Environmental Impact Assessment

Document stage: Draft
Project Number: 50161-003
May 2018

Bangladesh: Rupsha 800-Megawatt Combined Cycle Power Plant Project

Prepared by North-West Power Generation Company Limited for the Asian Development Bank. This is an updated version of the draft originally posted in February 2018 available on https://www.adb.org/projects/documents/ban-50161-003-eia

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Volume 1
(Component 1 – Rupsha 800 MW Gas-fired Combined Cycle Power Plant)

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CURRENCY EQUIVALENTS
(as of 8 May 2018)

Currency unit	–	taka (Tk)
Tk1.00	=	$0.0120228
$1.00	=	Tk83.1751

ABBREVIATIONS

ADB	–	Asian Development Bank
CCPP	–	combined cycle power plant
CITES	–	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	–	chemical oxygen demand
DO	–	dissolved oxygen
DoE	–	Department of Environment
DPHE	–	Department of Public Health Engineering
ECA	–	Environment Conservation Act
ECC	–	Environmental Clearance Certificate
ECR	–	Environment Conservation Rules
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EMoP	–	Environmental Monitoring Plan
HSD		high speed diesel
IEE	–	Initial Environmental Examination
MoEF	–	Ministry of Environment and Forests
PMU	–	project management unit
RoW	–	right-of-way
SPS	–	Safeguard Policy Statement

WEIGHTS AND MEASURES

^{o}C	–	degreescelsius
dB(A)	–	A-weighted decibel
ha	–	hectare
NTU	–	Nephelometric Turbidity Unit
lac	–	100,000
kV	–	Kilovolt
MW	–	megawatt
mg/L	–	milligram per liter
m^2	–	square meter
µg/Nm^3	–	microgram per normal cubic meter
ppm	–	parts per million

GLOSSARY

Bangla	–	official language of Bangladesh
gher	–	farming where a pond is dug into a rice field to use for fish farming and with the dugout soil used to create dykes around the pond for growing vegetables (traditional agriculture system in Bangladesh)
hydrostatic testing	–	process of filling a pipeline with water, or a mixture of water and ethylene glycol or methanol to test the structural integrity of the pipeline under pressure
khal	–	Bangla word for a small channel or canal
thana	–	sub-district level of government administration, comprising several unions under the district
union	–	smallest unit of local self-government comprising several villages
upazila	–	Bengali for subdistrict (formerly called *thana*)

NOTE

In this report, "$" refers to United States dollars.

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EXECUTIVE SUMMARY

1.0 Introduction

1. The 2015-2016 Annual Report of the Bangladesh Power Development Board (BPDB) indicates that the installed generation capacity is 12,365 megawatts (MW). During this year, the maximum peak generation was 9,036 MW (15.6% higher than the previous year) while the maximum peak demand was 11,405 MW. This situation is expected to cause power outages and load-shedding. Lower generation capacity was due mainly to some generating plants out of operation for maintenance, rehabilitation and overhauling, and capacity of some plants de-rated due to aging. With an estimated 2017 population of 164.47 million, demand for power will continue to grow.

2. To mitigate the demand-supply gap in the power sector, the Government of Bangladesh (GoB) embarked on an aggressive plan with a goal to have 17,984 MW generation capacity by 2021. Aside from this, efforts to cushion the effects of load shedding include introducing a two-part tariff for 3-phase consumers to avoid or lessen use of power during peak hours, closure of shopping malls and markets after 8pm, staggering of holidays by area, encouraging consumers to use energy efficient lighting systems and appliances, and to keep the temperature of their air conditioning systems at 25^{o}C.

3. The Power System Master Plan 2016 recommends for diversification in the use of fuel for power generation such as domestic and imported coal and natural gas, oil, nuclear power, and renewable energy. As of December 2017, the energy mix in Bangladesh consist of 64.5% natural gas, 1.66% hydro, 4.8% power import, 6.4% diesel, 20.9% furnace oil, 1.81% coal, and 0.02% renewable. To advance this recommendation, North-West Power Generation Company Limited (NWPGCL), an enterprise of BPDB has taken the initiative to enhance the power generation capacity of Bangladesh in addressing the growing demand for electricity. This initiative will involve the construction of the new Rupsha 800 MW combined cycle power plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP is designed to use natural gas as main fuel and high-speed diesel (HSD) as back-up to be used during emergency estimated at a maximum of 500 hours annually. Natural gas will be supplied by the Sundarban Gas Company Limited (SGCL) while HSD will come from Bangladesh Petroleum Corporation (BPC).

4. The GoB has applied for financing from the Asian Development Bank (ADB). The use of natural gas is consistent with the Energy Policy (June 2009) of ADB which indicates that in maximizing access to energy for all, “ADB will continue to support financing natural gas-based power plants because of their environmental benefit.” In addition, construction of combined cycle power plants is one of the existing mitigation actions of GoB to reduce greenhouse (GHG) emissions in meeting with their commitment to the Intended Nationally Determined Contributions (September 2015). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

2.0 Project Description

5. Key interrelated project components include: (i) **Output 1: Efficient gas-fired power generation increased.** This will be achieved through the design, supply, installation and commissioning of new Rupsha 800 MW CCPP. Combined cycle technology provides the best efficiency among all power generating technologies. It enables the power plant to be built in stages, with the ability to commission the gas turbines within two years, which is useful to meet

the ongoing capacity deficit in Bangladesh power system. Khulna City, where the Rupsha power plant will be based, is served by the national gas transmission network, enabling domestic or imported gas to be readily supplied. (ii) **Output 2: Energy transfer systems upgraded.** For gas supply to the Rupsha power plant, the project will construct (i) a 10 kilometer (km) 24-inch, gas distribution pipeline to connect the Khulna City Gas Station to the Rupsha power plant, and (ii) an additional 2 km 20-inch gas pipeline (off-take) from the Rupsha power plant to NWPGCL's existing 225 MW power plant at Khulna, which is currently operating on high-speed diesel (HSD). The project will replace the HSD at the Khulna power plant and provide a stable gas supply for its operation, resulting in significant environmental, economic, and financial benefits. To transfer generated electricity from the Rupsha power plant to the existing Khulna South grid substation, a 230 kilovolt switchyard at the Rupsha power plant site and 29 km of 230 kilovolt high capacity, double circuit transmission line, will be built. (iii) **Output 3: Institutional capacity of NWPGCL strengthened.** This includes: (i) implementation and operation of an ERP system; (ii) supply and installation of a universal power plant operations training simulator; and (iii) delivery of capacity enhancement through on the job training for NWPGCL staff in: (a) project management, implementation, and supervision; (b) monitoring and evaluation; (c) operation and maintenance; (d) environment and socials safeguards; (e) gender equity; and (f) effective project communications. (iv) **Output 4: Socially inclusive development of communities neighboring the project site pilot tested.** The project will provide grant financing to improve livelihood of the communities in the project area by (i) increasing awareness on safe and efficient use of electricity, (ii) delivering capacity building trainings on livelihood activities and employment opportunities, and (iii) installing a 10 kilowatt solar system, two information technology laboratories, and two science laboratories in schools near the Rupsha power plant.[1]

6. ***Land*.** Component 1 will be built in the (now abandoned) premises of the Khulna Newsprint Mill (KNM) factory. The total area occupied by KNM from its previous operations is about 87 acres (or 35.2077 hectares (ha)). NWPGCL will only require about 50 acres (or 20.2343 ha) to accommodate Component 1. The power block will occupy 6.37 acres, switch yard at 4.3 acres, gas supply facility at 2.31 acres, HSD supply facility at 2.72 acres, water treatment facility at 5.61 acres, and the balance of plant at 3.16 acres.

7. The power plant will use combined cycle gas turbine technology, comprising two identical generating units, each nominally rated at 400MW. Each combined cycle unit will consist of one gas turbine and one heat recovery steam generator (HRSG), forming a one-on-one configuration. At full capacity of 800 MW, the Rupsha power plant is capable of meeting 5% of the forecast peak demand of Bangladesh in 2022. The cooling system will be closed-loop forced-draft cooling tower system. The stack height of the combined cycle steam turbine is 70 m while the open cycle gas turbine bypass stack height is 50 m.

8. NWPGCL opted to have CCPP with exhaust gas bypass system to allow for construction of the power plant in phases. This operational flexibility is critical for Bangladesh currently suffering from energy shortfall. Power generation through the open cycle mode awaiting for the completion of CCPP will make a huge difference to Bangladesh currently suffering from severe power shortage. The exhaust gas bypass is useful to the system grid as the units can still provide partial load.

9. During start-up, the open cycle gas turbine can be commissioned using natural gas and put into commercial operation within 7 to 8 months prior to completion of the HRSG installation

[1] [Trust Fund] Grant Report: Supporting Socially Inclusive Development for Better Livelihood Through Rupsha Power Plant Project (accessible from the list of linked documents in Appendix 2).

for the combined cycle power plant. This is where the bypass stack of 50 m will be used at flue gas temperature of 886°C. The exit gas temperature is very high 886°C (or 1,159 °K). The effective stack height (i.e., physical stack height + plume rise) for simple cycle operation will be 513 m. For combined cycle with a physical stack height of 70 m, the effective stack height will be 243.4 m. Simple cycle gas turbine will only be used in the event of HRSG downtime. It will not be economically feasible to shut down the entire power plant during HRSG downtime when the simple cycle power plant can be operational. This is the high operational flexibility inherent in combined cycle power plant which is an essential prerequisite from economic standpoint. Use of low-NO_x burner in the gas turbine will have a guaranteed emission below 10 ppmv.

10. ***Fuel requirements.*** Natural gas will be the primary fuel and will require a maximum of 125 million cubic feet per day (MMCFD). This will be supplied by SGCL from the Khulna CGS in Aronggatha through a 10 km, 24-inch gas distribution pipeline terminating to the regulation and requirements of the Natural Gas Safety Rules 1991 (amended 2003). Composition of natural gas required will be a minimum of 85% mole methane (CH_4). The following sources from imported regasified liquefied natural gas (R-LNG) and domestic supply will provide adequate supply of natural gas for Component 1.

- FSRU Moheskhali - 500 MMSCFD of R-LNG will be made available by April 2018 developed by Excelerate Energy, USA-Bangladesh
- Summit LNG Terminal Company Limited – 500 MMSCFD R-LNG will be made available by October 2018
- GoB and RasGas (Qatar) has signed a deal in September 2017 for a 15-year LNG sales and purchase agreement to supply 1.8 million (M) tons LNG/year for 5 years and 2.5 M tons/year for the next 10 years
- According to Petrobangla, there will be additional supply (domestic) of 2,750 MMSCFD
- By 2021, Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) will have 55 exploration wells and 31 development wells

11. The natural gas produced in Bangladesh is “sweet gas” (does not contain hydrogen sulfide) and thus, all the existing natural gas transmission and distribution pipeline networks are designed for high quality natural gas.

12. The use of HSD as secondary fuel will be required in case of emergency and is estimated to be about 500 hours maximum per year (or about 21 days assuming continuous operation of 24 hours, or less than 2 days per month). HSD must not be used during the commissioning period. HSD requirement will be about 2,773 kiloliters (KL) per day. Two HSD storage tanks with a capacity of 15,000 cubic meter (m^3) will be constructed within the power plant site. Each storage tank can supply about 5 days of continuous operation on HSD. Fuel supply agreement between BPC and NWPGCL in November 2015 provides that the HSD will have a maximum sulfur content of 0.25%wt. In practice, BPC has provided NWPGCL with HSD with sulfur content of 0.1%wt analyzed in 2016 by the Chemical Engineering Department of Bangladesh University of Engineering and Technology (BUET).

13. ***Plant efficiency.*** With an F-class gas turbine and operating on natural gas, the plant net Low Heat Value (LHV) thermal efficiency of Component 1 will be 55.9% which is expected to have CO_2 emissions ranging from 348-374 g CO_2/kWh but when operating on HSD during emergency, the net LHV thermal efficiency will be no less than 54%, with the optimization of the design by EPC contractor. Thermal efficiency is one of the reasons to ensure that Component 1 needs to

operate only on natural gas and combined cycle power plant. This thermal efficiency is consistent with the IFC-EHS Guidelines for Thermal Power Plant 2008.

14. ***Water.*** Raw water will be taken from the Bhairab River located east of the project site through two intake channels with an area of 12.5 m^2 each. The Feasibility Report (August 2017) indicates that a one-time water demand for both plants needed for the closed-loop forced-draft cooling system will be about 60,000 m^3 with 2,010 m^3/h as make up water. Make up water will pass through the water treatment facility and about 1,780 m^3 will go to the two cooling towers (each at 890 m^3) while 230 m^3 will be diverted to the reverse osmosis plant then to the demineralization plant to provide the high quality water required by the gas turbine, HRSG, NO_x control water if running on HSD, etc. The effluent treatment plant (ETP) will receive about 1,030.5 m^3/hr from spent process water and blowdown from the cooling towers. Oily wastewater will pass through the oil-water separator prior to ETP. The quality of effluent from the ETPwill be monitored to ensure compliance with Schedule 10 of ECR 1997 and Table 5 of IFC-WB EHS Guidelines for Thermal Power Plants 2008. Effluent from the ETP will be discharged to a monitoring basin. CCPP will apply zero discharge technology. Water from the monitoring basin will be used for watering plants, cleaning and other general purpose washing. No discharge of effluent to the Bhairab River will be permitted. Water for domestic requirements such as drinking will come from the Khulna Water Supply and Sewerage Authority.

Implementation Arrangements

15. As the executing agency of the project, NWPGCL will create a Project Management Unit (PMU) to manage the day-to-day implementation of the project and will get the necessary technical support from SGCL for Component 2 and the Power Grid Corporation of Bangladesh (PGCB) for Component 3. The project will have a high-level Project Steering Committee (PSC) consisting of members from various government departments, NWPGCL, PGCB and SGCL and act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB. The installation and commissioning of Component 1 is expected to be about 36 months.

