts beyond AoI, at regional or international level • Time: Permanent Change

Receptors

Settlements in close proximity to the Project Site (within 500 m) and along the access road and labour camp (within 100 m) and the villages using the temporary jetty area for fishing are potential receptors of the impacts from the project activities.

Impact Significance

Employment Generation

Employment generation will be a significant contribution of the project, especially considering that the employment scenario in project area (refer to ***Section 4.6.5***). The project is expected to employ 1000 un-skilled and semi-skilled labours during the construction phase. The civil works and installation of power plant equipment 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 Generation*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Benefit to Local Enterprises

Local enterprises, particularly those involved in the production and sale of construction materials, are potential benefactors of the civil works involved in the project. Brick-making provides employment to a large number of local un-skilled labours. Similarly, stone crushers and local transporters of these materials will also benefit from the project. The significance of the benefit to local enterprises is summarized below:

Impact	*Benefit to Local Enterprises*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Impact on Fishing Households

Khas Chtragachha located to the north of the power generation complex and adjacent to the temporary jetty has approximately 35 households out of total 110 households whose primary occupation is fishing. Apart from this Paschim Mohanpur and Purba Radhunibari has a few fishing households. It was observed that these households particularly in Khas Chtragachha own small boats and use them for fishing in the Yamuna River. Apart from the around Bangabandhu Bridge, there is no restriction of fishing in the Yamuna River. Hence, they access both upstream and down-stream locations to carry out fishing.

The dredging at the proposed temporary jetty and use of the jetty location for part of the construction phase will impinge on the locations used by these households to anchor their boats. The dredging will temporarily drive away the fish in the immediate downstream locations. Increased navigation may reduce the overall fish-catch for these households. However, only approx. 10% of the households in the community are reported to be using the temporary jetty area. These impacts are also going to be restricted to the duration in which the jetty is used. Keeping this in mind, the impacts on fishermen households due to the use of the jetty area are evaluated as **Minor**.

Impact	*Impact on fishermen households using the temporary jetty location to anchor their boats*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Out of the 35 households practicing fishing in Khas Chtragachha 5-10 households use the temporary jetty location to anchor their boats. The dredging activities near the temporary jetty to provide sufficient draft for the barges/ vessels will also impact the fish catch near the jetty location. However, the areas upstream of the jetty location to the newly constructed closure will be available for both fishing and anchoring of boats.				
Frequency	Restricted to Construction Phase only.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

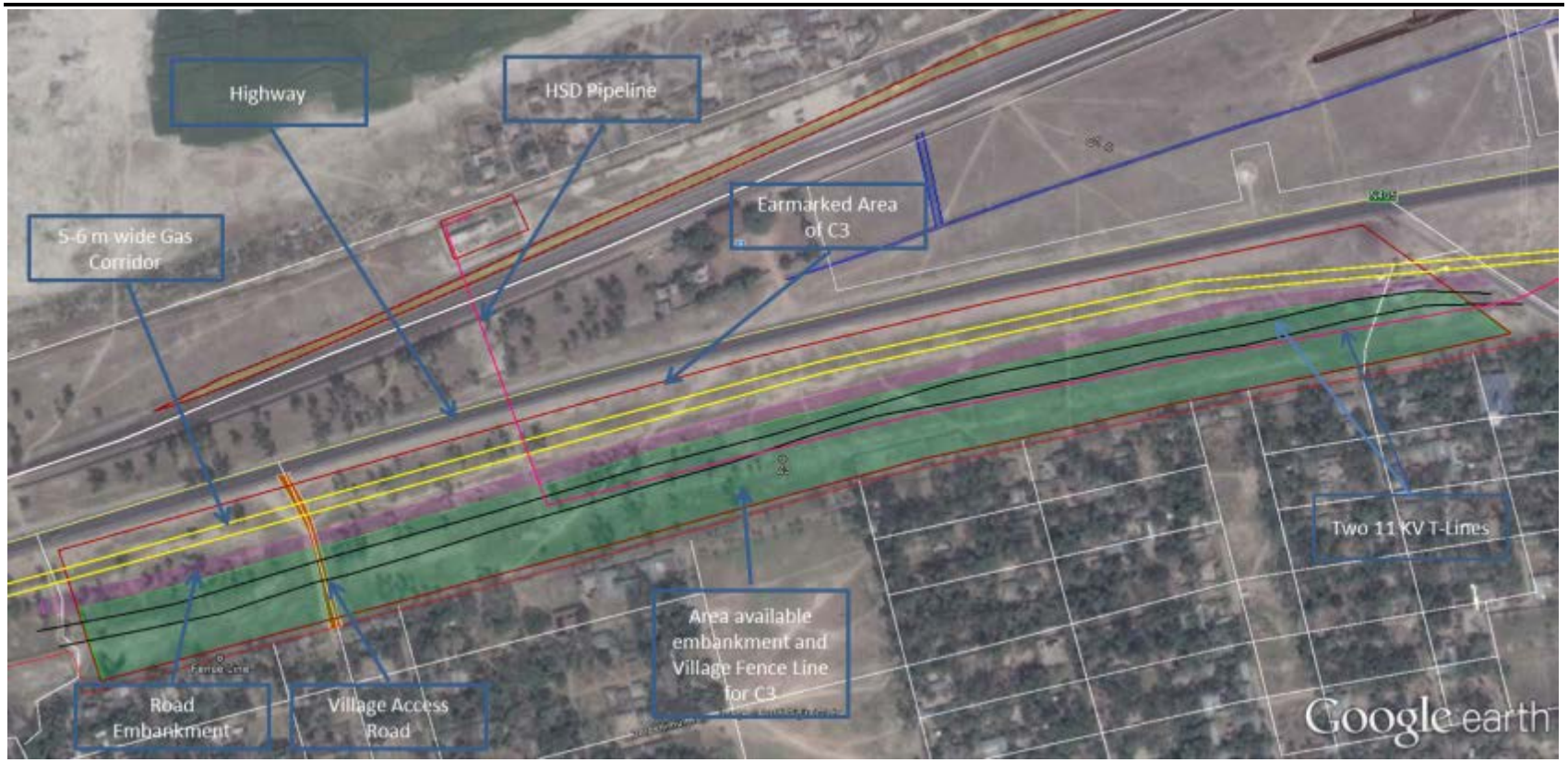
Labour Influx and Construction Workers Accommodation

Out of the total labour requirement of 1500 (during peak construction), it is expected that about 25% would be sourced from other parts of Bangladesh. The migrating labour population will primarily consists of more skilled labour workforce while unskilled workforce would be mostly procured locally through local contractors. The labour influx will be for short term and they would return back to their home provinces at the end of construction period.

There is a likelihood of overlapping in the construction schedule of Sirajganj 4 and Sirajganj 2 projects within the power generation complex and this will lead to unavailability of land within the complex for construction workers camp. Therefore, the labour camp will be located outside the power generation complex. The area identified for the construction workers camp is located between the main highway and Punorbason village fence line. Available land area for this purpose is about 8.37 acres.

Total area earmarked was earlier about 15.6 acres, however, during the site reconnaissance, it was noted that elevated land portion towards the national highway has a ~6 m wide right of way for the Main Gas Pipeline of PGCL and no activity is permitted on top of this corridor. Furthermore, the embankment of the road also need to be avoided and hence only the area between the slope of embankment and the fence line of Punorbason village has been considered suitable for the construction camp, due to its proximity to the project site as well as availability of land (BBA land).

Figure 6.14 Construction Camp Area Identified- C3



Keeping in mind the key features of C3, the following main risks were identified with using this area for a labour camp:

- High interaction with the local community, with a potential of certain risks associated with increase in conflict and social unrest, health related issues including risk of sexually transmitted and communicable diseases.
- Strain on local resources and infrastructure, especially water, medical facilities, electricity, food and provisions in the local markets. This may also result in an increase in the overall price of essential commodities in the area.
- The construction of the labour camp, will require the diversion of the small tracks used by the community for reaching the highway and other villages as well as the drainage of the waste water from the village into the block identified, to avoid health risks from accumulated water to community and workers.
- As the C3 area is low lying, specific measures will have to be put in place to avoid collection and stagnation of water in and around the labour camp.
- The provision of sanitation facilities will also have to take into account the proximity of the local community and ensure that the presence of the labour camp does not result in increased risks in terms of hygiene and sanitation for the community.
- Also, due to the presence of pipelines in the area identified, precautions will have to be taken to mitigate the risks of fire and explosions and the workers will have to be aware of the same.

The influx of labour also raises other challenges such as health related issues (including sexually transmitted and communicable diseases), unhygienic conditions in constructed labour camps, strain on local food produce available in the local markets etc. Considering the fact that proper accommodation facilities are provided as part of the project design and also the fact that the total migrant labour will account for about 25% of the total workforce of about 1,500 (which is an insignificant number as compared to the existing population within the AOI), the severity of the impacts raised above is expected to be ***Moderate.***

Impact	*Labour Influx during Construction Phase*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Out of 1500 expected workforce during peak construction stage, 25% are expected to be sourced from outside of Sirajganj District				
Frequency	Restricted to Construction Phase only. The labour camps are going to be de-constructed during the operation phase of the project				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate.**				

Meeting Community expectations

The construction phase of the project is expected to create both employment opportunities as well as indirect opportunities for service and contract providers. There would be an increase in expectation from the local community with respect of these generated opportunities and an expected level of preference to them above foreign parties from Sembcorp and EPC contractor. These expectations have to be managed by Sembcorp and EPC contractor strategically in order to prevent any negative sentiment rising within the community about the project or any sense of disassociation from it. At the present status quo, neither the level of this expectation on behalf of the community could be identified quantitatively, nor could it be identified that how much of participation Sembcorp/EPC contractor wants to engage in, the impact has been kept as ***neutral***. However, Sembcorp has planned to engage with the community during the entire project execution and operation phase.

Commitments already communicated with the community include:

- Engaging closely with local NGOs to understand the key collective requirements of the surrounding community and identify one or more of the highlighted concerns which SNWPCL will support to resolve.
- Some of the collective requirements could be access to (i) clean drinking water (ii) medical consultation (iii) education, etc.
- Enhance employment opportunities by maximizing utilization of the local population, as far as possible.
- Communication of a clear plan of action to improve the welfare of the neighboring community, before commencing construction works on site.

Mitigation Measures

The following mitigation measures are proposed to avoid impact due to labour influx:

- Preventing stress on local infrastructure by providing labour related infrastructure such as camps, sanitation facility, drinking water facility, etc. in accordance with local regulations;
- Consulting with the local community prior to finalization of location of labour camp to get their consent
- Preparation of a detailed plan, in keeping with lender requirements, for the construction of the labour camp and the mitigation measures to be put in place
- Ensure proper administrative channel to manage labour related statutory compliance, such as payment of wages, provident fund, insurance etc. as well as labour issues arising during the construction phase activities;
- Manage illegal labour practices such as child labour, bounded labour or forced labour through internal vigilance mechanisms and surveillance; and
- Awareness shall be generated amongst migrant labourers in maintaining congenial relations with local labourers as well as community.
- Consultations with the fishing households should be done before dredging and other site improvement activities are carried out at the Jetty location.

Alternative anchorage areas should be identified and safe anchorage of their boats to be facilitated.

- The reduction in fish catch for these fishing households should be compensated through cash payment during the period for which jetty is used.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Remark
Impact on fishermen households using the temporary jetty location to anchor their boats			
Residual Impact	Minor	Negligible	Providing alternate anchorage, if required will minimise the impacts and the residual impacts will be negligible in nature.
Labour Influx and Construction Workers Accommodation			
Residual Impact	Moderate	Minor	Proper management of construction workers accommodation and implementation of the mitigation measures will minimise the impacts and the residual impacts will be minor in nature.

6.5 POTENTIAL POLLUTION SOURCES AND MITIGATION MEASURES

This section discusses the potential sources of pollution and in built/ pre-planned measures taken up by Sembcorp. The impact assessment has been done taking in to consideration the inbuilt/pre-planned scenario.

6.5.1 *Air Emissions*

The flue gas stack and by-pass stack will have sufficient height to ensure compliance with emission standards as specified in the Emission Guidelines for Combustion Engines in the World Bank *EHS Guidelines for Thermal Power Plants*. It is proposed to provide 72.3 m and 45 m tall stacks above grade for the main stack and by-pass stack respectively, to ensure adequate dispersion of discharged combustion gases in the atmosphere.

The air emissions from the Plant will primarily be in the form of Oxides of Nitrogen (NOx) and Carbon Monoxide (CO). Sulphur Dioxide (SO_2) emission in the flue gas is not anticipated as there is no sulphur in the natural gas. Particulate matter emissions are also not anticipated due to use of natural gas.[1] However, in case of use of HSD as fuel for power generation in the combustion turbine, SO_2 and particulate matter will also be generated. The Plant will demonstrate air emission criteria at 100% capacity as guaranteed to BPDB, which are presented in ***Table 6.33.***

(2) [1] 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, may be released if poor air/fuel mixing and the incomplete combustion of the fuel source occurs.

Table 6.33 Air Emission Criteria for Flue Gas Stacks

Pollutant	Unit	At 100% Capacity	
		Natural Gas	HSD
NOx	ppmv	≤ 25	≤ 74
CO	ppmv	≤ 100	≤ 100
SO_2	mg/Nm^3	N/A	<150
PM	mg/Nm^3	N/A	≤50

Source: Sembcorp

Notes:

- ppmv is defined as parts per million by volume at 15% oxygen dry at 32°C, 85% relative humidity and 1.013 bar pressure.
- The proposed guaranteed value for NOx emission level is based on site conditions of 32°C ambient temperature and 85% humidity.
- Values given are related to 3% excess oxygen in dry exhaust gas, where Nm3 = 1m^3 at 1.01325 bar pressure, dry at 0°C.
- HSD will have maximum sulphur content of 0.25%.

To ensure compliance with air emission criteria for flue gas discharge and a safe working environment, the following measures will be implemented during operations:

- Continuous emission monitoring (CEM) equipment for the measurement of air emission levels in the exhaust stack of HRSG. The stack will be provided with safe access to the sampling points for CEM;
- Sampling points for the CEM equipment will be provided on the stack;
- The gas vent stack will have sufficient height to ensure that the concentration of gas at ground level is significantly less than the explosive limit[1] and that the odour of gas cannot be detected; and
- The vent from the lubricating oil tank will be fitted with coalescer.

6.5.2 Greenhouse Gas (GHG) Emissions

The combustion of natural gas/ HSD produces GHG emissions. 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 consumption. Based on the natural gas requirement for the Project, it is anticipated that the annual GHG emissions from the Plant will be of the order of 1.404 x 10^6 tonnes of CO_2e considering use of natural gas as primary fuel.

6.5.3 Noise Emissions

The Project will comply with the noise emission criteria as per the standards stipulated in the reference framework, i.e. Schedule 4 of Environmental Conservation Rules (ECR), 1997 of Bangladesh as well as Noise Level Guidelines as prescribed in the General EHS Guidelines of World Bank. The noise emission criteria for the Project have been presented in ***Table 2.10***.

(1) [1] The natural gas is mainly consisting of methane, which is having lower explosive limit (LEL) of 5% by volume of air, whereas upper explosive limit (UEL) of 15% by volume of air.

To ensure compliance with the noise emission criteria and compliance with the stipulated standards/ guidelines in the reference framework, the following measures will be implemented during operations:

- The Combustion Turbine will have noise attenuation, which will consist of air intake silencers and acoustic insulation;
- To reduce the noise level for the fuel gas skid, sound absorbing walls will be provided;
- Noise levels within the Steam Turbine building will be less than 85 dB(A);
- The Central Control Room will have sufficient sound insulation to ensure noise levels below 55 dB(A);
- Noise levels in any area in which an operator may be continuously exposed will be less than 85 dB(A) for 8-hour normalized exposure level limit[1];
- Further, the noise limits at office areas and control rooms will be 45-50 dB(A);
- All above ground piping outside buildings will be acoustically insulated as necessary to reduce the noise emanating from the piping;
- The specified noise criteria will be met under all normal operating conditions including Start-up, Shutdown and other normal operating conditions. An exceedance of the Noise limitations will only be allowed during emergency operating conditions (limited to 100 decibels) where physical damage to the Plant or physical harm to an individual may result, this will include the lifting of safety relief valves. Local community residing within 500 m from the project boundary should be informed about any such emergency condition as part of the offsite emergency plan;
- Warning signs will be provided at all entrances to rooms/areas where the noise level may exceed 75 dB(A); and
- Construction work during the night-time on weekdays will be carried out only after taking approval of the local authority.

6.5.4 Water Pollution

The cooling water and all other effluents will be disposed on land close to the southern boundary of the Saidabad Power Generation Complex (refer to Box 6.4 for location of the discharge point), which is about 300 m away from the adjoining channel, according to GOB Environment Conservation Rule (1997) Schedule 9 and Schedule 10. The temperature of the effluent discharged will not exceed 40°C in winter and 45°C in summer. Maximum allowable cooling water temperature rise will not be more than 3°C. Review of geo-technical data collected for Sirajganj 2 Project[2] also reveals that (a) The soil is mostly silty sand and fine sand in all the bore logs with some small layers of silty and clayey sand in a couple bore logs, which indicates that the soil profile is

(2) [1] As per the World Bank/ IFC General EHS Guidelines: Occupational Health and Safety

[2] Geotechnical Ivestigation Report of Sirajganj 225 MW Combined Cycle Power Plant (2nd Unit) – Detailed Design (April 2015), prepared by Fujian Electric Power Survey & Design Institute, Fuzhou

porous in nature and is good for water percolation; (b) Soil permeability coefficient is in the range of 10 to 15 m/day, which is as per soil permeability classes represent "very rapid" soil permeability class (i.e. > 6 m/day); (c) Shallow ground water depth is about 8 m from the Saidabad Power Generation Complex and will be about 4 to 5 m from the water discharge locations during dry season.

Water intake for the project will be approximately 600 m^3/hr and water outfall will be about 74.4 m^3/hr. The cooling water discharge will be continuously monitored for pH and temperature.

Sources of liquid effluent generation in the Plant will be as follows:

- 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;
- CTG washing;
- HRSG washing;
- Filters (service water filtration plant) back wash; and
- CW side stream filter backwash.

The liquid effluents will be collected and treated/ recycled as per the following design philosophy:

- Reverse Osmosis (RO) plant reject, RO chemical cleaning waste, mixed bed (MB) regeneration waste after neutralisation will be led to CW mixing chamber;
- Filter/ ultra-filtration (UF) backwash water will be led to CW mixing chamber;
- Oily wastewater from fuel oil area, power house area, transformer yard will be collected and treated in oil water separator and then disposed to CW mixing chamber; and
- Boiler blow down after quenching will be led to the CW mixing chamber.

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.

Plant drains (storm water drains) from the power house area, transformer area and fuel oil handling storage area will be collected in different sumps and led to a common oily waste sump. This will include all oil filled motors and pumps. These oily effluents will be further treated in an oil water separator

for removal of oil traces. The clear water will be led to CW mixing chamber and the dirty oil will be disposed of in drums separately. Boiler blow down will be collected in a common blow down sump and released to the Jamuna River. The RO module and MB cleaning waste will be led to CW mixing chamber after neutralisation.

The ion exchange units of the water treatment plant will be regenerated with sulphuric acid and caustic soda. The effluent from regeneration will be mixed, neutralised and diluted before discharge.

Treated effluent generated from sewage treatment plant (~ 3 m^3/hr) will be used within the site for greenbelt development. No untreated sewage will be directly discharged into Jamuna River/Channel or disposed of on land through the project life cycle.

Plant wastewater and all effluents (***Table 6.34)*** will be treated to comply with the effluent discharge limit criteria according 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 (whichever is more stringent). The effluent discharge criteria adopted by the Project are presented in ***Table 2.8***.

Table 6.34 Wastewater Generation from the Plant

S. No.	Source of Generation	Quantity (m3/hr)
1.	Cooling Tower Blow Down	67.0
2.	Boiler Blow down	4.1
3.	DM Neutralisation Pit Discharge	2.0
4.	Effluent Treatment Plant	1.3
5.	Sewage Treatment Plant	3
	Total	***77.4***

Source: Sembcorp

The sewage will be treated in a sewage treatment plant, and treated effluent (complying with the effluent discharge limit criteria according to the GOB Environment Conservation Rules (1997) Schedule 9 (Standards for Sewage Discharge) will be discharged on land (refer to ***Table 2.9***). Treated sewage effluent will be used for gardening purposes within the plant premises.

Instrumentation will be used to monitor the Plant's compliance with discharge limitations. In the event that the effluent discharge is detected above the effluent discharge limit criteria, isolation valves will be automatically closed to prevent accidental discharge of untreated effluent.

6.5.5 Solid and Hazardous Waste Generation

During the operation phase of the Project, the main sources of wastes generation with the quantity, storage and disposal options are presented in ***Table 6.35***.

Table 6.35 Solid and Hazardous Wastes during Operation Phase

S. No.	Waste Type	Source	Quantity	Collection & Storage	Disposal Method
1.	Chemical Waste	Regeneration waste discharge to wastewater	500 m^3/year	ETP	After treatment discharge on land
2.	Chemical Cleaning	GT Compressor	300 l/year	Concrete Pit	Offsite treatment (approved and authorised by DoE)
3.	Waste Oil	Oily water from power house, workshop area	2 m^3/year	Oil separator in ETP. Oil stored either in separator or steel barrels	To be sold to licensed contractor for treatment and recycling for permitted use or disposal
4.	Oil-dust contaminated cloth/cotton rags	Lube oil system	600 kg/year	Stored in steel containers on-site	Offsite disposal facility (approved and authorised by DoE)
5.	Solid waste	Dewatered sludge from WTP/ETP (primarily composed of silts and inorganic salts precipitated in WTP/ETP)	300 kg/year	Dried sludge to be stored at site	To be disposed through a DoE approved contractor for land filling.
6	Office and Food waste	Waste paper, kitchen wastes, household waste	5,000 kg/year	Waste paper box, waste bins	Recyclable waste to be sold to local vendors. Other wastes to be disposed through waste disposal contractor.
7	Air filters	Gas Turbine	300 kg/year	Bags	Dispose to an authorized recycling company or disposal contractor
8	Solid Waste	Dewatered STP sludge	200 kg/year	Dried sludge to be stored at site	To be used as manure

Note: All the hazardous waste to be stored at site in paved and covered area with provision of containment for any accidental spillage

6.6 ASSESSMENT OF IMPACTS - OPERATION AND MAINTENANCE PHASE

The assessment of operational phase impacts includes those arising both from routine operations and maintenance of the power plant, including the gas and HSD supply systems. An activity-impact interaction matrix for the operation phase of the Project is presented in Table 6.4.

6.6.1 Soil and Sediment Quality

Contamination of soil and sediment from wastes

The potential sources of waste generation during operation of the Power plant are from the following:

- Office and Canteens;
- WTP, ETP and STP;
- Gas Turbines;
- Laboratories;
- GT Compressors;
- Lube oil systems;
- DG sets; and
- Power house and workshop area.

Criteria
Presently the rules of solid waste management and hazardous waste management are under preparation in Bangladesh. Once they are drafted the Project will be governed by these rules. As Bangladesh is a signatory to the *Basel Convention on Transboundary Movement of Hazardous Waste, 1989 (assessed by the GOB in 1993)* and the *Stockholm Convention on Persistent Organic Pollutants, 2001 (assessed by GOB in 2007),* these will also apply to the Project.

Receptors
Land around the Project site is mostly fallow or agricultural. A Channel is located about 200 m in east direction and about 400 m in south direction of the project site. 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 odour and cause health hazards to employees and communities nearby. Referring to sensitivity criteria described in ***Table 6.5***, the receptor soil and sediment has been assessed low.

Impact Significance

The impact assessment of the wastes generated from the sources identified above is summarized below:

Generation of Non-Hazardous Solid Waste
The type and approximate volume of non-hazardous solid waste anticipated from operational activities will be as follows:
- Office and kitchen, 5,000 kg/year;
- Dewatered STP sludge from the WTP, ETP and STP sludge, 50 - 70 kg/year; and
- Air filters from the gas turbines, 300 kg/year.

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.

Generation of Hazardous Waste

The type and approximate volume of hazardous waste anticipated from operational activities will be as follows:

- Chemical waste generated, 500 m^3/year;
- Chemical Cleaning waste from the CT compressor, 300 l/year;
- Waste/used oil from the power house and workshop, 2 m^3/year;
- Dewatered sludge from the WTP and ETP, 200 - 230 kg/year; and
- Oil/dust contaminated cloths and rags from the lube oil system and spill kit waste, 600 kg/year.

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 planned embedded controls, i.e. segregation measures, collection and disposal by licensed waste collectors, dedicated storage areas with secondary containment, the impacts magnitude during operation as a result of solid and hazardous waste generation is assessed as ***small***.

Impact	*Contamination of Soil and Sediment from Wastes*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to Project Site Surroundings and nearby communities				
Frequency	Not Applicable				
Likelihood	Likely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

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; and
- Disposal of hazardous waste by engaging DOE approved waste management agencies.

6.6.2 Water Resources

Sources of Impact

The potential sources of impact to surface and ground water resources during the operational phase include:

- The discharge of effluent and sewage from the operational plant that may have an impact on land or the quality of surface water; and
- The abstraction of ground water for drinking purposes for the employees of the power plant.

Criteria

For the assessment of water resources, the sensitivity and magnitude criteria outlined in *Table 5.7* and *Table 5.8* have been used respectively. The assessment of potential impacts to surface water has considered *Schedule 3 (a), 9 and Schedule 10 of ECR, 1997* (refer to ***Table 2.8*** and ***Table 2.9*****).** For groundwater, *Schedule 3 (b) of ECR, 1997,* standards for drinking water has been considered.

Receptors

Surface water: A Channel is located about 200 m in east direction and about 400 m in south direction of the project site (refer to Box 6.3), which is dried most of the time and gets water only during the monsoon season. The main Jamuna River flows on the eastern side about 1.2 km from the Project site and will be the source of water for the Project. The source of water would be the Jamuna River. Based on the sensitivity criteria Table 6.7, surface water resource is assessed as Medium.

Box 6.3 ***View of Adjoining Channel from Saidabad Power Generation Complex Boundary during non-monsoon season***

Source: ERM (June 2015)

Groundwater: Ground water samples analysis indicate high levels of iron with other parameters being within standard permissible limits for drinking water specified by Bangladesh ECR, 1997 Schedule 3 (B). Arsenic concentration is also reported in ground water tube well in the Project AOI though the samples analysed were within limits. Groundwater is used by local residents in the area for drinking. Based on the sensitivity criteria Table 6.7, ground water resource is assessed as Medium.

Impact Significance

Surface water abstraction

About 600 m^3/hr of water will be abstracted for the Jamuna River for the proposed plant. This may result in:

- Reduced availability of water to downstream users;
- Affect the sustainability of the Project due to non a-availability of water in lean season;
- Result in changes in to the morphology of the adjacent Channel; and
- Cause ecological effects.

A study carried out by the Institute of Water Modelling (IWM) in Feb 2013[1] concluded that the total amount of water required for the power plant is insignificant when compared to the lowest discharge during lean flow period. Based on the last 15 years data of water flow in the River Jamuna as recorded by BWDB, minimum flow of the River was measured as 7,332,552 m^3/hr on 5th March 2013. Whereas the proposed water requirement of the Sirajganj 4 project is about 600 m^3/hr. This amount is only 0.008% of the lean season flow of the Jamuna River in Sirajganj and hence, the amount of intake is negligible in the context of River Jamuna. Furthermore, the study conducted by IWM also revealed that the minimum discharge of the channel near West Guide Bund (WGB) is about 745 m^3/s and the maximum char extent between the channel and WGB is around 910 m at intake location and 1040 m after 250 m downstream. Considering the lean season flow of the channel near intake location, the water intake is of the order of 0.02%. Considering the lean season water availability in the River Jamuna as well as the channel near WGB, it is evident that the amount of water intake is negligible in the context of water availability in the River/ Channel. The amount of intake is also incapable of changing the morphology of the right channel.

The EIA study Report of NWPGCL's Sirajganj 2 (proposed 225 MW CCPP) prepared by Engineer's Associates Limited, May 2014 states that its existing plant uses 600 m^3/hr from ground water and the proposed Sirajganj 2 project would use a similar quantity of 600 m^3/hr from ground water. At present, source of water for Sirajganj 3 project is not known and it has been assumed that the project will also use ground water with similar quantity of 600 m^3/hr. So there would not be any impact on surface water due to abstraction from these NWPGCL's plants on the river Jamuna.

Therefore based on the impact magnitude criteria described in Table 6.8 and referring to above discussion, the impact of water abstraction on river Jamuna for the proposed plant would be **negligible.**

[1] The study was carried out by IWM on behalf of LANCO Power International Pte Ltd for the proposed project.

Impact	*Impact from Surface Water Abstraction*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Downstream of Jamuna River and Project area				
Frequency	Throughout Operation Phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Water Pollution from Wastewater Discharge

Approximately 74.4 m^3/hr of effluent will be discharged from the plant to the southern boundary of the plant on land in the upstream of adjacent Channel 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.

Theses discharges may have a direct impact on the water quality which in turn would have ecological implications.

As discussed in ***Section 6.5.4*** and in the water balance ***(Figure 3.11)*** 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 (which ever more stringent).

In order to assess the impact of existing discharges from Sirajganj 1 power plant, monitoring of discharges at the outfall location and at mixing zone (where the discharge water mixes with temporarily stagnant water, which seeps into the ground or gets evaporated during the non-monsoon season) on the eastern boundary were being monitored in June 2015. The results of on-site water quality testing are presented in Table 6.36.

Table 6.36 On-site Water Quality Test Results of S1 Discharge

Date	Time	Location	Temperature	pH	TDS
02 June 2015	12:30 PM	S1 Discharge Point	34.8°C	8.73	490 mg/L
	12:40 PM	At Mixing Zone	34.2°C	8.70	490 mg/L
02 June 2015	6:30 PM	S1 Discharge Point	32.0°C	8.87	470 mg/L
	6:40 PM	At Mixing Zone	30.9°C	8.83	480 mg/L
03 June 2015	9:45 AM	S1 Discharge Point	32.9°C	8.77	470 mg/L
	9:57 AM	At mixing zone	32.8°C	8.73	480 mg/L
	10:05 AM	50 m downstream	31.8°C	8.75	440 mg/L

Source: ERM

The above table clearly indicates that the discharges from S1 plant for TDS are below 500 mg/L, as against limit of 2,100 mg/L defined for discharge of effluent on inland surface water and on land for irrigation in the "*Schedule 10 - Standard for Waste from Industrial Units or Projects Waste*" of the ECR, 1997. It was also been observed that the maximum discharge temperature was recorded as 34.8°C and at mixing zone, the temperature of the water reduces to about 34.2°C. pH was also observed well within the limit of 6 – 9. During the monsoon period (1-2 months), the discharge location gets connected with the adjacent channel, which provides sufficient dilution to the discharge water.

Review of geo-technical data collected for Sirajganj 2 Project also reveals that (a) The soil is mostly silty sand and fine sand in all the bore logs with some small layers of silty and clayey sand in a couple bore logs, which indicates that the soil profile is porous in nature and is good for water percolation; (b) Soil permeability coefficient is in the range of 10 to 15 m/day, which is as per soil permeability classes represent "very rapid" soil permeability class (i.e. > 6 m/day); (c) Shallow ground water depth is about 8 m from the Saidabad Power Generation Complex and will be about 4 to 5 m from the water discharge locations during dry season. There was no infiltration test conducted as part of the geo-tech investigation, however, the these points do indicate that soil properties are favorable for water percolation on the soil during dry season.

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 based on the results of the Sirajganj 1 project and magnitude criteria described in Table 6.8 is assessed as **negligible**.

Impact Nature	Negative		Positive		Neutral
Impact Type	Direct		Indirect		Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local	Regional			International
Impact Scale	On land in the upstream of adjoin Channel during non-monsoon season and in the channel during monsoon season (about 2 months).				
Frequency	Not Applicable				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Secondary Impacts on Aquatic Flora and Fauna due to Discharge of Cooling Water

Water is mainly required for cooling purposes in the project which will be sourced from Jamuna River 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). The project has a raw water requirement of the order of about 600 m^3/hr, whereas the outfall is expected to be 74.4 m^3/hr. The cooling tower blow down and other treated effluent generated from boiler blow down, effluent treatment plant and DM plant will be discharged on land in the southern boundary of the project site during non-monsoon period and on channel containing water in the monsoon period (refer to Box 6.4 for location of discharge point). 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 used non-toxic and heavy metal base free dispersants and algaecides in the project.

Box 6.4 Discharge Locations of S1 and S4

Discharge location of Sirajganj 1 Project

Proposed location of Treated Wastewater Discharge of Sirajganj 4 Project

Since, the project will not have any direct discharge into the Jamuna River or Channel during non-monsoon season and during monsoon season the water will be available in abundance in the Channel to provide sufficient dilution and hence, the impact of the discharge on aquatic flora and fauna is considered as ***negligible***.

Impact	*Discharge of Cooling water due to operation of Power Plant*		
Impact Nature	Negative	Positive	Neutral
Impact Type	Direct	Indirect	Induced

Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Outfall point in the southern boundary of the Project				
Frequency	Operation Phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Mitigation Measures

The following mitigation measures are suggested to minimize the impact on 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)*.
- In the unlikely event water percolation does not occur as expected, SNWPCL could rely on temporary solutions such as to engage a sub-contractor to use the portable pumps & hoses to evacuate this water to the river or dry canal, thereby allowing a larger surface area for the water to percolate.
- SNWPCL will monitor the wastewater discharge and if water stagnation if observed to persist continuously over an extended period of [12-18] months, then SNWPCL will evaluate permanent solutions to resolve the issue. However if the water stagnation is observed to occur for only part of the year, then the temporary solution should suffice.

Impact due to Groundwater Abstraction

Groundwater abstraction at the Plant will be undertaken for drinking water purposes only. The quantity of groundwater abstraction will be 4-5 m^3/day.

A license for groundwater abstraction well installation will be sought from the Sirajganj Sadar Upazilla Parishad prior to installation. The quantity of groundwater abstracted and associated draw down will be monitored. Arsenic concentration is also reported in ground water tube well in the Project AOI though the samples analysed were within limits. It has been proposed in the project to have water treatment facility for potable water, which will also have the provision for arsenic removal.

With the operational control measures in place, the small number of operational staff at the site and the nearness to the Jamuna River, the magnitude of impact to groundwater depletion in the area as a result of abstraction is considered to be low. Any impact would be short term, reversible and localised in nature. Based on Magnitude criteria described in Table 5.8, the overall significance is therefore assessed as ***negligible.***

Impact	*Impact from Ground Water Abstraction*				
Impact Nature	Negative	Positive			Neutral
Impact Type	Direct	Indirect			Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local	Regional			International
Impact Scale	Project site and vicinity				
Frequency	Throughout operations phase for potable purpose				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High	
Impact Significance	Negligible	Minor		Moderate	Major
	Significance of impact is considered **negligible.**				

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 maximum volume stored will be 2 tonnes each of hydrochloric acid, caustic lye. The hazardous materials will be stored in a dedicated room at the water treatment plant area. HSD to be used as secondary fuel for power generation will be stored in two tanks with capacity equivalent to 15 days operation at 80% output on HSD. Diesel for emergency DG sets will be stored in above ground oil tanks located in the vicinity of the Black Start DGs and Emergency DG set. 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 ***minor.***

Impact	*Groundwater contamination*				
Impact Nature	Negative	Positive			Neutral
Impact Type	Direct	Indirect			Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local	Regional			International
Impact Scale	Project Footprint Area				
Likelihood	Unlikely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major
	Significance of impact is considered **minor.**			

Mitigation Measures

Other mitigation measures which will be adopted to reduce impacts on water quality to As Low as Reasonably Practicable are as follows:

- For minimising use of antifouling and corrosion inhibiting chemicals appropriate depth of water intake will be maintained and use of screens will be ensured;
- Minimum required quantities of chlorinated biocides or alternatively intermittent shot dosing of chlorine will be practised 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.