16. NWPGCL has an Environmental, Health and Safety and Social (EHSS) Policy approved on 17 October 2015. Aside from the EHSS Policy, NWPGCL is also certified in ISO 9001, ISO 14001. BS OSHAS 18001 valid until October 2019.

3.0 Environmental Requirements

17. **National requirements.** The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997. Under these regulations, except for Component 4, all the three components of the Project are “Red” category requiring an environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (ToR) of the EIA needs the approval of the Department of Environment (DoE). The ToR of the EIA for all Components has been approved by the DoE on 5 November 2017 (see **Annex 1**). NWPGCL has obtained exemptions for submitting an IEE in obtaining the SCC for all the project components as follows:

(1) Component 1 – 5 November 2017; DoE/Clearance/5584/2016/564
(2) Component 2 – 5 November 2017; DoE/Clearance/5668/2016/563
(3) Component 3 – 5 November 2017; DoE/Clearance/5669/2016/549

18. Once the EIA is finalised and approved by ADB, NWPGCL will submit the EIA to DoE immediately. Without the EIA approved by DoE, NWPGCL cannot open a line of credit in favor of importable machineries and cannot start any physical activities for the project. In August 2016, NWPGCL contracted the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, to prepare the EIAs for the three components required by the DoE.

19. **ADB and IsDB requirements.** Component 1 is subject to the environmental requirements of both ADB and IsDB since NWPGCL is seeking their financial support. The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility. Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

20. Under SPS 2009, projects are screened and categorized based on their potential environmental impacts. Following this screening procedure, the project is category A on environment which requires the preparation of an EIA. To streamline the preparation of the EIA, each component has an EIA such that Component 1 will correspond to Volume 1, Component 2 as Volume 2, and Component 3 as Volume 3. This EIA covers Component 1.

4.0 Description of the Existing Environment

21. The description of the environment was based on the project area where Component 1 will be located and the study area covering about 10-km radius from the power plant.

22. The project site is an area formerly used by the Khulna Newsprint Mills (KNM) Limited located in Khalishpur Thana, Khulna Division. KNM was under expatriate management from start in 1959 until the end of 1965 when it was put under the management of the East Pakistan Industrial Development Corporation.[2] KNM was the first and major producer of newsprint paper in Bangladesh using *Gewa* wood (*Excoecaria agallocha*), a native mangrove species in Bangladesh, as raw material. Sand well and Company, a Canadian firm, was engaged as a consultant in the construction and commissioning of KNM.

23. In 1969, problems were encountered with the steam supply needed to operate the three paper machines. By mid-1973, the Canadian International Development Agency (CIDA) has commissioned studies of KNM in order to define areas where Canadian aid might assist in rehabilitating the mill. A project advisor from CIDA was provided until 1976. However, beset with problems ranging from market behaviour after the independence, availability of spare parts, low capacity utilization (newsprint production at KNM has not been able to reach the levels achieved prior to independence), operational management, price of oil, interrupted supply of raw material due to security issues, etc., GoB stopped its operations completely in November 2002. A total of 2,128 persons are employed at KNM, 472 salaried, 1,506 permanent labour, and 150 casual labour.

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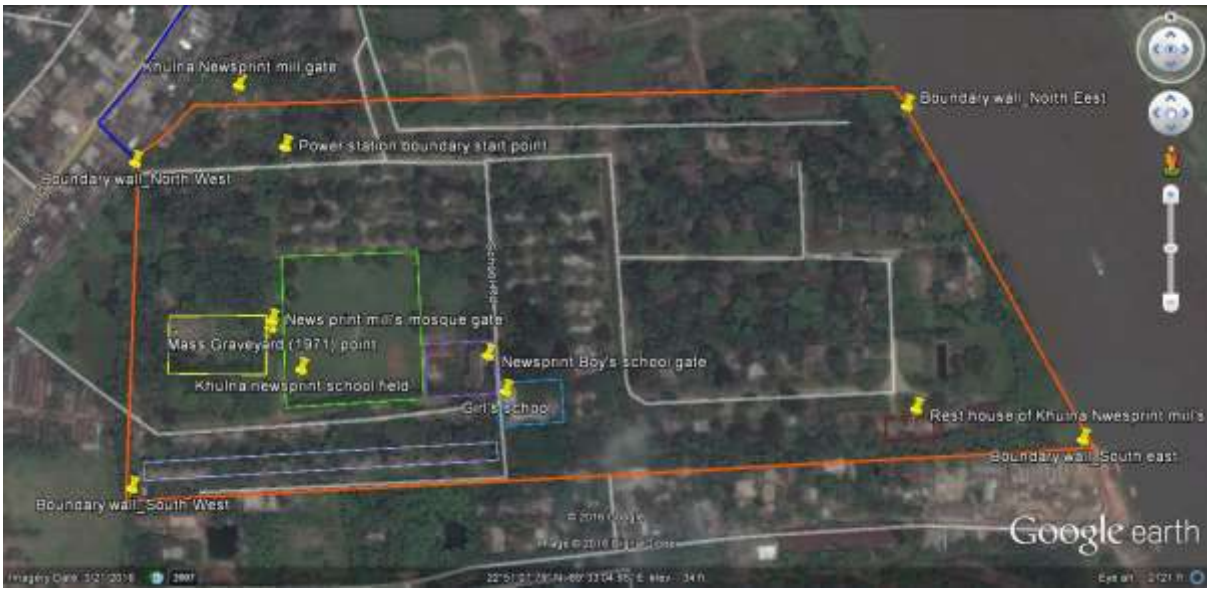
[2] The World Bank. Bangladesh: Survey of Steel, Pulp and Paper, and Leather Tanning Industries. Report No. 1219-BD. Industrial Projects Department. 30 November 1976. http://documents.worldbank.org/curated/en/879431468007479695/Bangladesh-Survey-of-steel-pulp-and-paper-and-leather-tanning-industries.

24. No newspaper printing was involved in KNM operations but mainly production of newsprint using mechanical pulping from ground wood process as chips is not used for papermaking in Bangladesh. Mechanical pulping involves the use of mechanical energy to weaken and separate fibers from *Gewa*wood through grinding action. The process produces up to 95% pulp, however, since it does not dissolve lignin, fiber strength and age resistance of resulting pulp are low and the product has shorter fibers. Mechanical pulp is used mainly for lower grade papers like newsprint. Before demolition, experts will check the site thoroughly to solve the contaminated issue, if any.

25. As a result of closure of KNM operations, there are about 151 structures standing within the 50 acres consisting of 122 primary residential structures such as bungalow for the Managing Director, dormitories and residences of staff, kitchen and dining, guest house, and Ansar camps, etc. while the remaining 29 structures are non-residential like auditorium/cinema, water tank, fire fighting system, swimming pool and rest house, mosque, boys and girls school, etc.[3] (See below) The structures are mainly made from reinforced concrete, wood, tin sheets, pacca, and semi-pacca generally used in Bangladesh. The possibility of land contamination within the project site and the use of asbestos in the structures as insulation are unlikely.



26. At present, the two schools (one for boys and one for girls) are still being used and some of the abandoned buildings are used as residence by workers tasked to secure the property (appointed through GoB from Ansar Force), cook and cleaners. Outside of the 50 acres property but adjacent to the project site are the mosque and the mass graveyard marker of the freedom fighters who were killed in 1971 during the liberation war (*Mukti Bahini*) of Bangladesh. The mosque is still being used by about 10 local people every day for their prayers. The graveyard marker has a brick fence and is not listed as a cultural heritage by GoB but will be considered as a physical cultural resource defined by SPS 2009.[4] Some vegetation has grown from the abandoned structures providing temporary habitat to some species.

[3] Bangladesh Ansar is a paramilitary auxiliary force responsible for the preservation of internal security and law enforcement in Bangladesh and administered by the Ministry of Home Affairs.

[4] ADB. Safeguard Policy Statement. June 2009. Glossary. Physical cultural resources - Movable or immovable objects, sites, structures, groups ofstructures, and natural features and landscapes that have archaeological, paleontological,

historical, architectural, religious, aesthetic, or other cultural significance. Physical culturalresources may be located in urban or rural settings and may be above or below ground or underwater. Their cultural interest may be at the local, provincial, national, or international level.

Physico-chemical environment

27. Component 1 is located at elevation +3.5 m and +2.3 m towards the bank of the Bhairab River. Surrounding area is at elevation +3.5 m and +3.2 m MSL. This area is within the least vulnerable to earthquakes (Zone III). Climatological data recorded from 1985-2015 by the Bangladesh Meteorological Department were used to describe climate in the area. Khulna division falls under Aw category according to Köppen climate classification which is characterized by tropical wet and dry climate resulting to hot and humid summer and dry winter. Maximum monthly temperature ranges from 30.7°C to 40.7°C while minimum temperature varies between 6.4°C to 22.2°C. Average monthly humidity is 72.6% to 87.8% while average annual rainfall is 1,808 mm/yr. Wind speed ranges from 18.52 km/hr to 120.38 km/hr while wind direction varies depending on the season. According to the Hydrological Investigation and Model study of the Bhairab River by the Bangladesh Power cell in May 2016, the maximum flood level in the project site is estimated as 3.86 m PWD (4.32 MSL) in 100 years return period based on the yearly maximum water level of Khulna since 1946 (SW241 of the Bangladesh Water Development Board).[5]

28. Available continuous ambient air quality monitoring data from 2013-2015 and 2017-2018 recorded in Khulna Continuous Air Quality Monitoring Station (CAMS)-9 station of the DoE, Clean Air and Sustainable Environment (CASE) show that particulate matter 2.5 micrometers (µm) or less in diameter ($PM_{2.5}$) exceeded the National Ambient Air Quality Standards (NAAQS) limit of 65 µg/m^3 for 24-hour averaging period and for particulate matter 10 micrometers (µm) or less in diameter (PM_{10}) exceeded the limit of 150 µg/m^3 for 24-hour averaging period in 2014. Due to these exceedences, the airshed is considered highly degraded airshed for PM_{10} and $PM_{2.5}$. It meets national standards, but is also degraded for NO_x and SO_2 compared to the WHO guideines. NO_x is 27.072 µg/m^3 for annual averaging period in 2013 at temporal coverage of 56.7% and 122 µg/m^3 in 2015 at temporal coverage of 29.3%. The IFC-WB EHS General Guidelines 2007 limit for NO_2 at annual averaging time is 40 µg/m^3 while the national limit (ECR 2005) for the same averaging time is 100 µg/m^3. Given that the national limit was exceeded in 2015 as well as the IFC-WB EHS General Guidelines 2007, the airshed can be considered as degraded on NO_x. CASE project is funded by the World Bank which started the continuous ambient air quality monitoring in November 2011. Khulna CAMS-9 is about 2.5 km from the project site. Given that there have been no continuous ambient air quality measurements for the project site, the results from CAMS-9 can be considered as showing the long-term ambient air quality within the study area to determine if airshed is degraded or not.

29. Ambient air quality measurements for carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), total suspended particulates (TSP), PM_{10}, and $PM_{2.5}$ were conducted on 13-19 March 2017 at six sampling stations within the study area. Results of 24-hour average concentration show that all the parameters at the time of sampling were within the limits of NAAQS.

30. Ambient noise level measurements were conducted on 27 October 2016 to 3 November 2016 at 14 stations. Results show that noise limits set by the Noise Pollution Control Rules 2006 were exceeded in some stations during daytime. A number of factors like vehicular movement (e.g. bus, train), noise from the loud speaker, and construction works contributed to the increase in the noise levels during the time of measurements.

[5] Bangladesh Water Development Board and other government departments refer water levels to the Public Works Datum (PWD). PWD is a horizontal datum believed originally to have zero at a determined Mean Sea Level (MSL) at Calcutta. PWD is located approx. 1.5 ft (or 0.46m) below the MSL established in India under the British Rule and brought to Bangladesh during the Great Trigonometric Survey. http://www.ffwc.gov.bd/index.php/definitions.

31. Four soil sampling stations were identified: one station at the project site and three within the vicinity of the site. These tests were for agricultal suitability test but not site investigation to determine contaminated land. Results of analysis show that top soil organic matter concentrations were higher than the average condition of Bangladesh. The pH levels of the soil samples are slightly alkaline to alkaline; non-saline with some slightly saline. These suggest that soil quality is good for supporting plant growth. The project site was not used for newprint operations. The 50 acres proposed for the power plant was used to accommodate residential structures and non-residential structures only. Given the process used in newsprint production and only residential structures were accommodated in the 50-acre land provided to NWPGCL, no land contamination within the project site is expected.

32. Available discharge data indicate that the available water from the Bhairab River range from 38.64 million cubic meters per day (MCM/day) to 54.47 MCM/day. Results of in-situ surface water quality measurements of pH, dissolved oxygen, biochemical oxygen demand, total dissolved solids (TDS), electrical conductivity, salinity, and temperature conducted in October 2016 at six sampling stations in Bhairab River, Atai River, and Rupsha River showed within limits of ECR 1997, Schedule 3 (Standards for Water, Rule 12). Existing beneficial uses of these rivers include fishing, bathing, general purpose washing, navigation, industrial use. Four groundwater sampling stations were also identified and results of analysis were referred to the drinking water standards which showed groundwater is saline with salinity levels from 2 parts per thousand (ppt) to 3 ppt and iron level exceeding the limit of 1 mg/l. Drinking water should have zero salinity level.

Biological environment

33. The proximity report generated by the Integrated Biodiversity Assessment Tool (IBAT) on 30 January 2017 indicates that there are no protected areas and key biodiversity areas within 5 km and 10 km from Component 1.

34. Based on Biodiversity Assessment for Component 1 conducted by IUCN (Annex 11), A total of 50 species of fishes were identified during the surveys. Among them 6 species are nationally Endangered (*Mastacembelusarmatus, Chitalachitala, Channamarulis, Ompokpabda, Pangasiuspangasius, Rita rita*), 4 species are nationally Vulnerable (*Sperataaor, Wallagoattu, Gudusiachapra, Notopterusnotopterus*), 7 species are nationally Near Threatened (*Hemibagrusmenoda, Labeogonius, Mystuscavasius, Plotosuscanius, Pseudambassisbaculis, Nandusnandus, Cirrhinuscirrhosus*). A total of 60 species of trees were found within the project site consisting of about 2,614 trees that are mostly planted with few species regenerating naturally. There is no endangered, protected, or threatened plant species in the project site. The West Indian Mahogany (*Swietenia mahagoni*) was found in the project site and listed as endangered in the IUCN Red List of Threatened Species. However, this species is widely cultivated in Bangladesh as timber plant, a non-native species, and is not included in the Red List of IUCN Bangladesh. Mahogany is native species to South America.

35. There were 32 species of butterflies identified but none of conservation status. Other classes of fauna include: 103 species of birds, 20 species of reptiles, six species of amphibians, and 14 species of mammals. Of the bird species, only 13 species were noted in the project site and these are all of no conservation status. At least 8 species of reptiles were observed by local people in the site and nine species of terrestrial fauna observed as visitors. With the temporary habitat created as a result of the abandonment of KNM, these species used the project site temporarily for feeding, roosting, and nesting.

36. For aquatic mammal species, Ganges River dolphin (*Platanista gangetica*) was observed in October 2016 and March 2017 along the Bhairab River close to the project site. The Ganges River dolphin is an obligate freshwater dolphin and is essentially blind. They are listed as endangered in the IUCN Red List 2012 but listed as vulnerable in the IUCN Bangladesh Red List 2015. Also, these dolphins are listed in the Third Schedule of the Bangladesh Wildlife (Preservation) Order 1973 as species not to be captured, killed or harmed.

37. IUCN Bangladesh was engaged by NWPGCL to conduct a biodiversity assessment in May 2017 to determine the presence of critical habitat based on SPS 2009 and the IFC Performance Standard (PS) 6. The assessment was done from May 2017 until January 2018 to capture seasonal variations consisting of 7 surveys. Study area covered about 30 km of river stretch spread over the Bhairab River, Atai River, and Rupsha River. Based on the 7 surveys completed in January 2018, the total population of dolphins is 34 individuals with an overall encounter of 1.18 individual/km. The dolphin population within the study area represents less than 1% of the global population and less than 10% of the national population. Global population of the Ganges River dolphins is estimated at less than 5,000 while the national population is about 451 individuals (225 in Sundarbans, 125 in Karnaphuli River, 38–58 in Jamuna River and 34–43 in nine groups in Kushiyara River). Given these results, the project area is not a “critical habitat” for the Ganges River dolphins.

38. There are 15 unions and 33 wards under Khulna City Corporation with a population of about 1,038,877 consisting of 244,630 households. The male-female ratio is 108 higher than the national figure of 100.3. Average household size is 4.2. The highest number of population (about 26.8%) belongs to the age group, 30 to 49 years while the lowest number (about 2.6%) belongs to the age group, 60 to 64 years old. The inhabitants belong to two main religious groups, Muslim and Hindu.

39. Main occupation is service (55%), about a quarter (23%) of the population is engaged in agriculture, and 22% in industrial work. Of the 55% engaged in the service group, 42% are male and only 13% female. About 86% of the households are grid-connected to meet their daily demand. On average, 30% of the households live in pucca houses, 38% in kutcha, 30% in semi-pucca, and about 2% in Jhupri houses. About 87% of the population has sanitary toilet facilities but still about 12% use non-sanitary toilet. Tube wells as source of drinking water supply accounts for 95% of the total households in the study area, 4% depend on tap water from Khulna Water and Sewerage Authority while about 1% rely on other sources such as ponds and canals (there are three locations within the study area which are about 6-7 km from the project site). Bhairab River is not used for drinking water due to varying salinity level affected by tidal flows in the Bay of Bengal. People will get the drinking water from Khulna Water and Sewerage Authority. Domestic water for the project will come from the Khulna water district. No ground water wells are located within 100 m of the project site and ground water will not be used for the operational requirements of the project as this is not allowed by GoB.

5.0 Anticipated Environmental Impacts and Mitigation Measures

40. Prior to construction of Component 1, demolition is required for the abandoned structures at the project site. Two schools will be affected and will be relocated at a site within KNM campus (no clearance requested) selected by the school management committee, the school authority, and NWPGCL. No demolition or construction work for Component 1 will start until the new schools are completed. Selection of site for the new school is being finalized by the school authority, school management committee, and the NWPGCL and will consider factors such as proximity to

the power plant, access to the new location, etc. Impacts mitigation measures may include but not limited to the followings, school not be located within 500m of CCPP, no asbestos or other hazardous materials be used in construction, seismic desihn as per national guidelines and good international practice, and adequare sanitation and clean drinking water supplied, etc..

41. Demolition of the existing structures in the project site will not be funded by ADB or IsDB. Based on the inventory of the structures, most of them are made of bricks, reinforced concrete, tin sheets, pacca and semi-pacca ranging from single to three-story buildings. The proposed project site is mainly occupied with abandoned brick buildings and the presence of asbestos or asbestos-containing material may be unlikely. However, prior to any demolition works, NWPGCL will require the contractor to appoint suitably qualitified surveyors to conduct an assessment for any presence of asbestos or asbestos-containing materials in the structures that will be demolished. This will be included in the tendering process where contractor for demolition will be selected. The winning bidders will take care of the demolition works which would take no more than 4 months. The bidding document which will be tendered by NWPGCL will include a copy of the EIA/EMP and specify the regulatory requirements and permits/standards/codes relevant to demolition and disposal of material and debris, by which the contractor will be required to comply. Bid documents will also describe the measures required to ensure occupational, environmental and public safety risks are minimized. A demolition plan will be prepared by the Contractor following the requirements of the Bangladesh National Building Code, regulations of the Khulna City Corporation, and Khulna Development Authority and the EHS Guidelines on Construction and Demolition. Demolition works will commence only once the school children have moved to the new schools outside of the power plant boundary. A site demolition plan outlining procedures and guide for safe demolition will generally cover the following key elements: scope, definition, strategy, practical stages of demolition, clearance of final operation, clearance of system isolation, and closure report.

42. Prior to any civil works for Component 1, PMU, NWPGCL will have an orientation briefing to the Engineering, Procurement, and Construction (EPC) Contractor and their workers about the environmental requirements by the DoE and ADB that need to be complied with, their roles and responsibility for compliance, record keeping and reporting, awareness on socially transmitted disease like HIV/AIDS to avoid the potential occurrence of this diseases in the construction site.

43. Construction of schools is not specifically indicated as subject to Environmental Conservation Rules (ECR) 1997 but indicates that construction of multi-storied commercial and apartment building is Orange-B category. However, there is no clear definition of multi-storey building. In practice, a 10-storey building within Dhaka City based on building construction rules of RAJUK and more than 6-storey building outside of Dhaka City are considered as Orange B category requiring an IEE for site clearance and EIA for environmental clearance. The new schools will not be higher than four storeys considering the total amount of students, and thus, not subject to ECR 1997.

44. A total of about 2,614 trees will be cleared resulting to an estimated loss of carbon sequestration by about 6,880.5 mega-gram (Mg) for the 30-acre vegetation coverage (include trees, shrubs and under growth weeds/grasses). Rest of the areas (20 acres) is covered by physical structures, roads and fields etc. The estimated loss was based on 20 quadrats of 10m x 10 m within the 30-acre land with vegetation. The trees that will be cleared are mainly fruit trees (about 1,775). There is no requirement from the DoE to replace trees cleared during development but recommends to maintain at least about 33% greening. Planting trees and developing greenbelt is one of the requirements of BPDB in its key point installations.

45. Other impacts during pre-construction, demolition, and construction phase include potential increase of noise and dust level affecting ambient air quality, potential flooding due to storm water runoff, loss and/destruction of habitat and life of species due to improper clearing of vegetation, potential damage to aquatic habitat due to unplanned transportation and untreated discharges in the river system, generation of waste, potential erosion due to movement of heavy equipment and machineries, and health and safety risks to workers and community. A demolition plan will be submitted and cleared before any demolition work commenced. Buildings will be demolished by suitsble contractor in accordance with good international practice as well as national requirement. Storm water, roof drains, and water tank overflows will be diverted into a check pit while wastewater generated from the power plant operations will be treated in the effluent treatment plant (ETP) prior to reuse. Effluent will be checked for water quality prior to reuse within the plant to ensure compliance to Schedule 10 of ECR 1997 and Table 5 of IFC-WB EHS Guidelines for Thermal Power Plants 2008.

46. With vegetation clearing, excavation and earthmoving works, the EPC Contractor will be required to follow the "chance find" procedures including a fauna rescue and handling procedures. A storm water drainage system around Component 1 will be installed and will be connected to the existing drainage network of the KNM.

47. 19 environmental codes of practice (ECP) were prepared covering various aspects during construction phase such as construction camp management, protection of fisheries, workers health and safety, protection of fish and aquatic system, etc. The EPC Contractor will be required to prepare a Construction Environmental Action Plan covering the requirements of the environmental management plan (EMP) and the ECPs. A greenbelt of at least 3.5 m width consisting of two rows plantation with gradual increase of height of plant will be developed within the project site after construction phase. The greenbelt will be retained of existing well-established vegetation, so the habitat for fauna remains.

48. The main impact during operation phase is the emissions from the 70 m stack due to combustion of natural gas. Natural gas will be the main fuel and will not emit significant quantities of SO_2, PM_{10} and $PM_{2.5}$. During emergency situations, where it is expected to be 500 hours in a year maximum, HSD will be the fuel. With HSD as fuel, it will emit SO_2 as it contains sulfur at 0.25%$_{wt}$ maximum and particulate matter (PM). A stack height determination based on good international industry practice (GIIP) technique was undertaken to demonstrate that 70 m is sufficient for proper dispersion and prevention of excessive ground level concentrations (GLCs). CALPUFF 7.5.3, a USEPA-approved air dispersion modelling was used to simulate the maximum GLCs of criteria pollutants. The built-in dry low-NOx burners and water injection of 100 m^3/hr will ensure that NOx emission is lower than 10 ppmv at all times. About 31 air sensitive receptors (ASRs) such schools, mosque, hospital, etc. were identified within the area covered by the air quality modelling. Levels of background concentration on ambient air quality were based on the continuous monitoring data from CAMS-9 station of the CASE project of DoE (2013-2015) which is about 2.5 km southwest of Component 1. These ambient air quality monitoring data show that the airshed is highly degraded on PM (PM_{10} and $PM_{2.5}$) and degraded for SO_2 and NO_2.

49. When running on natural gas, the contribution of Component 1 to PM_{10}, $PM_{2.5}$ and SO_2 to GLCs will be negligible. Natural gas does not contain sulfur. The contribution of Component 1 to NO_2 GLC when running on both natural gas and HSD will be 1.2 µg/m^3 (annual averaging time) on guaranteed emission of 25 ppmv for simple cycle technology and 2.3 µg/m^3 (annual averaging time) when on combined cycle technology. With an emissions standard of 25ppmv the emissions contribute more than a fraction of the national ambient air quality standards. On a guaranteed emission of 10 ppmv, the contribution of Component 1 to GLC for NO_2 will be 0.7 µg/m^3 (annual

averaging time) on simple cycle and 0.8 µg/m^3 (annual averaging time) for combined cycle. If Component 1 will run on HSD, Component 1 will contribute 54.8 µg/m^3 (24-hour annual averaging time) on simple cycle and 84 µg/m^3 (24-hour annual averaging time) on combined cycle. With an emissions standard of 10 ppmv the emissions are considered to have a negligible impact on the national ambient air quality standards, this is therefore the standard that will be adopted for the project.[6]

50. **Cumulative ambient air quality impacts** All the major emission sources in the airshed including future developments were included (i.e., three brick kilns and the upcoming 300 MW Goalpara dual-fired power plant of BPDB, etc). The cumulative ambient air quality impact scenario covers contribution of Component 1, background level concentration from CAMS9 of CASEproject of DoE, closure of 2 KPCL power plants (110 MW and 115MW) using heavy fuel oil (HFO), start of 300 MW Goalpara power plant, and three brick kilns. The project also incorporates a partial offset to convert existing 225 MW Kulna Combined Cycle Power Plant owned by NWPGCL which is currently using HSD as fuel to natural gas, which will offset about 2 tons per year of particulate matter, about 607 tons per year of residual SO_2 emissions and about 193 tons per year of residual NO_2 emissions. Health impact assessment will be completed before civil works commence, to provide a baseline for monitoring health impacts and confirm no significant impact on human health.

51. In Khulna district, most common illness is pneumonia, bronchial asthma, chronic obstructive pulmonary disease, and whooping cough. These illnesses can be aggravated by poor air quality, nutrition, and smoking. Except for the identified common illness in Khulna district, there are no data on public health. According to the International Agency for Research on Cancer (IARC), ambient particulate air pollution is now classified as carcinogenic to humans (Group 1).[7] This suggests that long-term exposures to PM (PM_{10} and $PM_{2.5}$) can cause cancer.

52. The European Study of Cohorts for Air Pollution Effects (ESCAPE) has recently found that a 5 µg/m^3 increase in estimated annual mean $PM_{2.5}$ was associated with a 13% increased risk of coronary events (95%CI 0.98 to 1.30) while the lung cancer meta-analysis found a pooled hazard ratio for all lung cancers of 1·18 (0·96–1·46) per 5 µg/m³ $PM_{2.5}$.[8] The combined meta-analysis of ESCAPE for Chronic Obstructive Pulmonary Disease (COPD) showed that there were weak but non-significant positive associations between NO_2, $PM_{2.5}$ and the prevalence/ incidence of COPD. Health impact assessment will be completed before submission of the EIA to DoE for environmental clearance.