6.6.3 Air Quality

Operation of Sirajganj-4 Project

Sources of Impact

The Project includes dual fuel fired combined cycle power plant (CCPP), consisting of 1 GT, 1 HRSG and 1 ST. As indicated in the Project Schedule, the simple cycle plant will be ready for operation by 24th month from the start of construction, whereas the combined cycle plant will be operational by 30th month from the start of construction.

The GT 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.

Taking the above operational conditions into consideration, two scenarios each for natural gas and HSD as fuel, were modelled as part of the impact assessment on air quality due to the Project (Table 6.37).

Table 6.37 Modelling Scenarios for Air Quality Impact Assessment

Fuel	Scenario	Description
Natural Gas (Primary Fuel)	1	Plant running in simple cycle (During initial 6-months of Plant Operation and during start-up)
	2	Plant running in combined cycle (During normal operations after commission of combined cycle system)
HSD (Secondary Fuel)*	1	Plant running in simple cycle (During initial 6-months of Plant Operation and during start-up)
	2	Plant running in combined cycle (During normal operations after commission of combined cycle system)

* *In case of HSD, plant load factor (PLF) will be not more than 50%, as the fuel supply infrastructure is limited to supplying HSD for 50% PLF. However, in order to consider worst case scenario, the plant availability has been considered as 78% time of the year as 100%, 6% time of the year as 70% and 6% time of the year as 40% in line with the RFP requirement.*

The operation of the plant with natural gas as fuel in simple/ combined cycle will generate flue gas emissions containing NOx and CO. Emissions of SO_2 are likely to be negligible, as natural gas typically has a very low sulphur level (as per the natural gas specifications for the Project). 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 un-burnt hydrocarbons and Volatile Organic Chemicals (VOCs) such as benzene and formaldehyde, may be released if poor air/fuel mixing and the incomplete combustion of the fuel source occurs. However, operation of the plant with HSD as fuel in simple/ combined cycle will generate flue gas emissions containing NOx, SO_2, PM and CO.

Summary of Emission Sources and Emission Rates

The emission source during the operation of the Plant will be either the bypass stack (simple cycle operation) or main stack (combined cycle operation). Emissions from each stack based on the simple/ combined cycle operation along with stack parameters depending upon the fuel are presented in Table 6.38 and Table 6.39, respectively.

Table 6.38 Emission Parameters for the Power Plant with Natural Gas as Fuel

Stack	UTM Co-ordinates* (m)		Stack Height (m)*[1]	Stack Internal Diameter (m)	Flue Gas Exit Velocity (m/s)	Flue Gas Temperature (°C)	Volumetric Flow Rate (Nm³/s)	Emission Concentration				Emission Rate	
								NOx		CO		NOx	CO
	Easting	Northing						ppm	mg/Nm³	ppm	mg/Nm³	(g/s)	(g/s)
Bypass Stack (Stack 1)[2]	778276	2699681	45	5	40	570	255	25	51	100	125	13	32
Main Stack (Stack 2)	778278	2699632	72.3	6	25	110	504	25	51	100	125	26	63

* UTM Zone - 45

Note: During the plant operation, only one of the two stacks will be functional based on the simple/ combined cycle operation.
Stack parameters are as provided by Sembcorp.

Table 6.39 Emission Parameters for the Power Plant with HSD as Fuel

Stack	Stack Height (m)	Stack Internal Diameter (m)	Flue Gas Exit Velocity (m/s)	Flue Gas Temperature (°C)	Volumetric Flow Rate (Nm³/s)	Emission Concentration					Emission Rate				
						NOx		SO_2	PM_{10}	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$*	CO
						ppm	mg/Nm³	kg/hr	mg/Nm³	ppm	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
Bypass Stack (Stack 1)	45	5	40	570	255	74	152	237.44	50	100	39	66	12.8	11.52	113
Main Stack (Stack 2)	72.3	6	25	110	504	74	152	237.44	50	100	77	66	25.2	22.68	108

Note: During the plant operation, only one of the two stacks will be functional based on the simple/ combined cycle operation.
Stack parameters are as provided by Sembcorp.
* $PM_{2.5}$ fraction of particulate matter varies from 80 – 90% and it has been considered as 90% of total PM

[1] Stack height has been calculated based on average SO2 emission rate of 237.44 kg/hr in case of use of HSD as fuel.

[2] The bypass stack shall only be used continuously during the 6 months of simple cycle operations upon COD of combined cycle operations. After which, the plant will be running in combined cycle mode continuously. During planned maintenance of the ST, the plant will not be running as typically the GT will also be on planned maintenance.

Criteria

For the assessment of air quality, the sensitivity and magnitude criteria outlined in Table 6.9 and Table 6.40**,** respectively have been used. The standards considered for assessment of potential impacts to air quality, are *Schedule 11 ECR, 1997 of the GOB* (***Table 2.7***),

Table 6.40 Criteria for Impact Magnitude for Assessment of Impact to Air Quality (Operation Phase)

Magnitude Criteria	Negligible	Small	Medium	Large
Air Quality change in undegraded airshed (Baseline < applicable air quality standard (AQS))	• Project contribution < 25% of AQS	• Project contribution > 25% of AQS but < 50% of AQS; and Predicted environmental concentration < 100% of AQS	• Project contribution > 25% of AQS but < 50% of AQS; and Predicted environmental concentration >100% of AQS; or • Project contribution > 50% of AQS but < 100% of AQS; and Predicted environmental concentration <100% of AQS;	• Project contribution > 50% of AQS but < 100% of AQS; and Predicted environmental concentration >100% of AQS; or • Project contribution > 100% of AQS
Air Quality change in degraded airshed (Baseline > AQS)	• Project contribution < 10% of AQS	• Project contribution > 10% of AQS and < 15% of AQS	• Project contribution > 15% of AQS and < 25% of AQS	• Project contribution > 25% of AQS

Receptors

From the landuse analysis and field study, it is clear that most of the land surrounding the Project site is agricultural/fallow land on the north and west sides and plantations done by the BBA on their land on the north eastern side. On the immediate east exists vacant land for two proposed 225 MW dual fuel based combined cycle power plant (Sirajganj 2 and Sirajganj 3) and existing 225 MW NWPGCL power plant (Sirajganj 1) followed by a Channel, char lands and Jamuna River. The immediate south of the Project site has barren land followed by a dried channel and char/waste lands. A few (3-4) scattered huts are located on the west side about 200-220 m from the Project site boundary and few settlements are located along the access road. The main village settlements (Panchosona and Khas Bara Shimul) start at about 400 m away from the Project site boundary on the west and north-west side. It has further been noted that the area on the western and southern part of the

Saidabad Power Generation Complex is currently being acquired for development of an export processing zone (EPZ) by the Government of Bangladesh. However, details of type of industries planned were not available at the time of this assessment.

As can be referred from Table 6.9 and above discussion, the human receptors were assessed to be of Medium sensitivity, whereas ecological receptors were considered as of Low sensitivity.

Prediction of Impacts

Impacts due to the operation of the plant were assessed by modelling projected emission rates (Table 6.38 and Table 6.39) using 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 DEM maps as well as user generated receptor grids. AERMAP's output file consists of the x, y locations of each receptor, mean sea level (MSL) elevation and hill profile parameters. The hill profile parameter is used in determining plume flow around elevated terrain.

Model Options: The AERMOD model was run with the following regulatory default options in this assessment:

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

The area surrounding the Project site has one operational 150 MW SCGT of NWPGCL and scattered rural settlements in the surroundings. 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 one year period (2012). 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, defined the locations of predicted ground level concentrations (GLCs) used to assess compliance with the relevant standards or guidelines. The following comprehensive fine and coarse receptor network was used for this analysis:

- 50 m spaced receptors from the project boundary up to 2.5 km; and
- CartEIAn receptors located within the study area, where baseline monitoring was carried out during the study period.

This network used CartEIAn (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 CartEIAn receptor locations are shown in Figure 6.15 and details have been presented in Table 6.41:

Figure 6.15 Receptor Network and Emission Sources

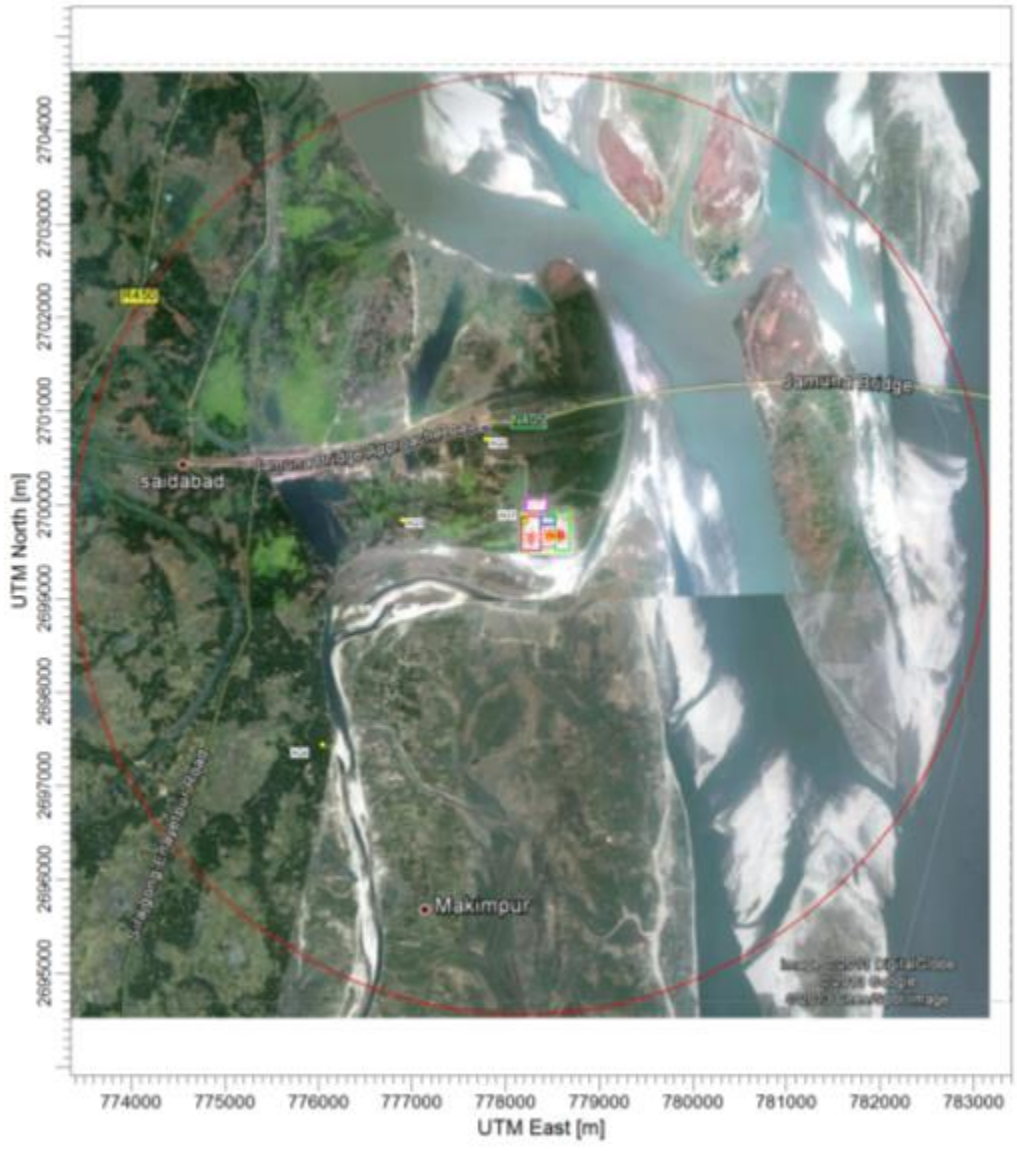


Table 6.41 Monitoring Locations with respect to the Project

S. No.	Name of monitoring location	UTM Co-ordinates* (m)			Distance from Project Boundary (km)	Direction from Project Area
		Easting	Northing	Elevation		
1	Project Site (AQ1)	778201	2699830	16	Inside	-
2	Near Access Road (AQ2)	777785	2700710	17	0.95	N
3	Punorbason Village (AQ3)	776896	2699843	15	0.75	NW
4	Radhunibari Village (AQ4)	776041	2697441	15	3.00	SW

* UTM Zone - 45

Modelling Results

Predicted maximum ground level concentrations within the Project AOI with natural gas and HSD as fuel are presented in Table 6.42. While conducting the air dispersion modelling with HSD as fuel, it has been considered that the plant will run as peaking power plant with peak load factor of 50% only.

It is evident from Table 6.42 that the maximum ground level concentration (maximum baseline concentration + predicted maximum concentration) in the Project AOI with natural gas as fuel will be well within the applicable standards for air quality in both the scenarios. Furthermore, using the determination of magnitude criteria (Table 6.40), it is evident that the project contribution for all the pollutants considered in the modelling study is < 25% of the applicable air quality standard. Therefore, the impact magnitude due to the operation of Sirajganj 4 project is assessed to be negligible.

On this basis, the potential air quality impacts due to the operation of the Plant by using natural gas as fuel are predicted to be ***negligible.***

Impact	*Ambient Air Quality (by use of natural gas as fuel for power generation)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 2 km from project boundary in the downwind direction				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Table 6.42 Predicted Concentrations at Receptors due to Operation of Sirajganj 4 Project - Scenario 1 and 2 with Gas and HSD as Fuel

Scenario	Pollutant	Average	Predicted Concentration (µg/m³)					Max. Background Concentration (µg/m³)*					Total Concentration (Predicted + Background) (µg/m³)					*Bangladesh Standard* (µg/m³)
			Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	
Sirajganj 4 (SCGT) with Gas as Fuel	NO_x	1-hourly	3.82	1.64	2.68	2.3	2.64	-	-	-	-	-	-	-	-	-	-	-
		24-hourly	0.99	0.35	0.95	0.35	0.38	20.9	20.9	20.8	13.3	20.6	21.89	21.25	21.75	13.65	20.98	-
		Annual	0.19	0.1	0.16	0.07	0.06	-	-	-	-	-	-	-	-	-	-	*100*
	CO	1-hourly	9.41	4.03	6.61	5.66	6.5	-	-	-	-	-	-	-	-	-	-	*40000*
		8-hourly	5.99	2.2	5.57	2.32	2.64	2300	2300	2300	1150	1150	2305.99	2302.2	2305.57	1152.32	1152.64	*10000*
Sirajganj 4 (CCGT) with Gas as Fuel	NO_x	1-hourly	14.45	8.5	9.67	11.5	9.03	-	-	-	-	-	-	-	-	-	-	-
		24-hourly	3.58	1.58	3.53	1.72	1.06	20.9	20.9	20.8	13.3	20.6	24.48	22.48	24.33	15.02	21.66	-
		Annual	0.81	0.37	0.69	0.29	0.18	-	-	-	-	-	-	-	-	-	-	*100*
	CO	1-hourly	35	20.6	23.42	27.86	21.89	-	-	-	-	-	-	-	-	-	-	*40000*
		8-hourly	21.91	10.37	19.66	11.27	7.31	2300	2300	2300	1150	1150	2321.91	2310.37	2319.66	1161.27	1157.31	*10000*
Sirajganj 4 (SCGT) with HSD as Fuel	NO_x	1-hourly	11.46	4.91	8.05	6.9	7.92	-	-	-	-	-	-	-	-	-	-	-
		24-hourly	2.98	1.04	2.86	1.04	1.13	20.9	20.9	20.8	13.3	20.6	23.88	21.94	23.66	14.34	21.73	-
		Annual	0.56	0.29	0.47	0.21	0.17	-	-	-	-	-	-	-	-	-	-	*100*
	SO_2	24-hourly	3.01	1.05	2.9	1.06	1.41	7.2	5.7	7.2	2.9	3.6	10.21	6.75	10.1	3.96	5.01	*365*
		Annual	0.57	0.29	0.48	0.22	0.17	-	-	-	-	-	-	-	-	-	-	*80*
	PM2.5	24-hourly	0.88	0.31	0.84	0.31	0.33	24.8	22.7	24.8	19.1	22.6	25.68	23.01	25.64	19.41	22.93	*65*
		Annual	0.17	0.09	0.14	0.06	0.05	-	-	-	-	-	-	-	-	-	-	*15*
	PM10	24-hourly	0.98	0.34	0.94	0.34	0.37	145.8	145.8	142.8	118.7	113.5	146.78	146.14	143.74	119.04	113.87	*150*
		Annual	0.18	0.1	0.16	0.07	0.06	-	-	-	-	-	-	-	-	-	-	*50*
	CO	1-hourly	33.21	14.22	23.34	19.98	22.95	-	-	-	-	-	-	-	-	-	-	*40000*
		8-hourly	21.15	7.78	19.69	8.19	9.32	2300	2300	2300	1150	1150	2321.15	2307.78	2319.69	1158.19	1159.32	*10000*
Sirajganj 4 (CCGT) with	NO_x	1-hourly	42.78	25.18	28.63	34.05	26.76	-	-	-	-	-	-	-	-	-	-	*---*
		24-hourly	10.6	4.68	10.46	5.08	3.13	20.9	20.9	20.8	13.3	20.6	31.5	25.58	31.26	18.38	23.73	*---*

Scenario	Pollutant	Average	Predicted Concentration (µg/m³)					Max. Background Concentration (µg/m³)*					Total Concentration (Predicted + Background) (µg/m³)					*Bangladesh Standard* (µg/m³)
			Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	
HSD as Fuel		Annual	2.39	1.1	2.05	0.87	0.52	-	-	-	-	-	-	-	-	-	-	*100*
	SO_2	24-hourly	9.08	4.01	8.97	4.36	2.68	7.2	5.7	7.2	2.9	3.6	16.28	9.71	16.17	7.26	6.28	*365*
		Annual	2.05	0.94	1.75	0.74	0.45	-	-	-	-	-	-	-	-	-	-	*80*
	PM_{10}	24-hourly	3.47	1.53	3.42	1.66	1.02	145.8	145.8	142.8	118.7	113.5	149.27	147.33	146.22	120.36	114.52	*150*
		Annual	0.78	0.36	0.67	0.28	0.17	-	-	-	-	-	-	-	-	-	-	*50*
	$PM_{2.5}$	24-hourly	3.12	1.38	3.08	1.5	0.92	24.8	22.7	24.8	19.1	22.6	27.92	24.08	27.88	20.6	23.52	*65*
		Annual	0.71	0.32	0.6	0.26	0.15	-	-	-	-	-	-	-	-	-	-	*15*
	CO	1-hourly	60.01	35.31	40.15	47.76	37.53	-	-	-	-	-	-	-	-	-	-	*---*
		8-hourly	37.57	17.77	33.7	19.32	12.53	2300	2300	2300	1150	1150	2337.57	2317.77	2333.7	1169.32	1162.53	*10000*

* *Refer* ***to Table 4.16***

While using HSD as fuel, the maximum ground level concentrations (maximum baseline concentration + predicted maximum concentration) of PM_{10}, $PM_{2.5}$, NOx, SO_2 and CO will be within the applicable standard and overall project contribution will be < 25% of the applicable standard. Therefore, using the determination of magnitude criteria (Table 6.40), the impact magnitude due to the operation of Sirajganj 4 project is assessed to be negligible. It shall be noted that the Project will be using natural gas as primary fuel and HSD will only be used in case of non-availability of natural gas from GTCL. Furthermore, in the event of a gas supply failure, the facility will not automatically switch to HSD as the decision rests with BPDB whether to operate the Plant on HSD or to pay capacity charges for the period of gas outage.

On this basis, the potential air quality impacts due to the operation of the Plant by using HSD as fuel are predicted to be ***negligible.***

Impact	*Ambient Air Quality (by use of HSD as fuel for power generation)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 2 km from project boundary in the downwind direction				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

The concentration isopleths of NOx, SO_2, PM_{10}, $PM_{2.5}$ and CO for different averaging periods without baseline concentrations for Simple Cycle operations have been presented in ***Annex N1*** and for Combined Cycle operations have been presented in ***Annex N2***

Mitigation Measures

To ensure compliance with the air emission criteria for flue gas stacks, the following measures will be implemented during operations:

- The use of continuous emission monitoring (CEM) equipment for the measurement of air emission levels in the exhaust stack of HRSG. CEM will be undertaken for NO_x, SO_2, CO and O_2;
- $PM_{2.5}$ and VOCs will be monitored periodically, to ensure that these emissions are not occurring as a result of the incomplete burning of the natural gas fuel and use of HSD as fuel.
- The stack will be provided with safe access to sampling points for CEM.
- HSD shall be used only during shortage of natural gas supply.

6.6.4 *Green House Gas Emissions*

The Kyoto Protocol – United Nations Framework Convention on Climate Change nominates the following GHGs:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous Oxide (N_2O);
- 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 (CO_2e). Gases are converted to CO_2e by multiplying by the gas' global warming potential (GWP). The GWP of gases are as follows[1]:

- GWP for CO_2 = 1
- GWP for CH_4 = 21
- GWP for N_2O = 310

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred in terms of CO_2-equivalent (CO_2e) emissions.

Operation of Sirajganj 4 Project

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 consumption. In order to estimate GHG emissions, the IFC recommended Carbon Emission Estimation Tool (CEET model – Version February 2014)[2] has been used as set out below.

Table 6.43 Estimated GHG Emissions from the Plant

SN	Particular	Value	Unit
A*	Net Heat Rate (Natural Gas in Combined Cycle)	7,278	KJ/KWH
B*	Gross Generation Capacity (Combined Cycle)	427,180	KW
C	Operating Days	330	days
D	Daily Operating Hours	24	Hours/day
E	Total Annual Output (= B x C x D)	3,383,265,600	KWH

(1) [1] Source: Intergovernmental Panel on Climate Change (IPCC) (1995), Second Assessment Report

[2] http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/CB_Home/Measuring+Reporting/

SN	Particular	Value	Unit
F	Annual Fuel Consumption (= E x A)	2.46234 x 10^{13}	KJ
		24,623.407	TJ
G*	GHG Emission Rates		
	CO_2	56.1	tCO_2/TJ
	CH_4	0.001	tCO_2/TJ
	N_2O	0.003	tCO_2/TJ
H	**Annual GHG Emission in Combined Cycle**	**1,404,790**	**tCO_2e/year**

* Based on natural gas specification provided by Sembcorp (refer to Table 3.1 for details).
** Based on GHG emission factors provided in CEET

As per the latest report (26 December 2012) of GHG emission submitted by Bangladesh to the United Nations Framework Convention on Climate Change (UNFCCC)[1], electricity generation sector contribution to GHG emission in year 2005 was 1.192 x 10^7 tons CO_2e 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 10^7 tons CO_2e and 5.9168 x 10^7 tons CO_2e, respectively. Taking this into consideration, GHG emission contribution of the proposed Project in the year 2020 will be 5.1% of the electricity generation sector in Bangladesh. Considering this fact, the GHG emission impact will be **moderate**.

Impact	*GHG emissions from operation of Sirajganj 4 project*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	National		
Impact Scale	Impact zone will be regional/ national				
Frequency	Operation Phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate.**				

Mitigation Measures

The following mitigation measures will minimise GHG emissions to ALARP levels:

- Consituous monitoring and recording of CO_2 emission from the stacks through CEMS.
- 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.

[1] **http://unfccc.int/resource/docs/natc/bgdnc2.pdf**

6.6.5 Noise

Operation of Sirajganj-4 Project

Sources of Impact

For gas/oil-fired power plants, 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.

Noise and vibration from the Project 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 engineering noise control measures with respect to key project components are specified below:

Combustion Turbine: High noise levels originate in the air inlet and flue gas exhaust. Strong pure tonal components are associated with the inlet while the exhaust results in high levels of low frequency noise. Specially designed silencers are provided to control such noise emissions to acceptable levels.

HRSG: Venting of steam will occur during HRSG start up and blowdowns. This is routinely controlled by suitable silencers. Boiler safety valves are tested on an annual basis. Outside of such testing, operation of safety valves will occur for very short periods under fault conditions. They will be fitted with silencers but will be audible outside the plant. Owing to their safety function it is not possible to totally abate noise from such high temperature/high volume sources.

Steam Turbine: The steam turbine, together with a range of auxiliary plant, much of which contains rotating or reciprocating machines, is a source of noise. This is attenuated by acoustic lagging and enclosure and by the acoustic design of the turbine house.

Gas Release: When it is required to purge the gas pipelines and gas compressor, gas will be vented to the atmosphere. This will last for a short period and may result in slightly increased noise levels.

Transformers: Fans on generator and other large transformers are provided for cooling purposes. The transformers themselves may emit noise at multiples of the power line frequency (50 Hz) but are treated to minimise noise emission and will be inaudible at the site boundary.

Substation and Transmission Lines: Transmission lines can also generate a small amount of sound energy (a crackling or humming sound) as a result of corona[1]. It becomes more noticeable at higher voltages (345 kV and higher). As the existing transmission line is of 230 kV, no corona is heard in vicinity of the transmission line.

Criteria

It is planned that the Project will meet the noise emission criteria specified in the GOB ECR, 1997, as presented in Table 2.10. Furthermore, for the assessment of ambient noise, the sensitivity and magnitude criteria outlined in Table 6.12 and Table 6.13, respectively have been used:

Table 6.44 Noise Emission Criteria

Location	Noise Level Limit (dB(A)	
	Daytime (0600 – 2100 hrs)	Night-time (2100 – 0600 hrs)
Equipment (1m from source)	85	85
Plant Boundary	70	70
Nearest Residential Area	55	45

Receptors

The nearest noise receptor is located 200-220 m from the Project boundary in the western side, whereas other settlements are located about 400 m away from the Project boundary. As can be referred from Table 6.12 and above discussion, the receptors within the Saidabad Power Generation Complex as well as the ecological receptors were assessed to be of Low sensitivity, whereas the human settlements in the surrounding areas (residential areas) were assessed to be of Medium sensitivity.

Prediction of Impacts

Methodology: The environmental noise prediction model SoundPLAN 7.2 was used for modelling noise emissions from the use of power plant equipment and vehicular movement in the access road. It has been assumed that all the plant equipment will adhere to the equipment noise emission criteria of 85 dB(A) noise level at a distance of 1 m from the source. Operation of equipment with 100% usage scenario was modelled to cover the operation phase of the Project. Major plant components with higher noise generation considered in this study include GTG, STG, HRSG, Auxiliary Boiler, Cooling Tower, CW Pump House, Emergency DG, Water Treatment Facility, Pump House, RMS, and Gas Booster and Conditioning Station. 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

[1] Corona is the partial electrical breakdown of the insulating properties of air around the conductors of a transmission line. In a small volume near the surface of the conductors, energy and heat are dissipated. Part of this energy is in the form of small local pressure changes that result in audible noise.

operating simultaneously. Attenuation due to already constructed boundary wall of the Power Generation Complex has been considered in the modelling.

Predicted Noise Levels at Receptors: The predicted noise levels within the Project AOI during day time are presented in Figure 6.16. Predicted noise levels at twenty receptors (where baseline noise levels were also monitored, which include eight receptors within or just outside the boundary of the Saidabad complex) have been presented in Table 6.45. It is evident from the predicted results that in the worst case scenario, the nearest receptor (220 m from the western boundary of the Project site) will have a daytime noise level of 55.8 dB(A) during the operation phase.

Figure 6.16 Predicted Operation Phase Noise Levels of Sirajganj 4 Project during Daytime (Leq $_{day}$)

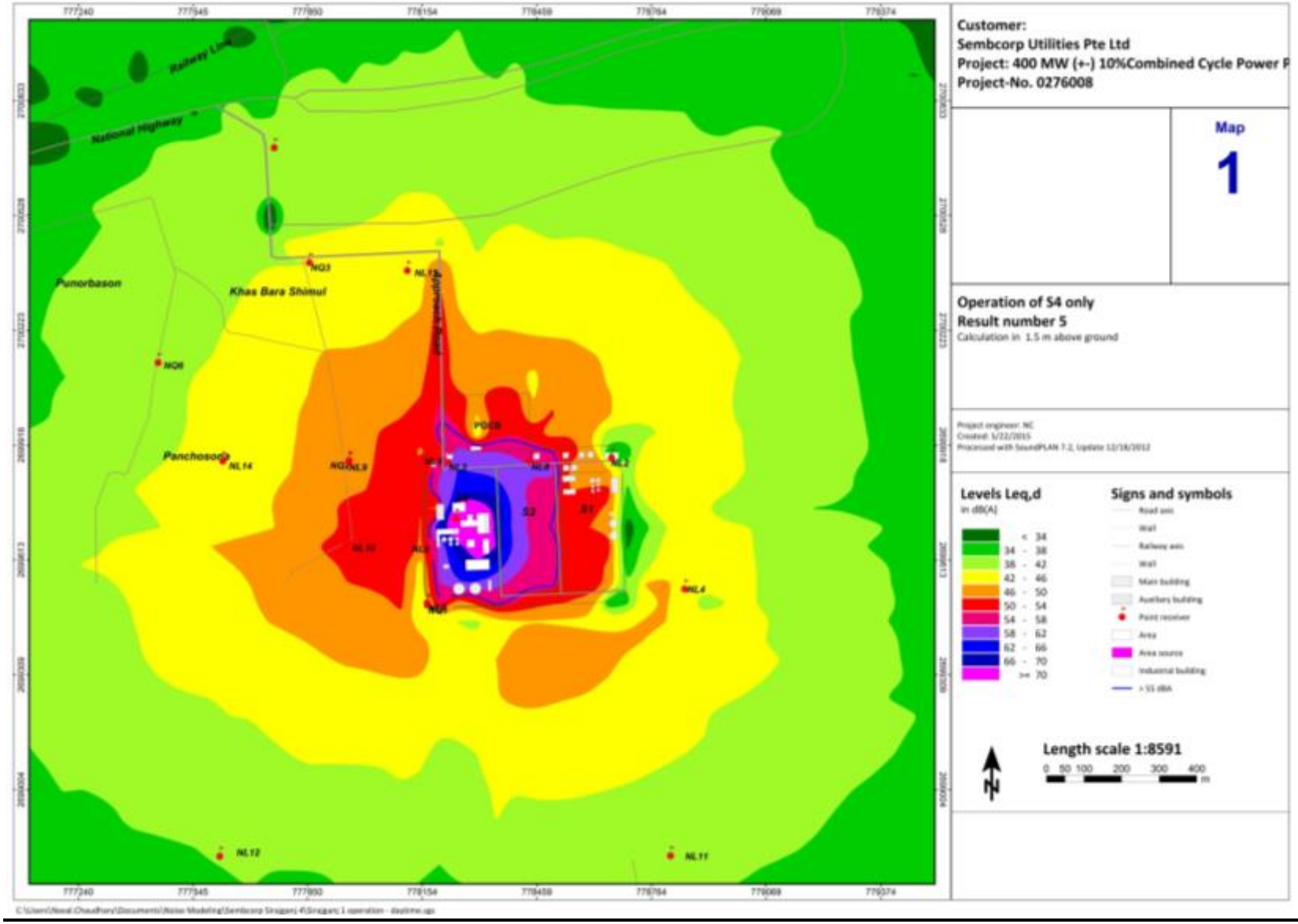


Table 6.45 Predicted Noise Levels at Noise Receptors during Operation Phase of Sirajganj 4 Project

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	Baseline Sound Pressure Levels at Receptors, Leq (dBA)(1)		Predicted Sound Pressure Levels at Receptors, Leq (dBA)(4)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard (dB(A))(2) (3) as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Day	Night
NQ1	Project Site Boundary	0 (-)	48.2	48.9	60.6	60.6	**60.8**	**60.9**	***70***	***70***
NQ2	Khas Bara Shimul	220 (W)	48.9	42.5	42.1	42.1	**49.7**	**45.3**	***55***	***45***
NQ3	Near Access Road (MMS Office)	665 (WNW)	47.0	42.4	32.8	32.8	**47.2**	**42.9**	***55***	***45***
NQ4	Access Road near National Highway	945 (WNW)	54.5	55.3	39.4	39.4	**54.6**	**55.4**	***55***	***45***
NQ5	Makimpur village	3000 (SW)	52.8	42.6	28.3	28.3	**52.8**	**42.8**	***55***	***45***
NQ6	Punorbason Village	760 m (NW)	50.4	42.4	32.3	32.3	**50.5**	**42.8**	***55***	***45***
NL1	Center of the Project area	0 (-)	40.7	32.4	73.5	73.5	**73.5**	**73.5**	***85***	***85***
NL2	North-East Corner	0 (-)	45.9	46.9	51.2	51.2	**52.3**	**52.6**	***70***	***70***
NL3	South side of the Mosque	0 (-)	40.2	24.8	51.2	51.2	**51.5**	**51.2**	***70***	***70***
NL4	NWPGCL Jetty	140 m (E)	40.2	47.6	39.8	39.8	**43.0**	**48.3**	***70***	***70***
NL5	North-west corner of the boundary	0 (-)	47.7	44.5	48.4	48.4	**51.1**	**49.9**	***70***	***70***
NL6	Middle point of the west side boundary (outside)	30 m (W)	48.0	45.1	55.5	55.5	**56.2**	**55.9**	***70***	***70***
NL7	South west corner of the boundary	0 (-)	39.5	40.6	59.2	59.2	**59.2**	**59.3**	***70***	***70***

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	Baseline Sound Pressure Levels at Receptors, Leq (dBA)[1]		Predicted Sound Pressure Levels at Receptors, Leq (dBA)[4]		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard (dB(A))[2] [3] as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Day	Night
NL8	In front of the GTCL's quarter	0 (-)	46.8	47.5	48.8	48.8	**50.9**	**51.2**	***70***	***70***
NL9	Khas Bara Shimul village	220 m (W)	55.6	45.2	42	42	**55.8**	**46.9**	***55***	***45***
NL10	Khas Bara Shimul village	220 m (W)	47.3	43.5	52	52	**53.3**	**52.6**	***55***	***45***
NL11	Chak Boira Village	680 m (S)	46.5	40.7	35	35	**46.8**	**41.7**	***55***	***45***
NL12	Chak Boira Village	840 m (SW)	46.4	40.8	29.5	29.5	**46.5**	**41.1**	***55***	***45***
NL13	Bara Shimul village	490 m (N)	44.6	42.6	40.3	40.3	**46.0**	**44.6**	***55***	***45***
NL14	Panchosona village	560 m (W)	50.8	44.2	42.8	42.8	**51.4**	**46.6**	***55***	***45***

[1] Ambient noise levels as monitored during the baseline survey

[2] Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

[4] All operations have been considered as continuous and hence there is no change in the day and night time prediction results.

It is evident from Table 6.45 that ambient noise levels due to operation of Sirajganj 4 project will be well within the applicable standard during day time at 19 receptors and night time at 15 receptors, out of total 20 receptors considered in the study. However, ambient noise level will be slightly higher from applicable standard (with < 3 dBA increase from the applicable standard) at 1 location (NL9) during daytime, which is primarily due to higher background noise level recorded during the baseline study at that location and the predicted noise level at that location is much lesser. Therefore, the noise impact from S4 operations during day time is expected to be **negligible**. Furthermore, noise levels at night time will be slightly higher than the applicable standard (with < 3 dBA increase from the applicable standard) at 5 locations. Due to this the noise impact from operational activity during night time is expected to be **minor.**

Impact	*Noise from Operation of Plant (Daytime)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 100 m from project boundary				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Impact	*Noise from Operation of Plant (Night time)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 100 m from project boundary				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Mitigation Measures

To mitigate operational noise impacts the detailed design specifications will have the following measures in place:

- 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;
- Installation of vibration isolation for mechanical equipment; 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.