53. To build confidence in monitoring ambient air quality within the airshed, an additional CAMS will be installed by NWPGCL to complement the existing CAMS-9 of the DoE which is about 2.5 km from the project site. The proposed location of CAMS by the NWPGCL will be at

[6] On a 1 hour averaging time, the project's contribution to NO_2 will be 57.7 µg/m^3 and 53 µg/m^3 for simple cycle and combined cycle, respectively at a guaranteed emission of 25 ppmv and for a guaranteed emission of 10 ppmv, the resulting ambient NO_2 will be 146 µg/m^3 and 142 µg/m^3 for simple cycle and combined cycle, respectively. Table 6B of the IFC-WB EHS Guidelines for Thermal Power Plants 2008 requires a guaranteed emission for NOx as 25 ppmv for degraded airshed. However, this project will adopt a much lower guaranteed emission of 10 ppmv as the two power plants owned by KPCL and operating on HFO may not actually shutdown considering the fact that NWPGCL has no authority to require KPCL to shutdown their existing power plants within the airshed.

7 World Health Organization. International Agency for Research on Cancer. Press Release N° 221. 17 October 2013. Group 1. This category is used when there is sufficient evidence of carcinogenicity in humans.

[8] Beelen R, Raaschou-Nielsen O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B, et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet. 2014;383(9919):785-95

about 800 m NE from the power plant. The location was determined based on the results of CALPUFF. The cost of the additional unit of CAMS is estimated at BDT1,500,000.

54. The Areal Locations of Hazardous Atmospheres (ALOHA) software was used to simulate the consequences of gas leakage or pipeline failure following sequential hazards such as thermal radiation from jet fire, toxic area of vapor cloud formation, flammable area of vapor cloud formation, and blast area of vapor cloud formation. Simulation results show that the threat and/or danger zone will be from 19 m to 313 m from the source. The area within these distances will be within the power plant only. There are no sensitive receptor areas within this zone.

55. In the event a fire/explosion will occur at the receiving and metering station (RMS), the estimated threat/fire zone will extend up to 43 m from the source and the simulated zone for vapor cloud formation is 313 m. This distance will be within the power plant only. In natural gas, the lower explosion limit of CH_4 is 5% while the upper explosion limit is 15% in the presence of an ignition source. This means that CH_4 concentration lower than 5% ("too lean") and higher than 15% ("too rich") will not cause fire in the presence of ignition source. The supervisory control and data acquisition (SCADA) system in the control room of the power plant allows for emergency automatic valve shut-off along the pipeline or the RMS valves which can be shut-off remotely from the main control unit. The pipeline operations will be monitored 24/7 from the control room and detects any change in the gas pressure and can automatically shut off the gas flow to prevent or minimize the gas released into the environment.

56. Also, the RMS area will be lined with cementitious fire-retardant materials. The use of flame inhibitors in pipeline jacket system, flange and connectors will reduce considerably vapor cloud explosions. Component 1 will be equipped with fire-fighting systems and alarms including a disaster and emergency preparedness plan.

57. Design, construction and operation of Component 1 will be subject to compliance with the Bangladesh Natural Gas Safety Rules 1991 (amended 2003), Explosives Act 1884, Explosive Substances Act 1908 (amended 1987), Explosive Rules 2004, and Gas Pressure Vessel Rules 1995 (amended 2004). There are several relevant codes and standards which include ASME B31.8 Gas Transmission and Distribution Piping Systems, API Spec 5L for line pine (for branch line pipeline only), ASME Boiler and Pressure Vessel Code for all pressure vessels, ASME B31.1 Piping for all pressure piping within the confines of the power plant, ASME B16.5 Pipe Flange and Flanged Fittings, NFPA 10 Standard on Portable Fire Extinguishers, NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, IEC 79 Electrical Apparatus For Explosive Gas Atmospheres, and IEC 529 Classification of Degrees of Protection Provided By Enclosures. Compliance to these regulations, codes and standards will ensure that safety risks will be negligible.

58. SoundPlan Essential 3.0 was used to simulate the noise levels within Component 1. The noise level considered for gas turbine, steam turbine, and receiving and metering station were 90 dBA, 90 dBA and 80 dBA, respectively as these levels are typically used for noise modeling of power plants. Predicted noise levels at 11 sensitive stations show that six stations will exceed the daytime limit of the IFC-WB EHS General Guidelines 2007 and four locations during nighttime. Noise-generating equipment like gas turbine and steam turbine will be housed in a sound-proof building to meet the noise limits. The use of personal protective equipment will be mandatory for to workers exposed to high noise levels (85 dB for more than 8 hrs) and will be rotated every two hours to limit exposure based on occupational health and safety standards. There will be three exhaust silencers, low-noise type of fans and cylindrical hood at the air exit of axial air fans from the cooling towers for Component 1. Since detailed design may alter, noise assessment will be

updated to ensure that the limits of 55 dB daytime and 45 dB nighttime at receptors will be met including start up and shut down.

59. Following the IPCC guidelines for national greenhouse gas (GHG) emissions inventories for energy industries, the contribution of Component 1 to the CO_2 emissions will be 1.67 million (M) tons per year using natural gas as fuel and 1.86 M tons per year on HSD. When running on natural gas at 5,632 hours and 500 hours on HSD (in case of emergency), the CO_2 emissions will be 1.69 M tons per year. Annual monitoring of GHG emission will be conducted as per EMoP.

60. The available annual discharge in Bhairab River ranges from 39.73 million m^3 (MCM) per day to 54.47 MCM per day. Bhairab River is influenced by diurnal tidal occurrences during daytime and nighttime. Water requirement for the cooling system will be 2,010 m^3/hr and will be taken from the Bhairab River. This amount of water accounts for less than 1% of the available average discharge per hour at the Bhairab River.

6.0 Analysis of Alternatives

61. A “no project” option negates the need to meet the future demand for electricity and planned development in Bangladesh. The previous site of KNM now abandoned will remain the same as the current condition and will not have the benefit of the highest and best use of government land. The “with project” option evaluated the following:

- *Suitability of site*

62. With a population density of 1,139 people/km^2 and the geography of Bangladesh, it makes it difficult for GoB to acquire land for development projects. Scarcity of land is one of the major obstacles for development of industries like a combined cycle power plant. The abandoned land of about 50 acres previously used by KNM is the best site for Component 1.

- *Suitability of fuel*

63. Solar power plants require large area of land that is not easily available in Bangladesh. There is very limited hydropower potential except for Chittagong and the Chittagong Hill Tracts which may have potential for micro-hydro and mini-hydro. Burning of coal, diesel, and natural gas contribute to greenhouse gas (GHG) emissions as CO_2 but natural gas contributes the lowest among these fuels at 117 lbs CO_2 per million British thermal units (BTU) and is, thus considered more environment-friendly. Natural gas is mainly CH_4 with higher energy content compared to other fuels.

64. Wind resources potential in Bangladesh for generating electricity is limited.[9] Available data from measurements and satellite data indicate that onshore wind speeds are below 5 m/s average a year which is quite low wind speed for the purpose of wind energy. Available satellite data for offshore wind speeds are slightly higher but still relatively low about 6 m/s. Availability of suitable space for wind farm is also a challenge given the population density, and if at all available, it will in in flood-prone areas. Government has taken initiative to generate electricity through renewable sources as per Power and Energy Sector Master Plan (PSMP)-2016 and according few initiatives are under way. However, there are few pilot projects for wind based power plant has been undertaken.

[9] Netherlands Enterprise Agency. Baseline Study Wind Energy Bangladesh. Commissioned by the Ministry of Foreign Affairs. 13 April 2017.

- *Suitability of power technology*

65. Modern combined cycle power plants have undergone many developments to much more improve its capability in areas such as fuel flexibility, reduce life cycle costs, operational flexibility, low emission levels, operate on a wide range of fuel, rapid ramping rates, higher efficiency (can be over 60% with most new gas turbine systems), and higher availability.

66. There are several classes of gas turbine in the market. GE Power's largest 9HA.02 gas turbine is now available at more than 64% net efficiency in combined cycle power plants. The project prefers F-class compared to H-class for the following reasons: (i) total net power output falls within the net power output of the proposed gas turbine/CCPP and the maximum block size shall be in compliance with the current limits governing the national grid system security in Bangladesh; (ii) commercial operation is a proven design; (iii) NWPGCL has the ability to cope with F-class gas turbine technology based on experience in terms of operation and maintenance; and (iv) the net power output can be accommodated by the system according to the power load study conducted by PGCB. F-class units provide more flexibility in burning a wide spectrum of fossil fuels including gasified coal and it is of high efficiency machine with proven technology. In addition, fuels can be switched after start-up without sacrificing performance.

67. G, H and J class machine are not widely proven from different sources. For the H-class gas turbine CCPP, (i) the net power output is higher than the planned new capacity, (ii) it is a relatively new technology, (iii) the higher power output may cause system instability based on the load study conducted by PGCB, and (iv) there is a need to acquire new knowledge and skills to effectively and reliably operate and maintain.

- *Cooling system options*

68. Three cooling system options were considered: (i) once-through cooling; (ii) forced draft cooling tower system (or closed-loop cooling system); and (iii) forced draft air cooling system (or air-cooled condenser). Once-through cooling will take huge amount of water and will discharge about the same amount of water at a higher temperature (usually well above 3^{o}C from ambient). This is not advisable for Bhairab River. In forced draft cooling tower system, it reuses water thus; water requirement is less compared to once-through cooling. Forced draft air cooling system does not require water but is not advisable due to increase noise level and the rise in ambient temperature of the surrounding area. Water intake will be two channels with an area of 12.5 m^2 each located in the southeast side river bank of the Bhairab River. Based on the dolphins' survey conducted by the IUCN from May 2017 until January 2018, there have been no sightings of dolphins in the river stretch along the project site.

- *Modes of transporting heavy and oversize equipment to the site*

69. There are several options: (i) by highway, (ii) by railway, and (iii) by waterway along the Bhairab River from the Mongla Port through the Rupsha River. The maximum carrying limit for transportation by road is 70 tons and by railway would require transport by road from the railway station. The best and with less disturbance to local people will be by waterway which will be the only transportation way for this project.

70. The weight of the major equipment that will be transported to the site ranges from 50 tons (transformer) to 320 tons (gas turbine transformer). Equipment will be unloaded to barges from the main vessel at Mongla Port and will be carried through river to project site. Bhairab River is

classified as Class II by the Bangladesh Inland Water Transport Authority (based on minimum depth, length of route, and minimum vertical and horizontal clearance). Atai River and Rupsha River are Class III. Barges/cargo boats that will deliver equipment to the site will have a vertical clearance of 12.2 m and horizontal clearance of 76.22 m. The number of truck loads and river vessels are not quantified at this stage. Therefore, it is suggested that, EPC shall develop a plan for transportation of materials during construction period and also quantify the possible size and number of vessels and movement including loading unloading time.

71. Based on studies, mortality of dolphins is attributed mostly to entanglement/entrapment in fishing net and water development and not from navigating vessels like ships (IUCN 2014).

7.0 Information Disclosure, Consultation and Participation

72. Consultations were done through workshop, focus group discussion, and rapid rural appraisal. Stakeholders were invited by sending letters, telephone calls, and advertisement in Bengali at the local newspaper. A total of seven consultation events were conducted from 28 October to 13 November 2016 during the preparation of the EIA and on 21 October 2017 to present the outcome of the EIA. Two consultation events were participated by the ADB Project Team. These consultations were joined by the Mayor and Councillor of the Khulna City Corporation, students, teachers from the KNM Boys & Girls Grade School that will be relocated, School Management Committee, representatives from the media, fisher folks from the Deyara Jugiyati and Chandimohan Villages, and interested individuals. A project brief hand-out in Bengali was given out during the consultation.

73. Major concerns raised during the consultations include (i) disruption of school activities in the KNM Boys and Girls school, (ii) potential loss of jobs of people currently maintaining the KNM property that will be taken over by NWPGCL (about 50 ha), (iii) clearing of vegetation at the project site resulting to loss of habitat, (iv) demolition works may generate dust, noise, solid waste and debris that may affect local people, (v) indirect impacts to fishing village along the Bhairab River across the project site, and (vi) potential increase in noise level during the operation of the power plant may affect activities in mosque, school, and residential areas. Participants during the consultations recognize that Component 1 can accelerate local business development due to available and reliable power, the abandoned area previously used by KNM will now have economic use, creation of jobs, renovation of the mosque and mass graveyard marker, and may result to setting up of new industrial area along with small and medium industry. NWPGCL assured the participants that construction works for Component 1 will begin only after the new schools are completed and that all their concerns will be considered. Consultations will continue and a communications action plan will be finalized by NWPGCL with support from communications expert to ensure that stakeholders are consulted, as and when needed.

74. A project summary covering all components with details on grievance redress mechanism (GRM) and contact person in case of complaints will be prepared in both Bengali and English and will be made available at the field office of PMU in Khulna and at the NWPGCL office in Dhaka. More details are available from the EIAs posted in the website of ADB.

8.0 Grievance Redress Mechanism

75. The GRM will provide three-tier entry points in grievance redress. Two grievance redress committees (GRCs) will be formed: (i) local grievance redress committee (LGRC); and (ii) project grievance redress committee (PGRC). Grievances considered minor can be resolved onsite at the LGRC level within seven days from receipt of complaint. Other complaints not resolved at the

LGRC level will be forwarded to PGRC which will take two weeks (or 14 days) to resolve. Meetings of the LGRC will be held onsite (PMU office) and members may do site visits to check or verify the issue. Complainants will be informed of the status of resolution. The third tier entry point for grievance redress will be the appropriate rule of court.

9.0 Environmental Management Plan

76. The Corporate environmental staff of NWPGCL and the PMU, NWPGCL will monitor the EPC Contractor on its compliance to the EMP. Environmental monitoring plans (EMoPs) have been prepared which covers demolition, during pre-construction, semi-annually construction, and annually during operation. Environmental monitoring reports will be submitted by PMU to ADB and these reports will be posted in the ADB website as required by SPS 2009 and PCP 2011. An external monitor will be appointed.

10. Conclusion and Recommendation

77. Component 1 is designed as a dual-fired combined cycle power plant with natural gas as the main fuel and HSD as back-up fuel to be used only during emergency.

78. The project is “red category” based on ECA 1995 and ECR 1997 of the DoE requiring an EIA. According to SPS 2009, the project is category A requiring an EIA. Following the requirements of DoE and ADB, an EIA was prepared.

79. The EIA was conducted covering the project site and about 10 km radius from the power plant. Description of the environment was based on available relevant secondary data and field surveys carried out in October 2016 and March 2017. A biodiversity assessment was conducted by the IUCN from May 2017 until January 2018 covering a total of 30 km of river stretch in Bhairab River, Atai River and the Rupsha River to determine critical habitat for the globally endangered Ganges River dolphin (*Platanista gangetica*) according to the IUCN (2012) but nationally vulnerable (2015). The biodiversity assessment concluded that the study area cannot be considered as critical habitat according to criterion 1 to criterion 5 of the IFC Performance Standard 6 and SPS 2009.

80. Water requirement for the cooling system of Component 1 will be less than 1% of the available discharge per hour from the Bhairab River. The project will have a water treatment plant, sewage treatment plant and an effluent treatment plant. Groundwater will not be used for power plant requirements. Domestic water requirements for Component 1 will be supplied by the Khulna Water Supply and Sewerage Authority. Low NO_x burner will be used at the power plant to reduce the NO_2 emissions. Air dispersion modeling results confirm that the ground level concentration of SO_2, NO_2, PM_{10}, $PM_{2.5}$ and CO from the project alone will not exceed the limits of NAAQS 2005 (also referred to as ECR 2005).

81. Stakeholders have been identified and consulted in seven occasions from 28 October to 13 November 2016 and in October 2017. The GRM will be set up by PMU, NWPGCL consistent with the requirements of GoB and ADB. A project brief in English and in Bengali with details on the GRM will be made available at the NWPGCL office in Khulna and in Dhaka. Consultations will continue in varying degrees throughout the project’s life cycle. With guidance from experts, NWPGCL will finalize the communication action plan for the project.

82. While there are associated impacts in implementing Component 1, they can be readily mitigated through design, employing best available technology (e.g. emissions reduction), good

engineering construction methods, effective stakeholder engagement (as and when needed), diligent monitoring of EMP implementation, and compliance to relevant regulations on power plant operations, and environmental, health, and safety.

83. Except for the biodiversity assessment done by IUCN Bangladesh in May 2017, there have been no surveys and studies on the Ganges River dolphins along the Bhairab River, Atai River, and Rupsha River. More studies will help to confirm the locations of "hotspots" that will guide GoB in making plans for protecting them. Additional surveys are included in the EMoP within this area to confidently determine the abundance and dispersal of these endangered species. As project contribution, dolphins' survey will be part of the environmental monitoring.

84. This draft EIA will be disclosed in the ADB website in accordance with SPS 2009 and PCP 2011. Prior to construction works, all the relevant permits required for Component 1 will be obtained by NWPGCL.

1.0 INTRODUCTION

1. The Power System Master Plan 2016 recommends for diversification in the use of fuel for power generation such as domestic and imported coal and natural gas, oil, nuclear power, and renewable energy.[10] As of December 2017, the energy mix in Bangladesh consist of 64.5% natural gas, 1.66% hydro, 4.8% power import, 6.4% diesel, 20.9% furnace oil, 1.81% coal, and 0.02% renewable.[11] Consistent with this, the North-West Power Generation Company Limited (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB) has taken the initiative to enhance the power generation capacity of Bangladesh to address the growing demand for electricity. This initiative will involve the construction of a new Rupsha 800 megawatt (MW) Combined Cycle Power Plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP will be designed to use natural gasas main fuel and high speed diesel (HSD) as back-up fuel to be used only for about 500 hours maximum annually during maintenance or emergency. The Government of Bangladesh (GoB) has applied for financing of this new power plant from the Asian Development Bank (ADB). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

2. The objectives of this initiative include the following:

- To contribute in meeting the demand for electricity and to increase reliability of supply by minimizing load-shedding;
- To support in achieving the vision of GoB, “Power to All by 2021”;
- To reduce the increasing gap between demand and supply of electricity throughout the country;
- To accelerate economic development by providing adequate and reliable power generation;
- To enhance the stability and reliability of the national grid system, and to reduce the systems loss by local generation; and,
- To develop human resource through technology transfer.

3. Overall, the goal is to improve the economic growth of Bangladesh by providing a reliable and stable power supply with this initiative.

1.1 Overview of the Project

4. The project targets strengthening energy security in Bangladesh. The country faces serious electricity shortages in the short- to medium-term and needs to secure cost-effective, new and diversified energy sources. Key interrelated project components include: (i) the development and operation of the Rupsha 800 MW gas-fired CCPP; (ii) the construction of a gas distribution pipeline and related network infrastructure ensuring reliable supply of fuel to the CCPP; (iii) the construction of a power transmission interconnection facility to transfer the generated power to the national grid at the existing substation in Khulna; and (iv) capacity strengthening of NWPGCL. The project will establish the first power plant to use gas from the Bangladesh gas transmission

[10] Ministry of Power, Energy and Mineral Resources, and Bangladesh Power Development Board. People’s Republic of Bangladesh Power and Energy Sector Master Plan. http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised.pdf. (Accessed 18 August 2017)

[11] Bangladesh Power Development Board. Key Statistics. http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5&Itemid=6

network in the southwestern region where its gas supply would be attributed to the imported regasified-liquefied naturals gas (R-LNG). The gas transmission and distribution pipeline network in the southwestern region particularly Khulna is part of the project funded by ADB, Loan2622/2633-BAN: Natural Access Improvement Project (formerly Clean Fuel Development Project) approved on 26 March 2010 with a total amount of $537 million. Part of the inland gas transmission pipeline network from Moheskhali FSRU is ADB funded Loan 3641/3642-BAN: Natural Gas Infrastructure and Efficiency Improvement Project approved on 18 November 2016 with a total amount of $227 million. **Figure 1.1** shows the project.

Component 1: Rupsha 800 MW CCPP

5. Rupsha 800 MW CCPP will be built in the (now abandoned) Khulna newsprint factory premises. The power plant will use combined cycle gas turbine technology, comprising two identical generating units, each nominally rated at 400 MW. Each combined cycle unit will consist of one gas turbine and one heat recovery steam generator (HRSG), forming a one-on-one configuration. At full capacity of 800 MW, the Rupsha power plant is capable of meeting 5% of the forecast peak demand of Bangladesh in year 2022. The cooling system will be closed-loop forced-draught cooling tower system that will require 2,010 m^3/hour of water to be taken from the Bhairab River.

Component 2: Gas Supply to the Power Plant

6. Petrobangla, the national gas utility and the single-buyer for the gas industry, will procure LNG from international sources and deliver regasified LNG to Khulna city gas station (CGS). The regional gas distribution company, Sundarban Gas Company Limited (SGCL) will deliver gas from the existing Khulna CGS in Arongghata to the Rupsha power plant in Khalishpur. A new 24-inch (0.6 m) underground gas pipeline about 10 km long will be installed from Khulna CGS to the Rupsha 800 MW power plant. The gas regulating and metering station (RMS) will be located at the Rupsha power plant. In addition, a new 20-inch (0.5 m) underground gas pipeline 2 km long will be branched off from the line from Khulna CGS to Rupsha power plant, to serve NWPGCL's existing Khulna 225 MW power plant. Owing to non-availability of gas, this 225 MW power plant is presently operating on diesel.

7. The following sources from imported regasified liquefied natural gas (R-LNG)[12] and domestic supply will provide adequate supply of natural gas for Component 1.

- FSRU Moheskhali - 500 MMSCFD of R-LNG will be made available by April 2018 developed by Excelerate Energy, USA-Bangladesh
- Summit LNG Terminal Company Limited – 500 MMSCFD R-LNG will be made available by October 2018
- GoB and RasGas (Qatar) has signed a deal in September 2017 for a 15-year LNG sales and purchase agreement to supply 1.8 million (M) tons LNG/year for 5 years and 2.5 M tons/year for the next 10 years
- According to Petrobangla, there will be additional supply (domestic) of 2,750 MMSCFD

[12] These sources are not associated facilities as the existing Khulna CGS will have several sources such that one would no longer know which gas comes from which among the sources identified above (a-e). These sources were not embarked by the Government only for the project but for the entire country which could provide for power generation, transportation or industry.

- By 2021, Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) will have 55 exploration wells and 31 development wells

8. The natural gas produced in Bangladesh is “sweet gas” (does not contain hydrogen sulphide) and thus, all the existing natural gas transmission and distribution pipeline networks are designed for high quality natural gas.

Component 3: Power Transmission Interconnection

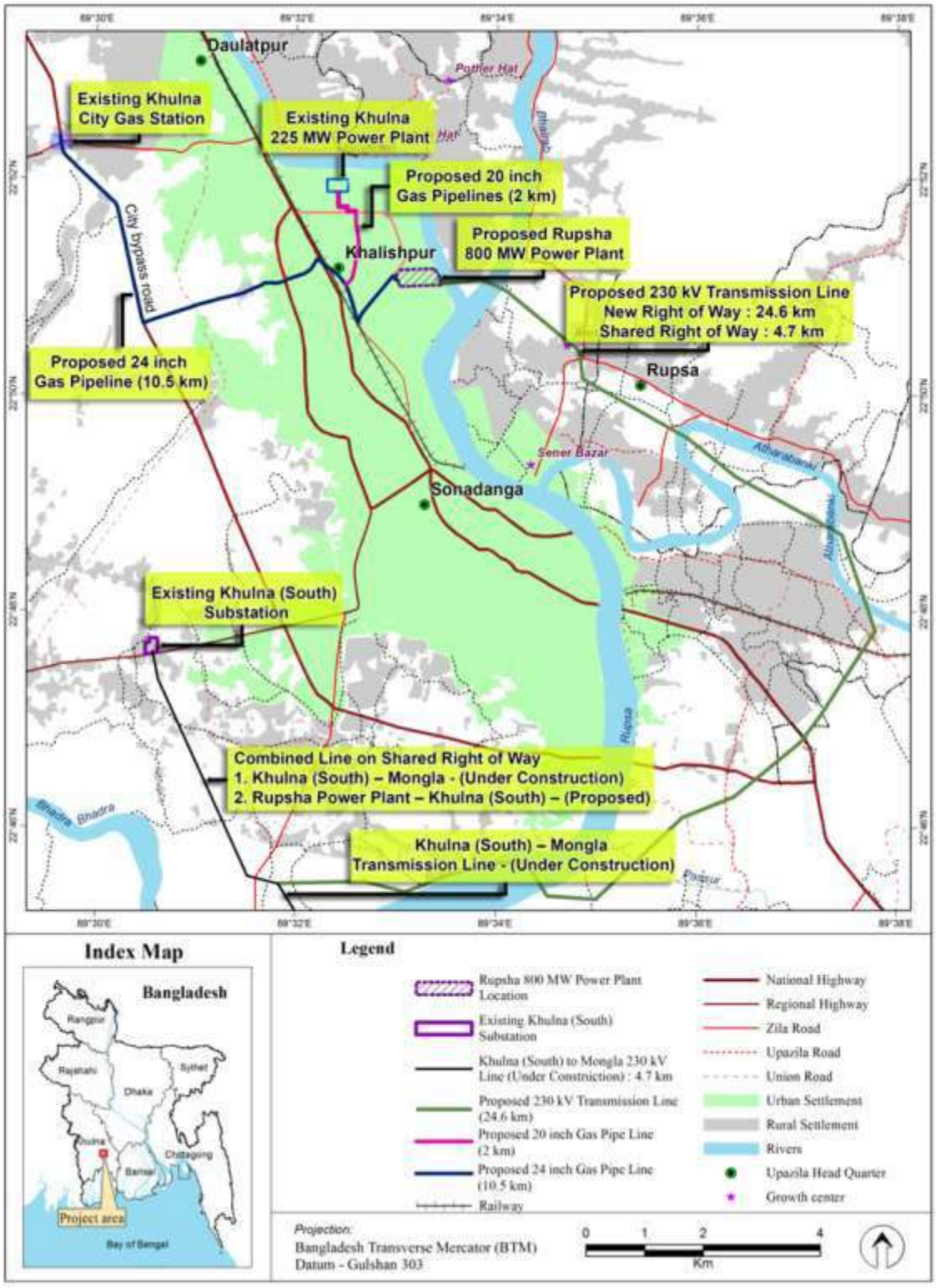
9. Electricity generated in the Rupsha power plant will be stepped-up to the transmission voltage of 230 kilovolts (kV). A new 29.3 km transmission line will be built from Rupsha 800 MW CCPP to the existing Khulna South Substation. The conductor to be used is twin-Aluminium Conductor Composite Core Hamburg,[13] and the line will have two circuits, each capable of transferring 1,400 MW. The new transmission line will require three main river crossings and three minor river crossings, and would traverse for 29.3 km, mostly through rice fields. Upon reaching the existing Khulna South SS, the line will be terminated at two new line bays and termination equipment to be installed under the project. Thereafter, electricity produced at Rupsha power plant will flow into the 230 kV transmission network, to serve the electricity demand in Khulna and elsewhere in the country.

10. Occupying an area of 12.96 acres, the Khulna South SS is part of the West Zone Power System Development Project funded by ADB and the Nordic Development Fund and was commissioned on 29 January 2007. The 4.7 km stringing is part of the 24-km four circuit 230 kV Mongla to Khulna South SS transmission line project of the Power Grid Company of Bangladesh (PGCB) funded by GoB. The 230 kV transmission line from Mongla to Khulna South SS has completed the requirements of the Environmental Conservation Rules (ECR) 1997 of the Department of Environment (DoE) for red category project. Together, these transmission lines form part of the power evacuation interconnection facilities in southwestern Bangladesh.[14]

[13] Aluminium Conductor Composite Core (ACCC) Hamburg has a current carrying capability of 1,440 amperes at 120^0C.