Residual Impacts

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Change in Ambient Noise Levels during night time			
Residual Impact	Minor	Negligible to Minor	With implementation of the mitigation measures mentioned for minimizing the noise generation at source and providing barriers wherever feasible, the night time noise residual impacts would be negligible to minor.

6.6.6 *Electric and Magnetic Field (EMF)*

Sources of Impact

An electric field is said to exist in a region of space if an electrical charge, at rest in that space, experiences a force of electrical origin (i.e., electric fields cause free charges to move). The electric field will be created by a the sub-station and 230 kV high-voltage transmission line which extends from the energised conductors to other conducting objects such as the ground, towers, vegetation, buildings, etc.

Magnetic fields can be characterized by the force they exert on a moving charge or on an electrical current. As with the electric field, the magnetic field is a vector quantity characterized by both magnitude and direction. Electrical currents generate magnetic fields. In the case of sub-station and transmission lines the 60-Hz electric current flowing in the conductors generates a time varying, 60-Hz magnetic field in the vicinity of these sources.

Prediction of Impact

Short-term effects from transmission-line electric fields are associated with perception of induced currents and voltages or perception of the field. Induced current or spark discharge shocks can be experienced under certain conditions when a person contacts objects in an electric field. Such effects occur in the fields associated with transmission lines that have voltages of 230-kV or higher. These effects could occur infrequently under the existing 230 kV

transmission line. It is understood that potential impacts of electric fields are being mitigated through grounding policies and adherence to the regulatory requirements.

Magnetic fields associated with transmission and distribution systems can induce voltage and current in long conducting objects that are parallel to the transmission line. As with electric-field induction, these induced voltages and currents are a potential source of shocks. A fence, irrigation pipe, pipeline, electrical distribution line, or telephone line forms a conducting loop when it is grounded at both ends. The earth forms the other portion of the loop. The magnetic field from a transmission line can induce a current to flow in such a loop if it is oriented parallel to the line. If only one end of the fence is grounded, then an induced voltage appears across the open end of the loop. The possibility for a shock exists if a person closes the loop at the open end by contacting both the ground and the conductor. The magnitude of this potential shock depends on the following factors: the magnitude of the field; the length of the object (the longer the object, the larger the induced voltage); the orientation of the object with respect to the transmission line (parallel as opposed to perpendicular, where no induction would occur); and the amount of electrical resistance in the loop (high resistance limits the current flow). Knowledge of the phenomenon, grounding practices, and the availability of mitigation measures mean that magnetic-induction effects from the existing 230-kV transmission line would be minimal.

Mitigation

Occupational health and safety EMF standards in EHS guidelines on thermal power and electric transmission lines is suggested to be adhered to and referred for following the best practices.

ICNIRP Exposure limits for occupational exposure to EMF

Frequency	Electric field	Magnetic Field
50 Hz	10,000	500
60 Hz	8300	415

Source: ICNIRP (1998): "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).

6.6.7 Terrestrial & Aquatic Habitat

Likely impact on the flora and fauna during operation phase of the project will be mostly from the following activities;

- Noise generation due to operation of the power plant
- Disposal of cooling water discharge on land during non-monsoon season and on adjoining channel during monsoon season.

Criteria

The assessment of the potential impacts to the flora and fauna has considered the Sch. I-III of Bangladesh Wildlife Prevention Order, 1973 and IUCN category for conservation status of flora and fauna to determine their rare, endangered and threatened status.

Receptors

Terrestrial Flora and Fauna: The impact will be mainly on the terrestrial flora and fauna within the project site and its surrounding.

Aquatic Flora and Fauna: The water requirement for operational phase will be met from Jamuna River. The cooling water discharge will be on land in the upstream of adjoining Channel during monsoon season, which may affect aquatic flora and fauna including phyto and zooplanktons and fish.

Impact Significance on Terrestrial Flora and Fauna

Impact due to air emissions from operations of Power Plant
Impact on ecology of AOI due to air emissions is not envisaged as reference from air emission ***Section 5.6.3*** the impact is negligible when the power plant will be running on natural gas and minor when running on HSD.

Impact due to incremental noise levels due to operation of Power Plant
The AOI harbours species such as Spotted Dove, Red Wattled Lapwing, Black Kite, Black Drongo, Rock Pigeon, Long –tailed Shrike and Common Myna. Some of these species are listed as Sch-III of the Bangladesh Wildlife Prevention Order, 1973. Impacts of elevated sound levels on the avifauna are summarized in Table 6.46. Noise levels due to 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 be further attenuated to 70 dB (A) at plant boundary and further to 50 dB (A) at the nearest habitation.

Table 6.46 Avian Auditory Response to various Sound Power Levels (SPL)[1]

Sound Power Level dB (A)	**Avian Response**
110-140	Damage to Auditory organs
93-110	Behavioural and/or physiological effects of high nature
75-93	Behavioural and/or physiological effects of medium nature
75-45	Behavioural and/or physiological effects of lower nature
45-Below Ambient level	No Damage

Incremental noise may have significant impact on the avifauna around the project site and force them to avoid the power plant area and migrate to other part of the project AOI. Increase noise levels may also affect the birds and

1 http://www.dot.ca.gov/hq/env/bio/files/caltrans_birds_10-7-2007b.pdf

mammals in the Eco park plantation areas, but predicted noise impact in this area is low due to distance from the Project site and the noise levels at the boundary of the project will be complying with the 70 dB(A) noise criteria and therefore, the noise impact magnitude is considered to be small. Impact rating matrix for impact of noise on terrestrial fauna and avifauna is given as ***negligible***.

Impact	*Incremental Noise Levels due to operation of Power Plant*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Limited to project site and immediate surroundings				
Frequency	Operation Phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible** for Species & Habitats**.**				

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 water pipeline ROW and adjoining degraded Eco park land will be undertaken. 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.

Impact Assessment of Aquatic Flora and Fauna

Impact due to discharge of cooling water in the Jamuna River

Water is mainly required for cooling purposes in the project which will be sourced from Jamuna River 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). The project has a raw water requirement of the order of 600 m^3/hr, whereas the outfall is expected to be 74.4 m^3/hr. The cooling tower blow down and other treated effluent generated from boiler blow down, effluent treatment plant and DM plant will be discharged on channel outside the southern boundary of the project site for location of discharge point). 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 used 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.([1]) 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. ([2])

The discharge of cooling water will be into the adjoining channel with the boundary, so the cooling water discharge would seep into the ground without much impact on the aquatic ecosystem. During the monsoon, the water quantity and flow is enhanced and this would lead to quick dilutions reducing the impact on aquatic ecosystem.

Since, the project is not having any direct discharge into the Jamuna River or the adjoining Jamuna Channel and magnitude criteria described in the impact magnitude is considered to be negligible.

Impact	*Discharge of Cooling water on land upstream of adjoining channel due to operation of Power Plant*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Outfall point in the southern boundary of the Project				
Frequency	Operation Phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitats)	Low	Medium	High		
Resource/ Receptor Sensitivity (Species)	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

([1]) www.eolss.net/Sample-Chapters/C06/E6-13-04-07.pdf
([2]) http://drs.nio.org/drs/bitstream/2264/3339/2/Indian_J_Environ_Prot_11_525.pdf

Mitigation Measures

Following mitigation measures are suggested to minimize the impact on aquatic flora and fauna:

- 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 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)*. Treated waste water will be discharged along with cooling water to Jamuna River.
- Undertake a post operational assessment study through independent 3rd party agency/experts with an objective to assess the impact of cooling water discharge on Jamuna River ecological resources and social aspects. Such study will be conducted preferably after 12 months of commissioning the Project and the study recommendations will be implemented to further fine tune the mitigation strategy.

6.6.8 Social Impacts

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 impacts is discussed in sub-sections below.

Employment Generation and In-Migration of Skilled workforce

The workforce requirement in operation phase requires approximately 20 to 25 un-skilled workers and approximately 49 skilled, technical, professional and executive staff. 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 expats. Some of them would be residing nearby the plant location or in Sirajganj. 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 in the proposed industrial park and economic zones due to reliable power availability which will increase the demand for employment in and around Sirajganj.

Impact	*Employment Generation and in migration of skilled workforce*		
Impact Nature	Negative	Positive	Neutral
Impact Type	Direct	Indirect	Induced

Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	National	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

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. The project will provide on-site lodging facility to the temporary visitors in a guest house. However, other staff would be resident in the adjoining Sirajganj town. 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.

Impact	*Demand for lodging, housing and civic services*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	National	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Increments in cost of living

The presence of a salaried working class population will bring in greater cash income in project area. Hence, the spending capability of this population will be higher than the local population which depends on agriculture or household based small scale industries. The spending capacity, in turn will increase local consumption thereby increasing demand for a range of commodities in daily life. This often results in price rises for these regularly consumed items. Hence, the cost of living in the project area may experience an incremental rise. Such rise in cost of living may have a detrimental effect on vulnerable households in project area. As this is an induced project impact, and the contribution to the cumulative effect of industrialisation in the project area is limited, the impact significance is assigned as low.

Impact	*Increments in cost of living*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	National	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Opportunity for local transporters

The project operation will require a number of transportation services including regular requirement for commuting short term visitors and industrial provisioning of a range of materials. Hence, this would create business opportunity for local transporters. The significance of such an impact is however will be low.

Impact	*Opportunity for Local Transporters*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	National	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large

Competing demand on natural gas fuel supply

The consumption of natural gas has been increasing on several fronts including domestic use and transport vehicles. Hence, availability of natural gas for power generation will compete with these demands. The regular and reliable supply of natural gas therefore may not be possible all the time. This would diminish the production efficiency. In an extreme scenario, the bulk use of gas supply by power companies may cause resentment by the general public, although this would likely be offset by the perceived local benefits of the project. Due to their numbers, they have potential to influence the policy decisions. However, Sembcorp has a gas-supply agreement to ensure adequate and regular gas supply. Keeping this in mind the significance of its impact is assigned as low.

Impact	*Competing demand on natural gas Diminishing production efficiency for deficiency in fuel supply*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	National	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Demand for power amongst locals in AOI

The electricity produced from the power plants are supplied to the distribution grid and GoB decides on the areas to which the power generated is to be supplied. So, though the power plant will be at Sirajganj, the local community in Project AOI may or may not benefit from the power generated.

Influx of Skilled Workforce

The man power requirement in the operation phase is estimated as 49 skilled and 20 un-skilled workers. The un-skilled workers will be employed from the project locality. However, the skills work-force will be employed from different places in Bangladesh. Some of these families will be accommodated in the staff residences and others will be staying in rented accommodation in Sirajganj. The in-migrant population will constitute a negligible proportion of the total population in the project locality. The in-migrant population is expected to have higher income and would contribute to the local consumption. Thereby one expects this would provide opportunity for local population to provide services and goods and reap economic benefits.

Impact	*In-migration of skilled workforce*				
Impact Nature	Negative	Positive			Neutral
Impact Type	Direct	Indirect			Induced
Impact Duration	Temporary	Short-term	Long-term		Permanent
Impact Extent	There would be only 49 skilled staff in operation stage, who would be recruited from different parts of the country. They comprise an insignificant proportion of the project area population.				
	Local	National			International
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High	
Impact Significance	Negligible	Minor	Moderate		Major
	Significance of impact is considered **negligible.**				

6.7 CUMULATIVE IMPACTS DUE TO OPERATION OF SIRAJGANJ 1, 2, 3 AND 4 PROJECTS

6.7.1 Water Resources

Cumulative Impacts on Water Resources

Criteria

For the assessment of water resources, the sensitivity and magnitude criteria outlined in Table 5.7 and Table 5.8 have been used respectively. The assessment of potential impacts to surface water has considered *Schedule 3 (a), 9 and Schedule 10 of ECR, 1997* (refer to ***Table 2.8*** and ***Table 2.9*****).** For groundwater, *Schedule 3 (b) of ECR, 1997,* standards for drinking water has been considered.

Receptors

Surface water: A channel flows adjacent to the eastern and southern boundary of the Project site, which is dried most of the time and gets water only during the monsoon season. The main Jamuna River flows on the eastern side about 1.2 km from the Project site and will be the source of water for the Project. The source of water would be the Jamuna River for Sirajganj 4, whereas other power plants will be dependent on ground water. Based on the sensitivity criteria Table 6.7**,** surface water resource is assessed as Medium.

Groundwater: Ground water samples analysis indicate high levels of iron with other parameters being within standard permissible limits for drinking water specified by Bangladesh ECR, 1997 Schedule 3 (B). Arsenic concentration is also reported in ground water tube well in the Project AOI though the samples analysed were within limits. Groundwater is used by local residents in the area for drinking as well as for irrigation purposes. Based on the sensitivity criteria Table 6.7, ground water resource is assessed as Medium.

Impact Significance

Cumulative Impact due to Groundwater Abstraction

The EIA study report of NWPGCL's Sirajganj 2 (proposed 225 MW CCPP) prepared by Engineer's Associates Limited, May 2014 states that its existing plant (Sirajganj 1) uses 600 m^3/hr from ground water and that its proposed plant (Sirajganj 2) would be also using similar quantity of 600 m^3/hr from ground water. Groundwater modelling in this EIA study was undertaken to assess the suitability of the aquifer system of Sirajganj and surrounding areas to provide a continuous supply of 1200 m^3/hour of water for cooling purposes of both their power plants. The EIA study concluded that the natural aquifer condition in the Project area would be suitable for supplying 30000 m^3/day of water continuously without any permanent lowering of groundwater table or environmental degradation. Jamuna River invariably fully recharges the aquifer in the wet season of each year preventing any adverse effect on the natural condition of the project area. Since, there is another project Sirajganj 3 (225 MW) proposed within the Saidabad Power Generation Complex and due to similar capacity as that of Sirajganj 1 and 2 project, it has been assumed that the water requirement for this project will also be of the order of 600 m^3/hr. Source of this water demand is currently unknown (i.e. ground water or surface water from River Jamuna) and it has been assumed that the project will follow same source as that of Sirajganj 1 and 2 projects, i.e. ground water abstraction from project site. This will lead to daily water abstraction from ground water within the power generation complex of the order of 43,500 m^3.

The above clearly indicates that overall ground water abstraction from the Saidabad Power Generation Complex after commissioning of all the four projects will be higher than safe water supply potential of the aquifer of the order to 30,000 m^3/day. This will create some stress on the ground water aquifer and quality due to higher abstraction in comparison of recharge. However, it was further been observed that the Sirajganj 1 project is currently discharging the cooling tower blowdown and other effluent after treatment on land in the eastern boundary of the complex (which is about 200 m away from the adjoining channel) and the other 3 projects will also be doing the discharge in the similar manner, which will lead to a total discharge of the order of 6,700 m^3/day, which do not flow towards the adjoining channel during non-monsoon season and will help in recharging the ground water aquifer. Further it was also mentioned in the ground water modelling study that, recent studies indicate that the rainfall in Bangladesh and surrounding areas is

increasing due to climate change (UK Met Office 2011) which would contribute to enhanced recharge to the aquifer in the projected period. Therefore, the overall cumulative impact of ground water abstraction is assessed as **moderate**.

Impact	*Cumulative Impact from Ground Water Abstraction*				
Impact Nature	Negative	Positive			Neutral
Impact Type	Direct	Indirect			Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local	Regional			International
Impact Scale	Project Site and surrounding area.				
Frequency	Continuous during operation phase				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High	
Impact Significance	Negligible	Minor		Moderate	Major
	Significance of impact is considered **moderate.**				

Water Pollution from Wastewater Discharge

Since the water requirement of all the four power plants is same (i.e. about 600 m3/hr) and hence it has been assumed that the discharge from all the plants will be same as that of S4 project (i.e. about 75 m^3/hr). Based on this assumption, the total treated wastewater discharge from the complex will be about 300 m^3/hr, which will be discharged from the respective plant to the eastern/ southern boundary of the complex in the upstream of adjacent Channel (which is about 200 – 400 m away from the discharge points during non-flooding season) after treatment.

Considering the on-site monitoring results of the discharge from Sirajganj 1 project (refer Table 6.36), it is assumed that the treated wastewater from all the plants will also follow similar discharge quality (temperature, TDS, pH and other parameters) and as the discharge points will be different and will have a minimum distance of about 100 – 150 m between the two discharge points, the cumulative impact of wastewater discharge on land will not affect the quality of surface/ ground water or the condition of soil in that area.

Furthermore, review of geo-technical data collected for Sirajganj 2 Project[1] also reveals that: (a) The soil is mostly silty sand and fine sand in all the bore logs with some small layers of silty and clayey sand in a couple bore logs, which indicates that the soil profile is porous in nature and is good for water percolation; (b) Soil permeability coefficient is in the range of 10 to 15 m/day, which is as per soil permeability classes represent "very rapid" soil permeability class (i.e. > 6 m/day); (c) Shallow ground water depth is about 8 m from the Saidabad Power Generation Complex and will be about 4 to 5 m

[1] Geotechnical Ivestigation Report of Sirajganj 225 MW Combined Cycle Power Plant (2nd Unit) – Detailed Design (April 2015), prepared by Fujian Electric Power Survey & Design Institute, Fuzhou

from the water discharge locations during dry season. (d) Treated wastewater discharge from all the four plants operation will be of the order of about 300 m^3/hr, whereas the groundwater withdrawal by S1 and S2 from deeper aquifer will be of the order of 1,200 m^3/hr. It is unknown currently, whether the shallow and deeper aquifers are connected or not. However, in case of their inter-connection, the shallow water aquifer will help in recharging of the deeper aquifer. There was no infiltration test conducted as part of the geo-tech investigation, however, these points do indicate that soil properties are favorable for water percolation on the soil during dry season.

In addition, instrumentation will be used to monitor the Plants' 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 based on the results of the Sirajganj 1 project is assessed as **negligible**.

Impact	*Wastewater Discharge*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Channel downstream of treated wastewater discharge points				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Mitigation Measures

Other mitigation measures which will be adopted to reduce impacts on water quality to As Low as Reasonably Practicable are as follows:

- Considering the ground water abstraction in large quantity by NWPGCL's 3 projects within the complex, it is suggested to provide piezometers for monthly monitoring of ground water level and quality within the complex;
- For minimising use of antifouling and corrosion inhibiting chemicals appropriate depth of water intake will be maintained and use of screens will be ensured;
- Minimum required quantities of chlorinated biocides or alternatively intermittent shot dosing of chlorine will be practised 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;
- Oil water separators will be provided to intercept any accidental discharge of oil and grease on the storm water channels;

- 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.
- In the unlikely event water percolation does not occur as expected, SNWPCL could rely on temporary solutions such as to engage a sub-contractor to use the portable pumps & hoses to evacuate this water to the river or dry canal, thereby allowing a larger surface area for the water to percolate.
- SNWPCL will monitor the wastewater discharge and if water stagnation if observed to persist continuously over an extended period of [12-18] months, then SNWPCL will evaluate permanent solutions to resolve the issue. However if the water stagnation is observed to occur for only part of the year, then the temporary solution should suffice.

6.7.2 Air Quality

Cumulative Impacts on Air Quality – Operation of Sirajganj 1, 2, 3 and 4 Projects

Sources of Impact

The four projects within Saidabad Power Generation Complex include dual fuel fired combined cycle power plant (CCPP), consisting of 1 GT, 1 HRSG and 1 ST, each. Emission parameters in combined cycle mode from the four projects are presented in Table 6.47.

Table 6.47 Summary of Emissions for the Power Plants for Separate stacks within Saidabad Power Generation Complex

Fuel	Stack	UTM Co-ordinates* (m)		Stack Height (m)	Stack Internal Diameter (m)	Flue Gas Exit Velocity (m/s)	Flue Gas Temperature (°C)	Volumetric Flow Rate (Nm^3/s)	Emission Concentration					Emission Rate				
									NOx		SO_2	PM_{10}	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$**	CO
		Easting	Northing						ppm	mg/Nm^3	kg/hr	mg/Nm^3	mg/Nm^3 or (kg/hr)	(g/s)	(g/s)	(g/s)	(g/s)	(g/s)
NG	Main Stack (S1)	778582	2699659	60	6	25	110	504	40	82	-	-	125	41	-	-		63
	Main Stack (S2)	778475	2699657	60	6	25	110	504	40	82	-	-	125	41	-	-		63
	Main Stack (S3)	778424	2699655	60	6	25	110	504	40	82	-	-	125	41	-	-		63
	Main Stack (S4)	778278	2699632	72.3	6	25	110	504	25	51	-	-	125	26	-	-		63
HSD	Main Stack (S1)	778582	2699659	60	6	25	110	504	74	152	125	50	205	77	34.8	25.2	22.7	57
	Main Stack (S2)	778475	2699657	60	6	25	110	504	74	152	125	50	205	77	34.8	25.2	22.7	57
	Main Stack (S3)	778424	2699655	60	6	25	110	504	74	152	125	50	205	77	34.8	25.2	22.7	57
	Main Stack (S4)	778278	2699632	72.3	6	25	110	504	74	152	237.4	50	390	77	66.0	25.2	22.7	108

* UTM Zone – 45

** * $PM_{2.5}$ fraction of particulate matter varies from 80 – 90% and it has been considered as 90% of total PM

Note: During the plant operation, only one of the two stacks will be functional based on the simple/ combined cycle operation.

Stack parameters are as provided by Sembcorp and based on assumptions for S1, S2 and S3, based on limited information available with respect to stack design and emission parameters from NWPGCL. It has been assumed that due to similar capacity of S1, S2 and S3 and the plants will be operated by NWPGCL, the emissions will be same as that of S1, available from the EIA Report.

Criteria

For the assessment of air quality, the sensitivity and magnitude criteria outlined in *Table 6.9* and *Table 6.40*, respectively have been used. The standards considered for assessment of potential impacts to air quality, are *Schedule 11 ECR, 1997 of the GOB* (***Table 2.7***),

Receptors

From the landuse analysis and field study, it is clear that most of the land surrounding the Project site is agricultural/fallow land on the north and west sides and plantations done by the BBA on their land on the north eastern side. On the immediate east exists vacant land for two proposed 225 MW dual fuel based combined cycle power plant (Sirajganj 2 and Sirajganj 3) and existing 225 MW NWPGCL power plant (Sirajganj 1) followed by a Channel, char lands and Jamuna River. The immediate south of the Project site has barren land followed by a dried channel and char/waste lands. A few (3-4) scattered huts are located on the west side about 200-220 m from the Project site boundary and few settlements are located along the access road. The main village settlements (Panchosona and Khas Bara Shimul) start at about 400 m away from the Project site boundary on the west and north-west side. It has further been noted that the area on the western and southern part of the Saidabad Power Generation Complex is currently being acquired for development of an export processing zone (EPZ) by the Government of Bangladesh. However, details of type of industries planned were not available at the time of this assessment.

As can be referred from Table 6.9 and above discussion, the human receptors were assessed to be of Medium sensitivity, whereas ecological receptors were considered as of Low sensitivity.

Prediction of Impacts

Impact on ambient air quality due to the Sirajganj 1 project (gas/HSD), proposed gas based Sirajganj 2 project (gas/HSD), Sirajganj 3 (gas/HSD) and Sirajganj 4 project (gas/HSD) were also evaluated by using air dispersion modelling. Predicted maximum criteria pollutant concentrations due to the Project in the Project AOI with natural gas and HSD as fuel have been presented in Table 6.48. Additionally, predicted concentrations at the receptor locations (refer Table 6.41) combined cycle operations of these projects with natural gas and HSD as fuel have been presented in Table 6.48. The concentration isopleths of NOx, SO_2, $PM_{2.5}$ and CO for different averaging periods without baseline concentrations have been presented in ***Annex N3.***

Table 6.48 Predicted Concentrations at Receptors due to Operation of Sirajganj 1, 2, 3 and 4 Projects - Scenario 1 and 2 with Gas and HSD as Fuel

Scenario	Pollutant	Average	Predicted Concentration (µg/m³)					Max. Background Concentration (µg/m³)*					Total Concentration (Predicted + Background) (µg/m³)					*Bangladesh Standard*
			Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	Max	AQ1	AQ2	AQ3	AQ4	(µg/m³)
Sirajganj 1, 2, 3 and 4 (CCGT) with Gas as Fuel	NO_x	1-hourly	86.22	38.55	47.77	74.55	47.62	-	-	-	-	-	-	-	-	-	-	-
		24-hourly	21.02	9.63	17.21	9.34	5.89	20.9	20.9	20.8	13.3	20.6	41.92	30.53	38.01	22.64	26.49	-
		Annual	4.94	3.07	4.08	1.58	1.00	-	-	-	-	-	-	-	-	-	-	*100*
	CO	1-hourly	145.12	66.77	81.31	124.74	81.18	-	-	-	-	-	-	-	-	-	-	*40000*
		8-hourly	86.15	45.43	69.57	42.99	28.51	2300	2300	2300	1150	1150	2386.15	2345.43	2369.57	1192.99	1178.51	*10000*
Sirajganj 1, 2, 3 and 4 (CCGT) with HSD as Fuel	NO_x	1-hourly	177.36	81.60	99.37	152.46	99.22	-	-	-	-	-	-	-	-	-	-	***---***
		24-hourly	42.01	19.59	36.14	19.40	12.20	20.9	20.9	20.8	13.3	20.6	62.91	40.49	56.94	32.7	32.8	***---***
		Annual	10.04	6.17	8.40	3.28	2.07	-	-	-	-	-	-	-	-	-	-	***100***
	SO_2	24-hourly	22.18	10.75	20.57	10.83	6.78	7.2	5.7	7.2	2.9	3.6	29.38	16.45	27.77	13.73	10.38	***365***
		Annual	5.46	3.23	4.63	1.83	1.15	-	-	-	-	-	-	-	-	-	-	***80***
	$PM_{2.5}$	24-hourly	12.39	5.78	10.65	5.72	3.60	24.8	22.7	24.8	19.1	22.6	37.19	28.48	35.45	24.82	26.2	***65***
		Annual	2.96	1.82	2.48	0.97	0.61	-	-	-	-	-	-	-	-	-	-	***15***
	PM_{10}	24-hourly	13.75	6.41	11.83	6.35	3.99	145.8	145.8	142.8	118.7	113.5	159.55	152.21	154.63	125.05	117.49	***150***
		Annual	3.29	2.02	2.75	1.07	0.68	-	-	-	-	-	-	-	-	-	-	***50***
	CO	1-hourly	159.32	77.08	91.04	135.41	91.17	-	-	-	-	-	-	-	-	-	-	***---***
		8-hourly	90.89	49.32	78.86	48.02	31.71	2300	2300	2300	1150	1150	2390.89	2349.32	2378.86	1198.02	1181.71	***10000***

* *Refer* ***to Table 4.16***

It is evident from *Table 6.48* that the maximum ground level concentration (maximum baseline concentration + predicted maximum concentration) in the project AOI with natural gas as fuel will be well within the applicable air quality standard. Furthermore, project contribution for all the pollutants considered in the study are < 25% of the applicable air quality standard and therefore, using the determination of magnitude criteria (Table 6.40), impact magnitude due to operation of S1, S2, S3 and S4 projects with natural gas as fuel is assessed to be negligible.

Impact	*Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with natural gas as fuel*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 2 km from project boundary in the downwind direction				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

While using HSD as fuel, the maximum ground level concentrations (maximum baseline concentration + predicted maximum concentration) of PM2.5, NOx, SO_2 and CO will be within the applicable standard and overall project contribution of all the four projects will be < 25% of the applicable standard. Therefore, using the determination of magnitude criteria (*Table 6.40*), the impact magnitude due to the operation of Sirajganj 1, 2, 3 and 4 projects is assessed to be negligible. It shall be noted that the all four projects will be using natural gas as primary fuel and HSD will only be used in case of non-availability of natural gas from GTCL. Furthermore, in the event of a gas supply failure, the facilities will not automatically switch to HSD as the decision rests with BPDB whether to operate the Plants on HSD or to pay capacity charges for the period of gas outage.

On this basis, the potential air quality impacts due to the operation of the Plant by using HSD as fuel are predicted to be ***negligible.***

Impact	*Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with HSD as fuel*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 2 km from project boundary in the downwind direction				

Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High	
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

Mitigation Measures

Refer to mitigation measures for Sirajganj 4 Project (Section 6.6.3).

6.7.3 *Green House Gases Emissions*

Cumulative Impacts due to Operation of Sirajganj 1, 2, 3 and 4 Projects

GHG Estimation and Impact

In order to estimate overall GHG emissions generation from Sirajganj 1, 2, 3 and 4 projects operation, the IFC recommended Carbon Emission Estimation Tool (CEET model – Version February 2014)[1] has been used as set out below.

Table 6.49 Estimated GHG Emissions from the Sirajganj 1, 2, 3 and 4 Project

SN	Particular	Unit	Sirajganj 1	Sirajganj 2	Sirajganj 3	Sirajganj 4
A*	Net Heat Rate (Natural Gas in Combined Cycle)	KJ/KWH	7,278	7,278	7,278	7,278
B*	Gross Generation Capacity (Combined Cycle)	KW	225,000	225,000	225,000	427,180
C	Operating Days	days	330	330	330	330
D	Daily Operating Hours	Hours/day	24	24	24	24
E	Total Annual Output (= B x C x D)	KWH	1782000000	1782000000	1782000000	3383265600
F	Annual Fuel Consumption (= E x A)	KJ	1.29694E+13	1.2969E+13	1.2969E+13	2.46234E+13
		TJ	12969.396	12969.396	12969.396	24623.40704
G**	GHG Emission Rates					
	CO_2	tCO_2/TJ	56.1	56.1	56.1	56.1
	CH_4	tCO_2/TJ	0.001	0.001	0.001	0.001
	N_2O	tCO_2/TJ	0.003	0.003	0.003	0.003
H	***Annual GHG Emission in Combined Cycle***	***tCO_2e/year***	***739,917***	***739,917***	***739,917***	***1,404,790***
I	**Gross GHG Emission from Sirajganj 1, 2**	**tCO_2e/year**			**3,624,541**	

[1] http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/CB_Home/Measuring+Reporting/

and 4 Plants operation in Combined Cycle Mode	

* Based on natural gas specification provided by Sembcorp (refer to Table 3.1 for details) and Gross Generation Capacity of Sirajganj 1, 2 and 3 Power Plants.
** Based on GHG emission factors provided in CEET

As per the latest report (26 December 2012) of GHG emission submitted by Bangladesh to the United Nations Framework Convention on Climate Change (UNFCCC)[1], electricity generation sector contribution to GHG emission in year 2005 was 1.192 x 10^7 tons CO_2e 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 10^7 tons CO_2e and 5.9168 x 10^7 tons CO_2e, respectively. Taking this into consideration, GHG emission contribution of the Saidabad Power Generation Complex (with total power generation capacity of about 1,100 MW) in the year 2020 will be 13.17% of the electricity generation sector in Bangladesh. Considering this fact, the GHG emission impact will be **moderate**.

Impact	*GHG emissions due to Operation of Sirajganj 1, 2, 3 and 4 Projects*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	National		
Impact Scale	Impact zone will be regional/ national				
Frequency	Operation Phase				
Likelihood	likely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **moderate.**				

Mitigation Measures

The following mitigation measures will minimise GHG emissions to ALARP levels:

- 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.
- Actual annual GHG emissions from all the plants within the complex shall be compiled and reported by the project owners of Sirajganj 1, 2, 3 and 4.

[1] **http://unfccc.int/resource/docs/natc/bgdnc2.pdf**

6.7.4 Noise

Cumulative Noise Impacts

Impact on ambient noise levels due to the operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects were also evaluated by using noise prediction model.

Criteria
It is planned that the Project will meet the noise emission criteria specified in the GOB ECR, 1997 and the WB/IFC EHS Guidelines, as presented in Table 2.10. Furthermore, for the assessment of ambient noise, the sensitivity and magnitude criteria outlined in Table 6.12 and Table 6.13, respectively have been used:

Receptors
The nearest noise receptor is located 200-220 m from the Project boundary in the western side, whereas other settlements are located about 400 m away from the Project boundary. As can be referred from Table 6.12 and above discussion, the receptors within the Saidabad Power Generation Complex as well as the ecological receptors were assessed to be of Low sensitivity, whereas the human settlements in the surrounding areas (residential areas) were assessed to be of Medium sensitivity.

Methodology: The environmental noise prediction model SoundPLAN 7.2 was used for modelling noise emissions from the use of power plant equipment and vehicular movement in the access road. It has been assumed that all the plant equipment of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 will adhere the equipment noise emission criteria of 85 dB(A) noise levels at a distance of 1 m from the source. Major plant components with higher noise generation considered in this study include GTG, STG, HRSG, Auxiliary Boiler, Cooling Tower, CW Pump House, Emergency DG, Water Treatment Facility, Pump House, RMS, and Gas Booster and Conditioning Station of all the three projects. Operation of equipment with 100% usage scenario was modelled to cover the operation phase of the projects. 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 were assumed to be operating simultaneously. Attenuation due to already constructed boundary wall of the Power Generation Complex has been considered in the modelling.

Predicted Noise Levels at Receptors: The predicted noise levels within the Project AOI during day time are presented in Table 6.50. Predicted noise levels at twenty receptors (where baseline noise levels were also monitored, which include eight receptors within or just outside the boundary of the Saidabad complex) have been presented in Figure 6.17. It is evident from the predicted results that in the worst case scenario, the nearest receptor (220 m from the western boundary of the Project site) will have a daytime noise level of 55.1 dB(A) during the operation phase.