[14] The 4.7 km will only involve stringing as the 24 km four circuit 230 kV is existing and has completed the requirements of DoE, so is not associated facilities.

Figure 1.1: Location map



Component 4: Capacity Strengthening of NWPGCL

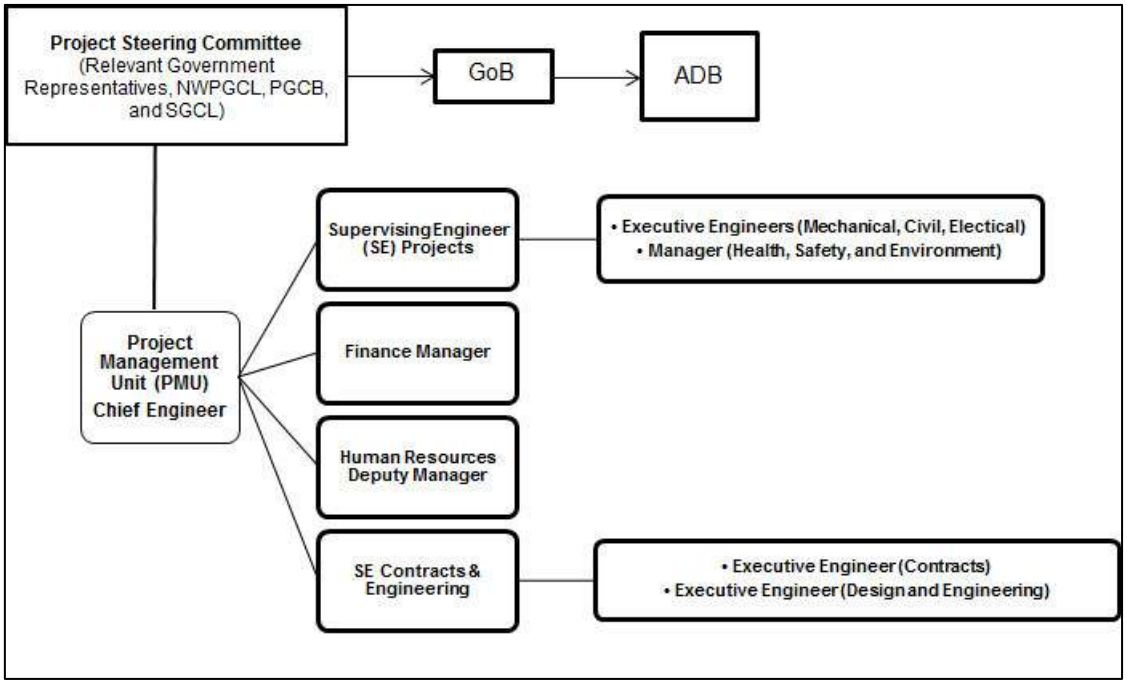
11. Strengthening institutional capacity has the following three major subcomponents: (i) improving project implementation, management, and construction supervision capabilities; (ii) establishing enterprise resource planning system in NWPGCL; and (iii) enhancing operation and maintenance practices through procurement and installation of modern and high technology universal power plant operations training simulator. Project management and construction supervision support will be provided for the development of Rupsha power plant. enterprise resource planning system support includes both hardware and software for introducing computerized management system for NWPGCL. The enterprise resource planning system will substantially improve business process and NWPGCL's efficiency and transparency by computerizing the Financial Accounting, Budgeting and Costing, Human Resource Management, Procurement Inventory, Planning and Monitoring, Operations and Maintenance and Project Management and Accounting.

1.2 Project Implementation Arrangements

12. Implementation supervision for the Rupsha 800 MW CCPP, power transmission, and gas distribution facilities will be carried out by the NWPGCL with assistance from a team of international and national implementation consultants. From time to time, assistance will be provided by the Power Grid Company of Bangladesh (PGCB) for Component 3, and the SGCL for Component 2 to ensure that coordination is achieved and implementation progresses smoothly. During construction, further assistance will be provided by SGCL and PGCB for approval of detailed design and drawings submitted by the contractors of Component 2 and Component 3, respectively. This arrangement has worked well for the Bheramara 360 MW CCPP project financed by the Japan International Cooperation Agency, which is very similar to the Rupsha 800 MW CCPP.

13. NWPGCL is currently setting up the project management unit (PMU) and so far, has assigned limited staff to it. The organogram (see **Figure 1.2**) prepared for the PMU shows the unit will have a compliment of 80 staff. It will be headed by a Chief Engineer and will have four divisions, headed by: (i) Supervising Engineer Projects; (ii) Manager Finance; (iii) Deputy Manager Human Resources; and (iv) Supervising Engineer Contracts and Engineering. Supervising Engineer Projects will have reporting to them, three Executive Engineers, (Mechanical, Civil, and Electrical) and Manager Health, Safety and Environment (HSE). The Executive Engineer Contracts and Executive Engineer Design and Engineering will report to the Supervising Engineer Contracts and Engineering. In addition, the project will have a high-level Project Steering Committee consisting of members from various government departments, NWPGCL, PGCB and SGCL and act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB.

Figure 1.2: Project implementation arrangements



1.3 The Need for Environmental Assessment

14. The project is subject to the environmental requirements of GoB, ADB, and IsDB since NWPGCL is seeking the financial support of ADB and IsDB.

1.3.1 National Requirements

15. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997. Under these regulations, all the three components of the Project are “Red” category requiring and environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (ToR) of the EIA needs the approval of the Department of Environment (DoE). The DoE is the authority that regulates and enforces environmental management regulations to ensure that development projects are implemented sustainably, and to conserve and manage the environment in Bangladesh.

16. NWPGCL has obtained exemptions for submitting an IEE in obtaining the SCC for all the project components as follows:

Component 1: 5 November 2017; DoE/Clearance/5584/2016/564
Component 2: 5 November 2017; DoE/Clearance/5668/2016/563
Component 3: 5 November 2017; DoE/Clearance/5669/2016/549

17. The ToR of the EIA for all components was approved by the DoE on 5 November 2017 (see **Annex 1**). Without the EIA approved by DoE, NWPGCL cannot open line of credit in favor

of importable machineries and cannot start any physical activities for the project. In August 2016, NWPGCL has engaged the Center for Environmental and Geographic Information Services (CEGIS) to prepare the EIAs of all the project components required by the DoE for the issuance of the ECC. Once the EIA I finalized by ADB, NWPGCL will submit the EIAs to DoE for issuance of ECC.

1.3.2 Environmental requirements of ADB and IsDB

18. The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[15]ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

19. Under SPS 2009, projects that require funding from ADB will be subject to screening and categorization based on their potential environmental impacts. The categorization determines the required environmental assessment. The project has four components: (i) Component 1 – Rupsha 800 MW CCPP; Component 2 – Gas Supply to the Power Plant; Component 3 – Power Transmission Interconnection; and Component 4 – Capacity Strengthening of NWPGCL. Component 4 is not expected to have adverse environmental impacts. Based on these components, the project is category A on environment according to ADB's SPS 2009 which requires the preparation of an EIA.[16]

20. The EIA required by ADB was based on the findings of CEGIS, collation of primary data, and additional research from available secondary data to meet SPS 2009. Aside from the EIA, NWPGCL will provide ADB a copy of the ECC issued by the DoE for all the project components.

1.4 EIA Methodology

21. The EIA was prepared following the requirements of DoE, GoB and SPS 2009 of ADB.

22. Environmental quality measurements were conducted and relevant secondary data were collected as basis for the EIA. The latest project design from the feasibility study and the Development Project Proposal were also referred to.

23. *Primary data collection.* The project's area of influence was identified and environmental sampling was conducted on air, noise, surface water and groundwater, and soil. Ecological surveys were done at the project site and the study area (about 10-km radius from the power plant). Field works were carried out in October 2016, March 2017, and May to December 2017.

24. *Secondary data collection.* Sources of secondary data include publications from specialized government agencies, international organizations like the International Union for Conservation of Nature (IUCN), Wildlife Conservation Society, World Bank, WHO, International

[15] IDB. Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nationas Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

[16] Asian Development Bank Safeguard Policy Statement (SPS 2009),https://www.adb.org/documents/safeguard-policy-statement.

Finance Corporation (IFC), ADB, and other relevant NGOs. Global and national research works on the Ganges River dolphins provided guidance on biodiversity assessment.

25. *Modeling.* CALPUFF is a USEPA regulatory model to predict the ground level concentration of air quality criteria pollutants (CO, NO_x, SO_2, NO_2, PM_{10} and $PM_{2.5}$). It is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometers.

26. Areal Locations of Hazardous Atmospheres (ALOHA) is the hazard modeling program used in the event of an emergency at the Rupsha 800 MW CCPP particularly at the natural gas receiving and metering station. This is a widely-used program to plan for and respond to chemical emergencies.

27. Sound PLAN Essential 3.0 model was used to simulate noise levels from sources such as gas turbines, heat recovery steam generators, steam turbines and other equipment.

28. The Hydrologic Engineering Center, River Analysis System (HEC-RAS) model was used to simulate flooding at the project site. HEC-RAS is a software developed by the U.S. Army Corps of Engineers for the simulation of superficial flow and has applications for hydraulic design, floods, sediment transport and water quality.

29. Data and information collected were then used to predict, analyze, and mitigate the potential environmental impacts.

1.5 Structure of the Report

30. Following the requirements of SPS 2009, the environmental assessment for the project is presented as follows:

Volume 1 – EIA of Component 1
Volume 2 – EIA of Component 2
Volume 3 – EIA of Component 3

31. The EIAs of all the project components are based generally on the EIA format given in Annex to Appendix 1 of SPS 2009, pp41-43. This EIA covers Component 1 – 800 MW CCPP.

2.0 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 National environmental agency

32. The Ministry of Environment and Forests (MoEF) is the agency responsible for planning, promoting, coordinating and overseeing the implementation of programs and plans regarding environment and forestry. The MoEF deals with all national environmental matters and is responsible for the prevention and control of pollution, forestation and regeneration of degraded areas and protection of the environment, and in the framework of legislations. MoEF also undertakes surveys, impact assessment, pollution control, research, and collection and dissemination of environmental information, as well as environmental awareness among all sectors in Bangladesh.

33. Under the MoEF is the DoE, which performs regulatory functions. DoE was created in 1989 as the primary government agency responsible for enforcing environmental management regulations to ensure sustainable development and to conserve and manage the environment. The DoE ensures the consistent application of environmental rules and regulations, and provides guidance, training and promotional campaign on improving environmental awareness.

2.2 National environmental regulations

34. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and Environment Conservation Rules (ECR) 1997. ECA 1995 provides the requirements on environmental protection, improvement of environmental standards, and control and abatement of environmental pollution. Through the ECA 1995, the DoE is mandated to undertake any activity needed to conserve and enhance the quality of environment and to control, prevent and mitigate pollution.

35. ECR 1997 provides for the declaration of ecologically-critical areas, categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.; (ii) the requirement for and procedures to obtain ECC; and (iii) the requirement for the IEE and their based on categories of industrial and other development interventions. ECA 1995 and ECR 1997 outline the regulatory mechanism to protect the environment in Bangladesh. Aside from ECA 1995 and ECR 1997, **Table 2.1** presents a summary of relevant environmental regulations.

Table 2.1: Relevant national environmental regulations

Regulation	Brief Description	Remarks
Environment Court Act 2000 (amended in 2002 and 2010)	This Act is under the Judiciary and MoEF to ensure the resolution of disputes on environmental and social damages resulting from any development activities. This Act also allows for the completion of environment-related legal proceedings effectively.	NWPGCL will ensure that all potential environmental complaints will be dealt with effectively at the project level through the PMU. SPS 2009 requires setting up of a grievance redress mechanism for projects known to cause potential environmental impacts.
Bangladesh Water Act 2013	Makes provisions for integrated development, management, abstraction,	Component 1 will abstract water from Bhairab River for its

Regulation	Brief Description	Remarks
	distribution, use, protection and conservation of water resources	recirculating cooling system. NWPGCL will ensure that relevant permits (if any) will be obtained prior to abstraction.
Vehicle Act 1927, the Motor Vehicles Ordinance 1983	These are under the BRTA which regulates vehicular emissions and noise including road safety.	This regulation will be complied with by vehicles that may be used during pre-construction, construction and operation of Component 1.
Bangladesh Labour Act 2006, Bangladesh Labor Act 2013, Factory Rule 1979	Regulations that aim to protect the interests and rights of the workers, provision of comfortable working environment, reasonable working conditions, and to ensure workers' safety.	Workers recruited under Component 1 will be provided with PPE (if needed) and will comply with these regulations. No worker under 18 years old will be recruited.
The Forest Act 1927 (amended in 1982 and 1989)	This Act under the MoEF aims to protect the forest resources.	Component 1 will not affect forest area or other forest type.
Electricity Act 1910	Relates to the supply and use of electrical energy, allows any person to secure a license to supply energy and to put down or place electrical supply lines for the transmission of energy. Sect 19(1) of the Act provides that the licensee, in the exercise of any of the powers conferred by or under this Act, will cause as little damage, detriment and inconvenience as may be, and will make full compensation for any damage, detriment or inconvenience caused by the licensee or by any one employed by the licensee.	Component 1 referred to the applicable provisions in this Act.
NG Safety Rules 1991 (amended 2003)	Provides guidelines on the materials, design and construction of gas transmission and pipeline industry. This Safety Rules were based on the American National Standard Codes for Gas Transmission and Piping System.	NWPGCL and SGCL will comply with these safety rules.
Bangladesh Petroleum Act 1974 (amended 1994)	Provides for the exploration, development, exploitation, production, processing, refining, and marketing of petroleum	NWPGCL and BPCL will comply with the relevant provisions
Petroleum Act 1934 (amended 1986)	Act to consolidate and amend the law relating to the import, transport, storage, production, refining, blending, or reclaiming by recycling of petroleum and other inflammable substances.	NWPGCL and BPCL will comply with the relevant provisions
Explosives Act 1884, Explosive Substances Act 1908 (amended 1987), Explosive Rules 2004, Gas Pressure Vessel	Regulations related to the manufacture, possession, use, sale, transport and importation of explosives	NWPGCL, SGCL, and BPCL will refer to the relevant provisions in handling of natural gas and HSD

Regulation	Brief Description	Remarks
Rules 1995 (amended 2004)		
Bangladesh Gas Act 2010	Regulates the transmission, distribution, marketing, supply and storage of natural gas and liquid hydrocarbon	NWPGCL and SGCL will comply with this Act.
The Antiquities Act 1968 (amended 1976)	Regulation on the preservation and protection of antiquities.	NWPGCL will have a "chance find" procedures.
Natural Water Bodies Protection Act 2000	According to this Act, the character of water bodies i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans formulated under the laws establishing the municipalities in division and district towns shall not be changed without approval of concerned ministry. This Act is under the Rajdhani Unnayan Kartipakkha/Town Development Authority/Municipalities.	Component 1 will abstract water from the Bhairab River for its recirculating cooling system. NWPGCL will comply with the relevant requirements.
Wildlife (Protection and Safety) Act 2012	Provides for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Under this Act, hunting, trapping, killing of wildlife are strictly prohibited.	The site for Component 1was used previously by the KNM Limited operated by the KNM Authority but ceased operations in November 2002 and since then was not affected by any change in land use. Vegetation onsite provided temporary habitat for wildlife. The Bhairab River has sightings of the Ganges River dolphin (*Platanista gangetica*), a known obligate riverine dolphin. Component 1 will ensure that relevant provisions in this Act will be complied with.
The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	Provides for the requirements for the protection and conservation of fish. This Act defines fish as "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, molluscs, echinoderms and frogs at all stages in their life history."	Component 1 will use Bhairab River to supply the water requirements. NWPGCL will ensure compliance to the relevant provisions of this Act

BPCL = Bangladesh Petroleum Corporation Limited, BRTA = Bangladesh Road Transport Authority, HSD = high-speed diesel, KNM = Khulna Newsprint Mills, MoEF = Ministry of Environment and Forests, NWPGCL = North-West Power Generation Company Limited, PMU = project management unit, PPE = personal protective equipment, SGCL = Sundarban Gas Company Limited, SPS = Safeguard Policy Statement.
Source: ADB Consultant, November 2017.

2.3 Overview of the environmental approval process

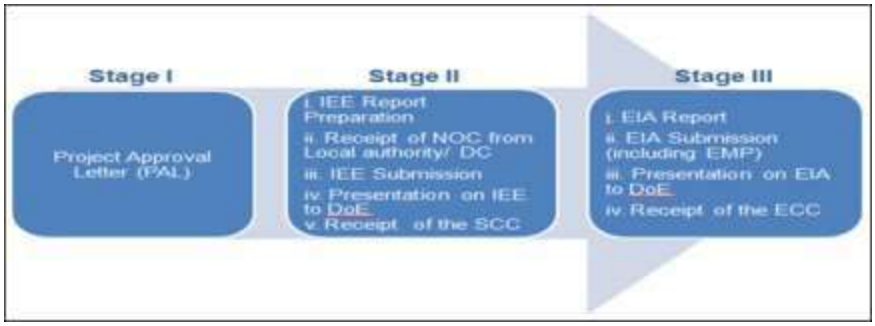
36. Section 12 of ECA 1995 provides that no industrial unit or project can be established or undertaken without securing an ECC from the DoE. Following the requirements of ECR 1997, the DoE has classified various development interventions according to the potential adverse environmental impacts for the purpose of issuing the ECC. This classification includes: (i) green; (ii) orange-A; (iii) orange-B; and (iv) red. Green category refers to industries or projects considered

to be relatively pollution-free, thus, no environmental study will be required while the Red category refers to industries/projects which may cause significant adverse environmental impacts and therefore, require an EIA.

37. For projects and industrial units classified as Orange-A, Orange-B, and Red (those that may have potential adverse environmental impacts), securing the ECC involves two steps: (i) issuance of site clearance certificate (SCC), and then (ii) the ECC.

38. SCC will be issued by the DoE upon approval of the IEE, receipt of the No Objection Certificate, which a "proof of authorization" to initiate a project, and the ECC will be issued upon the approval of the EIA. The project proponent cannot open line of credit in favor of importable machineries and cannot start any physical activities for the project without the EIA approved by the DoE. **Figure 2.1** shows the process of obtaining the ECC for Red category project.

Figure 2.1: Process of obtaining ECC



2.3.1 National environmental requirements for Component 1

39. According to ECR 1997, Component 1 is a Red category requiring an SCC and an ECC. The No Objection Certificate from the local government, Aviation Authority, and the Department of Forest have been obtained. On 5 November 2017, NWPGCL obtained exemption from the DoE for submitting an IEE in obtaining the SCC and the approval of the TOR of the EIA (DoE/Clearance/5584/2016/564)

2.4 Relevant International Environmental Agreements

40. **Table 2.2** lists the applicable international environmental agreements where Bangladesh is a signatory which can provide guidance during the implementation of Component 1.

Table 2.2: Relevant international environmental agreements

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972)	Defines and provides for the conservation of world`s heritage by listing the natural and cultural sites	3 November 1983	23 November 1972	Component 1 will have "chance find" procedures

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
	whose value should be preserved.			
Convention on Biological Diversity (1992)	A framework for biodiversity and requires signatories to develop national strategies (National Biodiversity Strategy and Action Plan) for the conservation and sustainable use of biological diversity.	3 May 1994	29 December 1993	Any replacement of cleared vegetation resulting from Component 1 will be consistent with the objectives and priorities of the current Action Plan. A biodiversity assessment was conducted by IUCN in May 2017 until January 2018 to determine critical habitat for the Ganges River dolphin (*Platanista gangetica*).
Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington 1973) – also known as CITES	Addresses the exploitation patterns and overharvesting that threaten species of flora and fauna. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.	20 November 1981	1 July 1975	Site of Component 1 was previously occupied by the KNM Limited operated by the KNM Authority but ceased operations in November 2002. Component 1 will ensure that it will not cause any harvesting and exploitation of wild flora and fauna during implementation.
Vienna Convention for the Protection of the Ozone Layer	A framework for efforts to protect the globe's ozone layer by means of systematic observations, research and information exchange on the	2 August 1990	22 March 1985	Component 1 will not use chemicals that can affect the ozone layer like methyl chloroform, a solvent generally used for industrial processes.

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
	effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.			
Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer)	Designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.	2 August 1990	1 January 1989	Component 1 will not use chemicals that can cause harm to the ozone layer.
Kyoto Protocol (1997)	Commits its Parties to set internationally-binding emission reduction targets. This agreement is linked to the UNFCCC.	22 October 2001	16 February 2005	Component 1 will ensure zero or minimal fugitive natural gas emissions. Potential fugitive emissions will be monitored by high-technology instrumentation like SCADA. Component 1 is consistent with the mitigation action to reduce GHG emissions (INDC 2015, p5)
UNFCCC (1992)	This framework came into force on 21 March 1994 and aims to achieve stabilization of GHG concentrations in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system.	15 April 1994		Component 1 will ensure zero or minimal fugitive natural gas emissions. Potential fugitive emissions will be monitored by high-technology instrumentation like SCADA. Component 1 will contribute to CO_2 emissions by burning natural gas or HSD.

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	Aims to reduce the amount of waste produced by signatories and regulate the international traffic in hazardous wastes.	1 April 1993	5 May 1992	Component 1 will ensure that disposal of chemicals used (if and when needed) will follow the instructions in the accompanying material safety data sheet.

GHG = greenhouse gas, KNM = Khulna Newsprint Mills, SCADA = supervisory control and data acquisition, UNFCC = United Nations Framework Convention on Climate Change.
Source: ADB Consultant, November 2017.

2.5 Environmental requirements of Asian Development Bank and Islamic Development Bank

41. SPS 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[17] Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

2.5.1 Asian Development Bank

42. SPS 2009 sets the environmental requirements and review procedures of ADB for all the projects and grants they finance. SPS 2009 consists of three key safeguard areas, (i) environment, (ii) involuntary resettlement, and (iii) indigenous peoples; aims to avoid adverse project impacts to both the environment and the affected people; minimize, mitigate and/or compensate for adverse project impacts; and help Borrowers to strengthen their safeguard systems and to develop their capacity in managing the environmental and social risks.

43. During the project identification stage, ADB uses a categorization system to indicate the significance of potential environmental impacts and is determined by the category of its most environmentally-sensitive component, including direct, indirect, cumulative, and induced impacts within the project's area of influence. The project categorization system and the assessment required is described in **Table 2.3**.

Table 2.3: SPS 2009 environmental categorization

Category	Definition	Assessment Requirement
A	Likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the	Environmental impact assessment (EIA)

[17] IDB.Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nationas Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

Category	Definition	Assessment Requirement
	sites or facilities subject to physical works.	
B	Likely to have adverse environmental impacts that are less adverse than those of Category A. Impacts are site-specific, few if any of them irreversible, and in most cases mitigation measures can be designed more readily than Category A.	Initial Environmental Examination (IEE)
C	Likely to have minimal or no adverse environmental impacts.	No environmental assessment is required but the environmental implications of the project will be reviewed.
FI	Project involves investment of ADB funds to or through a financial intermediary (FI).	FIs will be required to establish an environmental and social management commensurate with the nature and risks of the FI's likely future portfolio to be maintained as part of the FI's overall management system.

Source: ADB. Safeguard Policy Statement 2009, p. 19. http://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf.

2.5.1.1 Environmental requirements of ADB for Component 1

44. Based on SPS 2009, Component 1 is category A and the EIA is referred to in the overall project environmental assessment as Volume 1. This draft EIA was based on the findings of CEGIS, collation of primary data, and additional research from available secondary data to meet the requirements of SPS 2009. Aside from this draft EIA, the NWPGCL will provide ADB with a copy of the ECC issued by the DoE for Component 1.

2.5.1.2 Disclosure requirements

45. Aside from SPS 2009, the Public Communications Policy (PCP) 2011 provides for the requirements of disclosure for project information of projects and grants funded by ADB. Consistent with SPS 2009, PCP 2011 requires the disclosure of documents submitted by the borrower and/or client:

(i) a draft EIA report for category A project, at least 120 days before Board consideration;
(ii) a draft environmental assessment review framework, where applicable, before appraisal;[18]
(iii) the final EIA or IEE, upon receipt by ADB;
(iv) a new or updated EIA or IEE, and a corrective action plan, if any, prepared during project implementation, upon receipt by ADB; and,
(v) the environmental monitoring reports, upon receipt by ADB.

46. To meet the disclosure requirements of ADB, the EIA of Component 1 will be disclosed to ADB website at least 120 days prior to Board consideration of the project.

[18] If no further mission for appraisal is required, the document will be posted before the management review meeting or the first staff review meeting for sovereign projects, or before the final investment committee meeting for nonsovereign projects, as applicable (ADB procedures).

2.5.2 Islamic Development Bank

47. On 8 December 1974, the Islamic Development Bank (IsDB) was created as an international financial institution in accordance with the Articles of Agreement signed and ratified by all member countries done in the City of Jeddah, Kingdom of Saudi Arabia.[19] Consisting of 57-member countries in Africa, Asia, Europe, and Latin America, IsDB aims to foster the economic development and social progress in its member countries, and Muslim communities in non-member countries. Among others, IsDB is already a key player in the clean energy sector, with investments of around $1 billion between 2010 and 2012.[20] Since inception, IsDB has funded about $2.75 billion in renewable energy projects and has allocated six percent of its operation to climate change mitigating projects.[21]

48. During the projects' appraisal/negotiations stage in the IsDB's project cycle, activities cover the review and assessment of the following major aspects of a project: technical, institutional, economic, financial, social, and environmental impact.

49. IsDB is ADB's third-largest multilateral partner for project cofinancing since December 2015 and has signed a framework cofinancing agreement in September 2008 and was extended until 2017.[22]

2.6 Comparison of environmental safeguard principles between ADB and Bangladesh

50. **Table 2.4** presents a summary comparing the environmental safeguard principles of ADB and GoB.

Table 2.4: Comparison of environmental safeguard principles ADB SPS 2009

No.	Principles	Delivery Process	GoB	Gaps (if any)
1	Use of screening process to determine the appropriate environmental assessment	Uses sector-specific rapid environmental assessment checklist for screening and assigns categories based on potential impacts: • A - EIA required (irreversible, diverse or unprecedented adverse environmental impacts) • B - IEE required • C - no environmental assessment required but a review of environmental implications • FI - ESMS required	ECA 1995 and ECR 1997 set screening criteria to classify industries/projects based on potential environmental impacts as follows: Green (pollution-free), Orange-A, Orange-B and Red (cause significant environmental impacts). The screening criteria is based on project or industry type and do not consider the scale and location. The category determines the level of environmental assessment.	No major gaps

[19] Islamic Development Bank, About IsDB. http://www.isdb.org/irj/portal/anonymous?NavigationTarget=navurl://24de0d5f10da906da85e96ac356b7af0

[20] UN Environment. UNEP and Islamic Development Bank Sign Agreement on Environmental Conservation. 20 January 2016. http://web.unep.org/newscentre/unep-and-islamic-development-bank-sign-agreement-environmental-conservation. (Accessed 6 December 2017)

[21] IsDB. What do Islamic Bank Care About the Environment: Role of Islamic Development Bank in Financing Sustainable Development. 6 March 2017.

[22] Asian Development Bank-Islamic Development Bank Partnership and Cofinancing Guide. 2016.