Figure 6.17 Predicted Operation Phase Noise Levels of Sirajganj 1, Sirajganj 2 and Sirajganj 4 Projects during Daytime (Leq $_{day}$)

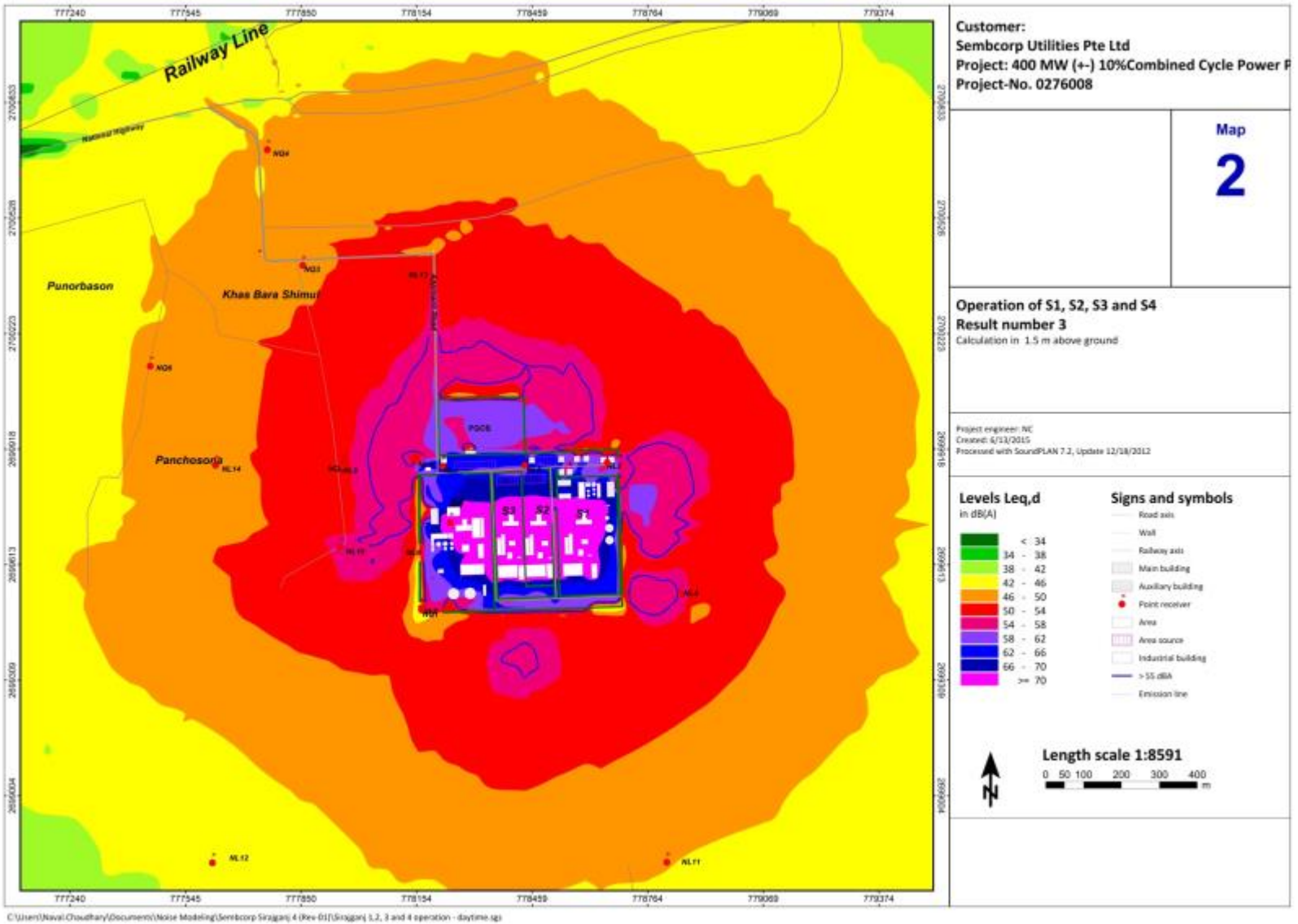


Table 6.50 Predicted Noise Levels at Noise Receptors during Operation Phase of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Projects

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	Baseline Sound Pressure Levels at Receptors, Leq (dBA)[1]		Predicted Sound Pressure Levels at Receptors, Leq (dBA)[4]		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard (dB(A))[2] [3] as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Day	Night
NQ1	Project Site Boundary	0 (-)	48.2	48.9	62.0	62.0	**62.2**	**62.2**	*70*	*70*
NQ2	Khas Bara Shimul	220 (W)	48.9	42.5	47.1	47.1	**51.1**	**48.4**	*55*	*45*
NQ3	Near Access Road (MMS Office)	665 (WNW)	47.0	42.4	39.9	39.9	**47.8**	**44.3**	*55*	*45*
NQ4	Access Road near National Highway	945 (WNW)	54.5	55.3	47.0	47.0	**55.2**	**55.9**	*55*	*45*
NQ5	Makimpur village	3000 (SW)	52.8	42.6	24.7	24.7	**52.8**	**42.7**	*55*	*45*
NQ6	Punorbason Village	760 m (NW)	50.4	42.4	37.3	37.3	**50.6**	**43.6**	*55*	*45*
NL1	Center of the Project area	0 (-)	40.7	32.4	73.5	73.5	**73.5**	**73.5**	*85*	*85*
NL2	North-East Corner	0 (-)	45.9	46.9	51.9	51.9	**52.9**	**53.1**	*70*	*70*
NL3	South side of the Mosque	0 (-)	40.2	24.8	55.0	55.0	**55.1**	**55.0**	*70*	*70*
NL4	NWPGCL Jetty	140 m (E)	40.2	47.6	48.1	48.1	**48.8**	**50.9**	*70*	*70*
NL5	North-west corner of the boundary	0 (-)	47.7	44.5	50.9	50.9	**52.6**	**51.8**	*70*	*70*
NL6	Middle point of the west side boundary (outside)	30 m (W)	48.0	45.1	57.1	57.1	**57.6**	**57.4**	*70*	*70*
NL7	South west corner of the boundary	0 (-)	39.5	40.6	60.0	60.0	**60.0**	**60.0**	*70*	*70*

Receptor Code	Receptor	Approximate Distance to Project Site Boundary (m) and Direction from Project Site	Baseline Sound Pressure Levels at Receptors, Leq (dBA)[1]		Predicted Sound Pressure Levels at Receptors, Leq (dBA)[4]		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard (dB(A))[2] [3] as per Landuse	
			Leq $_d$*	Leq $_n$*	Leq $_d$	Leq $_n$	Leq $_d$	Leq $_n$	Day	Night
NL8	In front of the GTCL's quarter	0 (-)	46.8	47.5	56.1	56.1	**56.6**	**56.7**	***70***	***70***
NL9	Khas Bara Shimul village	220 m (W)	55.6	45.2	47.0	47.0	**56.2**	**49.2**	***55***	***45***
NL10	Khas Bara Shimul village	220 m (W)	47.3	43.5	55.1	55.1	**55.8**	**55.4**	***55***	***45***
NL11	Chak Boira Village	680 m (S)	46.5	40.7	42.0	42.0	**47.8**	**44.4**	***55***	***45***
NL12	Chak Boira Village	840 m (SW)	46.4	40.8	35.7	35.7	**46.8**	**42.0**	***55***	***45***
NL13	Bara Shimul village	490 m (N)	44.6	42.6	47.3	47.3	**49.2**	**48.6**	***55***	***45***
NL14	Panchosona village	560 m (W)	50.8	44.2	48.0	48.0	**52.6**	**49.5**	***55***	***45***

[1] Ambient noise levels as monitored during the baseline survey

[2] Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

[3] [4] All operations have been considered as continuous and hence there is no change in the day and night time prediction results.

It is evident from Table 6.50 that ambient noise levels due to operation of all four projects within the Saidabad Power Generation Complex will be well within the applicable standard during day time at 17 receptors and night time at 14 receptors, out of total 20 receptors considered in the study. However, ambient noise level will be slightly higher from applicable standard (with < 3 dBA increase from the applicable standard) at 3 locations (NQ4, NL9, and NL10) during daytime. Therefore, the cumulative noise impact during operation of all 4 projects during day time is expected to be **minor**. Furthermore, noise levels at night time will be slightly higher than the applicable standard (with < 5 dBA increase from the applicable standard) at 4 locations and higher than the applicable standard (with < 10 dBA increase from the applicable standard) at 2 locations, out of which one locations is close to the project boundary, whereas the other location is close to the national highway with higher background noise levels. Due to this the noise impact from operation activity during night time is expected to be **minor to moderate.**

Impact	*Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Day time)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 250 m from the power generation complex boundary				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Impact	*Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Night time)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Maximum impact zone within 600 m from the power generation complex boundary				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor to moderate.**				

Mitigation Measures

- Installation of vibration isolation for mechanical noise control;

- The current assessment of cumulative noise impact due to Sirajganj 1, 2, 3 and 4 plants operation is based on mathematical modelling. Once all the four plants are operational, periodic ambient noise monitoring is suggested as part of the EMP to monitor the noise levels. This will be done to ensure compliance with the specification and guaranteed performance at noise generating sources as well as ambient noise levels at the receptors located in the surroundings.
- Review of noise guarantees and supporting data of all equipment suppliers with interim noise reports from EPC contractor/s in order to demonstrate compliance with the applicable noise emission criteria at source/s. In case of exceedence from the specified noise limits, adequate corrective actions as may be required shall be implemented by the specific project.

Criterion	Rating pre mitigation	Rating post mitigation	Comment
Change in Ambient Noise Levels during day time			
Residual Impact	Minor	Negligible	With implementation of the mitigation measures mentioned for minimizing the noise generation at source and providing barriers wherever feasible, the night time noise residual impacts would be negligible.
Change in Ambient Noise Levels during night time			
Residual Impact	Minor to Moderate	Negligible to Minor	With implementation of the mitigation measures mentioned for minimizing the noise generation at source and providing barriers wherever feasible, the night time noise residual impacts would be negligible to minor.

6.7.5 *Labour Influx*

Cumulative Impacts from Labour Influx

In addition to the labour requirements of the project, the labour requirements of Sirajganj 2 and the potential impacts from the same were analysed as part of the impact assessment. The labour requirement of Sirajganj 2 is estimated at 1500 labourers in the peak construction phase, of which 25-30% is expected to be comprised of migrant workers. The migrant workers will be comprised of the skilled workforce, while the semi-skilled and unskilled workforce will be sourced locally to the extent possible.

Due to the non-availability of land within the complex, the labour camp for the Sirajganj 2's construction phase (approx. 25-30 months) will be located outside the power generation complex. Since the Sirajganj 2 project's construction phase, is likely to be around the same time as the Sirajganj 4's construction phase, a total of 700-900 migrant workers may be present in the area. This is likely to result in an increase in the interaction of the local community with migrant workers, with an increased risk of sexually transmitted and communicable diseases, conflict and social unrest. Also, due to the presence of a large workforce, there may be a strain on local resources

and infrastructure, especially water, medical facilities, electricity, food and provisions in the local markets. This may also result in an increase in the overall price of essential commodities in the area,

However, keeping in mind the existing population of the AOI and that the migrant population is unlikely to comprise more than 30% of the workforce requirement, the severity of the impacts identified in expected to be **moderate**.

Impact	*Cumulative Impact from Labour Influx due to Sirajganj 2 and Sirajganj 4 projects construction*				
Impact Nature	Negative	Positive			Neutral
Impact Type	Direct	Indirect			Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local	Regional			International
Impact Scale	A total of 700-900 workers are expected to be sourced from outside Sirajganj District. The labour camps will be temporary and will be de constructed during the operation's phase of the project				
Frequency	Construction phase.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High	
Impact Significance	Negligible	Minor		Moderate	Major
	Significance of impact is considered **moderate**				

Mitigation Measures

The mitigation measures proposed to avoid significant impact due to the labour influx are as discussed in ***Section 6.4.10***.

6.8 RESIDUAL IMPACTS

The table below present the outcomes of the comprehensive assessment of identified impacts as a result of various phase of the project and present significance of residual impacts before mitigation (with embedded controls) and with suggested mitigation measures.

Table 6.51 Impact Assessment Outcome and Significance of Residual Impacts

Project Activities/ Impacts	Nature of Impact	Significance of Residual Impacts	
		Before Mitigation	With Mitigation
Construction Phase (Sirajganj 4 Project)			
Soil compaction	Negative	Negligible	Negligible
Soil erosion	Negative	Negligible	Negligible
Soil and sediment contamination from spills and leaks	Negative	Minor	Negligible

Project Activities/ Impacts	Nature of Impact	Significance of Residual Impacts	
		Before Mitigation	With Mitigation
Soil contamination from waste handling	Negative	Negligible	Negligible
Wastewater discharge	Negative	Negligible	Negligible
Ground water contamination	Negative	Minor	Negligible
Air quality degradation due to dust generation	Negative	Moderate	Minor
Air quality degradation due to exhaust emissions	Negative	Minor	Negligible
Noise from Construction Activities and transportation of man/ material (Day-time)	Negative	Negligible to Minor	Negligible
Noise from Construction Activities and transportation of man/ material (Night-time)	Negative	Minor to Moderate	Negligible to Minor
Clearance of vegetation at the Project Site	Negative	Negligible	Negligible
Clearance of vegetation at the Right of way of Water Pipeline Route & Water Intake Structure	Negative	Negligible	Negligible
Clearance of vegetation at the Jetty Location and Transportation Route	Negative	Negligible	Negligible
Excavation for laying fuel pipelines	Negative	Negligible	Negligible
Spillage from transportation vessels	Negative	Moderate	Minor
Habitat Disturbance due to construction of Temporary Jetty and Dredging	Negative	Moderate	Minor
Impact on endangered species (based on critical habitat assessment)	Negative	Minor to Moderate	Negligible to Minor
Traffic impact on road network	Negative	Minor	Negligible
Community health from changes in environmental conditions	Negative	Moderate	Minor
Increased Prevalence of Diseases	Negative	Moderate	Minor
Traffic safety due to heavy traffic movement	Negative	Moderate	Minor
Employment generation	Positive		
Benefit to local enterprises	Positive		
Impact on fishermen households using the temporary jetty location to anchor their boats	Negative	Minor	Negligible
Labour influx and construction workers accommodation	Negative	Moderate	Minor
Community expectations	Neutral		
Operation Phase (Sirajganj 4 Project)			
Contamination of soil and sediment from wastes	Negative	Negligible	Negligible
Surface water abstraction	Negative	Negligible	Negligible
Water pollution from wastewater discharge	Negative	Negligible	Negligible
Discharge of Cooling water due to operation of Power Plant	Negative	Negligible	Negligible
Ground water abstraction	Negative	Negligible	Negligible
Ground water contamination	Negative	Minor	Negligible
Ambient Air Quality (by use of natural gas as fuel for power generation)	Negative	Negligible	Negligible
Ambient Air Quality (by use of HSD as fuel for power generation)	Negative	Negligible	Negligible
GHG Emission due to Sirajganj 4 project	Negative	Moderate	Moderate
Noise from Operation of Plant and vehicular movement in Access Road (Day-time)	Negative	Negligible	Negligible
Noise from Operation of Plant and vehicular movement in Access Road (Night-time)	Negative	Minor	Negligible to Minor
Electric and magnetic field	Negative	Minor	Negligible
Natural hazards risk (Earthquake, Cyclone and Wind, Climate Change)	Negative	Minor to Moderate	Negligible to minor
Impact on terrestrial flora and fauna due to incremental air emissions	Negative	Negligible	Negligible

Project Activities/ Impacts	Nature of Impact	Significance of Residual Impacts	
		Before Mitigation	With Mitigation
Impact on fauna due to incremental noise levels	Negative	Negligible	Negligible
Discharge of cooling water to Jamuna River due to operation on aquatic flora and fauna	Negative	Negligible	Negligible
Risks due to hazardous materials handling and storage	Negative	Minor	Negligible
Community health and safety due to project induced traffic	Negative	Negligible	Negligible
Risks of industrial accidents and fatalities to workers	Negative	Minor	Negligible
Health associated risks from air emissions and waste water release	Negative	Negligible	Negligible
Employment generation and in-migration of skilled workforce	Positive		
Demand for lodging, housing and civic services	Positive		
Increments in cost of living	Neutral	Negligible	Negligible
Opportunity for local transporters	Positive		
Competing demand on natural gas	Negative	Negligible	Negligible
Demand for power amongst locals in AOI	Neutral		
In-migration of skilled workforce	Neutral	Negligible	Negligible
Cumulative Impacts due to Operation of Sirajganj 1, 2, 3 and 4 Projects)			
Cumulative Impact due to Groundwater Abstraction	Negative	Moderate	Minor
Water Pollution from Wastewater Discharge	Negative	Negligible	Negligible
Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with natural gas as fuel	Negative	Negligible	Negligible
Ambient Air Quality (Cumulative impact due to Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 projects) with HSD as fuel	Negative	Negligible	Negligible
GHG emissions due to Operation of Sirajganj 1, 2, 3 and 4 Projects	Negative	Moderate	Moderate
Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Day time)	Negative	Minor	Negligible
Noise from Operation of Sirajganj 1, Sirajganj 2, Sirajganj 3 and Sirajganj 4 Plants (Night time)	Negative	Minor to Moderate	Negligible to Minor
Cumulative Impact from Labour Influx due to Sirajganj 2 and Sirajganj 4 projects simultaneous construction	Negative	Moderate	Minor

7 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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;

It is to be noted that environmental, social and governance (ESG) considerations are embedded in the Project Sponsor's (Sembcorp), business decisions and processes. The ESMP for the project will also align with the Sustainability and HSE Policies of Sembcorp, which are presented in ***Box 7.1*** and ***Box 7.2***, respectively. The project will also follow these policies and will plan specific action to align with them.

Box 7.1 Sustainability Policy of Sembcorp

Sembcorp, as a member of the international business community, recognises that our business activities have varying direct and indirect impacts on the societies in which we operate. We commit to manage these in a responsible manner, believing that sound and appropriate performance in this area is linked to business success.
For Sembcorp, being a responsible corporate citizen is reflected in the following principles:

Standards of Business Conduct
We ensure that our business is conducted according to rigorous ethical, professional and legal standards, through maintaining robust corporate governance and an Employee Code of Conduct for staff.

Health, Safety and the Environment
Management of our health, safety and environmental responsibilities is our first priority. We are committed to continuously improving our HSE performance and managing health, safety and environmental risks associated with our activities, products and services. We integrate health, safety and environmental considerations into all aspects of our business operations and processes with the aim of preventing accidents, injuries, occupational illnesses and pollution and conserving natural resources.

Employees
We aim to be a fair and caring employer offering our staff equitable opportunities to develop and grow.

Community
We act as a responsible corporate citizen through support for community care initiatives, community partnerships and philanthropic and charitable causes, in particular causes supporting children and youth, education and the environment.

Sembcorp's operations throughout the world are committed to these principles. The stage and level of implementation varies according to each operation and maturity of business.

Source: http://www.sembcorp.com/en/esg-sustainability.aspx

Box 7.2 Health, Safety and Environment Policy of Sembcorp

Sembcorp manages health, safety and environment responsibilities as our first priority. We are committed to continuously improving our HSE performance and managing HSE risks associated with our activities, products and services. We are committed to continuously improving our HSE performance and managing HSE risks associated with our activities, products and services.

Sembcorp has established and will maintain a HSE management system, and integrate HSE considerations into all aspects of our business operations by implementing the following policy which aims to prevent accidents, injuries, occupational illnesses and pollution as well as conserve natural resources:

- Stress to all employees and contractors their responsibility and accountability for safe performance and set appropriate objectives and targets to continually improve HSE performance
- Educate employees to be aware of and understand the safety risks and health hazards associated with their job and the potential impact on the environment
- Make available this policy to all interested parties upon request
- Build, design, operate and maintain facilities and conduct operations in a manner that safeguards people, property and the environment, and minimises waste
- Comply with all HSE laws and regulations and other HSE requirements applicable to Sembcorp's activities, products and services
- Offer assistance to and influence suppliers, contractors and other interested parties to improve their HSE performance where necessary
- Review and evaluate operations to measure progress and ensure compliance with this policy via periodic system audits and management reviews
- Prepare for, and respond quickly to, accidents or other emergency situations to mitigate adverse impact on people, property and the environment

Source: http://www.sembcorp.com/en/esg-health-safety-and-environment.aspx

7.1 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[1] and operation phases of the Project is presented in ***Table 7.1***. 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 SNWPCL 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.

(1) [1] Social impacts associated with the planning phase of the Project have also been covered under the construction phase.

The construction phase of the Project is anticipated to last approximately 30 to 36 months, whereas the operation phase of the Project is 22 years, as per the Power Purchase Agreement (to be signed between SNWPCL and the BPDB). However, the design life of the Project is 30 years and SNWPCL will be responsible for ensuring that the mitigation measures in the ESMP are implemented throughout the life span of the Project. A commitment register came out from the EIA study has been presented in ***Annex U***.

7.2 ENVIRONMENTAL MONITORING

The environmental monitoring programme has been devised with the following objectives:

- To evaluate the effectiveness of the proposed mitigation measures and the protection of the ambient environment as per prescribed/ applicable standards for the Project;
- To identify the need for improvements in the management plans;
- To verify compliance with statutory and community obligations; and
- To allow comparison against baseline conditions and assess the changes in environmental quality in the Project AOI.

7.2.1 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 7.2***. This includes parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits, cost and responsibilities for implementation and supervision.

7.2.2 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 HSE Division of SNWPCL will finalise the format for reporting on the status and progress of environmental monitoring. The format will be designed to meet all the compliance conditions associated with the environmental clearance from the Department of Environment and the Government of Bangladesh. The contractor will be required to submit the duly filled up reporting form on a monthly basis to the Project Developer (i.e., SNWPCL). 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 SNWPCL HSE team with a periodic third party audit.

During the operation phase of the Project, the Operations Manager and HSE Personnel will monitor the effectiveness of the EMP implementation. The Project Administration and Human Resources (HR) Manager will have additional responsibility of monitoring the implementation of social components of the ESMP. He/ she will also responsible for implementation of corporate social responsibility (CSR) activities to be conducted by SNWPCL. Both Operations Manager and HR Manager will further report to the Plant 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 7.1 Environmental and Social Management Plan of the Project

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
A	*Environmental Issues Associated with Site Preparation and Construction*							
1.1	Soil Quality	Site clearing and preparation, Laying of gas pipeline, use of heavy loaders from the temporary jetty site	Soil erosion and compaction	• Demarcation of routes for movement of heavy vehicles especially near the temporary jetty; • Stripping and placing soils when dry, and not when wet; and • Restricting the height of topsoil stockpiles to minimize erosion and compaction. • Building small bunds in areas with slope to prevent soil erosion.	Appointed EPC Contractor	On site Project Management team of Project developer	Route plans and top soil management inventory submitted to HSE and Project Management team	• EPC Contractor Cost
1.2	Soil and sediment Quality	• Fuelling and operation of heavy machinery and transport vehicles, Unloading and loading activities near the temporary jetty • Storage and handling of chemicals	Soil and sediment contamination through spills and leaks	• Fuel tanks and chemical storage areas to be sited on sealed areas and provided with locks to prevent unauthorized entry; • 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; • Implementation of a training program to familiarise staff with emergency procedures and practices related to contamination events; • 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; • 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 bunded areas prior to discharge to the storm water system.	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 SNWPCL	• EPC Contractor Cost
1.4	Soil Quality	Storage, handling and disposal of construction waste	Soil contamination	• Design processes to prevent/minimise quantities of wastes generated and hazards associated with the waste generated; • Training labourers for waste disposal in designated areas and use of sanitation facilities; • Provide dedicated storage areas for construction materials to minimise the potential for damage or contamination of the materials; • Implement a construction materials inventory management system to minimise over-supply of the construction materials, which may lead to disposal of the surplus materials at the end of the construction period; • 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 minimise odour 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 accommodate 110% of the volume of the largest waste container;	Appointed EPC Contractor	HSE Division of Project developer and on site Project Management team	Monthly report to SNWPCL	• EPC Contractor Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				• Storage of inert concrete waste in a laydown area near the concrete batching plant and reuse of these wastes under floors or roads; and • Dispose of hazardous waste including bitumen by licensed contractors.				
2.1	Water Resources	• Wastewater Discharge from washing of equipment and machinery • Sanitary facilities	Wastewater contamination	• Vehicle servicing areas and wash bays located within roofed and cemented areas. The drainage in these covered areas connected to oil/water separator and channelized properly to the land/inland waters ; • Oil leakage or spillage contained and cleaned up immediately. Waste oil to be collected and stored for recycling or disposal; • Oil and grease separator shall be used for wastewater generated from cleaning activities; • Any surplus wastewater from the concrete batching to be treated to comply with discharge standards before it is discharged; • Adequate sanitary facilities, i.e. toilets and showers, provided for the construction workforce; • Workers trained in the use of designated areas/bins for waste disposal and encouraged to use toilets. • Septic tanks provided to treat sanitary wastewater; and all sewage and liquid effluent treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997 respectively and IFC EHS Guidelines prior to discharge to land/inland waters.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to SNWPCL	• EPC Contractor Cost
2.2	Surface Water Quality	• Leaks and spills of oil, lubricants, fuel • Improper handling of sewage or chemical	Groundwater contamination					
	Air Quality	• Site preparation and levelling; • Excavation of soil to create building and equipment foundations; • Pile driving for the equipment foundation; • Concrete works • Transportation related activities	Dust generation	• Implementation of a regular and rigorous watering and sprinkling regime for dust suppression during the dry season; • As far as possible, locate the concrete batching plant away from sensitive receptors and additional net fencing on section of boundary wall facing the residential receptors to reduce dust transport.; • 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. • 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.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to SNWPCL	• EPC Contractor Cost
4.2	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, PM_{10} and SO_2; • Where available use low sulphur diesel (LSD) in HGVs and diesel powered equipment; • Implement best practice procedures to control vehicle / equipment air emissions (such as turning off equipment when not in use); and	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to SNWPCL	• EPC Contractor Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				• Vehicle / equipment exhausts observed to be emitting significant black smoke from their exhausts will be serviced/ replaced.				
	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 Monday to Sunday. If work needs to be undertaken outside these hours, it should be limited to activities that do not lead to exceedance of the noise criteria at nearby NSRs; • Only well-maintained equipment should be operated on-site; • Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted; • Machines and construction plant items (e.g. trucks) that may be in intermittent use should be shut down or throttled down between work periods; • Low noise equipment should be used as far as practicable; • The number of equipment operating simultaneously should be reduced as far as practicable; • Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable; • Noisy plant (such as breakers and rollers) shall be located as far away from receptors as practicable.	Appointed EPC Contractor	On site Project Management team and designated HSE team	Monthly report to SNWPCL	• EPC Contractor Cost
	Terrestrial Flora and Fauna	• Site preparation and related activities • Excavation for Fuel Pipelines	• Clearance of Vegetation at Project site, RoW of Water pipeline and intake structure, Jetty location and transportation route	• Pre-construction surveys shall be conducted by qualified ecologist hired by project developer to identify the floral and faunal species of conservational significance. The location of CR/EN species (if chance found) shall be marked in advance and the area will be avoided; • If tree removal cannot be avoided, adequate compensatory afforestation including conservation of EN species in consultation with Forest Department shall be undertaken; • Efforts to be taken to replant the species nearby where no disturbance due to project activity is envisaged; • Vegetation clearing will be kept to the minimum extent practicable for the project site, temporary jetty, transportation route through Jamuna eco park, water and gas pipeline; • 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/ 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; and • Improved management of eco-park needs to be	Project Management along with hired specialists and Appointed EPC Contractor	On site Project Management Team including specialist as required	Monthly report to SNWPCL	• Project Developer and EPC Contractor Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				supported by the project to reduce impacts during the construction phase of the project. • There is a likelihood of introduction of invasive species due to movement of Vehicles in the Jamuna Eco Park. All vehicles tyres should be properly washed before entering Jamuna Eco Park.				
6.2	Terrestrial Flora and Fauna	Construction and transportation related activities	• Impact on species of conservational significance	• Identification of any trees where vultures nest on in the AOI and protection of these trees with a surrounding buffer area. • Exclusion of cattle from project area by site security to reduce risks of carcasses contaminated by diclofenac being consumed by vultures.	• 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 SNWPCL	• Project Developer Cost and EPC Contractor Cost
6.3	Aquatic Flora and Fauna	• Construction of temporary jetty and dredging • Transportation of equipment • Leakages and Discharges from River Transportation	Impact on habitat of aquatic and riverine fauna due to accidental spillage	• Conservation training shall be given and a ban on hunting, capture of species by any contractor/subcontractor/construction worker working on water pipeline, jetty area including logistics contractor not complying being immediately removed from the project; • Proper maintenance for avoidance of any leakage of fuels and other contaminants from barges/trawlers to Jamuna River; • During transportation of equipment's the vessel speed should be regulated and observer for the Dolphin movement should be appointed to guide the vessel to the temporary jetty area. Ballast discharge to be regulated near the AOI; and • Trawlers/barges with valid requisite licenses and emergency handling capacity or tie-ups shall only be engaged. • All vessels plying the river are to be properly maintained with oil seals etc. regularly checked for oil leaks etc. All containers used for hydrocarbons storage (vessels and jetty area) should be sealed tightly and secured to prevent accidental spillage or leaks into the river. Vessels plying the river and on shore facilities should be routinely inspected by the site security to ensure compliance to these principles. •	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 SNWPCL	• Project Developer Cost and EPC Contractor Cost
6.4	Aquatic Flora and Fauna	• General construction and transportation of material	• Impact on species of conservation significance	***Mammals: South Asian river dolphin (Jamuna Dolphin)*** • Movement of vessels in the Jamuna River to temporary jetty area shall require vessel patrols or deck monitoring for detecting movement of South Asian River Dolphin. If such movement is observed, the vessel should be stopped until the species moves out of the path of the vessel. Vessel patrols and deck monitoring should organize or enforced/ supervised by the site security.	EPC Contractor	On site Project Management Team and Designated HSE team on site	Monthly report to SNWPCL	• Project Developer Cost and EPC Contractor Cost
	Transportation	• Transportation of construction material, and personnel	Disturbance to existing road users through increase in road traffic	• Avoiding peak hours for heavy vehicles movement where possible; • During transportation of heavy equipment from	SNWPCL, Appointed EPC Contractor	On site Project Management team and designated HSE	Monthly report to SNWPCL	• EPC Contractor Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				the temporary jetty inside the ecopark to the main road a speed limit of 10 km/hr needs to be maintained by all heavy vehicles; • 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.		team		
	Community Health and Safety	• General construction activities • Influx of construction workers	Health Impacts due to Changes in environmental conditions Increased prevalence of disease	• Barriers will be provided to prevent ingress of persons into the construction site and also to protect public exposure to hazards associated with construction activities; • 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 in labour camps and surrounding areas; and • Avoiding formation of stagnant water pools in and around the site; • Prevention of larval and adult mosquito propagation through sanitary improvements and elimination of breeding habitats close to human settlements in the close vicinity of Project site; • Educating area residents and workers on risks, prevention, and available treatment for vector-borne diseases.	Appointed EPC Contractor along with Project Management	On site Project Management Team and Designated HSE team on site	Monthly Report to SNWPCL	• EPC Contractor Cost
8.2	Community Health and Safety	Heavy traffic movement	Traffic safety	• 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.	Appointed EPC Contractor	On site Project Management Team and Designated HSE team on site	Monthly Report to SNWPCL	• EPC Contractor Cost
B	***Social Issues Associated with the Construction Phase***							
9.1	Social Scenario	Construction related activities	• Influx of Construction Workers • Stress on Local infrastructure	• Preventing stress on local infrastructure by providing labour related infrastructure such as camps, sanitation facility, drinking water facility, etc. in accordance with local regulations as well as IFC handbook for labour accommodation; • Consulting with the local community prior to finalization of location of labour camp to get their consent • Preparation of a detailed plan, in keeping with lender requirements, for the construction of the	Project Management and EPC Contractor	Designated CSR team on site and GRC	Need Based Assessment Report and Monthly reports to top management, SNWPCL	• Project Developer Cost and • EPC Contractor Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				labour camp and the mitigation measures to be put in place • Ensure proper administrative channel to manage labour related statutory compliance, such as payment of wages, provident fund, insurance etc. as well as labour issues arising during the construction phase activities; • Manage illegal labour practices such as child labour, bounded labour or forced labour through internal vigilance mechanisms and surveillance; and • Awareness shall be generated amongst migrant labourers in maintaining congenial relations with local labourers as well as community.				
9.2	Social Scenario	Construction of temporary Jetty	• Partial loss of livelihood of fishing households due to reduction in fish catch.	• Consultations with the fishing households should be done before dredging and other site improvement activities are carried out at the Jetty location. Alternative anchorage areas should be identified and safe anchorage of their boats to be facilitated. • The reduction in fish catch for these fishing households should be compensated through cash payment during the period for which jetty is used.	Project Management and EPC Contractor	Designated CSR team on site and GRC	Monthly reports to top management, SNWPCL	• Project Developer Cost and • EPC Contractor Cost
9.3	Community	Construction activities	• Community Expectations	• Engaging closely with local NGOs to understand the key collective requirements of the surrounding community and identify one or more of the highlighted concerns which SNWPCL will support to resolve. • Some of the collective requirements could be access to (i) clean drinking water (ii) medical consultation (iii) education, etc. • Enhance employment opportunities by maximizing utilization of the local population, as far as possible. • Communication of a clear plan of action to improve the welfare of the neighbouring community, before commencing construction works on site.	Project Management along with CSR , NGOs and EPC Contractor	Designated CSR team on site and GRC	Monthly reports to top management, SNWPCL	• Project Developer Cost and • EPC Contractor Cost
C	***Environmental Issues Associated with the Operation Phase***							
1.1	Soil and Sediment Quality	Waste generated from • Office and Canteens; • WTP, ETP and STP; • Gas Turbines; • Laboratories; • GT Compressors; • Lube oil systems; • DG sets; and • Power house and Workshop area.	• Contamination of soil and sediment from wastes	• Wastes shall be stored in a manner that will prevent contact between incompatible wastes i.e. post compatibility checks, • Proper labelling of hazardous wastes; • Special care shall 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 shall 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 shall be prepared to address accidental spillages or release	Project Developer/Plant Management/Plant HSE Team	Designated Team comprising of representation from relevant departments as HSE, Operations, Administration and HR.	Monthly internal reports to top management and reporting to regulatory authorities/lenders as required.	• Plant O&M Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				of hazardous wastes; and • A proper manifest record shall be maintained of waste travelling/ removed from the site; and • Disposal of hazardous waste by engaging DOE approved waste management agencies.				
2.1	Water Resources	Wastewater discharge	• Impact on aquatic flora and fauna • Contamination of soil and sediment	• 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; • 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.	Project Design Team to implement design phase mitigation measures. Operations and Plant HSE Team to implement O&M Phase Mitigation Measures	HSE department and Operations. Study by 3rd Party agency /experts.	Records maintained and Monthly internal reports to top management and reporting to regulatory authorities/lenders as required.	• Included in Project Capital and Plant O&M Cost as mentioned above
2.2	Water Resources	Surface water abstraction	• Impact on surface water availability	• 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.	Operations team	Designated Team comprising of representation from HSE and Operations	Records maintained and Monthly internal reports to top management	• Included in Project Capital and Plant O&M Cost as mentioned above
2.3	Water Resources	Storage and handling of Fuel, Oil and chemicals	• Impact on soil and ground water environment • Storm water runoff carrying contaminants to nearby low lying areas and adjoining Channel	• For minimising use of antifouling and corrosion inhibiting chemicals appropriate depth of water intake will be maintained and use of screens will be ensured; • Minimum required quantities of chlorinated biocides or alternatively intermittent shot dosing of chlorine will be practised 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. • In the unlikely event water percolation does not occur as expected, SNWPCL could rely on temporary solutions such as to engage a sub-contractor to use the portable pumps & hoses to evacuate this water to the river or dry canal, thereby allowing a larger surface area for the water to percolate. • SNWPCL will monitor the wastewater discharge and if water stagnation if observed to persist continuously over an extended period of [12-18] months, then SNWPCL will evaluate permanent solutions to resolve the issue. However if the water stagnation is observed to occur for only part of the year, then the temporary solution should suffice.	Operations and Plant HSE Team	Designated Team comprising of representation from HSE and Operations	Records maintained and Monthly internal reports to top management	• Included in Project Capital and Plant O&M Cost as mentioned above
4.1	Air Quality	Stack emissions	• Impact on ambient	• The use of continuous emission monitoring	Plant HSE Team	Designated Team	Relevant Records	Included in Project

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
			air quality	(CEM) equipment for the measurement of air emission levels in the exhaust stack of HRSG. CEM will be undertaken for NOx, SO2, CO and O2; • PM2.5 and VOCs will be monitored periodically, to ensure that these emissions are not occurring as a result of the incomplete burning of the natural gas fuel and use of HSD as fuel. • The stack shall be provided with safe access to sampling points for CEM. • HSD shall be used only during shortage of natural gas supply.	and Operations	comprising of representation from HSE and Operations	maintained. Monthly internal reports to top management and reports to regulatory authorities/lenders as required.	Capital and Plant O&M and External 10 m BDT
4.2	Air quality	Stack emissions	• GHG emissions	• 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.	Plant HSE Team and Operations	Designated Team comprising of representation from HSE and Operations	Relevant Records maintained. Monthly internal reports to top management.	Plant O&M Cost as above
5.1	Noise	Plant operations	• Increased noise levels	• 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; • Installation of vibration isolation for mechanical equipment; 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 HSE Team and Operations	Designated Team comprising of representation from HSE, Operations and GRC	Relevant Records maintained. Monthly internal reports to top management and reports to regulatory authorities/lenders as required.	Included in Project Capital and Plant O&M
6.1	EMF	Magnetic fields associated with transmission and distribution systems	• Potential source of Shocks	• Occupational health and safety EMF standards in EHS guidelines on thermal power and electric transmission lines shall be adhered to	Plant Operations	Designated Team comprising of representation from HSE, Operations	Relevant Records maintained. Monthly internal reports to top management.	Plant O&M Cost
7.1	Climate Risk	Plant operations due to flood risk	• Loss of lives and property • Damage to critical equipment, plants and buildings leading to safety incidents	• Work closely with local authorities and NWPGCL on these issues a combined response is likely to be more cost-effective.	Plant HSE Team and Emergency Management Team with local authorities and NWPGCL	Designated Team comprising of representation from HSE ,Operations, Emergency Management	Relevant Records maintained and included as part of Emergency response.	Project O&M Cost and emergency contingency fund
8.1	Terrestrial Habitat	Plant Operations	• Incremental noise	• Noise levels must be attenuated to the extent possible by proper lubrication of machineries and equipment and installation of noise	Plant HSE Team and Operations along with	Designated Team comprising of representation	Relevant Records maintained and internal report to senior	Plant O&M Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				barriers/acoustic enclosures at appropriate locations; • Habitat improvement in form of dense plantation with native species along the water pipeline ROW and adjoining degraded Eco park land will be undertaken. 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.	Specialist as required	from HSE /Operations	management.	
8.2	Aquatic Ecology	Plant operations	• Discharge of cooling water	• Monthly monitoring of temperature at the discharge point; • Discharge system shutdown in the event that effluent temperature exceeds 3°C; • Maintain the cooling water chemistry at approximately 5 cycles of concentration (COC) 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. Treated wastewater will be discharged along with cooling water on land.	Plant HSE Team and Operations	Designated Team comprising of representation from HSE /Operations	Relevant Records maintained and monthly internal report to senior management and report to regulatory authorities as required.	Plant O&M Cost
8.3	Aquatic Ecology	Plant operations	• Discharge of cooling water on land in the upstream of Jamuna Channel • Discharge of treated effluent	• 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 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. Treated waste water will be discharged along with cooling water to Jamuna River. • Undertake a post operational assessment study through independent 3rd party agency/experts with an objective to assess the impact of cooling water discharge on Jamuna River ecological resources and social aspects. Such study will be conducted preferably after 12 months of commissioning the Project and the study recommendations will be implemented to further fine tune the mitigation strategy.	Plant HSE Team and Operations Team Study with help from Specialists	Designated Team comprising of representation from HSE /Operations	• Relevant Records maintained and internal report to senior management. • Study report	Plant O&M Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
9.1	Community Health and Safety	Plant operations	• Health associated risks from air emissions and wastewater release	• Same as given in 2.2, 2.2 and 2.3 and 4.1 and 4.2 (Operation Phase)	Plant HSE Team and Administration	Designated Team comprising of representation from HSE /logistics team and GRC	Relevant Records maintained and monthly internal report to senior management.	Plant O&M Cost
9.2	Occupational Health and Safety	Plant operations	• Risks of accidents and fatalities to workers	• 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; • SOPs need to be developed for operation and maintenance of the Plant;	Plant HSE Team and HR and Administration	Designated Team comprising of representation from HSE /HR/Administration	Relevant Records maintained and monthly internal report to senior management.	Plant O&M Cost
D	***Cumulative Impacts***							
1.1	Water Resources	Ground water Abstraction and waste water discharge of all plants	• Reduction in ground water availability • Contamination of water resources	• Considering the ground water abstraction in large quantity by NWPGCL's 3 projects within the complex, it is suggested to provide piezometers for monthly monitoring of ground water level and quality within the complex; • For minimising use of antifouling and corrosion inhibiting chemicals appropriate depth of water intake will be maintained and use of screens shall be ensured; • Minimum required quantities of chlorinated biocides or alternatively intermittent shot dosing of chlorine shall be practised 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; • Oil water separators shall be provided to intercept any accidental discharge of oil and grease on the storm water channels; • Liquid wastes such as waste oil, etc. shall be collected and stored for recycling in cemented areas; and • All drainage/tanks, etc. shall be positioned on concrete hard standing to prevent any seepage into ground.	Operations Team and Plant HSE Team	Designated Team comprising of representation from HSE /Operations	• Relevant Records maintained and internal report to senior management.	Plant O&M Cost
2.1	Air Quality	Operations of all plants	• Impact on Air Quality	• Refer Section 41. and 4.2 (Operation Phase)				
2.2	Air Quality	Operations of all plants	• Greenhouse gas emissions	• 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. • Actual annual GHG emissions from all the plants within the complex shall be compiled and reported by the project owners of Sirajganj 1, 2, 3 and 4.	Operations Team and Plant HSE Team with help from other operational plants	Designated Team comprising of representation from HSE /Operations with help from other operational plants	• Relevant Records maintained and internal report to senior management.	Plant O&M Cost
3.1	Noise	Operations of all plants	• Increased noise levels	• Installation of vibration isolation for mechanical noise control; • Once all the four plants are operational, periodic ambient noise monitoring is to monitor the noise	Operations Team and Plant HSE Team	Designated Team comprising of representation from HSE,	Relevant Records maintained. Monthly internal reports to top management and reports	Plant O&M Cost

S. No.	Affected Aspect	Project Activity /affected area	Potential Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Reporting Requirements	Approximate cost and Mitigation Cost Source
				levels to ensure compliance with the specification and guaranteed performance at noise generating sources as well as ambient noise levels at the receptors located in the surroundings. • Review of noise guarantees and supporting data of all equipment suppliers with interim noise reports from EPC contractor/s in order to demonstrate compliance with the applicable noise emission criteria at source/s. In case of exceedence from the specified noise limits, adequate corrective actions as may be required shall be implemented by the specific project.		Operations and GRC	to regulatory authorities/lenders as required.	
4.1	Social Scenario	Construction activities of other plants simultaneously	• Worker influx	• Same as in 9.1(Construction Phase)				

Table 7.2 Environmental and Social Monitoring Programme (Construction and Operation Phase)

Project Stage/ Affected Component	Potential Impact	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[1] and construction workers camp	Visual inspection of all active work areas	Daily	HSE Team of EPC Contractor	EPC Contractor Cost [1 x HSSE Manager & 2 x HSSE Supervisor]
Soil	Contamination of soil	pH, salinity, NH_4^+, total P, heavy metals, oil & grease	Construction site or laydown area or spill area	Standard analytical methods	In the event of any leakage or spillage of hazardous substances, oil, or toxic chemicals	3rd Party Environmental Consultant	BDT 100,000/ monitoring (EPC Contractor Cost)
Water	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	Near Temporary Jetty and near water intake and outfall structures	Standard analytical methods	Monthly	3rd Party Environmental Consultant	BDT 660,000/ annum (EPC Contractor Cost)
	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR 1997	Groundwater wells to be used for drinking water supply during this phase	Standard analytical methods	Once every fortnight	3rd Party Environmental Consultant	BDT 1,632,000/ annum (EPC Contractor Cost)
Ambient Air Quality	Dust generation	SPM and PM_{10}	Identified ASRs within 500 m from the construction site (4 locations)	24-hour	Once every fortnight	3rd Party Environmental Consultant	BDT 1,200,000/ annum (EPC Contractor Cost)

(2) [1] Activity areas are defined as Project site, access road and gas/fuel/ water pipeline RoW.

Project Stage/ Affected Component	Potential Impact	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	Vehicle exhaust	$PM_{2.5}$, NO_2, SO_2, CO	Identified ASRs within 100 m from the activity areas (2 locations)	24-hourly monitoring of PM2.5 and SO2 and 1-hourly monitoring of NO2 and CO	Monthly	3rd Party Environmental Consultant	BDT 900,000/ annum (EPC Contractor Cost)
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq day, Leq night and hourly Leq	Identified NSRs within 500 m from the activity area/s (8 locations)	24-hour	Monthly	3rd Party Environmental Consultant/ In-house monitoring	BDT 156,000/ annum (EPC Contractor Cost)
Occupational Health and Safety	Accidents or incidents due to construction activities, workers' health	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by EPC contractor	As defined in H&S Plan	HSE Team of EPC Contractor	EPC Contractor Cost [1 x HSSE Manager & 2 x HSSE Supervisor]
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Access Road connecting site	Incidents, accidents and community complaints	Based on occurrence	HSE and/or Community Liaison Officer of EPC Contractor	EPC Contractor Cost [1 x HSSE Manager; 2 x HSSE Supervisor; 1 x Liaison Officer]
	Public concerns	Complaints from community	Neighbouring communities around the Project activity areas	As per the grievance redress mechanism	Continuous	SNWPCL	Grievance Management Budget of SNWPCL

Project Stage/ Affected Component	Potential Impact	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Terrestrial Ecology	Impact on species of conservational importance	Tree cutting	Near temporary jetty ,transportation route, RoW of water pipeline and intake structure	Identification and Enumeration by ecologist	One time prior to start of work	SNWPCL with help of experts	As per the compensation demanded by the Forest Department (EPC Contractor Cost)
	Impact on habitat of avifauna and	Habitats and Disturbance to avifauna	Near temporary jetty ,transportation route, RoW of water pipeline and intake structure	Visual Inspection	Continuous	SNWPCL	EPC Contractor Cost
Aquatic Ecology	Impact on habitat of aquatic and riverine fauna due to spillage	Habitats and Disturbance to aquatic fauna	Near temporary jetty ,transportation route, RoW of water pipeline and intake structure	Identification by experts and visual inspections	Prior to start of work and Continuous visual inspection	SNWPCL	BDT 300,000/ (EPC Contractor Cost)
	Impact on Reptiles due to trawlers and barges	Habitats and Disturbance to aquatic fauna	temporary jetty ,transportation route	Visual monitoring	Continuous during unloading operations at temporary jetty area and transporation route	SNWPCL	EPC Contractor Cost
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	Plant HSE Team	Included in operation and maintenance (O&M) cost

Project Stage/ Affected Component	Potential Impact	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Soil	Soil and Sediment Contamination	pH, salinity, NH_4^+, total P, heavy metals, oil & grease	In waste storage area, and sediment of Jamuna River or as applicable	Standard analytical methods	In case of Accidental spillage	3rd Party Environmental Consultant	BDT 200,000/ monitoring (O&M Cost)
Water	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR 1997	Borewell water to be used for domestic purposes	Standard analytical methods	Monthly Quarterly	Inhouse laboratory 3rd Party Environmental Consultant/	O&M Cost BDT 50,000/ annum
	Wastewater	Temperature, chlorine, pH, BOD5, COD, oil & grease, heavy metals, total faecal coliform	Outlet of discharge channel	Standard methods	Daily Quarterly	Inhouse laboratory 3rd Party Environmental Consultant/	O&M Cost BDT 80,000/ annum
	Surface water quality	Temperature, conductivity, pH, DO, TDS	3 stations (at 0 m, 100 m and 200 m from the point of discharge of effluent)	Potable water quality analyser	Daily Quarterly	Inhouse laboratory 3rd Party Environmental Consultant/	O&M Cost BDT 60,000/ annum
	Cooling water	Temperature	Intake pipeline inlet and discharge pipeline outlet	Thermistor	Continuous	Inhouse laboratory	Installation included in EPC Cost Monitoring and maintenance in O&M cost
Air Emissions	Stack emissions	NOx, CO, $PM_{2.5}$ and O_2	Main stack and by-pass stack	CEM	Continuous	SNWPCL	Installation included in EPC Cost Monitoring and maintenance in O&M cost
	Emission concentrations	CEM validation for NOx, CO and $PM_{2.5}$	Main stack and by-pass stack	Standard methods	Annual	3rd Party Environmental Consultant	BDT 100,000/ annum (O&M Cost)

Project Stage/ Affected Component	Potential Impact	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	Ambient air quality	NOx, CO, PM_{10}, $PM_{2.5}$, SO_2	4 locations within 2 km from the Project boundary (Project boundary, Khas Barashimul, Panchosona and Punorbason Village)	Standard methods	Half yearly	3rd Party Environmental Consultant	BDT 400,000/ annum
Noise	Noise generation by Plant equipment	Sound Pressure Level	1 m from the noise generating equipment (For all the noise sources greater than 70 dB(A) noise level)	Noise monitor	Monthly Half yearly	In-house laboratory 3rd Party Environmental Consultant	O&M Cost BDT 50,000/ annum
	Ambient noise	Ambient noise levels	At Project boundary and at nearest noise sensitive receptors in all direction from the Plant	Noise monitor with data logger (24-hour observations with hourly noise levels)	Half yearly	3rd Party Environmental Consultant	BDT 40,000/ annum
EMF	EMF	EMF standards	Transmission line		Annual	SNWPCL	O&M Cost
GHG Emissions	Climate change	GHG production	Plant control room	Natural gas consumption	Annual	SNWPCL	No cost
Terrestrial Ecology	Disturbance to avifauna from noise	Nesting, bird count	In and around the Project site	Nesting, bird count	Half yearly for first two years of operations	SNWPCL by engaging Terrestrial Ecology Expert/ Agency	BDT 200,000/ annum (O & M Cost)
Aquatic Ecology	Impact on Fishes and riverine flora and fauna	Fish count, phytoplankton's, zooplanktons numbers	Upstream , downstream of Jamuna river	Abundance of aquatic flora and fauna	Once post 1 year of commissioning of the plant through experts	SNWPCL by engaging Aquatic Ecology Expert/ Agency	BDT 200,000 (O & M Cost)
	Aquatic ecology	Visible fish kills	Water intake and outlet and downstream of Jamuna River	Visual inspection and consultation with fishermen	Monthly	Plant HSE Team	O&M Cost

Project Stage/ Affected Component	Potential Impact	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	Aquatic Ecology	Phytoplankton, zooplankton and benthos	Jamuna River	Abundance and species composition	Half yearly	SNWPCL by engaging Aquatic Ecology Expert/ Agency	BDT 200,000/ annum O&M Cost
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Access Road	Incidents, accidents and community complaints	Based on occurrence	HSE and/or Community Liaison Officer of SNWPCL	O&M Cost
	Discharge of effluent and cooling water	Accidents, incidents and complaints	Adjoining Channel	Incidents, accidents and community complaints	Based on occurrence	HSE and/or Community Liaison Officer of SNWPCL	O&M Cost
	Public concerns	Complaints from community	Neighbouring communities around the Project activity areas	As per the grievance redress mechanism	Continuous	Community Liaison Officer of SNWPCL and Station Manager	O&M Cost
CSR Activities	Community Development	Activities/ Programmes and No. of beneficiaries	Vulnerable Groups around the Project activity areas	No. of beneficiaries and outcome of the activities	Periodic and need based	Admin/ HR Manager and Station Manager	CSR Budget

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 HSE 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 (SNWPCL) and EPC Contractor for implementation and monitoring have been outlined in ***Table 7.3***. The flow diagram depicting the institutional arrangement for implementation of the ESMP is presented in ***Figure 7.1***.

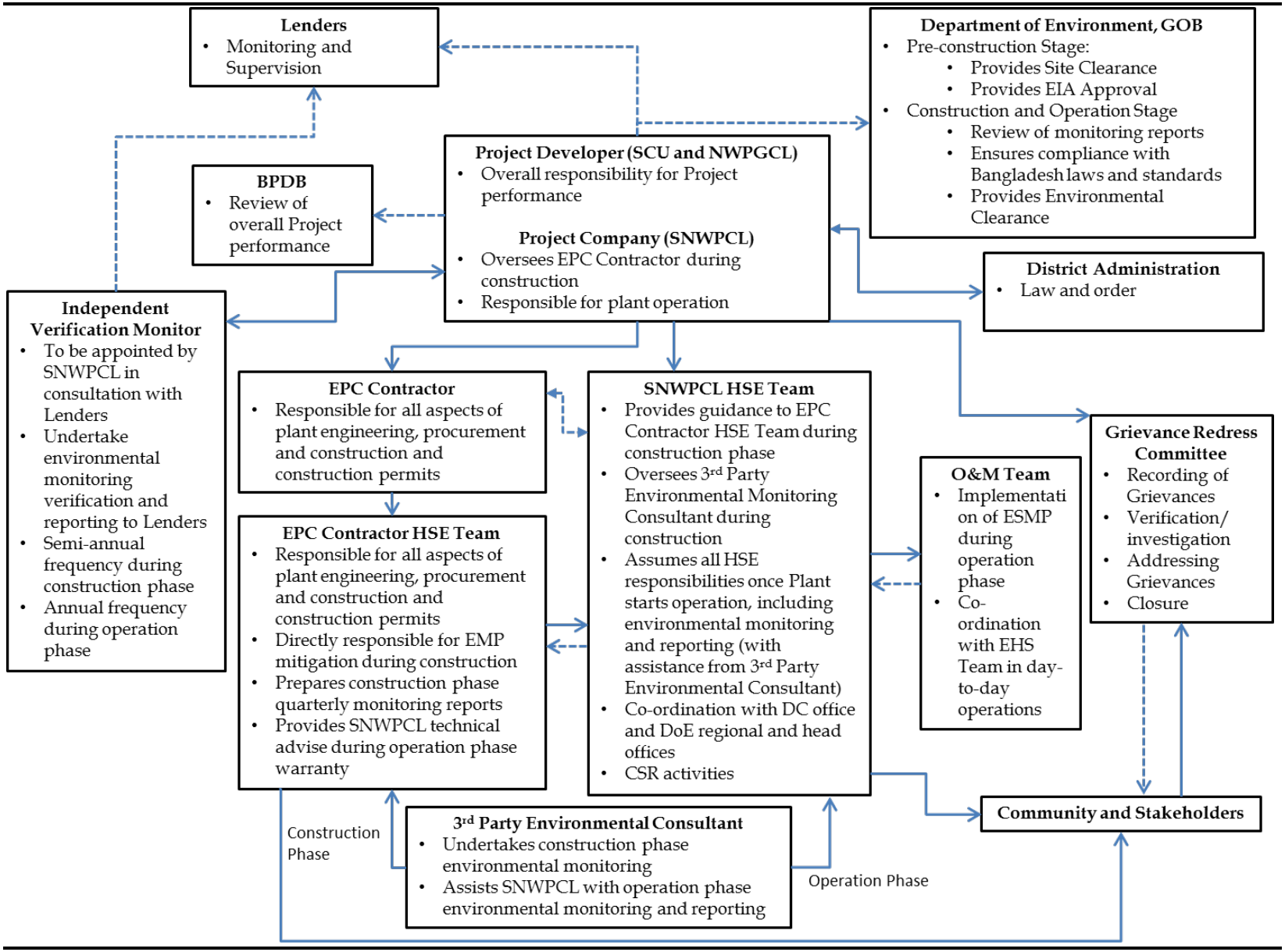
Table 7.3 ***Roles and Responsibilities of Project Developer and EPC Contractor***

Project Developer (SNWPCL)	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 labour camp, batch mix plant, laydown areas
Overall supervision of ESMP implementation	Management of labour 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 EMP, 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 HSE 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. SNWPCL will document the process for creating, allocating and approving unique identifiers and will communicate this to relevant staff.

Figure 7.1 *Organization Chart for Environmental and Social Management and Reporting Responsibilities during Construction and Operation Phase of the Project*



7.4 TRAINING

7.4.1 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 SNWPCL 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;
- HSE 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 semi-annual and the reports will be submitted to the DOE and the Lenders.

7.4.2 Operation Phase

Prior to the commencement of the Plant operation, a suitably qualified in-house/ external environmental expert will be engaged by SNWPCL 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:

- Continuous 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 annual and the reports will be submitted to the DOE and the Lenders.

7.5 PLANS FOR CONSTRUCTION AND OPERATION PHASE OF THE PROJECT

7.5.1 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 utilisation, construction sequence and safety arrangements. The HSE requirements agreed with the EPC contractor are attached as ***Annex R***. 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 (Dhaka – Bogra 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

Emergencies can be categorised into three broad levels on the basis of seriousness and response requirements, namely:

a) **Level 1:** This is an emergency or an accident, which:
   - can be effectively and safely managed, and contained within the site, location or installation by the available resources; and
   - has no impact outside the site, location or installation.

b) **Level 2:** This is an emergency or an accident, which:
   - cannot be effectively and safely managed or contained at the location or installation by available resource and additional support is alerted or required;
   - is having or has the potential to have an effect beyond the site, location or installation and where external support of mutual aid partner may be involved; and
   - is likely to be danger to life, the environment or to industrial assets or reputation.

c) **Level 3:** This is an emergency or an incident with off-site impact which could be catastrophic and is likely to affect the population, property and environment inside and outside the installation, and management and control is done by district administration. Although the Level-III emergency falls under the purview of District Authority but till they step in, it should be responsibility of the unit to manage the emergency.

Level 1 and Level 2 shall normally be grouped as on-site emergency and Level 3 as off-site emergency. In order to address any level of emergency situation, the EPC contractor must develop emergency response plan (ERP) during the construction stage of the project.

The ERP should ensure:

- Emergency Response Team (ERT) of the EPC contractor as initial responder in case of any on-site and/or off-site emergency situation caused due to the project related activities;

- Provide mutual aid in case of any emergency situation arising due to other construction/ operations within the Saidabad Power Generation Complex as well as any off-site facility;
- The local fire, police and district administration, emergency medical services, the public health authorities, collectively referred to as the External Emergency Response Team (EERT).

The EPC contractor will provide and sustain the required technical, human and financial resources for quick response during the construction phase of the project. Roles and responsibilities in case of any emergency incident response are presented in Table 7.4.

Table 7.4 Roles and Responsibilities in Emergency Incident Response

S. No.	Entity	Responsibility
1.	Emergency Response Team (ERT)	• Immediate response to the emergency situation • Prepare the emergency site to facilitate the response action, e.g. vacating, clearing, restricting, etc. • Communicate/ alert the EERT • When necessary and requested by the EERT, lends support/ provides assistance during the EERT's response operations. • Provide mutual aid in case of any emergency situation arises in the surrounding plant/s or construction site.
2.	EPC Contractor Resources	• Provide and sustain the people, equipment, tools and funds necessary to ensure Subproject's quick response to emergency situations. • Maintain good communication lines with the EERT to ensure prompt help response and adequate protection, by keeping them informed of Subproject progress.
3.	External Emergency Response Team (EERT)	• Provide support to the ERT based on communication received from ERT for Level 1 and Level 2 type emergencies. • Immediate action in case of Level 3 type emergency situation/ accident. • Co-ordination with different agencies.

The ERT will be led by the senior EPC Contractor Engineer (designated ERT-Lead) on-site with a suitably trained site supervisor or junior engineer as deputy. Trained first-aiders and security personnel will be the core members of the ERT. The EPC contractor will ensure that ERT members are physically, technically and psychologically fit for their emergency response roles and responsibilities.

Prior to the mobilization of civil works, the EPC contractor, through its Construction Manager, ERT-Lead, will meet with the ultimate response institutions to discuss the overall construction process, including, but not limited to:

- Project site, laydown areas, construction workers camp areas, temporary areas to be used for transportation of heavy lifts, etc., located within the project site and outside;
- construction time frame and phasing;
- any special construction techniques and equipment that will be used;

- any hazardous materials that will be brought to and stored in the construction premise and details on their applications and handling/management system;
- the Contractor's Emergency Management Plan; and
- names and contact details of the ERT members

The objective of this meeting is to provide the ultimate response institutions the context for:

- their comments on the adequacy of the respective Emergency Management Plans;
- their own assessment of what types, likely magnitude and likely incidence rate of potential hazards are anticipated; and
- the arrangements for coordination and collaboration with district administration and external agencies working on emergency response and disaster management.

To ensure effective emergency response, prior to mobilization of civil works, the EPC Contractor will:

- set up the ERT;
- set up all support equipment and facilities in working condition;
- made arrangements with the EERT;
- conducted proper training of ERT members, and encouraged and trained volunteers from the work force;
- conducted orientation to all construction workers on the emergency response procedures and facilities, particularly evacuation procedures, evacuation routes, evacuation assembly points, and self-first response, among others; and
- conducted drills for different possible situations.

To sustain effective emergency response throughout the Project implementation an adequate budget shall be provided to sustain the capabilities and efficiency of the emergency response mechanism, the emergency response equipment, tools, facilities and supplies. Drills and reminders will take place regularly, the former at least every two months and the latter at least every month.

Alert Procedures:

Means of communicating, reporting and alerting an emergency situation may be any combination of the following:

- audible alarm (siren, bell or gong);
- visual alarm (blinking/rotating red light or orange safety flag);
- telephone (landline);
- mobile phone;
- two-way radio; and
- public address system/loud speakers.

Some rules relative to communicating/alerting will be:

i. Whoever detects an emergency situation first shall immediately :

- call the attention of other people in the emergency site,
- sound the nearest alarm, and/or
- report/communicate the emergency situation to the ERT.

ii. Only the ERT-Lead and, if ERT-Lead is not available, the Deputy ERT-Lead are authorized to communicate with the EERT. Exceptional cases to this rule may be necessary and should be defined in the Emergency Management Plans.

iii. When communicating/alerting an emergency to the EERT, it is important to provide them with at least:

- the type of emergency situation;
- correct location of the emergency;
- estimated magnitude of the situation;
- time it happened;
- in case of a spill, which hazardous substance spilled; and
- in case of fire and explosion, what caused it.

Such details would allow the EERT to prepare for the appropriate response actions. For an effective reporting/alerting of an emergency situation:

i. The names and contact details of the relevant persons and institutions should be readily available in, or near to, all forms of communication equipment, and strategically posted (at legible size) in all Subproject sites and vehicles:
   - Most relevant construction/operations staffs namely, the ERTL, Deputy ERTL, first-aiders, supervising engineers, foremen
   - EERT institutions/organisations
   - Concerned Union authority/ies.

ii. Project site and activity areas outside (such as laydown area, construction workers camp, temporary jetty, water intake structure area, etc.) should have good access to any combination of audible and visual alarms, landline phones, mobile phones and two-way radio communication at all times.

iii. Contractor's construction vehicles should also be equipped with the appropriate communication facilities.

Emergency Response Situations

The following tables suggest general procedures that will be refined in the final EMP during detailed design, and described in more detail in the Emergency Management Plans of the EPC Contractor.

Table 7.5 Evacuation Procedures

S. No.	Procedure	Remarks
1.	Move out as quickly as possible as a group, but avoid panic.	All workers/staff, sub-contractors, site visitors to move out, guided by the ERT.
2.	Evacuate through the directed evacuation route.	The safe evacuation shall have been determined fast by the ERT-Lead/Deputy ERT-Lead and immediately communicated to ERT members.

S. No.	Procedure	Remarks
3.	Keep moving until everyone is safely away from the emergency site and its influence area.	A restricted area must be established outside the emergency site, all to stay beyond the restricted area.
4.	Once outside, conduct head counts.	Foremen to do head counts of their sub-groups; ERT-Lead/Deputy ERT-Lead of the ERT.
5.	Report missing persons to EERT immediately.	ERT-Lead/Deputy ERT-Lead to communicate with the EERT.
6.	Assist the injured in evacuation and hand them over to the ERT first-aiders or EERT medical group	ERT to manage injured persons to ensure proper handling.
7.	If injury warrants special care, DO NOT MOVE them, unless necessary and instructed/directed by the EERT.	ERT-Lead/Deputy ERT-Lead communicates with EERT to get instructions/directions in handling the injured.

Table 7.6 Response Procedure during Medical Emergency

S. No.	Procedure	Remarks
1.	Administer First Aid regardless of severity immediately.	Fundamentals when giving First Aid: • Safety first of both the rescuer and the victim. • Do not move an injured person unless: • victim is exposed to more danger when left where they are, e.g., during fire, chemical spill • it would be impossible for EERT to aid victims in their locations, e.g., under a collapsed structure • instructed or directed by the EERT. First AID to be conducted only by a person who has been properly trained in giving First Aid.
2.	Call the EERT emergency medical services and/or nearest hospital.	ERT-Lead/Deputy ERT-Lead or authorized on-site emergency communicator
3.	Facilitate leading the EERT to the emergency site.	ERTL/Deputy ERTL to instruct: • an ERT member on- site to meet EERT in access road/strategic location. He/she shall hold orange safety flag to get their attention and lead them to site. • Other ERT members to clear access road for smooth passage of the EERT.
4.	If applicable, vacate site and influence area at once, restrict site, suspend work until further notice.	Follow evacuation procedure.

Table 7.7 Response Procedure in Case of Fire

S. No.	Procedure	Remarks
1.	Alert a fire situation	Whoever detects the fire shall immediately: • call the attention of other people in the site, • sound the nearest alarm, and/or • Foreman or any ERT member among the construction sub-group contacts the fire department (in this case it should be agreed on that it is alright for any ERT member in the sub-group to alert the fire

S. No.	Procedure	Remarks
		department) • report/ communicate the emergency situation to the ERTL/Deputy ERTL.
2.	Stop all activities/operations and evacuate.	All (non-ERT) workers/staff sub-contractors, site visitors and concerned public to move out to safe grounds following the evacuation procedure.
3.	Activate ERT to contain fire/control fire from spreading.	Guided by the training they undertook, ERT members assigned to mitigate the fire shall assess their own safety situation first before attempting to control fire spread.
4.	Call the nearest fire and police stations and, if applicable, emergency medical services.	When alerting the EERT, ERTL will give the location, cause of fire, estimated fire alarm rating, any injuries.
5.	Facilitate leading the EERT to the emergency site.	ERT-Lead/Deputy ERT-Lead to instruct: • an ERT member to meet the EERT in the access road or strategic location and lead them to the site. He/she shall hold the orange safety flag to get their attention and lead them to the site. • some ERT members to stop traffic in, and clear, the access road to facilitate passage of the EERT.
6.	ERT to vacate the site as soon as their safety is assessed as in danger.	Follow appropriate evacuation procedure.

*Some of the guidance framework management plans for (a) pollution prevention, (b) waste management, (c) traffic management, (d) emergency response, and (e) stakeholder engagement, applicable for the site preparation and construction activities have been presented in **Annex V**. These management plans are prepared to provide guidance to the EPC Contractor and the Project Company (SNWPCL) on expected content and requirement from the detailed management plans and associated procedures/ checklists.*

7.5.2 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 SNWPCL.

Spill Response and Emergency Plan

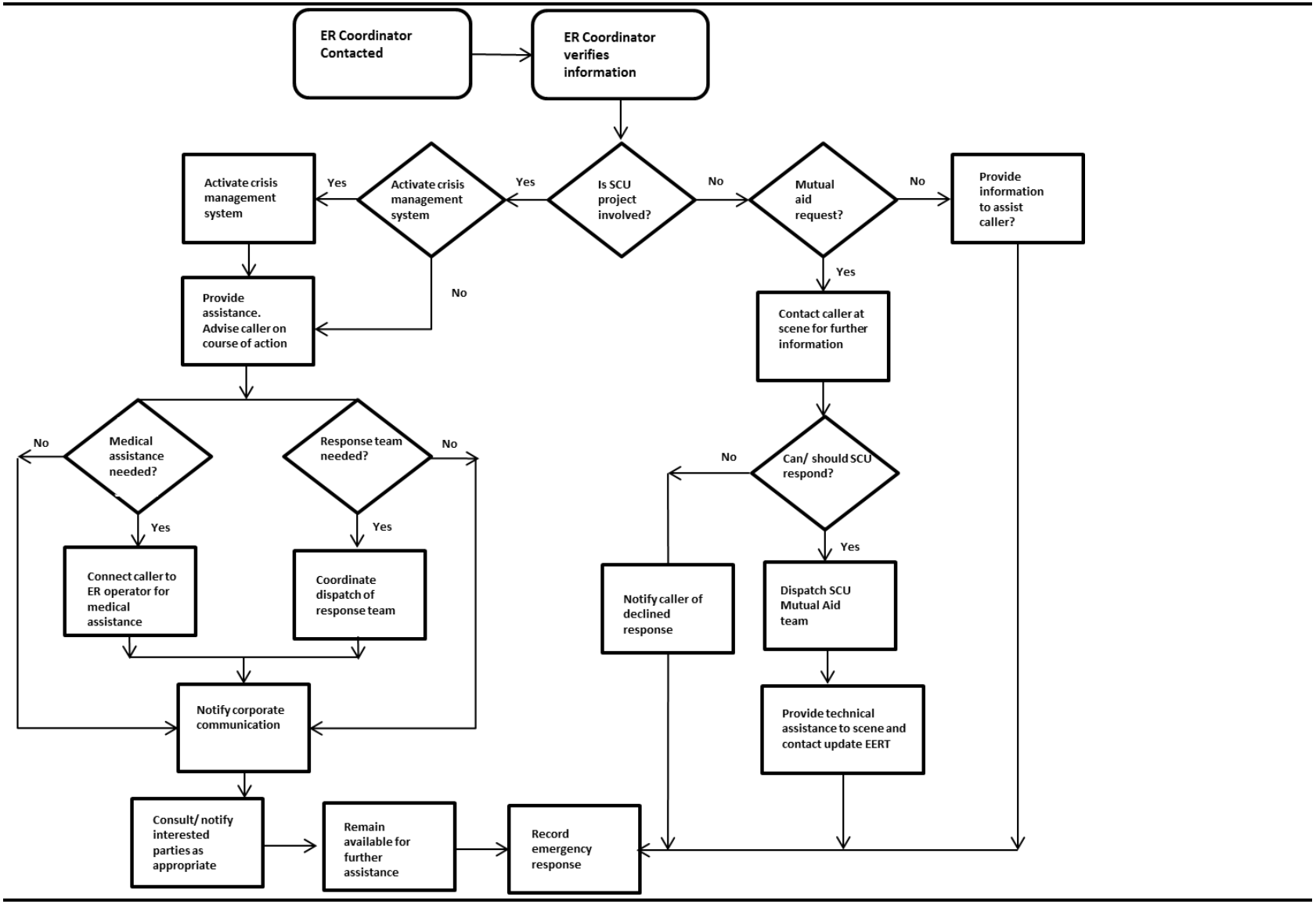
The Project Developer will prepare a spill response and emergency plan to address accidental spillages or release of hazardous wastes.

Emergency Response and Disaster Management Plan

Based on the outcome of the consequence analysis as well as detailed quantitative risk assessment of the Project after finalisation of project design, an emergency response and disaster management plan will be developed by SNWPCL. 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 address both on-site and off-site emergency situations due to the operation of the project. 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.

The emergency response action tree, which can be used during the operation phase of the project, has been presented in Figure 7.2.

Figure 7.2 Emergency Response Action Tree - Operation Phase



7.6 BUDGET

The EPC Contractor and SNWPCL 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 costs for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment, CEM, etc., are already included in the EPC contract cost estimate and/or operating cost estimates. In addition, 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/or verification has been included in ***Table 7.2***.

7.7 GRIEVANCE REDRESS MECHANISM

The implementation of an infrastructural project is a complex time and labour 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 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.

7.7.1 *Objectives of Grievance Redress Mechanism*

The basic objective of the GRM shall be to 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 Redress Cell (GRC) shall be an officially recognized "*non-judicial*" body that

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 labour, 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.

7.7.2 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 the Project Company (SNWPCL) 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. SNWPCL's EHS Officer can take this role and responsibility;
- Senior Representative on behalf of SNWPCL and part of the site level project management team. In most cases, this individual shall be of an authority not lower than the "***Site Manager***". However in cases where the 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 e.g. Senior contractor personnel as a part of the GRC in case of a contractor labour dispute or issue;
- There would be an external member nominated by the local District Administration to be part of the GRC. The nominated member may be an elected member from the Union Parishad or a senior administrative officer of the district.

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 SNWPCL. 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.

7.7.3 functional premises of GRC for Grievance Redress

The GRC meetings will be held in SNWPCL's site office and the same will be widely publicised 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 SNWPCL 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 SNWPCL's 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.

7.7.4 Disclosure of the Grievance Redress Mechanism

Some of the important points regarding disclosure of the grievance redress mechanism are:

- The grievance redress process shall be disclosed and the procedures mentioned therein shall be properly disseminated to the identified stakeholders.
- SNWPCL shall integrate it as a part of the training programme 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 centres, 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 (Bangla) so that people are aware of their rights and obligations, and procedure of grievance redress.

7.7.5 Grievance Reporting Procedure under GRM

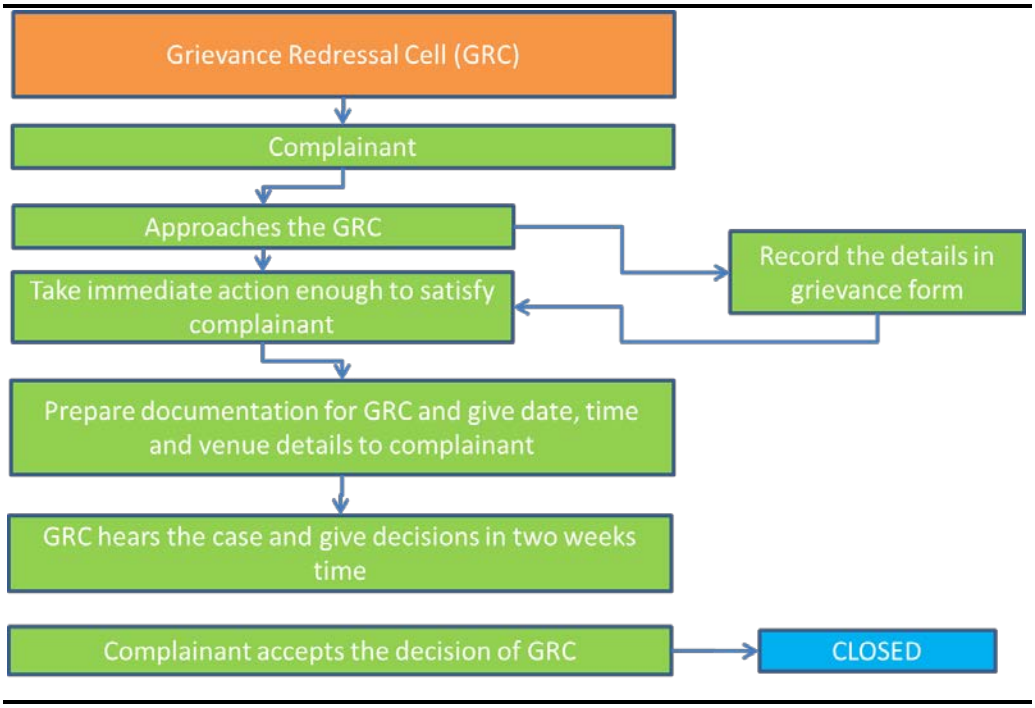
An aggrieved person, a group of persons or a community will be able to file grievances without any fear and intimidation. The grievances can be submitted in either in writing or may be submitted orally/ telephonically to the GRC; the whole purpose is to make the GRM easily accessible to the

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 register the grievance at the administrative level in case there are necessary channels for the same.

7.7.6 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 redress procedure to be followed by SNWPCL is being shown below in ***Figure 7.3***.

Figure 7.3 Grievance Redress Process for the Project



Grievances primarily related to any serious event such as accidents involving the community, labour 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.

- While every effort shall be made to resolve the complaint amicably, 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 any other arbitration mechanism with mutual agreement. If these alternative mechanisms of resolution of conflict fails, then the aggrieved person may take legal recourse 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 SNWPCL, pertaining to each of the grievance in a proper grievance register or record.

7.7.7 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 SNWPCL's 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.

7.7.8 Budgeting

SNWPCL's administration shall ensure adequate budgeting and resource allocation for implementing the grievance redress mechanism.

7.7.9 Contact Details for the Grievances

The project is currently in the process of finalising the key contracts including those for engineering procurement and construction with the selected contractor. The Project Company (SNWPCL) will be formed in due course after the receipt of LOI and any grievances related to the project, upto commencement of construction, can be directly addressed to the Commercial Head, of SNWPCL. After the commencement of construction, SNWPCL will duly form a Grievance Redress Cell (GRC). The possibility of including an external member nominated by the local District Administration to be part of the GRC will also be explored. The nominated member may be an elected member from the Union Parishad or a senior administrative officer of the district. In the interim period, any grievances may be addressed to:

Nazmul Ahsan
C/o House no.: 1, Road: 9C
Nikunja-1, Airport Road,
Dhaka-1229, Bangladesh

Email: Nazmul.ahsan@sembcorp.com
Mobile: +880 1819226635

Box 7.3 *Sample Grievance Form*

Reference No.		**Date**	
Full Name			
Address			
Phone no.			
Date, time & venue of GRC meeting			
Description of Incident or Grievance (What happened? Where did it happen? Who did it happen to? What is the result of the problem?)			
Date if Incident or grievance (provide details such as **One time incident/grievance (date _____)** **Happened more than once (how many times? _____)** **On-going (currently experiencing problem) _____)**			
What would you like to see happen to resolve the problem?			
Signature of complainant /thump impression of complainant		**Signature of person filling the form** **(SCU Representative)**	

8 STAKEHOLDER CONSULTATIONS AND PARTICIPATION

8.1 INTRODUCTION

Participation is a process, through which stakeholders influence and share control over development initiatives and the decisions and the resources which affect them. The effectiveness of the 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 Project is also a primary requirement in developing an appropriate ESMP that addresses Project's requirement and is suited to the needs of the stakeholders. Stakeholder's involvement also vastly increases the probability of successful implementation of the management plan. In order to make the consultation and disclosure process effective and fruitful, comprehensive planning is required to assure that the impacted community, local government, NGOs, host population and Project staff interacts regularly and purposefully, throughout all stages of the Project and contribute toward a common goal.

8.2 APPROACH AND METHODOLOGY FOR CONSULTATION

The approach undertaken for information sharing and consultation involved the following key processes.

- Mapping and identification of key stakeholders such as primary (directly influenced by the Project) and secondary (indirectly influenced by the Project) stakeholders;
- Undertaking expert consultations, interviews and focussed group discussions (FGD) with the respective stakeholders;
- Assessing the influence and impact of the Project on these stakeholder groups;
- Summarizing key findings and observations from the consultations; and
- Preparing a future stakeholder engagement strategy for a more detailed assessments at a more detailed level taking into account the various Project lifecycle phases and their implications on the stakeholder .

8.3 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, 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:*** Which implies a high degree of influence of the stakeholder on the Project in terms of participation and decision making or a high priority for the Project proponent to engage that stakeholder
- ***Medium Influence/Priority:*** Which implies a moderate level of influence and participation of the stakeholder in the Project as well as a priority level for the Project proponent to engage the stakeholder who are neither highly critical nor are insignificant in terms of influence.
- ***Low Influence/Priority:*** Which implies a low degree of influence of the stakeholder on the Project in terms of participation and decision making or a low priority for the Project proponent to engage that stakeholder

Based on the above attributes, ***Table 8.1*** delineates the stakeholders identified for the Project and their analysis.

Table 8.1 Stakeholder Mapping for the Project

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
Project Management				
Sembcorp Utilities Pte Ltd (SNWPCL)	Primary	• SNWPCL is a 100% subsidiary of Sembcorp Industries Limited, which is a leading energy, water and marine group operating across six continents worldwide. • SNWPCL is the primary Project proponent owning a controlling stake of 71% 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
North West Power Generation Company Limited (NWPGCL)	Primary	• NWPGCL is an enterprise of BPDB. This company was created in order to meet the prevailing demand of electricity and to solve the low-voltage problem the in the North-West region of the country. • NWPGCL is the co-sponsor of the Project with a stake of 29%.	High	• Influence in day to day activities of the Project including managing construction activities, engaging sub-contractors, procuring material etc. may be limited and mostly be carried out by SNWPCL • Participation will increase during operation phase as BPDB is the primary authority for overseeing continual functioning of the power assets in Bangladesh
Project Financiers to include the International Finance Corporation, the CDC Group plc and Clifford Capital	Primary	•	High	• Engagement is limited at the corporate management level • Key participants in the decision making process which may have direct or indirect implications for the Project • Compliance to funding agencies safeguard and other policies such as governance, transparency and accounting standard
External Stakeholders				
Bangladesh Power Development Board	Primary	• The BPDB is responsible for major portion of generation and distribution of electricity mainly in	High	• The land lease agreement (LLA) and power purchase agreement will be executed between SNWPCL and BPDB.

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
		urban areas except Dhaka and West Zone of the country. • The Board is under the Power Division of the Ministry of power, Energy and Mineral Resources, Government of Bangladesh.		• In the event of gas supply failure to the project, BPDB need to instruct SNWPCL to switch to HSD.
Pashchimanchal Gas Company Limited (PGCL)	Primary	• Wholly owned subsidiary of state controlled Petrobangla • The main objective of this company is to distribute natural gas as a fuel through its Gas Distribution Pipeline to Household, Commercial, Industrial, and Power Plant etc. of Rajshahi Division.	High	• The gas supply agreement will be executed between SNWPCL and PGCL. • Will provide gas supply for the Project • Will assist SNWPCL only in obtaining of necessary governmental licenses and permits • The responsibility of design, construction, commissioning and transfer of the gas pipeline from the plant to PGCL's connection point is that of SNWPCL. • However, due to an existing pipeline route, the pipeline for the gas supply would be channelled through the existing route. Only Right of Way in parallel to existing line of NWPGCL will be required
Bangladesh Petroleum Corporation (BPC)	Primary	• Bangladesh Petroleum Corporation (BPC) is a government-owned monopoly in Bangladesh dealing in importation of crude oil and refined oil, lubricant, refining of crude oil, and distribution and marketing of fuel oils, lubricants and other petroleum products in the country. • BPC imports up to 29 million barrels of petroleum products a year, including 9 million barrels of crude oil, to meet the country's demand, mainly from Kuwait, Saudi Arabia, India and United Arab Emirates.	High	• The fuel supply agreement will be executed between SNWPCL and BPC. • Under the supply agreement, HSD will have a content of 10,280 Kcal/kg, HSD price is determined by the GOB and will be a pass-through cost for SNWPCL. • The responsibility for the construction, installation and maintenance of the receipt and storage facilities would be that of SNWPCL while BPC would be responsible for installation of the facilities to transport fuel to the receiving point.
Power Grid Corporation of Bangladesh (PGCB)	Secondary	• Power Grid Company of Bangladesh Ltd. or PGCB has the primary	Low	• Transmission line corridor has already been established for the existing 225MW

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
		objective of managing, operating and expanding the national power grid of Bangladesh • Provides connectivity and power evacuation support for power Projects in order to connect them to the national power grid • Is the central authority on providing permits and clearances for power evacuation and supply		NWPGCL power plant. The same corridor is to be used for the upcoming power plant... • Engagement level during operation phase for obtaining requisite permits and clearances
Community				
Local Community	Primary	• The local community primarily comprises of the peripheral villages to the site boundary which are *Barashimul Panchasona* and *Khas Barashimul* • It also includes specific community groups in close interaction with Project site and related activities anywhere within the 5km Area of Influence	Low	• No major restrictions around the Project site especially with respect to access to grazing land, cultivation on Char land or uptake of water from the Jamuna River • Project will bring development to the area • Increase in employment opportunities and preference for local employment, where possible
Fishing Households		• The fishing households at Khas Chtragachha, Purba Radhunipur, Jagtala, Belutia and Paschim Mohanpur.	High	• Some of the households who use the temporary jetty location to anchor their boats during the dry season, when water levels recede, will face inconvenience and have to use other locations. • The dredging and increase navigation around the jetty location may reduce their fish catch. As reported during the consultations undertaken, past dredging activities were responsible for the declining fish catch in the area. • The fishing community, especially those with access to motor boats, fish in the main channel as well. The dredging activities and the use of the Jetty may result in temporary

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
				hardship on them.
Regulatory/Administrative Authorities & Agencies				
Department of Environment (DoE) Ministry of Environment and Forest, Bangladesh	Primary	• The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh. • The closest office is located in Bogra District	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 the Project's Environmental compliance throughout the Project lifecycle
Forest Department, Ministry of Environment and Forest, Bangladesh	Primary	• The forest department under the Ministry of Environment and Forest is responsible for management of forests and ecological assets of national or international importance within Bangladesh	Medium	• Permission for construction of temporary jetty close to the ecological park (maintained by Forest Department) located about 4 km from the Project site.
District Commissioners Office (DCO), Sirajganj	Primary	• The District commissioners office is the most senior administrative authority within the district	Low	• The participation of the district commissioners office is restricted to permitting and clearances • Is the primary agency for overseeing the Project's compliances to local administrative rules and regulations
Local Government Engineering Department (LGED), Sirajganj	Secondary	• Local Government Engineering Department (LGED) is one of the largest public sector organizations in Bangladesh entrusted with planning and implementation of local level infrastructure development programs.	Low	• Is responsible for maintenance of the approach road to the Project site over the lifecycle of the Project
Directorate of Labour, Ministry of Labour and Employment	Primary	• Primary nodal agency for creating employment opportunities, implementation for labour laws, fix minimum wages of labour, and ensuring addressal of labour related	Medium	• All labour related permits and licences have to be procured by both SNWPCL as the principal employer as well as the contractors and sub-contractors working in the Project

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
		grievances though labour courts		• Responsible for undertaking periodic audits and compliance check at the site in order to ensure proper implementation of the local labour regulations
Dept. of Social Welfare (DSW)	Secondary	• Local governmental agency responsible for implementation of governmental social welfare schemes and activities in Sirajganj District.	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
Dept. of Public Health and Engineering	Secondary	• Primary department responsible for managing the overall healthcare facilities in the district • Local community healthcare centres and hospitals functioning under this department are responsible for providing medication and healthcare facilities to the community	Low	• No major influence on Project related activities • Key agency responsible for managing healthcare facilities around the Project area • Controlling out-break of any major disease and monitoring the disease pattern
Other Regulatory & Permitting Authorities	Primary	• Bangladesh Railways for obtaining railways related clearances for transportation of HSD • Bangladesh Water Development Board (BWDB) for transportation of material and resources through the Jamuna River	Medium	• Agencies required for obtaining permits and licenses for establishment and operation of the Project • Primary involvement during pre-construction and operation phases
Contractor & Sub-Contractors				
Contractors (local and foreign)	Primary	• Contractors include OEM (Original Equipment Manufacturers), part suppliers, mechanical installers and maintenance service providers who would be engaged during the Project lifecycle	Medium	• Construction phase will require almost 1500 people (for both civil and mechanical work), during peak construction stage, including both local and migrant workers over a span of almost 2 and a half years • Engagement levels would be mostly during construction, and decommissioning phases

Stakeholders	Category of Stakeholder	Brief Profile	Overall Influence on the Project	Basis of Influence Rating
Migrant Workers and Labourers	Primary	• Labourers and workers arriving from outside of Sirajganj for participating in construction activities	Medium	• Responsible for undertaking mostly skill based work during construction phase • Engagement level during both civil and mechanical phases of work
Local Workers and Labourers	Primary	• Labourers and workers recruited from the Area of Influence mostly during the construction phase of the Project		• Responsible for undertaking mostly un-skill based work during construction phase and housekeeping related work during operation phase of the Project • Engagement level primarily in civil construction part of the work
Political Administration				
Upazilla (sub District Level) Political Administration Union leaders & local representatives	Secondary	• Elected representative of people at sub-district level for a fixed tenure • Elected representative at union level i.e. village level for a fixed tenure	Medium	• Key linkage between the community and the Project proponent • 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
Media	Secondary		Medium	• Public watchdog on the Project related activities • No major influence on the Project as of today

8.4 INFORMATION DISCLOSURE AND CONSULTATION

A combination of mixed methods of information disclosure and consultation processes was adopted at this stage of EIA preparation. The method selected for consultation was designed keeping in mind the profile of the stakeholders, type of information desired and level of engagement required. In each consultation session the consultant introduced themselves, introduced the Project and the purpose of engagement with the respective stakeholder. The primary methods followed in the consultation process are:

- Individual level consultation/discussion;
- Focus group discussion; and
- Community meetings.

A number of consultation exercises were conducted during preparation of this EIA. The stakeholders consulted include the community in the direct vicinity of the Project area, local elected representative such as the district commissioner of Sirajganj and the Union Chairman of Saidabad Union, and other external stakeholders such as relevant government departments and NGOs. The details of consultations held and the key points of discussion and the issues raised or discussed and suggestions provided by the respective stakeholders are presented in ***Table 8.2*** of this chapter and the photographs of consultation session are given in ***Annex O***. Every consultation meeting has been recorded and the minutes from every meeting have been compiled in the respective stakeholder consultation sheets. These sheets have been provided as part of this report in ***Annex P***.

In addition to the focussed group discussions and meetings with key stakeholders, two public consultation meeting were held on 21st March 2015 and on 18th April 2015at the Hall Room of Manab Mukti Sangstha (MMS) Head Office located at Khas Boro Shimul, Bangbandhu Bridge West sub, Saidabad Union, Sirajganj, which is located about 0.5 km away from the Project site. Local people including senior citizen and women, elected representatives of Saidabad Union, NGOs working in the Sirajganj District, District Administration and relevant departments of the Government were informed about the meeting agenda, date and venue 1 to 2 weeks in advance for both the meetings. Furthermore, notices were also put up for the public consultation meeting at prominent places in the surrounding of the project area about 2 weeks in advance (refer ***Annex Q***).

The first meeting was presided by the Honourable Deputy Commissioner of the Sirajganj District Mr. Billal Hosen, whereas the second public consultation meeting was presided by the Honourable Additional Deputy Commissioner (General Administration) of Sirajganj District. The second meeting was attended by the safeguard team of the ADB as it was initially planned to ADB funding. These public

consultation meetings were convened to discuss the project features of Sirajganj 4 project, findings of the EIA study as well as to get an opinion of the key stakeholders (including government officials, elected representatives, NGOs, village people including women). The details of public consultation meeting and the key points of discussion including the issues raised and suggestions provided by the respective stakeholders are presented in ***Table 8.3*** and ***Table 8.4***. Photographs of public consultation meeting, along with attendance sheet and information disclosure presentation are provided as part of this report in ***Annex Q***.

Table 8.2 Consultations held for the Project

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
Government Officials and Regulatory Authorities			
26/12/2012	Department of Social Welfare, Sirajganj Sadar	• Role and Responsibility of the Social welfare department in Sirajganj • Social Welfare schemes and programs that are being undertaken and implemented by the department in Sirajganj Sadar and Saidabad Union • Primary areas of social concern in Sirajganj and Saidabad • How is the Project beneficial in that area and will it any way have any negative impact as such on the locals • What is the local public perception about the Project • Participation level of the international and domestic NGO's and welfare organizations	• The department is implementing various government sponsored schemes • Any NGO or welfare organization working in the area are required to obtain permit or clearance from the Social welfare department • The department runs Women specific microcredit scheme and monthly pension scheme for other vulnerable groups such as old aged, divorced women • The primary area of concern in Sirajganj is destruction caused by flooding which leads to loss of life and property. • Education, healthcare, social fads like child marriage are also some of the other issues in the area. • International humanitarian groups such as UNICEF, WFP are also actively involved in this region.
26/12/2012	Bangladesh Water Development Board (BWDB), Sirajganj	• Flood scenario in Sirajganj • Protection /control measures being adopted • Role of BWDB in monitoring of Jamuna River near Hardpoint	• Sirajganj is a heavily flood prone area due to the massive flow of the Jamuna River. • Sirajganj has Brahmaputra Right embankment (BRE) for its protection and during the construction of the Bangabandhu Bridge, a River Bank Protection Project (RBPP) was initiated under which the 2.5 km length of Sirajganj Hardpoint was built for protection of the town and bridge. The construction for the same was carried out by Hyundai, Korea from 1195-1999. • Embankment (BRE) got broken in 2007 so water entered the Sirajganj town and also in 2009-11 slope failure took place at the embankment. About 74 crores were spent for repairing the same and every year GoB invests huge amounts for protection of the embankments. BWDB takes actions as placement of geotextile bags for flood protection. • BWDB monitors the flow of the Jamuna River at Sirajganj Hardpoint and also does daily monitoring of the Hardpoint embankment. BWDB carries out bathymetric survey monitoring and coordinates with

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
			(Institute of Water modelling) IWM to keep track on the river flow. • BWDB also monitors the various dredging activities being carried on the Jamuna River at Sirajganj.
27/12/2012	Department of Fisheries, Sirajganj District	• Role and responsibility of the local fisheries departments and how is the department structured • Where are the primary fishing point/ports/breeding areas located in and around in Sirajganj • Details of Fishing production in Sirajganj Sadar • Details on the key species of fishes observed in Jamuna River • Understanding on the Fishermen community and their practices	• The fisheries department is headed by the Director General at the central government level, under which there are directors at divisional and district levels. It is further segregated into District Officers, Sub-Officers and Field Assistants; • Fishing in Sirajganj Sadar is at a very small scale and involves only 1590 fishing households in Sirajganj Sadar Upazilla; • Though the Saidabad and Punorbason Colony do not have any fishermen household, a few fishermen households may be present in other villages in periphery zone. Fishing is prohibited under the bridge considering security reasons and adjoining channel that connects to the Jamuna river; • The fishing grounds in the other bank (east side – opposite of Project site) of the river are more productive, hence fishermen access them more often. The fish population in Jamuna River in Saidabad Union territory is sufficient to provide livelihood to local fishermen families. • The fishing department in Sirajganj Sadar is understaffed and there is shortage of field level workers; • Some of the key the vulnerable fishes found within the Jamuna river are Maha Sol, Jamuna Dolphin and Olive Barb fish; • There are no dedicated fishing villages within Saidabad Union or in Sirajganj Sadar; • No commercial scale fishing is carried out in Sirajganj Sadar. However, they are promoting small scale fishery in ponds in and around Saidabad Union at the household level; • The fisherman use primitive fishing practices for capturing fish. However, there has been an increase in

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
			usage of illegal nets (including current net, bed net and cast nets). • The current activities carried out by the fishing department includes field surveys, support to fishermen with respect to training, awareness and income generation activities;
27/12/2012	Department of Environment (DoE), Bogra	• Introduction of the proposed Project • Information regarding any sensitive zones/polluting industries in the Project Area • Regulations applicable to the proposed Project/suggestions for the Project • Information on Dredging permissions • Information regarding upcoming industrial parks or economic zones in Sirajganj	• Project details were introduced to the DoE officials • No sensitive zones in the Project area only the BBA eco-park for the protection of the Bridge. Few polluting industries upstream of the Project site near Sirajganj town. Many polluting dye units downstream of the Project site near Bagabari. Upcoming power plant should be built in consideration of future developments. 6 weeks AAQ monitoring should be carried out. Baseline data collection for Flora and Fauna should be Primary. Zero discharge technology or closed loop recycling to be applied to the extent possible. Installation of flow measuring device both at inlet and outlet of ETP. Consultations with communities in the area. • As per DoE, Dredging is red category and IEE is required. • No information on any industrial park or economic zones coming up in Sirajganj.
27/12/2012	Forest Department, Pabna	• Any forest stretches or patches within the 5km radius of the Project site • Major forest clusters within Sirajganj and Pabna • Any flora or fauna species found within the AOI • Background on the Ecological Park situated within the AOI	• No designated forest land is present within Sirajganj • The forest department only manages an Eco-Park within the AOI. The closest forests are located in Madhupur, Gazipur and in Dineshpur. • Roadside plantation under the purview of the forest department • No classified trees endangered or specific to Sirajganj within the Eco Park • In respect of fauna, monkeys, deer, peacocks, jackals and rabbits are observed within the Eco Park • The Project should comply with legal requirements or guidelines for any construction related activities if falling within the buffer zone of the Eco Park
27/12/2012	Bangabandhu Bridge	• Introduction of the Proposed Project	• BBA land near the bridge handed over to forest

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
	Authority	• Any regulations/permissions required from BBA as their land is just next to Project site and intake pipeline may come through the area • Data about Traffic passing through the Bangabandhu Bridge • Whether Barges can pass under the Bangabandhu Bridge or any permission required regarding the same	department for plantations and maintenance. The asset belongs to BBA. Any work in the area as for temporary jetty/intake pipeline needs permission from the BBA. Permissions required for any work near guide banks for protection of the Bridge. • Traffic statistics collected for Bangabandhu Bridge • Barges can pass if required below the bridge and no permission is required
Elected Representatives			
26/12/2012	Union Chairman, Saidabad	• Understanding of the union spread within 5km of the Project Site • General questions on the socio-economic structure of Saidabad including the type of industries around, the typed of occupation and livelihood followed by community, literacy and education system in Saidabad • Impacts of flooding in the union and subsequently on the local community • Any anticipated impacts on the locals from the development of power plant	• The Project Site is completely located within the Saidabad Union of Sirajganj Sub-District in Bara Shimul Panchosona Mouzas (Revenue Village). • Loam and textile industries are the largest (70% of total revenue) contributor to Saidabad's revenue; • People are engaged in agricultural practices and majority of the same cultivate three cropping seasons in a year. The major crops grown in the area are Rice, Pulses (Masoor, Maash), Peanuts and Til; • There is no fishing village within the Union involved in medium or large scale fishing. • The current operating power plant was constructed in 2011 and was formally inaugurated approximately 2 years back. The government provided Khas land for the development of the same; • No major complaints from the locals with respect to the existing power Project; • The advent of the power plant has improved the electricity provision in Sirajganj Sadar; • A large section of the community has to be rehabilitated during monsoon due to flooding. The last major flood came in 2007;
Non-Governmental Organisation (NGO)			
26/12/2012	Manab Mukti Sangstha (MMS) –NGO Office, Saidabad	• Understating on the NGO landscape in Sirajganj Sadar and initiatives in Saidabad • Biggest social challenges and issues in Saidabad. Understanding on the most vulnerable sections of the society	• MMS is the largest local NGO working in Sirajganj. Although the organization was started back in 1984, the branch in Sirajganj was established back in 2002; • Primary work is in disaster management, women and children development, poverty reduction,

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
		• Key on-ground issues and Social challenged by the agency • Type of programs run by the agency and its targeted audience	microfinance, minimizing local conflict over resources amongst others. • Work from the bottom most levels (Household) to the organizational level for disaster preparedness and resilience; • Examples of Household level interventions include homestead plinth area raising, fodder and fuel preservation, equipping households with essential commodities (dry ration, medicine, fuel oil etc.) for managing flood and disaster risks; • Common forms of disasters faced include river bank erosion and flooding, cold waves, tornadoes; • Some form of positive development has been seen from the construction of the previous power plant including proper embankment leading to control of river and lesser river bank erosion, employment of locals for labour work during the construction phase of the Project, • No complaints or community apprehensions have come under notice with respect to the NWPGCL power plant; • Primary challenges faced by the local community are natural disasters, unemployment, low income related to traditional agricultural practices, communication, electricity and road connectivity. Health associated problems include mostly water related problems such as Typhoid, Diarrhoea and Cholera being prevalent ; • MMS has identified the most vulnerable factions of the society as people with no regular income, no economic asset, beggars, women headed households, families with family heads with chronic sickness;
Local Community			
28/12/2012	FGD with Local Community (Khas Barashimul)	• Information on Khas Barashimul village • Common employment practices • Facilities within the village • Common livelihoods and income levels • Dependency on the char area • Any implication on livelihood or social	• The char area is mostly used for, cultivation of rice, til, pulses and peanuts during the dry season • It is also used for cattle grazing and collection of firewood for 5 to 6 months in a year • Most of the villagers are farmers with additional income from dairy sale as well as rearing of cattle for

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
		capital of the area from the establishment of the existing power plant complex • Any grievance in respect to power plant operation	meat • On average people earn between Tk 2000 to 5000 per month • No fishing is carried out exclusively for livelihood by any household. The village level infrastructure is poor with no medication facilities, electricity supply, kerosene lamps used for lighting • A school and masjid are the public facilities available within the village • The village is not susceptible to frequent floods as it is located at an elevated level • The last major flood happened 14-15 years ago when houses got destroyed • Some of the villagers were displaced as a result of the construction of the Bangabandhu Bridge. A number of villagers also gave land for the construction of the existing power plant. • No major impact on the local social capital during the construction phase of the Project as such • Local labour work especially unskilled work was provided during the construction phase at the rate of Tk 200-250 per day.
28/12/2012	FGD with Local Community (Barashimul Panchasona)	• Any grievances pertaining to the existing power Project • What sort of assistance was provided to the community at the time of construction of the existing Project • Any major issue or problems unresolved from the Project • Impact on the local human and social capital	• The planning and construction of the power complex started back in 2005-06 • The land prices of the area have increased up since the establishment of the Project • Not much visual changes have been observed since the establishment of the Project • Compensation was provided for the Project land but no compensation was provided for the transmission corridor • Issues with respect to construction of structures or buildings along the transmission line corridor • The land on which the towers have been constructed cannot be utilized productively • No support provided by the Project towards local development
Fishermen Community			

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
01-06-2015	FGD with local fishermen (Belutia)	• An understanding of the fishing activities in the area • The dependence on fishing as a livelihood • Any perceived major issue or problems due to use of Jetty and vessel movement in the area	• Fishing activities in the river are undertaken primarily by villages along the river, such as Belutia and Jagtala, in which a significant proportion of the households undertake fishing • Fishing activities are undertaken primarily during the monsoon and post monsoons seasons. The households who have access to motor boats undertake fishing in the main channel of the river, while those households with row boats undertaking fishing closer to the villages and near the jetty. The most preferred fishing gear are gill nets • The main fish species caught include Hilsha, Basa, Papda, Shrimp, Giant prawn, Golcha and River Pangas • The respondents were of the opinion that the overall fish population and catch has reduced over the years due to the dredging activities which were undertaken in the area in the past. These activities resulted in the churning of the river bed and siltation • The fishermen also acknowledged that every river in the country was facing a problem of reduced fish populations.
01-06-2015	FGD with local fishermen (Jagtala)	• An understanding of the dependence of the local community on fishing • The perception of the change in fish catch and population • The potential impacts of use of jetty by vessels on the fishing activities of the village	• Almost 95% of the households undertake fishing in the village • The fishing activities in the village are restricted to approx. 3 months in a year, around monsoon, • The key fish species in the area are Hilsha, Basa, Papda, Baluchata, Paturchala and Gangchala. • The average daily catch of the fishermen in the area was reported to be 1 to 1.5 kg of fish. • The representatives reported a severely declined population of Baluchata and Paturchata, and a declined population of the other species. • One of the reasons attributed for the low populations in the area was the sand mining activities in the area and the movement of vessels close to the villages.
03-06-2015	Individual Consultation with local fishermen	• To understand the household's dependence on fishing for livelihood	• The household uses the temporary jetty area for the purpose of parking their boat, as it is close to their

Date	Stakeholder Details	Key points of Discussions/Issues Raised	Response/Suggestions made
		• The use of the jetty area by the household • The potential impacts of use of jetty by vessels on the fishing activities	place of residence and is thus safe to park their • They also undertake fishing in the jetty area using traps and nets • However, during the time that the jetty area was used for vessel movement and dredging, the household was unable to use the jetty for fishing or parking of boats • During this time, the household faced problems of transporting their boat to the main channel for fishing and fishing for small fish species found in the jetty area • According to the household the best time to use the Jetty for vessel movement would be pre-monsoon, when the local community is not using the area for fishing purposes

Table 8.3 Public Consultation – 21st March 2015

Sl	Name	Address	Comment/Question	Response from Project Developer
01	Md. Saidul Islam Raja	Union Parishad Member, Saidabad Union	• The project is good for the surrounding people, as it will generate employment and other business opportunities for the locals. • There are negative impacts on the environment, due to the emissions from the existing plant, which may result in crop damage, possibility of skin diseases, and may also have health impacts. • We welcome this project, however, the project should adhere with the mitigation measures mentioned during the presentation and all work should be carried out as per the law. • The workers that will be employed in the project execution should be skilful and expert.	• The project is based on natural gas as primary fuel and will run on HSD for a small period of time in case of non-availability of natural gas. • Adequate mitigation measures have already been embedded in the project design in order to mitigate environmental risks. • Environmental monitoring carried out as part of the study indicates that the gaseous emissions (i.e. NOx) are much lower than the applicable standards. • The emission and discharge standards as prescribed by the World Bank/ IFC and the Department of Environment, Government of Bangladesh will be fully complied with by the Project.
02	Md. Iqbal Akand	Resident – Khas Bara Simul, Saidabad Union	• Local people should be employed or should get work at the project.	• Suggestions given will be incorporated during the project execution.

Sl	Name	Address	Comment/Question	Response from Project Developer
			• Means of transport and roadway of the project area should be good. • Water must be cool before discharging to the environment. • All the necessary help will be provided for the completion of the project	• As mentioned in the presentation, cooling towers will be used to cool the water before discharge. • The water system is a close circuit system and water will be reused in the cooling with a cycle of concentration (COC) of about 5. This will help in reducing the total water consumption as against the once through system, which requires lot of water.
03	Md. Masud Rana	Union Parishad Member, Saidabad Union	• Unskilled people were employed at 225 MW power plant of NWPGCL. So the local people should have most priority for the employment opportunity at the project.	• As per the current estimate about 1500 people will be engaged during peak construction phase and about 50 people during the operation phase. • SNWPCL will provide adequate opportunity to local people for employment during the construction and operation phase of the project. • Both unskilled and skilled people will be engaged as per the project requirement.
04	Md. Abdus Salam Sheikh	Resident – Khas Bara Simul, Saidabad Union	• Noise problem will be created which should be prevented. • Smoke that will emit from the project should not create problem to the environment and local people. It should be prevented. • Air pollution should be prevented.	• Noise levels monitored around the Saidabad Complex and surrounding residential areas indicate that the noise levels are well within the prescribed standards of the World Bank and the Department of Environment with the existing NWPGCL Plant operations. • We will ensure that the noise levels due to the upcoming project will be within the World Bank and DOE standards. Adequate provisions have already been made in the design. We will also conduct periodic monitoring during the construction and operation phase of this project. • The project is based on natural gas as primary fuel and will run on HSD for a small period of time in case of non-availability of natural gas. • The emission and discharge standards

Sl	Name	Address	Comment/Question	Response from Project Developer
				as prescribed by the World Bank/ IFC and the Department of Environment, Government of Bangladesh will be fully complied with by the Project.
05	Sardar Mohiuddin	Assistant Director, Fisheries Department, Sirajganj Sadar Upazilla	• What will be the NOx emission from the Project? How the NOx emission will be controlled. • Whether the grey water generated from the project will have any harmful elements. • Whether the project has any plans to use grey water generated from the processes. • How the waste generated from the project will be handled. Whether there will be any disposal around the site. • The water that will be released from the project area should be used for agriculture. • Impact on fisheries due to hot water discharge, which we have seen in Ghorashal project. • Local peoples should be aware of the problems or pollution created by the project in environment.	• Natural Gas is a cleaner fuel and it does not emit sulphur dioxide and particulate matter. NOx emission will be controlled by providing dry low NOx burners and the emissions will be less than 25 ppm as against the DOE standard of 40 ppm. • All the waste generated during the construction and operation phase of the project will be properly collected, segregated and stored at the site premises. All the waste will then be collected by the DOE authorised vendors. The project will verify and select these vendors before finalising the waste management contract. • All the effluent generated from the project will be treated within the project premise. Treated water will be reused in the project. Treated water will meet the specified standards of the World Bank and the DOE. • The Ghorashal Project is based on once through cooling system and does not have any provision of cooling towers. Whereas in this project, we will be using cooling towers for cooling of hot water and this will also reduce the water requirement significantly for the cooling purpose. As a result of this the temperature difference between the intake and outfall will be much less than 3°C, as specified by the World Bank/IFC. This can also be seen in the current discharge of the existing NWPGCL power plant. Therefore, this will not have any impact on the fisheries.

Sl	Name	Address	Comment/Question	Response from Project Developer
				• Work will be carried out by the Standard value given by DOE. • The project developer (SNWPCL and NWPGCL) will be open to discuss any of the concerns of the local people related to environmental and other matters and will act on all the grievances.
06	Md. Abdul Aziz Mondol	Union Parishad Member, Saidabad	• Importance should be given to the local people on employment opportunity. • Work should be done nicely according to the promise given to the people. It should not be delayed.	• The project developer agreed to the suggestions made.
07	Engr. A. T. M. Jahangir Kabir	Chief Engineer, NWPGCL	• During the execution of the existing NWPGCL Plant, we have received lot of co-operation from the local people and elected representatives. • We are also expecting similar co-operation during the implementation of this proposed project.	-
08	Mrs. Eti Rani Ghosh	Union Parishad Member, Saidabad Union	• We welcome this project in our area. • The promises mentioned in the presentation must be fulfilled.	• The project developer agreed to the suggestions made. It was also confirmed that all the mitigation measures will be taken care by the project to avoid any significant impact on the surroundings.
O9	Mr. Billal Hosen	Deputy Commissioner, Sirajganj	• This is a good project for providing electricity in the region as well as development of the area. • This project is not involving any land acquisition, as all the land has already been acquired by the BPDB/NWPGCL and developed for the power generation complex, which is otherwise a big problem for the major development projects. • Our population is increasing and with that the demand of power/ electricity has also increasing day by day. Due to this we need more power generation facilities in our country. • We have seen lot of promises for management of environmental and social impacts in this presentation. I expect that SNWPCL must fulfil these promises during the project implementation or development.	• The project developer thanked the DC and assured that the mitigation measures which will come out as part of the Environmental and Social Impact assessment will be fulfilled.

Table 8.4 Public Consultation – 18th April 2015

Sl	Name	Address	Comment/Question	Answer and Policy of Counter-measure
01	Md. Saidul Islam Raja	Union Parishad Member, Saidabad Union	• Previously many companies have completed their project in the area, but local people got zero shares from them. They employed 80-90% outside labour. Request for giving priority to local labour and skills. • If project equipment is available locally then same should be purchased from the local people.	• There will be a grievance/complain system for all. So that local people can go to right place/right person for grievance redressal. There is framework in place for grievance redressal if locals are not satisfied. • Man power from local areas will be given preference based on skill set. • There will be fair and unbiased system of recruitment. • If possible and available equipment from local area will be purchased. Local people need to be more competitive in terms of rates.
02	Foyej Shorkar	Director, LDP	• As 400 MW power plant is proposed, would water be impacted. • It says stacks height will be 60 m and all kind of prevention measure will be taken but is there any chance of air pollution? • There is an Eco park, will it be affected? Will the power plant create disturbance to the life of birds, plants? • What short of initiative SNWPCL will be taking along with NGO's?	• The existing plant will have a closed cycle. Very small quantity of water will be discharged into the Jamuna River. pH value of water will be adjusted before discharge. • 60 m Height Stack is being provided and it will help in dispersion of the gases generated from the power plant. • As per Bangladesh National Standards the NOx standard is 40 ppm and according to IFC guidelines emission standard is 25 ppm. The project will be complying with both National and IFC norms. • Most of the activities related to the power plant will be confined to the Saidabad power generation complex. Only some transport related activities for heavy machinery and jetty will take place near to the ECO park and water front. • There is already an existing access road. The same path will be used to cause minimal disturbance to both aquatic and terrestrial the ecology. Sembcorp is working closely with Institute of Water Modelling (IWM) for better design and any activity near west guide bund will be approved by Bangladesh Bridge Authority. Also SembCorp will be monitoring EPC for minimizing impacts on ecology.

Sl	Name	Address	Comment/Question	Answer and Policy of Counter-measure
				• There will be defined budget allocated for CSR initiatives and a need assessment study will be carried out along with NGOs. After need assessment study, best usage of the defined budget will be carried out for CSR activities.
03	Md Iqbal Akondo	Local People/ Businessman	• Local people gave land. There is already a power plant. But no electricity connection to local people. • On the south side of the plant there is more than one lakhs people living. Would it be possible to get electricity connection? • Request for employment to local people as peon, daily labour, security guard in the project.	• Electricity distribution is not managed by Sembcorp. But Sembcorp will definitely inform Government about this issue and also pursue with relevant departments for electrification of nearby areas. • SembCorp will try to ensure local people get preference for employment in the project.
04	Abdul Ajij Mondol	Union Parishad Member, Saidabad Union	• Will the local people get priority to electricity connection?	• SembCorp will only generate electricity and distribution will be done by the government. However SNWPCL will pursue with government for electricity allocation to Sirajganj area.
05	Abdul Momen	Union Parishad Member, Saidabad Union	• Is there any plan to build a) health complex. b) fire service station. • any kind of measure taken for agricultural activities if it gets affected?	• Sembcorp will work with local people and NGO's for need assessment of sectors for CSR related activities. • Some of the sectors identified are health, education, drinking water and it will be discussed. • No separate fire station but the power plant will have its own fire protection and extinguishing mechanisms. It will be further ensured that the surrounding community any fire related problems • Agriculture productivity will not be affected.
06	Eti Rani Dey	Female Union Parishad Member , Saidabad Union	• In the earlier power plant projects no women were employed. Will be there any chance for women employment?	• SembCorp will try best to give employment to women and also give priority to women. SNWPCL aims for equality amongst genders.
07	Md Motahar Hossain	Manager, MMS, NGO	• CSR activities will be limited to construction phase or will take place in operational phase as well.	• The CSR activities from Sembcorp will carry on till SembCorp is involved in the project.
08	Upanand Kumar Biswas	Superindent Engineer Incharge, NWPGCL	As local people helped in the previous power plant, similar support is expected	

Sl	Name	Address	Comment/Question	Answer and Policy of Counter-measure
			this time also. • The entire area will get developed due to the proposed power plants in the area in terms of employment, infrastructure etc. • NOx ,SOx, CO emissions will be discharged into the air. Standards will be followed and emission monitoring system will be attached to track compliance. • Water will be used in a closed cycle system. So river water will not be damage in this process. • About man power, maximum engineer and technical person are required. So priority to the person who is qualified. Though employment to the local people will be given preference • For women it is not a friendly job environment. But will try to give employment to women in administration, accounts, housekeeping, office assistance etc. • This power plant generates 230 voltage. It is a high voltage current. It cannot be delivered to houses directly. The transmission and distribution department of government is responsible for the distribution of electricity. Even though it is desired but it is up to government for distribution.	
09	Sardar Mohiuddin	Assistant Director Fisheries Department	• How much water is needed for the project actually? • Will grey water being recycled within the project?	• IWM has carried out preliminary studies for availability of water in the Jamuna river and the location suitable for the water abstraction. • The study also shows that the water availability will be there all throughout the year and water intake point will have depth of 5.4 m of water even in the lean season. The demand for the Project is only 482 m3/hr which is very less and amounts to only 0.017% of the total available

Sl	Name	Address	Comment/Question	Answer and Policy of Counter-measure
				river water • Use of grey water as per Bangladesh Environment Conservation Rules will be followed in terms of water characteristics. No water used within the plant will be discharged outside without treatment.
10	Protap Chandro Biswas	Additional Deputy Commissioner (Revenue)	• Bangladesh Government committed to support everyone. Nobody will be left behind. Sembcorp will help in this project. I hope all local people will cooperate in this project. • Land has been taken long back for the project and land issues resolved. No one has approached for land related issues for this particular project. • There may confusion regarding compensations for the land purchased for the upcoming EPZ in the area. • If there are any issues land related issues than the local administration can be approached and it will be resolved.	
11	Ichiro Aoki	ADB Officer, Manila		
12	Tonmoy Das	Additional Deputy Commissioner (General Administration)	• It is already understood by the local people about the type of problem that may arise and how the project design is taking care of the impacts. It is an extremely modern and eco-friendly power plant. • CSR activities will be carried out for the local people and it is strongly recommended to build a school in this area for local children. • If rain water is used for the project, pressure on ground water will be less. • The project is good for the development of the Project area.	• The project sponsor thanked the ADC and assured that the mitigation measures which will come out as part of the Environmental and Social Impact assessment will be fulfilled.

The main findings and observations from the consultation have been summarised here:

- ***Residual issues from the existing Power Plant:*** the consultation with the local community in *Barashimul Panchosona* revealed that there was some level of existing discontent within the local community with respect to the existing NWPGCL power plant adjacent to the Project site with respect to compensation, fragmentation of land due to the transmission corridor right of way and a lack of CSR initiatives amongst others. The current Project development has to be clearly presented to the community as a separate development in order to avoid any confusion within the community, who may associate the development with the existing plant and the residual issues having a cascading effect on the same.

- ***Limited interactions between the Project facility and the local community:*** based on the FGD with the community at Khas Barashimul which is located within the periphery of the Project site, it was reported that the Project construction phase did not have any major or significant interaction with the local population or the resource capital within the village. The only level of interaction was a positive impact in terms of labour employment.

- ***Limited restrictions on access to any community resource around the Project site:*** the local community reported that due to the establishment of the NWPGCL Project, no restrictions as such were imposed in terms of access to Char land, grazing land, the river or any similar community resource. It was observed as well as conveyed that the land around the unused jetty area and adjacent to the boundary wall of the Project site was being used yearly for growing of pulses and rice.

- ***Escalation of local land prices:*** it was reported by the community that the land prices around the Project area have increased significantly due to the establishment of the existing NWPGCL plant. It is expected to rise further with the advent of this Project as well as the construction of the Industrial Park upstream and Economic zone.

- ***Disruption of boat movement and fishing activities due to temporary Jetty:*** the local fishermen representatives were of the opinion that the use of the Jetty area for vessel and material movement would result in a negative impact on the local community. This negative impact is likely to be resultant from a restriction on boat movement and use of nets, restriction on fishing activities during certain time periods and a decline in fish population and catch due to churning of river bed and siltation. Resultant from this, the representatives were of the opinion that the use of the Jetty by the project should be undertaken during the pre-monsoons and outside of the spawning period of the important species.

8.5 *WAY FORWARD FOR CONTINUATION OF CONSULTATION*

The effectiveness of the EIA is directly related to the degree of continuing involvement of those affected directly or indirectly by the Project. During the preparatory stage, consultations were held at local, sub district and district level. Several additional rounds of consultations with stakeholders will be planned during construction and operation phase of the Project. A public consultation meeting with key stakeholders was completed in March 2015 during the EIA preparation stage. Another public consultation meeting was held in April 2015 to disclose the findings of the EIA study. Continued information disclosure and consultation process can either be done internally by the Project proponent or through engaging some outside agency on behalf of them. Should consultation be undertaken using internal resources by the Project proponent, an assessment of internal capacity and expertise should be undertaken. If the capacity is not available, the Project proponent should engage an external agency and gradually build up internal capacity by working alongside of that agency. This will help them in developing internal capacity and maintaining continued consultation process through the Project life cycle.

8.6 *BENEFICAL IMPACTS*

The generation and supply of electricity has a significant impact on the national economy of any country. Presently, 68% of the total population has access to electricity and per capita generation is 348 kWh, which is significantly lower than other developing countries (Power Division 2015). [1]

In the public sector a number of the generation units have become very old and have been operating at much reduced capacities. As a result, their reliability and productivity has been poor. For the last few years actual electricity demand in the country has not been met due to a shortage of available generation capacity. In addition, due to a shortage of gas supply, some power plants are unable to reach their full generation capability.

The current supply-demand in Bangladesh also has a knock on effect on all other key sectors including agriculture, industry, commercial and domestic sectors. There is therefore no alternative to adding more power generating units to the existing power system of Bangladesh, to help improve and meet the energy demand for both domestic and industrial requirements.

The Project is also likely to have a positive effect on opportunities for employment, both directly from the proposed power project and its dependant sectors such as agriculture, industries and manufacturing that require stable power supply in order to operate and be competitive.

[1] The neighbouring country India was having per-capita energy consumption in 2007-08 as 704.2 kWh (www.cea.nic.in), which in January 2012 is reported as 776 kWh per annum (The Wall Street Journal, January 3, 2012).

9 RISK ASSESSMENT

9.1 INTRODUCTION

This study entails risk assessment to personnel and environment from consequences of accidental events. The scope of work for the risk assessment includes the following:

- Hazard Identification
- Consequence Analysis
- Risk Reduction Measures and Recommendations

The risk assessment presented in the following sections is based on certain scientific principles and professional judgement to certain facts with resultant subjective interpretation. Professional judgement expressed herein is based on the available data and information to work out basic risk assessment requirements for project approvals. The detailed hazards and operability study will identify specific hazards based on actual equipment (type and specifications) installed onsite to further mitigate the risks involved.

9.2 NATURAL HAZARD RISK

9.2.1 Earthquake

The Project site falls in the Zone-II area as per the seismic zone map of Bangladesh and at moderate risks from earthquakes (refer *Figure 4.19*). It has been recommended that Civil and mechanical structures will comply the seismic proof design (site seismic factor = 0.05g) as per the guidelines of Bangladesh National Building Code 2010.

9.2.2 Cyclone and Wind Hazard

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

- depression (winds upto 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.).

As shown in ***Figure 4.20*** the Project site does not fall under cyclone affected area. There are reports of a Tornado in 1991, wind storm in 2001 and tropical storm in 2002[1]. All the structures will be designed taking into consideration maximum wind speed of 200 km/hr in order to avoid any impact in case of any cyclone and/or wind surge.

[1] (www.adrc.asia/publications/databook/ORG/...20th/BGD8.xls, 2008)

9.2.3 *Climate Risk*

Climate change could have a variety of impacts on operation of the Sirajganj 4 project, particularly with regards to increased flood risk. The high level climate change risk assessment study has recommended that risks identified as high (i.e. flooding of the facility causing business interruption and damage to infrastructure as well as flooding of surrounding areas) be investigated in further detail to fully understand the implications for operation of the plant in the future. Given that these both relate to the increased risk of flooding in the future, which will also apply to the Saidabad Power Generation Complex as a whole and its surrounding communities, options to work closely with local authorities and NWPGCL on this issue should be investigated as a combined response is likely to be more cost-effective. A high level assessment of the climate change risk on the project has been presented in ***Annex T***.

9.3 *HEALTH AND SAFETY – HAZARDOUS MATERIAL HANDLING AND STORAGE*

This study entails Consequence Analysis in case of Loss of Containment of hazardous materials from the respective storage facility and pipeline. The layout plan of the Sirajganj 4 Project with proposed Sirajganj 2 and existing Sirajganj 1 Plant.

9.3.1 *Storages*

All chemicals and compressed gases will be properly stored as per the guidelines of Department of Explosives, Bangladesh. Proposed chemical storage inventory at Sirajganj 1, and Sirajganj 4 Plants is presented in Table 9.1.

Table 9.1 Major Chemical Storages at Sirajganj 1 and Sirajganj 4 Plants

S. No.	Chemical Name	Maximum Storage Quantity	
		Sirajganj 4	Sirajganj 1
1.	Hydrochloric Acid (30%)	30 m^3	20 tonnes
2.	Caustic Lye (48%)	60 tonnes	20 tonnes
3.	Sulphuric Acid	40 m^3	NA
4.	Ammonia (25%)	500 l	NA
8.	Tri Sodium Phosphate	500 kg	NA
9.	Diesel	19000 m3	11000 m3

** No information available currently for hazardous chemical storages of Sirajganj 3 and 4 projects*
Source: Sembcorp and NWPGCL

9.3.2 *Study Methodology*

Elements considered for Consequence Analysis

The elements of the study consist of the following steps:

- Data Collection and Review;
- Hazard Identification;
- Consequence Analysis;

- Conclusion.

Data Collection and Review

- Storage details;
- Design and operating conditions; and
- Inventory and material properties.

9.3.3 Hazard Identification

A hazard is an undesired event, which may cause harm to people or to the environment or damage to property. The study is primarily concerned with the identification and evaluation of accidental events associated with proposed operations, which have potential to cause major incident and is defined as:

- A fire, explosion, the release of a dangerous substance like diesel and natural gas resulting from a work activity which could result in death or serious personal injury to people within the site;
- Hazards associated include uncontrolled release (liquid and gas) and subsequent fire due to accidental loss of containment.

A major hazard is defined as an event, which may have the potential to cause one or more fatalities, to affect the integrity of the facility as a whole and also to cause significant damage to the surrounding environment.

Hazards Due to Operations

Process / Production Events: The potential incidents resulting in loss of containment of material or loss of containment of energy include leaks of process materials, explosion in either a small container or a large container.

Accidental release of flammable or toxic vapours can result in severe consequences. Delayed ignition of flammable vapours can result in blast overpressures covering large areas. This may lead to extensive loss of life and property. Toxic clouds may cover yet larger distances due to the lower threshold values in relation to those in case of explosive clouds (the lower explosive limits). In contrast, fires have localized consequences. Fires can be put out or contained in most cases; there are few mitigating actions one can take once a vapour cloud gets released. To formulate a structured approach to identification of hazards understanding of contributory factors is essential.

Blast Overpressures: Blast Overpressures depend upon the reactivity class of material and the amount of gas between two explosive limits. Light hydrocarbons can give rise to a Vapour Cloud Explosion (VCE) due to high vapour pressures and it may result in extensive damage to persons and property.

Operating Parameters: Potential vapour release for the same material depends significantly on the operating conditions. The operating pressure increases

during pumping operations, where the pressures are those developed by the respective pumps. For example, the operating pressure of the storage tanks is almost atmospheric and there are no chances of a Boiling Liquid Expanding Vapour Explosion (BLEVE) in such tanks. Similarly, rate of evaporation from a release from atmospheric storage shall be much lower than that from a pressurized storage tank.

Inventory: Inventory Analysis is commonly used in understanding the relative hazards and short listing of release scenarios. Larger inventory of a system results in larger quantity of potential release. A practice commonly used to generate an incident list is to consider potential leaks and major releases from fractures of pipelines and tanks containing sizable inventories. The potential vapour release (source strength) depends upon the quantity of liquid released, the properties of the materials and the operating conditions (pressure, temperature).

Loss of Containment: Plant inventory may be discharged to the environment due to loss of containment. Various causes and modes for such an eventuality have been considered. Certain features of material to be handled need to be clearly understood to firstly list out all significant release cases and then to short list release scenarios for a detailed examination.

Liquid releases may be either instantaneous/spontaneous or continuous. Failure of a storage tank leading to an instantaneous outflow assumes the sudden appearance of such a major crack that practically all of the contents above the crack shall be released in a very short time. The more likely event is the case of liquid release from a hole in a pipe connected to a tank. The flow rate will depend on size of the hole as well as on the pressure, in the tank.

The vaporization of released liquid depends on the vapour pressure and the atmospheric conditions.

9.3.4 Consequence Analysis

This includes assessment of the consequences resulting from accidental release of flammable and toxic material by employing standard consequence analysis tools and simulation software. The consequences of all releases are modelled using empirical and integral models. Liquid releases will form a liquid pool. Ignition of the pool will result in a pool fire, which will continue till the liquid is completely burnt. Natural gas release can result in jet fire.

The consequences of each failure scenario have been modelled using PHAST software. These includes models for calculating discharge rates, dispersion of flammable/toxic gases, liquid spread and vaporisation, radiation effects from fires (jet fires, pool fires, flash fires etc.). The result of the consequence analysis is a hazard footprint for each accident scenario which is used to determine the level of harm to personnel and level of damage to equipment.

Consequences of Vapour Cloud Explosion and Flash Fire

A Vapour Cloud Explosion (VCE) begins with a release of large quantity of flammable vaporising liquid or gas from a storage tank, transport vehicle or pipeline producing overpressure wave. VCE may be formed by gas due to partial confinement or an area of congestion. In the event of gas cloud ignition, two situations may occur i.e. non explosive combustion (resulting into flash fire) and explosive combustion (resulting into flash fire). The unconfined gas cloud of methane normally leads to a flash fire. This is because of the low specific gravity of methane; it disperses very fast and does not tend to form a vapour cloud large enough to cause a Vapour Cloud Explosion.

A late ignition explosion can result in wave of peak overpressure. Following is the criteria for overpressure:

Impact Criteria

Impact criteria were used to assess the damage potential of fires to people. Fatality rates due to exposure to thermal radiation from a fire were determined based on the TNO Purple Book (2005), as follows:

$$P_r = -36.38 + 2.56 \cdot \ln\left(t_R I^{\frac{4}{3}}\right)$$

where;

P_r = probit corresponding to the probability of death
I = heat radiation (W/m2)
t = exposure time (s)

An exposure time of 20 seconds was adopted in this study for continuous release of hazardous material to the atmosphere in line with the recommendation based on TNO Purple Book (2005).

The corresponding personnel fatality criteria used for fire (thermal radiation) hazards including fireball are provided in Table 9.2.

Table 9.2 Personnel Fatality Criteria and the Corresponding Thermal Radiation Levels

Fatality Levels (%)	Thermal Radiation (kW/m²)
90	28.3
50	19.5
3	11.2

Fatalities from flash fires were only considered to occur within the flammable cloud footprint area. It was considered that persons within the path of a flash fire are not likely to escape. Therefore, a fatality rate of 100% was assigned to these individuals.

The fatality probabilities derived in this study were based on the assumption that people are present outdoors 100% of the time. The results of the study are therefore conservative.

Explosion Overpressure Impact

It is noted that a VCE involves explosion overpressure effects. Fatalities occur as a result of this phenomenon. Persons within the vapour cloud are considered fatally injured in an explosion due to the fire effects. For personnel inside the building, the effect would be dominated by building collapse or falling structures.

Based on OGP Vulnerability of Humans, the fatality probability for people outdoors due to blast overpressure adopted in this study is provided in Table 9.3.

Table 9.3 Fatality Probability for People Outdoors due to Blast Overpressure

Blast Overpressure (mbar)	Fatality Probability, People Outdoors
≥ 350	0.15
< 350	0

Table 9.4 Damage Criteria for Pressure Wave

S.N	Peak Overpressure (bar)	Type of Damage
1	0.01	Windows smashed
2	0.03	Damage by flying fragments of glass
3	0.10	10% of houses seriously damaged
4	0.30	90% of houses seriously damaged

Reference: World Bank Technical Paper No. 55- Technica Ltd. for assessing hazards- A manual

Consequences of Fire/Heat Wave

The effect of thermal radiation on people is mainly a function of intensity of radiation and exposure time. The effect is expressed in term of the probability of death and different degrees of burn. The damage caused due to incident power radiation is given in Table 9.5.

Table 9.5 Damage Caused Due to Incident Power Radiation at Various Distances due to Steady State Fire

Incident Power Radiation Kw/m^2	Damage Caused
37.5	Sufficient to cause damage to process equipment. 100% lethality in 60 seconds, 1% lethality in 10 seconds.
25.0	Minimum Energy to ignite wood at infinitely long exposures without a flame. 100% lethality in 60 seconds. Significant injury in 10sec.
12.5	Minimum Energy to ignite wood with flame, melting of plastic tubing etc. 1% lethality in 60 seconds. 1st degree burns in 10 seconds.
4.5	Sufficient to cause pain to personnel if unable to take cover within 20 seconds; 1st degree burns
1.6	Causes discomfort to long exposure

Event Classification and Modes of Failure

Hazards that can lead to accidents in operations are discussed in this section. Important hazardous events are classified in Table 9.6.

Table 9.6 Event Classification

Type of Event	Description
BLEVE	Boiling Liquid Expanding Vapour Explosion; may happen due to catastrophic failure of refrigerated or pressurized gases or liquids stored above their boiling points, followed by early ignition of the same, typically leading to a fire ball
Deflagration	Is the same as detonation but with reaction occurring at less than sonic velocity and initiation of the reaction at lower energy levels
Detonation	A propagating chemical reaction of a substance in which the reaction front advances in the unreacted substance at or greater than sonic velocity
Explosion	A release of large amount of energy that forms a blast wave
Fire	Fire
Fireball	The burning of a flammable gas cloud on being immediately ignited at the edge before forming a flammable/explosive mixture.
Flash Fire	A flammable gas release gets ignited at the farthest edge resulting in flash-back fire
Spill Release	'Loss of containment'. Release of fluid or gas to the surroundings from unit's own equipment / tanks causing (potential) pollution and / or risk of explosion and / or fire
Structural Damage	Breakage or fatigue failures (mostly failures caused by weather but not necessarily) of structural support and direct structural failures
Vapour Cloud Explosion	Explosion resulting from vapour clouds formed from flashing liquids or non-flashing liquids and gases

Risks to Environment

This is defined as the frequency per year of spills of a certain size. The following sizes have been considered:

- < 100 tonnes;
- 100 to 500 tonnes;
- 500 to 1000 tonnes; and
- 1000 to 2000 tonnes.

Toxic, flammable and explosive substances released from sources of storage as a result of failures or catastrophes can cause losses in the surrounding area in the form of:

- Toxic gas dispersion, resulting in toxic levels in ambient air,
- Fires, fireballs, and flash back fires, resulting in a heat wave (radiation), or
- Explosions (Vapour Cloud Explosions) resulting in blast waves (overpressure).

9.3.5 Emergency Situations Involving Loss of Containment

Maximum Credible Loss Scenarios (MCLS)

For the proposed facility, the following containment loss scenarios may be envisaged:

- Loss of Natural Gas due to hole of various sizes in the pipeline transporting natural gas to the process area.
- Loss of Natural Gas due to rupture of the pipeline transporting natural gas to the process area.
- Loss of Diesel due to hole of various sizes in the pipeline transporting diesel to the process area
- Loss of Diesel due to rupture of pipeline transporting diesel to the process area
- Loss of diesel due to catastrophic rupture of Diesel storage tank – a low probability event.
- Loss of Diesel due to leak of various sizes in the Diesel Storage Tank.

Overall hazards identified due to proposed operations are given in Table 9.7.

Table 9.7 Overall Identified Hazards

SN	Source	Hazard	Description
A-1	Diesel Storage tanks	Fire and explosion	Release of fuel (Diesel) from storage tank leading possibly to - Pool Fire - Tank on fire - Vapour cloud explosion
A-2	Diesel Pipeline	Fire and Explosion	Release of fuel (Diesel) from pipeline leading possibly to - Pool Fire - Vapour cloud explosion
A-3	Natural Gas Pipeline	Fire and explosion	Release of Natural Gas from pipeline leading possibly to - Jet Fire - Flash Fire - Vapour cloud explosion
A-4	Hydrochloric Acid Storage Tank	Toxic Release	Release of Hydrochloric Acid from storage tank leading possibly to - Toxic Vapour Cloud
A-5	Sulphuric Acid Storage tank	Fire & Toxic Release	Release of Sulphuric Acid from storage tank leading possibly to - Toxic Vapour Cloud - Pool Fire

9.3.6 Emergency Situations Not Involving Loss of Containment

Emergency situations not involving loss of containment are generally more likely to occur and the following are possible:

Hazards: Physical Injuries

- Injury due to manual handling of materials.
- Injury due to fall.
- Hand injuries while working with equipment.

Hazards: Others

- Falls due to working at heights.

- Electric shock caused by contact with faulty electrical equipment, cables, etc.
- Chronic health issues related to inhalation or ingestion of dust or chemical vapour.

9.3.7 External Hazards

External hazards which may impair safety include the following:
- Extreme weather conditions;
- Earthquake or ground movement; and
- Security breaches.

Extreme weather conditions are primarily lightening, cyclones, high winds and heavy rainfall. They may result in injury through slips trips of personnel or equipment damage. Thus there are potential hazards to workers from direct impact of the structure, i.e. falling equipment and storage tanks and any subsequent releases caused by storage tank damage. However, no fatalities are expected from such conditions i.e. risk to workers is low providing:
- Reliable weather forecasts are available; and
- Design and operational limits of the structures are known and not exceeded.

The project region falls in Zone II (i.e., moderate hazard zone) as per the Seismic Zone Map prepared by the BMD.

9.3.8 Representative Hole Size

The hole sizes which are detectable or hazardous are not constant, but dependent on a number of factors. Smaller hole sizes will result in lower release rates and longer leak duration, while larger hole sizes will lead to larger release rates but correspondingly shorter leak duration. The release scenarios or sizes that were considered are as follows:

Table 9.8 Hole size category for consequences and failure frequency

Hole Category	Equivalent Hole Size (mm)	Hole Size Range (mm)
Small	10	1-10
Medium	50	10 – 50
Large	100	50 – 150
Full bore rupture (FBR)	Piping diameter	150 – Rupture

9.3.9 Release Duration

The release duration for liquid release was estimated by the total available isolatable system inventory divided by the initial release rate. The release duration for gas release was estimated based on the total available isolatable system inventory depressurised through the leaks and through the blow down system, where applicable. It was assumed that detection and isolation can be achieved (via emergency shutdown, manual intervention, etc.) within 10 minute from the time of release.

9.3.10 Scenarios Identified

After the detailed analysis of the proposed facility and layout the following hazardous scenarios were identified listed in the below Table 5.4.

Table 9.9 Scenarios Identified

Leak Source	Scenario	Inventory	Leak Size (mm)
Diesel Tank 1 & 2 (Sirajganj 4)	Small Leak	9500 m^3 each	5
	Medium Leak		25
	Large Leak		100
	Catastrophic Rupture		
Diesel Tank 1 & 2 (Sirajganj 1)	Small Leak	5500 MT each	5
	Medium Leak		25
	Large Leak		100
	Catastrophic Rupture		
Natural Gas Supply Pipeline	Small Leak	29573.16 kg	5
	Medium Leak		25
	Large Leak		100
	Full Bore Rupture		508
Diesel Supply Pipeline	Small Leak	159418.61 kg	5
	Medium Leak		25
	Large Leak		100
	Full Bore Rupture		254
Hydrochloric Acid Storage in Sirajganj 4 (30% Conc)	Small Leak	2000 kg	5
	Medium Leak		25
	Large Leak		100
Sulphuric Acid Storage (50%)	Small Leak	1000 kg	5
	Medium Leak		25
	Large Leak		100
Hydrochloric Acid Storage in Sirajganj 1 (30% Conc)	Small Leak	20000 kg	5
	Medium Leak		25
	Large Leak		100

9.3.11 Consequence Analysis of the Identified Scenarios

The project will have continuous natural gas supply at a maximum rate of 59500 kg/hour.

The gas will be supplied through a pipeline of 20 inch diameter and at a pressure of 1000 psig and temperature of approximately 30^{o}C up to the Gas metering skid. This is a buried pipeline. Hence it can be said that the consequence in the portions where it is underground will not be very high and the probability of failure in those parts will be also insignificant. However there will be certain areas where the pipeline needs to come above the ground for unavoidable design issues. The consequence results will be high in those areas and this will represent the worst case scenario.

The main hazard associated with gas pipeline is loss of containment of the gas from the pipeline systems due to holes or rupture of pipeline in an extreme case. The loss of containment of the product (natural gas) and its escape to the environment can theoretically cause jet fire, flash fire, explosion etc. The heat radiation from the jet fire, flash fire and overpressure due to explosions like Unconfined Vapour Cloud Explosion (UVCE) can cause injury to people, damage buildings and equipment.

When gas/hydrocarbon is released through a hole or a rupture, the released hydrocarbon mixes with air (oxygen) to form a flammable mixture. Below a certain concentration of flammable gas i.e. at Lower Flammability Limit (LFL) the mixture is too lean, while above a certain concentration i.e. Upper Flammability Limit (UFL) the mixture is too rich. A concentration between the two limits constitutes the flammable range. For a flammable mixture to form, the hydrocarbons released should be thoroughly mixed with air to have the concentration between LFL and UFL. If the released gas and the mixture come in contact with an ignition source, the mixture will burn at the surface and the flame would rapidly spread from the point of ignition to the source resulting in what is known as a Flash Fire. Any person present in the range of the flash fire is likely to suffer potentially fatal burn injuries.

Analysis of the main hazards due to release of natural gas from pipeline indicates the following:

- The possibility of an explosion due to release of natural gas is extremely remote.
- Natural gas is a very light gas having a molecular weight much lower than that of air. This results in quick dispersion of natural gas. Therefore, cloud formation and delayed ignition leading to an Unconfined Vapour Cloud Explosion (UVCE) is a highly unlikely event. Another reason for low probability of UVCE is the high value of LEL of Natural gas i.e. 5.3%.
- Natural gas is a 'much super-heated vapour' (normally super-heated vapours are called as gas) at the atmospheric pressure. Boiling Liquid Expanding Vapour Explosion (BLEVE) can happen only when there is low boiling liquid stored under pressure. Therefore, there is no possibility of BLEVE in natural gas pipeline.
- Natural gas has very low toxicity and the main hazard is asphyxiation due to the reduced oxygen levels. Therefore, toxic effects are not considered since pipelines are traversing open terrain.
- Accidental release of natural gases from the pipeline either due to rupture of pipeline or leakage from valves or pinholes may result in a jet fire escaping at high velocity, thereby forming a turbulent jet. This jet will loose its momentum after a considerable distance and will then become a passive jet. A portion of the jet will also have the mixture between the LFL and UFL, which can ignite if there is an ignition source. This will be like a flame torch that will radiate heat in all directions. Therefore, jet fire and thermal radiation effects of jet fire are the main hazard.

The term jet fire is used to describe the flame produced due to the ignition of a continuous pressurised leakage from the pipe work. Combustion in a jet fire

occurs in the form of a strong turbulent diffusion flame that is strongly influenced by the initial momentum of the release. Flame temperatures for typical jet flames vary from 1600°C for laminar diffusion flames to 2000°C for turbulent diffusion flames. The principal hazards from a jet fire are thermal radiation and the potential for significant knock-on effects, such as equipment failure due to impingement of the jet fire.

Based on above, it can be concluded that jet fire and thermal radiation effects of jet fire are the main hazards in natural gas pipeline and therefore have been evaluated.

The project will have diesel supply at a maximum rate of 300 m^3/hour. The diesel will be supplied through a pipeline of 10 inch diameter and at a pressure of 58 psig and temperature of approximately 30^oC up to the storage tanks in Sirajganj 4 facility.

Two above ground storage tank of 9500 m^3 capacity each will be maintained for storage of Diesel required for diesel consumption for plant operations in the Sirajganj 4 Facility.

Two above ground storage tank of 5500 MT capacity each are being maintained for storage of Diesel required for diesel consumption for plant operations in the Sirajganj 1 facility.

The worst-case scenario is a catastrophic release of the full contents of a storage vessel. In the cases of leak of various sizes and catastrophic rupture of the tanks, pool fire was analysed to be the only major consequence. Possibility of explosion was observed as very remote due to relative low quantity of storage.

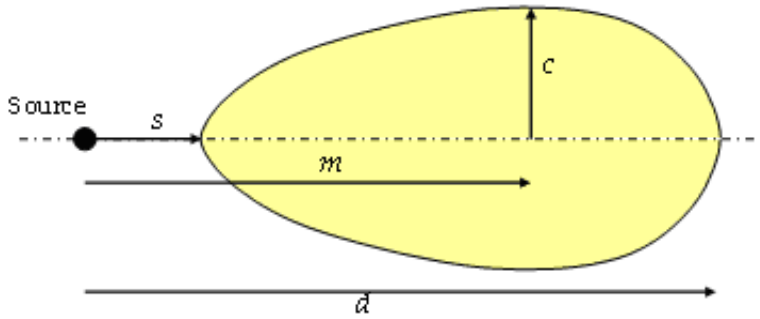
The worst-case scenario is a large release (100 mm) of the full contents of a storage vessel. In case of pressurised tanks the failure frequency for 100 mm release is in the range of $1.3E^{-04}$ i.e. once in every 7692 years of operation. Hence it can be concluded that the chances of that are very remote.

The worst-case scenario is a catastrophic release of the full contents of a storage vessel. In the cases of leak of various sizes and catastrophic rupture of the tanks, toxic dispersion was analysed to be the only major consequence.

30 m^3 Hydrochloric Acid and 40 m^3 of Sulfuric Acid will also be store in the Sirajganj 4 plant whereas 20 tons of HCl and 20 tons of sulphuric acid are stored in the existing power plant. Hydrochloric Acid has toxic effects and Sulfuric Acid has flammable characteristics.

The effects of the distances with respect to various fire scenarios have been analyzed based on the following consequence illustration.

Figure 9.1 An Illustration of Consequence Analysis Scenarios



Note: d= Downwind Distance in meter; c = Crosswind Distance, in meter; s = Offset Distance between source and effect zone, in meter; and m = Downwind Distance at which c occurs in meter.

The consequence analysis results for various scenarios have been presented in Table 9.10 to Table 9.14**.** Consequence contours of the affected areas on the layout in case of any large leak in HSD storage tanks in Sirajganj 4 and Sirajganj 1 facilities in the worst case scenarios have been presented in Figure 9.2 and Figure 9.3, respectively.

Table 9.10 Jet Fire results

			Weather State 2F				Weather State 5D			
Scenario	**Fatality Probability**	**Leak Size (mm)**	**d (m)**	**c (m)**	**s (m)**	**M (m)**	**d (m)**	**c (m)**	**s (m)**	**M (m)**
Natural Gas Pipeline	0.9	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas Pipeline	0.5	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas Pipeline	0.03	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas Pipeline	0.9	25	26.9	7.2	6.2	16.5	28.8	7.0	6.3	17.5
Natural Gas Pipeline	0.5	25	29.5	10.0	5.6	17.6	31.3	9.7	5.7	18.5
Natural Gas Pipeline	0.03	25	33.1	14.5	4.8	18.9	34.3	14.2	4.8	19.6
Natural Gas Pipeline	0.9	100	87.5	34.8	17.0	52.3	95.2	35.7	17.3	56.2
Natural Gas Pipeline	0.5	100	97.0	44.4	12.6	54.8	103.5	45.0	14.2	58.8
Natural Gas Pipeline	0.03	100	112.4	60.5	3.3	57.9	116.3	60.9	6.9	61.6
Natural Gas Pipeline	0.9	508	270.6	118.2	31.4	151.0	276.2	125.3	34.5	155.3
Natural Gas Pipeline	0.5	508	295.3	147.2	8.0	151.6	306.8	153.7	13.2	160.0
Natural Gas Pipeline	0.03	508	342.6	198.0	-36.3	153.1	355.3	202.9	-26.9	164.2
HSD Pipeline	0.9	5	3.0	0.9	1.2	2.1	3.5	1.4	0.5	2.0
HSD Pipeline	0.5	5	3.6	1.4	0.7	2.2	3.9	1.9	0.2	2.1
HSD Pipeline	0.03	5	4.3	2.0	0.2	2.2	4.7	2.6	-0.3	2.2
HSD Pipeline	0.9	25	10.8	4.1	0.5	5.7	10.5	4.8	0.0	5.2
HSD Pipeline	0.5	25	11.6	5.0	0.2	5.9	11.4	5.7	-0.6	5.4
HSD Pipeline	0.03	25	13.1	6.6	-0.5	6.3	13.0	7.4	-1.4	5.8
HSD Pipeline	0.9	100	22.0	9.0	0.1	11.1	20.5	9.8	-0.9	9.8
HSD Pipeline	0.5	100	23.7	10.8	-0.5	11.6	22.2	11.6	-1.4	10.4
HSD Pipeline	0.03	100	26.5	13.9	-1.3	12.6	25.4	15.0	-2.6	11.4
HSD Pipeline	0.9	254	33.4	14.2	-0.5	16.4	30.8	15.1	-1.5	14.6
HSD Pipeline	0.5	254	35.9	17.0	-1.0	17.4	33.4	17.8	-2.2	15.6
HSD Pipeline	0.03	254	40.3	21.6	-2.0	19.2	38.2	23.1	-3.8	17.2

Table 9.11 Flash Fire Results

				Weather State 2F		Weather State 5D	
Scenario	**Leak Size (mm)**	**LFL Fraction**	**Concentration (ppm)**	**Max Distance (m)**	**Max Width (m)**	**Max Distance (m)**	**Max Width (m)**
Natural Gas Pipeline	5	0.5	22000	7.23	0.73	5.91	0.66
Natural Gas Pipeline	5	1	44000	3.96	0.36	3.53	0.35
Natural Gas Pipeline	25	0.5	22000	58.75	5.05	55.88	4.10
Natural Gas Pipeline	25	1	44000	23.57	2.09	21.08	1.88
Natural Gas Pipeline	100	0.5	22000	222.88	20.23	247.59	17.65
Natural Gas Pipeline	100	1	44000	126.06	11.06	125.46	9.55
Natural Gas Pipeline	508	0.5	22000	415.58	59.64	465.94	60.50
Natural Gas Pipeline	508	1	44000	415.58	37.62	465.16	35.09
HSD Pipeline	5	0.5	2577.3	6.3	1.5	8.0	1.2
HSD Pipeline	5	1	5154.5	6.1	0.9	5.8	0.8
HSD Pipeline	25	0.5	2577.3	13.0	4.1	14.1	4.3
HSD Pipeline	25	1	5154.5	13.0	3.6	13.9	3.7
HSD Pipeline	100	0.5	2577.3	23.2	4.3	25.2	5.9
HSD Pipeline	100	1	5154.5	23.2	4.3	25.2	5.8
HSD Pipeline	254	0.5	2577.3	33.0	5.8	35.6	7.4
HSD Pipeline	254	1	5154.5	33.0	5.8	35.6	7.4
HSD Tank (Sirajganj 4)	5	0.5	2577.3	3.5	0.8	4.0	0.9
HSD Tank (Sirajganj 4)	5	1	5154.5	3.4	0.6	4.0	0.6
HSD Tank (Sirajganj 4)	25	0.5	2577.3	6.3	0.9	6.4	1.5
HSD Tank (Sirajganj 4)	25	1	5154.5	6.2	0.8	6.3	1.3
HSD Tank (Sirajganj 4)	100	0.5	2577.3	8.0	1.1	8.7	1.4
HSD Tank (Sirajganj 4)	100	1	5154.5	7.6	0.8	8.6	1.4
HSD Tank (Sirajganj 1)	5	0.5	2577.3	3.5	0.8	4.0	0.9
HSD Tank (Sirajganj 1)	5	1	5154.5	3.4	0.6	4.0	0.6
HSD Tank (Sirajganj 1)	25	0.5	2577.3	6.3	0.9	6.4	1.5
HSD Tank (Sirajganj 1)	25	1	5154.5	6.2	0.8	6.3	1.3
HSD Tank (Sirajganj 1)	100	0.5	2577.3	8.0	1.1	8.7	1.4
HSD Tank (Sirajganj 1)	100	1	5154.5	7.6	0.8	8.6	1.4

Table 9.12 Pool Fire Results

			Weather State 2F				Weather State 5D			
Scenarios	**Fatality Probability**	**Leak Size (mm)**	**d (m)**	**c (m)**	**s (m)**	**M (m)**	**d (m)**	**c (m)**	**s (m)**	**M (m)**
HSD Pipeline	0.9	5	21.6	10.8	-4.3	10.8	21.4	10.7	-2.1	10.7
HSD Pipeline	0.5	5	21.6	10.8	-4.3	10.8	21.8	10.7	-2.1	10.9
HSD Pipeline	0.03	5	28.9	13.7	-4.3	14.4	32.7	15.6	-2.1	16.4
HSD Pipeline	0.9	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HSD Pipeline	0.5	25	101.4	50.7	-37.7	50.7	100.8	50.4	-36.2	50.4
HSD Pipeline	0.03	25	102.5	50.7	-37.7	51.2	105.5	50.8	-36.2	52.7
HSD Pipeline	0.9	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HSD Pipeline	0.5	100	233.2	116.6	-93.3	116.6	232.8	116.4	-91.1	116.4
HSD Pipeline	0.03	100	233.6	116.6	-93.3	116.8	237.9	116.4	-91.1	119.0
HSD Pipeline	0.9	254	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HSD Pipeline	0.5	254	233.6	116.8	-83.8	116.8	233.5	116.7	-81.1	116.7
HSD Pipeline	0.03	254	234.0	116.8	-83.8	117.0	238.9	116.7	-81.1	119.4
HSD Tank (Sirajganj 4)	0.9	5	16.1	-4.6	28.3	8.1	7.0	2.6	2.0	3.5
HSD Tank (Sirajganj 4)	0.5	5	16.1	-4.6	19.5	8.1	8.3	3.4	2.0	4.1
HSD Tank (Sirajganj 4)	0.03	5	25.5	-5.1	11.2	12.7	9.6	4.8	1.9	4.8
HSD Tank (Sirajganj 4)	0.9	25	0.0	0.0	28.3	0.0	14.0	6.6	0.3	7.0
HSD Tank (Sirajganj 4)	0.5	25	55.8	-27.9	19.5	27.9	19.0	8.7	0.3	9.5
HSD Tank (Sirajganj 4)	0.03	25	55.8	-27.9	11.2	27.9	26.4	12.7	0.3	13.2
HSD Tank (Sirajganj 4)	0.9	100	0.0	0.0	28.3	0.0	0.0	0.0	0.0	0.0
HSD Tank (Sirajganj 4)	0.5	100	55.8	-27.9	19.5	27.9	42.4	21.2	-14.5	21.2
HSD Tank (Sirajganj 4)	0.03	100	55.8	-27.9	11.2	27.9	46.6	22.6	-14.5	23.3
HSD Tank (Sirajganj 1)	0.9	5	16.1	-4.6	28.3	8.1	7.0	2.6	2.0	3.5
HSD Tank (Sirajganj 1)	0.5	5	16.1	-4.6	19.5	8.1	8.3	3.4	2.0	4.1
HSD Tank (Sirajganj 1)	0.03	5	25.5	-5.1	11.2	12.7	9.6	4.8	1.9	4.8
HSD Tank (Sirajganj 1)	0.9	25	0.0	0.0	28.3	0.0	14.0	6.6	0.3	7.0
HSD Tank (Sirajganj 1)	0.5	25	72.7	-30.0	19.5	36.3	19.0	8.7	0.3	9.5
HSD Tank (Sirajganj 1)	0.03	25	72.7	-30.0	11.2	36.3	26.4	12.7	0.3	13.2
HSD Tank (Sirajganj 1)	0.9	100	0.0	0.0	28.3	0.0	0.0	0.0	0.0	0.0
HSD Tank (Sirajganj 1)	0.5	100	285.4	-133.9	19.5	142.7	42.4	21.2	-12.4	21.2
HSD Tank (Sirajganj 1)	0.03	100	285.4	-133.9	11.2	142.7	46.6	22.6	-12.4	23.3

Table 9.13 Vapour Cloud Explosion Results

Scenarios	Leak Size (mm)	Over Pressure Limit (bar)	Over Pressure Radii (m)	
			Weather State 2F	Weather State 5D
Natural Gas Pipeline	5	0.02	Not Reached	Not Reached
Natural Gas Pipeline	5	0.14	Not Reached	Not Reached
Natural Gas Pipeline	5	0.2	Not Reached	Not Reached
HSD Pipeline	5	0.02	Not Reached	Not Reached
HSD Pipeline	5	0.14	Not Reached	Not Reached
HSD Pipeline	5	0.2	Not Reached	Not Reached
Natural Gas Pipeline	25	0.02	92.94	87.83
Natural Gas Pipeline	25	0.14	61.11	59.79
Natural Gas Pipeline	25	0.2	58.6	57.57
HSD Pipeline	25	0.02	19.71	21.76
HSD Pipeline	25	0.14	12.51	13.04
HSD Pipeline	25	0.2	11.94	12.35
Natural Gas Pipeline	100	0.02	467.42	455.95
Natural Gas Pipeline	100	0.14	313.7	318.14
Natural Gas Pipeline	100	0.2	301.55	307.25
HSD Pipeline	100	0.02	28.86	29.83
HSD Pipeline	100	0.14	22.29	22.54
HSD Pipeline	100	0.2	21.77	21.97
Natural Gas Pipeline	Rupture	0.02	1246.59	1260.5
Natural Gas Pipeline	Rupture	0.14	784.99	894.85
Natural Gas Pipeline	Rupture	0.2	772.55	893.75
HSD Pipeline	Rupture	0.02	39.45	40.61
HSD Pipeline	Rupture	0.14	32.44	32.74
HSD Pipeline	Rupture	0.2	31.89	32.12

Table 9.14 Toxic Dispersion Results

Serial No	Scenarios	IDLH (ppm)	Distance to IDLH (m)	
			Weather State 2F	Weather State 5D
Small Leak				
1	Hydrochloric Acid (Sirajganj 4)	100	50.98	16.24
2	Hydrochloric Acid (Sirajganj 1)	100	50.98	16.24
Medium Leak				
1	Hydrochloric Acid (Sirajganj 4)	100	206.5	152.79
2	Hydrochloric Acid (Sirajganj 1)	100	206.5	152.79
Large Leak				

Serial No	Scenarios	IDLH (ppm)	Distance to IDLH (m)	
			Weather State 2F	Weather State 5D
1	Hydrochloric Acid (Sirajganj 4)	100	514.65	645.59
2	Hydrochloric Acid (Sirajganj 1)	100	623.72	756.19

Figure 9.2 ***Pool Fire Effect Zone for large leak in HSD Storage Tank in Sirajganj 4 facility for 2F weather state***

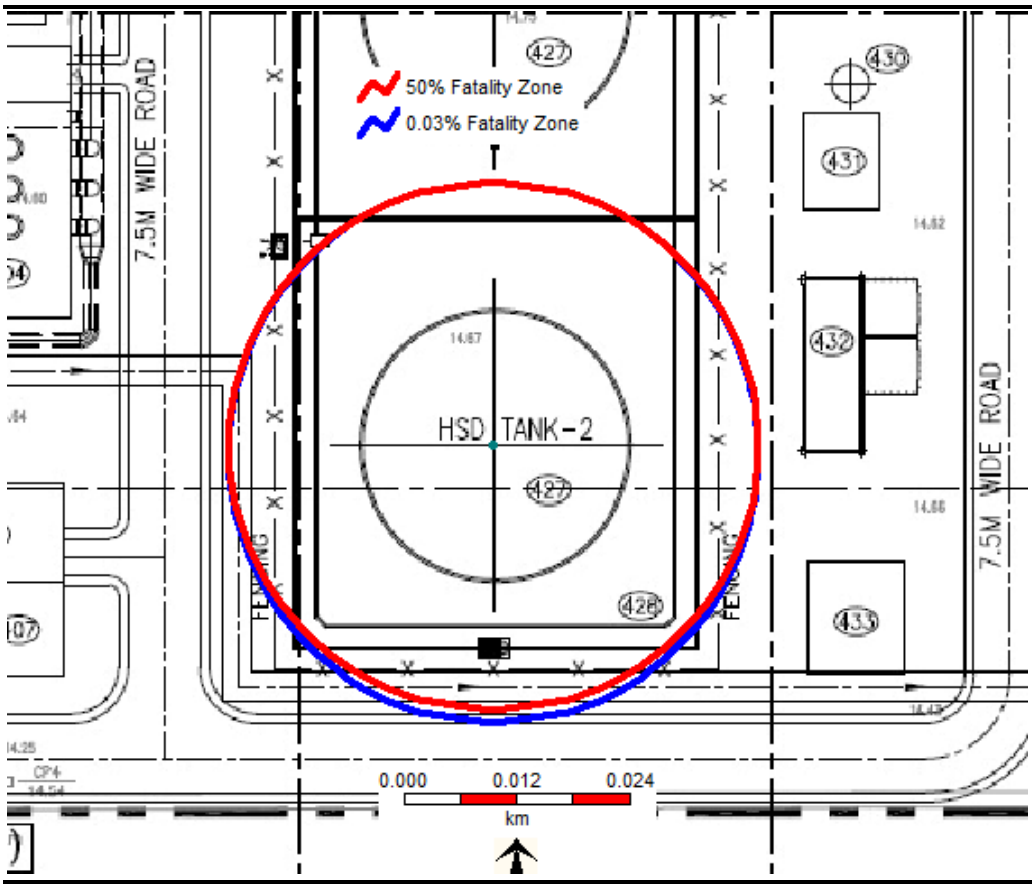
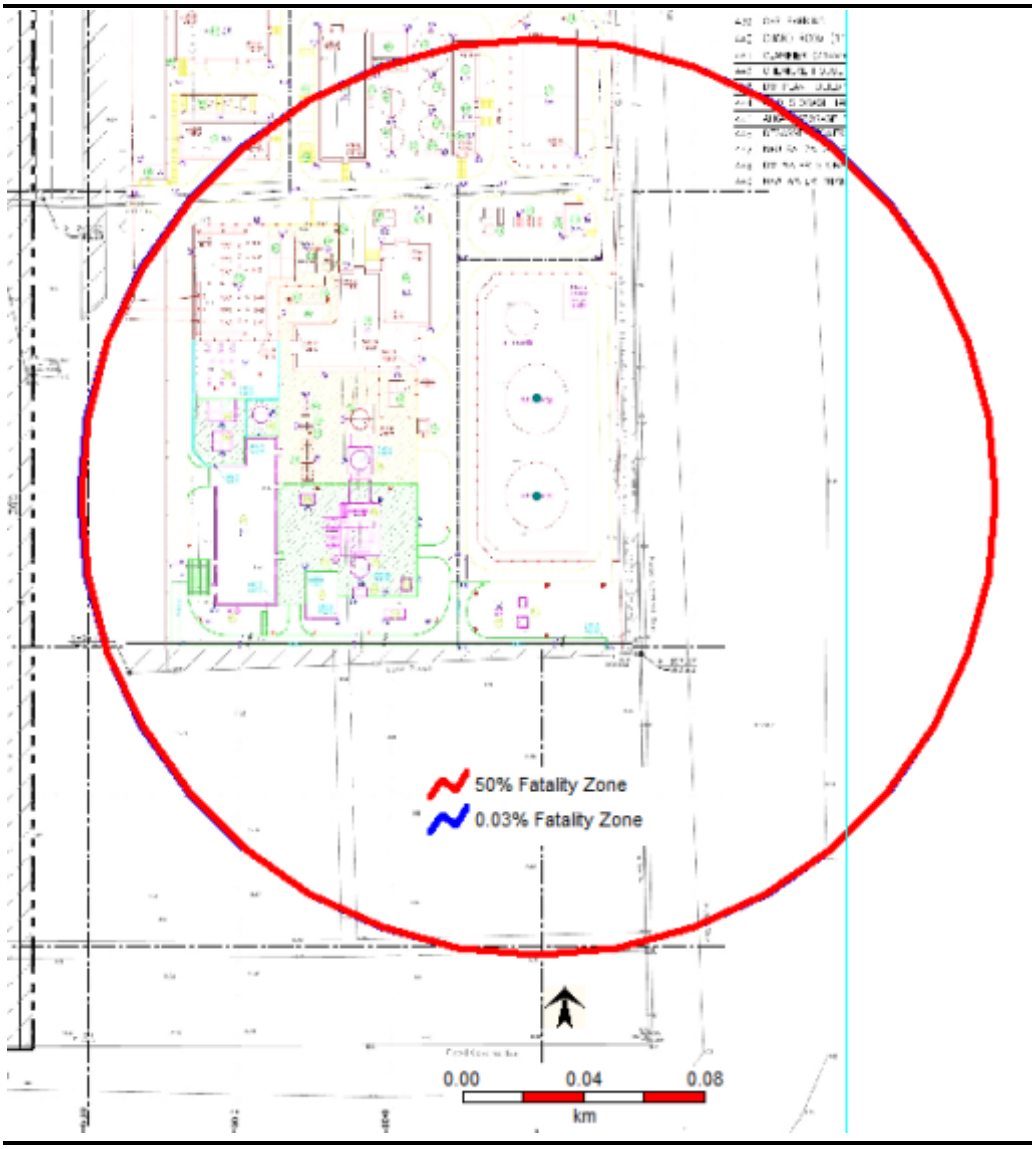


Figure 9.3 ***Pool Fire Effect Zone for large leak in HSD Storage Tank in Sirajganj 1 for 2F weather state***



Impact	*Hazardous Materials Handling and Storage*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	From localized to 750 m from the installation				
Frequency	Very low frequency during entire operation phase of the project				
Likelihood	unlikely				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

9.3.12 Risk Reduction Measures

Preventive Measures for Storage and Handling of HSD

Fire is one of the major hazards, which can result from HSD storage tanks. The preventive measures include the following:

- Fire prevention and relevant code enforcement. The fire service facilities should be equipped with:
  - Smoke and fire detection alarm system.
  - Water supply
  - Fire hydrant and nozzle installation
  - Foam system
  - Water for sprinkler system
  - Mobile firefighting equipment
  - First aid appliances
- Periodic training/ awareness to be given to work force at the project site to handle any emergency situation;
- Periodic mock drills to be conducted so as to check the alertness and efficiency and corresponding records should be maintained;
- Signboards including emergency phone numbers and 'no smoking' signs should be installed at all appropriate locations;
- Plant shall have adequate communication systems;
- All major units / equipment should be provided with smoke / fire detection and alarm system;
- 'No smoking zone' to be declared at all fire prone areas;
- Sand buckets, fire hydrant points and fire extinguishers to be provided at strategic locations;
- Storage location to be selected at an isolated place with proper fencing and guarding;
- Co-ordination with local authorities such as fire, police, ambulance, district administration and nearby industries should be ensured to manage / control, meet any eventuality; and
- Naked flame, welding etc. to be not permitted in storage area.

Preventive Measures for Handling of Natural Gas

- Leak detection sensors to be located at areas prone to fire risk/ leakages;
- All safety and firefighting requirements as per Oil Industry Safety Directorate (OISD) norms to be put in place;
- High temperature and high pressure alarm with auto-activation of water sprinklers as well as safety relief valve to be provided;
- Flame proof electrical fittings to be provided for the installation;
- Periodical training/awareness to be given to work force at the project site to handle any emergency situation;
- Periodic mock drills to be conducted so as to check the alertness and efficiency and corresponding records to be maintained;
- Signboards including emergency phone numbers and 'no smoking' signs should be installed at all appropriate locations;
- Plant shall have adequate communication system;

- Pipeline route/equipment should be provided with smoke / fire detection and alarm system. Fire alarm and firefighting facility commensurate with the storage should be provided at the unloading point;
- 'No smoking zone' to be declared at all fire prone areas. Non sparking tools should be used for any maintenance; and
- Wind socks to be installed to check the wind direction at the time of accident and accordingly persons may be diverted towards opposite direction of wind.

Preventing Fire and Explosion Hazards

- Proper marking to be made for identification of locations of flammable storages;
- Provision of secondary containment system for all fuel and lubricating oil storages;
- Provision of fire and smoke detectors at potential sources of fire and smoke;
- Storing flammables away from ignition sources and oxidizing materials;
- Providing specific worker training in handling of flammable materials, and in fire prevention or suppression;
- Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment;
- Fire and emergency alarm systems that are both audible and visible;
- For safety of people the building, regulations concerning fire safety to be followed. Some of the requirements include:
- Installation of fire extinguishers all over the building;
- Provision of water hydrants in operative condition;
- Emergency exit;
- Proper labelling of exit and place of fire protective system installation;
- Conducting mock drills;
- Trained personnel to use fire control systems.

General Health and Safety

- The facility will adopt a total safety control system, which aims to prevent the probable accidents such as fire accidents or chemical spills.
- Firefighting system, such as sprinklers system, portable extinguishers (such as CO_2) and automated fire extinguishers shall be provided at strategic locations with a clear labelling of the extinguisher so the type of the extinguisher is easily identifiable. Also a main hydrant around the buildings will be available. On all floors an automated fire detection system will be in place.
- The site operations manager will take steps to train all emergency team members and shall draw up an action plan and identify members. The appointed emergency controller shall act as the in-charge at the site of the incident to control the entire operation.
- The staff shall be trained for first-aid and firefighting procedures. The rescue team shall support the first-aid and firefighting team.

- A first-aid medical centre will be onsite to stabilise the accident victim. The emergency team will make contact with a nearby hospital for further care, if required.
- A training and rehearsal of the emergency response by emergency team members and personnel on site will be done regularly.
- A safe assembly area will be identified and evacuation of the premises will be practised regularly through mock drills.
- In case an emergency is being declared, the situation shall be reported to the authorities such as local police, the chief inspector of factories and the regional office of the DOE as per rules and regulation of law of the land.
- Safety manual for storage and handling of Hazardous chemicals shall be prepared.
- All the personnel at the site shall be made aware about the hazardous substance stored and risk associated with them.
- Personnel engaged in handling of hazardous chemicals shall be trained to respond in an unlikely event of emergencies.
- A written process safety information document shall be compiled for general use and summary of it shall be circulated to concerned personnel.
- MSDS shall be made available and displayed at prominent places in the facility. The document compilation shall include an assessment of the hazards presented including (i) toxicity information (ii) permissible exposure limits. (iii) Physical data (iv) thermal and chemical stability data (v) reactivity data (vi) corrosivity data (vii) safe procedures in process.
- Safe work practices shall be developed to provide for the control of hazards during operation and maintenance
- In the material storage area, hazardous materials shall be stored based on their compatibility characteristics.
- Near miss and accident reporting system shall be followed and corrective measures shall be taken to avoid / minimize near miss incidents.
- Safety measures in the form of DO and Don't Do shall be displayed at strategic locations.
- Safety audits shall be conducted regularly.
- Firefighting system shall be tested periodically for proper functioning.
- All hydrants, monitors and valves shall be visually inspected every month.
- Disaster Management Plan shall be prepared and available with concerned personnel department.

Personal Protective Equipment

In certain circumstances, personal protection of the individual maybe required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures. PPEs must be appropriately selected individually fitted and workers trained in their correct use and maintenance. PPEs must be regularly checked and maintained to ensure that the worker is being protected.

First Aid

First aid procedures and facilities relevant to the needs of the particular workforce should be laid down and provided in consultation with an occupational physician or other health professional.

Health assessment should form a part of a comprehensive occupational health and safety strategy. Where employees have to undergo health assessment, there should be adequate consultation prior to the introduction of such program. Medical records should be kept confidential. Site should be able to relate employee health and illness data to exposure levels in the workplace.

It is to be noted that the current assessment is based on the hazardous chemicals handling, transportation and storage at site for Sirajganj 1 and 4 projects. Since the detailed design of the Sirajganj 4 project is currently not finalised and details of hazardous material inventory of Sirajganj 2 and Sirajganj 3 projects are unknown and therefore, it is suggested to conduct a detailed quantitative risk assessment (QRA) for the entire complex after finalisation of the Sirajganj 4 design and availability of hazardous material inventory of Sirajganj 2 and 3 projects from NWPGCL.

9.4 HEALTH AND SAFETY - TRAFFIC MOVEMENT

9.4.1 Traffic Safety

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 who will work in shifts, their transportation will not lead to any impact on road safety of the nearby communities using the access road. Key raw material for power generation (natural gas/ HSD) will be transported by pipeline. Considering these facts, impact due to traffic movement during operation phase will be **negligible.**

Impact	*Traffic Safety (Operation Phase)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Access Road				
Frequency	Entire operation phase of the project				
Likelihood	Possible				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

9.4.2 *Risks of accidents and fatalities to workers*

The operation and maintenance of the power plant will have risks of industrial accidents and fatalities for workers. Both direct employees and Contractors would be exposed to such risks. Sembcorp has proposed to develop occupational health and safety system for the Plant and OHSAS certification within two years of commissioning the power plant. Keeping this in mind the significance of this impact is assigned below.

Impact	*Risks of industrial accidents and fatalities to workers*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **minor.**				

Mitigation Measures

In order to minimise 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;
- SOPs need to be developed for operation and maintenance of the Plant;

9.4.3 *Health associated risks from air emissions and waste water release*

The power plant will have air emissions which will contribute to the air pollution in Project AOI. This will contribute to the health risks of the local community. The assessment of air quality (refer to Section 6.6.3) and water resources impact due to discharge of treated effluent (refer to Section 6.6.2), have indicated that the impact magnitude will be negligible while compared with the magnitude criteria. Hence, the significance of the health associated risks from air emissions and waste water release is minor.

Impact	*Health associated risks from air emissions and waste water release*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High		

Impact Significance	Negligible	Minor	Moderate	Major
	Significance of impact is considered **negligible.**			

Mitigation Measures

The mitigation measures with respect to impacts of air emissions and effluent discharge in the Jamuna River have been presented in ***Section 6.6.3*** and ***Section 6.6.2***.

9.5 PLANS FOR CONSTRUCTION AND OPERATION PHASE

9.5.1 Construction Phase

Prior to the beginning of major land works in order to ensure occupational and community health and safety as well as to avoid any risk, the EPC contractor in cooperation with Project Developer will develop the following plans:

- Health and Safety Plan
- Traffic Management Plan
- Emergency Response Plan

The framework of these plans has been presented in Section 7.5.

9.5.2 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 and to ensure risk avoidance with respect to occupational as well as community health and safety:

- HSE Management System
- Spill Response and Emergency Plan
- Emergency Response and Disaster Management Plan

The framework of these plans has been presented in Section 7.5 and these needs to be prepared and finalised prior to the start of commercial operation of the Plant.

10 CONCLUSION AND RECOMMENDATION

This environmental and social impact assessment of the Project has been prepared based on an understanding of the technical specifications of the Project, existing studies and reports relevant to the project, a robust scoping exercise, site visits, stakeholder consultations, baseline environmental monitoring and socio-economic surveys which were undertaken between November 2012 to February 2013 and February to June 2015. Through this process an assessment has been done of the potential environmental and social impacts attributable to the construction and operation phases of the Project. Environmental and social impacts during decommissioning of the Plant have not been considered in the impact assessment, as these will depend on the options available at the time of expiry of the power purchase agreement between SNWPCL and BPDB.

Qualitative and quantitative (where possible) assessments of impacts have been presented with an impact rating against each potential impact and mitigation measures to minimize and reduce the impacts. Cumulative environmental impacts particularly on water resources, air quality, noise and community health and safety have also been assessed taking into consideration overall development of the Saidabad Power Generation Complex. An economic zone is also proposed adjacent to the power generation complex, however, at the time of study apart from total area involved for the economic zone, no other project specific information, such as master plan, type and nature of industries proposed, were not available and hence, those could not be covered as part of the cumulative impacts.

The environmental and social assessment of the Project ascertains that the Project is unlikely to cause any significant environmental and social impacts. Many of the impacts are localised and short-term or temporary in nature and can be readily addressed by some embedded control measures in the engineering design of the Project as well as additional mitigation measures as suggested in the Environmental Management Plan. The Project received favourable support from local people and other stakeholders during consultations. Stakeholders appreciated that in addition to providing a reliable power supply to the region, the Project will have several other benefits such as supporting economic growth in the region by opening avenues for further development, employment (direct and indirect) and improving local infrastructure.

The Project site is located within the area earmarked and developed for power generation by the Government of Bangladesh to support the industrial development in this area. Development of the Project will not cause any physical displacement of people living in the area. The Project is not located near any protected areas; however, there are critical habitats present within the Project AOI. Critical habitat assessment carried out as part of the impact assessment study highlighted that the impacts will be negligible to minor after

implementing the suggested mitigation measures. No archaeological or protected monuments are located in the Project vicinity. The nearest physical cultural resources of local importance are located over 500 m from the Project.

During the construction phase of the Project, the key environmental issues are noise and dust generation. There is also a risk of contamination of soil, groundwater and the Jamuna River from accidental spills and leaks of hazardous materials (e.g. oil) during handling, transportation, and storage at the site.

Various mitigation measures have already been developed by the Project Developer (SNWPCL), as part of their "*Master Specification Manual*" for the EPC Contractor. The adverse impacts identified are generally manageable through good housekeeping and a diligent implementation of the EMP by the EPC Contractor and its supervision by the Project Developer and their team of consultants. The nearest air quality and noise sensitive receptors will be a focus for monitoring of any impact arising due to the construction activities.

The social assessment of the Project ascertains that the Project is unlikely to cause any major social impacts. More importantly, the Project does not involve any physical and economic displacement of families. The Project will have both positive and negative impact on the social environment. The positive impacts include employment and business opportunities for the local people, increased availability of power supply, new infrastructure development etc. On the other hand, the possible negative impacts include impact on community health and safety. Most of the adverse impacts are localised, short-term or temporary although some of them are permanent in nature like health associated risks due to air emissions and effluent release, but can be mitigated with appropriate mitigation measures built in as part of the Project planning process. The Project appears to have strong favourable support from the local administration, political classes and other stakeholders including the local community.

During the construction phase there will be impact from migration of labour into the Project area, construction activities and increased movement of traffic. The range of impacts identified include: conflicts with the local community, health and safety issues inconvenience due to vehicle movements, risk of spread of communicable and sexually transmitted diseases, waste disposal and unhygienic conditions. The magnitude and significance of most of these impacts would be limited to the construction period, with limited spill over to the operation phase. As the project intends to have a construction camp at the facility, the interaction between the community and migrant workers would be limited. Furthermore, by implementing the recommended mitigation measures the Project will minimise the identified risks whereas on-going consultation and engagement will support the maintenance of a harmonious relation with the local community. Community health and safety related impacts will be managed at source to reduce the footprint. By adopting the mitigation measures as suggested in the EMP and systematic participatory approach to involve community would further minimise these impacts.

In addition, by implementing various social development schemes targeted at specific groups such as women, children and local people based on the outcome of need based assessment and adopting Sembcorp's Sustainability Policy, the Project will further enhance the good will and cooperation of the community. The Project in its entirety can bring prosperity and development into the region and pave the way for further industrialisation in sectors such as food and fish processing, local manufacturing etc.

During the operation phase of the Project, the two key impacts will be from the increase in ambient noise and air quality levels due to operation of plant equipment and auxiliary machinery. It has been demonstrated through air quality dispersion modelling with natural gas as primary fuel as well as HSD as secondary fuel, the incremental ground level concentrations due to the operation of the Plant will be well within the applicable ambient air quality standards. Continuous emission monitoring from the stacks and periodic ambient air quality monitoring throughout operations will confirm compliance to the applicable standards/ guidelines and enable identification of further measures to reduce impacts to ALARP. Incremental noise levels due to the operation of Plant will meet the applicable GOB standards. However, the nearest noise sensitive receptors will have slightly higher noise levels than the applicable standards/ guidelines due to the higher background noise levels which are resulted primarily due to anthropogenic activities.

Induced draft cooling towers have been proposed in the project to reduce the water intake and outfall. About 74.4 m^3/hr of warm water will be discharged on land in the southern boundary of the project in the adjoining Channel. Considering no direct discharge of this water into the Jamuna River or Channel, warming of surface water is not expected. A surface water quality monitoring program, along with quarterly monitoring of aquatic ecology and fisheries has been formulated to further understand the extent of impact, if any, and to alert SNWPCL to take additional mitigation measures. In the unlikely event water percolation does not occur as expected, SNWPCL could rely on temporary solutions such as to engage a sub-contractor to use the portable pumps & hoses to evacuate this water to the river or dry canal, thereby allowing a larger surface area for the water to percolate. SNWPCL will monitor the wastewater discharge and if water stagnation if observed to persist continuously over an extended period of [12-18] months, then SNWPCL will evaluate permanent solutions to resolve the issue. However if the water stagnation is observed to occur for only part of the year, then the temporary solution should suffice.

The effective implementation of the ESMP and adherence with the GOB will assist in minimising the environmental impacts to acceptable levels. No additional studies for the EIA are envisaged at this stage.

Post environmental assessment, surveillance and monitoring are essential to track and sustain the effectiveness of the mitigation measures suggested. A detailed monitoring plan has been prepared as part of the EMP. The focus

areas of monitoring cover air, surface water quality, groundwater quality, noise, soil erosion, soil and groundwater contamination, occupational health and safety as well as community health and safety. The reporting requirements along with the follow up actions in case of deviation from the norms have been detailed in the ESMP. The frequency has also been set in consideration of the likely impacts.

The construction phase of the Project will have an important role in the socio-economic development of the area, whereas the operation phase of the Project will play an important role by supplying power in the region. A reliable and expanded power supply will support future economic development of dependant sectors including agriculture, industry and manufacturing enabling them to operate and compete.

Based on the analysis conducted in this environmental and social assessment, it is concluded that overall the Project will result in positive socio-economic benefits and the negative environmental impacts that have been identified are mostly short-term and localised in nature, and can be minimized adequately through good design, appropriate application of mitigation measures and regular supervision of implementation.

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120 Robinson Road, #10-01
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