Table 2.4: Comparison of environmental safeguard principles ADB SPS 2009				
No.	**Principles**	**Delivery Process**	**GoB**	**Gaps (if any)**
2	Conduct an environmental assessment	• EIA and IEE - Identify potential impacts on physical, biological, physical cultural resources, and socioeconomic aspects in the context of project's area of influence (i.e., primary project site and facilities, and associated facilities) • ESMS for FIs	*Industry/project category* *Green* - no environmental assessment required *Orange A* - no IEE or EIA required but must provide process flow, lay-out showing ETP, etc. *Orange B* - IEE required *Red* - both IEE and EIA are required	No major gaps, however, SPS 2009 provides opportunities for the public to review and provide comments to the EIA through public disclosure of the environmental assessment in ADB website.
3	Examine alternatives	• Analyze alternatives to the project's location, design, and technology • Document rationale for selecting the particular project location, design, and technology • Consider "no project" alternative	Regulations (i.e., ECA 1995 and ECR 1997) do not require specifically the identification and analysis of alternatives	Not required by law but the TOR for EIA to be approved by the DoE now includes a discussion on analysis of alternatives. Analysis of alternatives will be included as a separate section in the EIA to meet requirements of SPS 2009 and DoE
4	Prepare an EMP	• EMP to include monitoring, budget and implementation arrangements	EMP and procedures for monitoring included in the IEE and EIA (i.e., Orange-A, Orange-B, and Red category projects)	No major gaps
5	Carry out meaningful consultation	• Starts early and continues during implementation • Undertaken in an atmosphere free of intimidation • Gender inclusive and responsive • Tailored to the needs of vulnerable groups • Allows for the incorporation of all relevant views of stakeholders • Establish a grievance redress mechanism	• Public consultation and participation are not mandatory based on ECA 1995 and ECR 1997 • Grievance redress mechanism is not mentioned in ECA 1995 and ECR 1997 • EIA format required by DoE includes stakeholders' consultation	Approval of the TOR of EIA by DoE now includes consultation with stakeholders. Consultations were conducted during the initial preparation of EIA and during the completion of draft EIA
6	Timely disclosure of draft environmental assessment (including the EMP)	• Draft EIA report posted on ADB website at least 120 days prior to Board consideration • Draft EA/EARF prior to appraisal • Final or updated EIA/IEE upon receipt • Environmental monitoring report submitted by borrowers upon receipt	No requirement for public disclosure of environmental reports but DoE posts the Minutes of the Meeting on the application for ECC to its website, http://www.doe-bd.org/minutes.php	Still no requirement for public disclosure of environmental assessment. Major gap. EIA will be posted in ADB website 120 days prior to

Table 2.4: Comparison of environmental safeguard principles ADB SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
				ADB Board consideration
7	Implement EMP and monitor effectiveness	• Prepare monitoring reports on the progress of EMP • Retain qualified and experienced external experts or NGOs to verify monitoring information for Category A projects • Prepare and implement corrective action plan if non-compliance is identified • Requires submission of quarterly, semi-annual, and annual reports to ADB for review	ECC is subject to annual renewal based on compliance of the conditions set by DoE	No major gaps
8	Avoid areas of critical habitats (use of precautionary approach to the use, development and management of renewable natural resources)	Provides guidance on critical habitats	ECA 1995 and ECR 1997 identifies ecologically-critical areas and the rules to protect them	No major gaps
9	Use pollution prevention and control technologies and practices consistent with international good practices	• Refers to World Bank's EHS General Guidelines 2007 (or any update) • If national regulations differ, more stringent will be followed • If less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification	• Effluent standards, ambient and emission standards included in ECA 1995 and ECR 1997 • Ambient noise levels included in Noise Pollution Control Rules 2006	No major gaps but EHS guidelines have more stringent standards.
10	Provide workers with safe and healthy working conditions	• Refers to World Bank's EHS General Guidelines 2007 (or any update)	Occupational health and safety standards included in the Factories Act 1965, the Bangladesh Labour Law 2006, and the Bangladesh Labor Act 2013.	No major gaps
11	Conserve PCR and avoid destroying or damaging them	• Use of field-based surveys and experts in the assessment • Consult affected communities on PCR findings • Use chance find procedures for guidance	Preservation and protection of cultural resources are within the Antiquities Act 1968.	No major gaps but national requirements do not include chance find procedures

ADB = Asian Development Bank, DoE = Department of Environment, EA = executing agency, EARF = environmental assessment review framework, ECA = Environment Conservation Act, ECC = environmental clearance certificate, ECR = Environmental Conservation Rules, EHS = Environmental Health and Safety, EIA = Environmental Impact Assessment, EMP = environmental management plan, ETP = effluent treatment plant, FI = financial intermediary, IEE = Initial Environment Examination, NGO = non-government organization, PCR = physical cultural resources, SPS = Safeguard Policy Statement, TOR = terms of reference, WB = World Bank.

3.0 DESCRIPTION OF THE PROJECT

3.1 Project Location

51. The project site is a developed but abandoned government industrial land of 50 acres earlier belonging to Khulna Newsprint Mill (KNM) Limited and is geographically located at around 22°51'11.32''N latitude and 89°32'56.00''E longitude on the eastern bank of the Bhairab River and on the western side of Bangladesh Industrial Development Corporation (BIDC) Road. The site is located at Khalishpur Upazila of Khulna District. The project location is shown in **Figure 3.1**.

52. Elevation at the project site varies approximately between +3.5 m to +2.3 m while the surrounding area varies about +3.3 m and +3.2 m, and towards the bank of the Bhairab River varies between +2.9 m and +2.1 m. The highest water level in Khulna is 3.86 m which occurred in 2005 based on yearly water level recorded by the Bangladesh Water Development Board (BWDB) since 1946. According to the Bangladesh Power cell (Hydrological Investigation and Model Study of Bhairab River, May 2016), maximum flood level is 3.86 m PWD or 4.32 m with a return period of 100 years. The BPDB requirement for site formation in its installation should be 0.8 m above high flood level (HFL) or 0.1 m above the nearest highway whichever is higher. Thus, to meet the requirement of BPDB and to consider the maximum flood level, the site must be at elevation 5.32 m rounded off as 5.5 m.

53. The site is well connected with Khulna city through metal road of 7.7 km and river route (which include Bhairab, Rupsha, Poshur to connect to Bay of Bengal). Khulna is a Divisional headquarter of Bangladesh and is well connected with Dhaka and all other cities of Bangladesh through road, rail, air and river route.

54. A number of strategically important structure (i.e. Key Point Installation) have been found around the proposed power plant details of which area is shown in **Figure 3.2**.

55. There is a mosque and a mass graveyard of 1971 liberation forces (*Mukti Bahini*) adjacent to the power plant area. The mosque is in a dilapidated condition and needs a massive renovation and the graveyard needs cleaning, dressing including some repairing as well. The mosque and the graveyard are about 200 m from the project boundary. The mosque and the graveyard are to be separated from the rest of the project area by constructing boundary wall and will be fenced with gate to allow for power plant employees to use the mosque for daily prayer and occasional visit to the graveyard.

56. The existing school buildings (one for boys and the other for girls) will be relocated outside of the power plant boundary. The proposed locations for the schoolhave been under consultation and yet to be confirmed. The school authority, school management committee, and NWPGCL continue to dialogue to have the best location. Other sensitive areas within the study area are given in **Table 3.1** and shown in **Figure 3.3.**

Table 3.1: List of environmentally-sensitive areas with GPS locations

Sensitive Areas within Project Study area	GPS locations
Graveyard	N22• 51' 22" E89• 32' 60"
Mosque	N22• 55' 23" E89• 38' 61"
Shohid Hadis Park	N22• 48' 32" E89• 34' 19"
Wonderland Park	N22• 51' 28" E89• 32' 19"
Kola Beel	N22• 52' 55" E89• 38' 40"
Basuakhali Beel	N22• 55' 27" E89• 38' 60"

Source: CEGIS field survey (from 26 to 30 October 2016).

Figure 3.1: Layout of Component 1

LEGEND

1. ARMY AREA
2. DORMITORY AREA
3. PARKING AREA
4. GUARD HOUSE
5. ADMIN BUILDING
6. WORKSHOP AND STORE
7. RMS AND GAS CONDITIONING PLANT
8. EXISTING JETTY–1
9. EXISTING JETTY–2
10. HSD UNLOADING STATION
11. HSD TRANSFER STATION
12. HSD FORWARDING STATION
13. HSD STORAGE TANK
14. HSD DAY TANK
15. STARTUP BOILER (OPTIONAL)
16. COOLING TOWER
17. HYDROGEN PLANT
18. NITROGEN PLANT
19. HRG–1
20. GAS TURBINE–1
21. STEAM TURBINE–1
22. STEAM TURBINE–2
23. GAS TURBINE–2
24. HRSG–2
25. CENTRAL CONTROL ROOM
26. ST–TRANSFORMER
27. GT–TRANSFORMER
28. AUXILIARY TRANSFORMER
29. STARTUP TRANSFORMER
30. FIREWATER PUMP HOUSE
31. FIREWATER TANK
32. SWITCH YARD
33. SWITCH YARD CONTROL ROOM
34. RIVER CROSSING TOWER FOOTING
35. RAW WATER INTAKE PUMP HOUSE
36. CLARIFIER
37. SAND FILTER
38. SLUDGE PIT
39. RO WATER TREATMENT PLANT
40. RAW WATER TANK
41. DM PLANT
42. CHEMICAL ROOM
43. DM WATER TANK
44. EFFLUENT WATER TREATMENT PLANT
45. EFFLUENT WATER STORAGE TANK
46. EFFLUENT WATER DISCHARGE POND
47. NEW JETTY
48. CW PUMP HOUSE

Figure 3.2: Location of Component 1

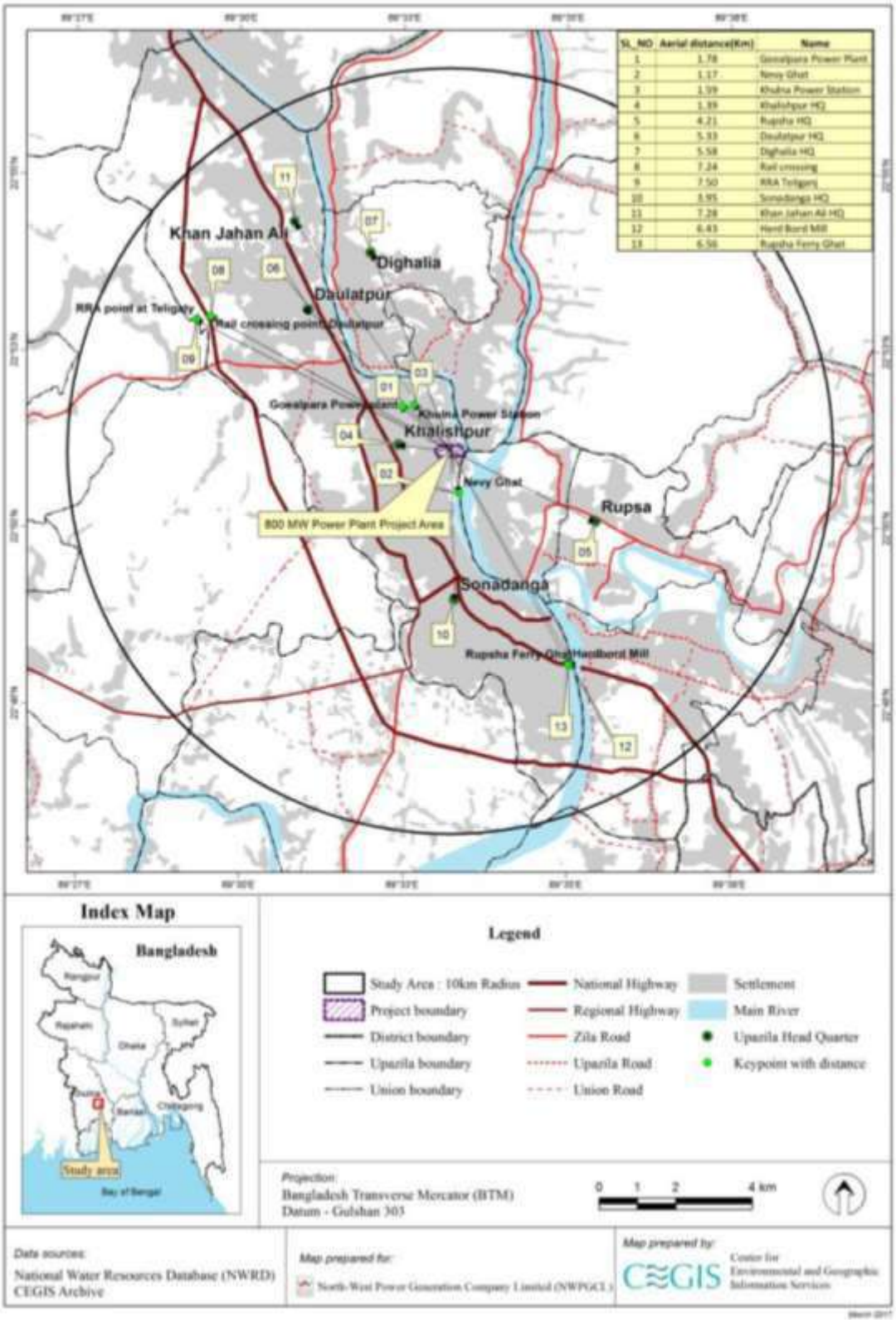


Figure 3.3: Important environmental and social areas

3.2 Nature and Size of the Project

57. The proposed project is a dual-fired combined cycle power plant (CCPP) that will use natural gas as primary fuel with HSD as back-up. There will two units of 400 MW each (2x400MW) with built-in low NO_x emission control technology, and closed-loop forced-draft cooling tower system. Natural gas will be supplied by SGCL from the Khulna CGS through a 10 km, 24 inch gas distribution pipeline while HSD will be supplied by Bangladesh Petroleum Corporation Limited (BPCL) from Daulathpure, Khulna. The net power generation capacity of the proposed CCPP will be 767.84 MW in gas and 648.34 MW in HSD. If operated as simple cycle power plant, the net power generation using natural gas will be 512 MW and 432 MW with HSD.

3.3 Project Components

58. According to the feasibility study, each unit of the proposed power plant shall have one industrial type F-class multishift gas turbine coupled with hydrogen-cooled generator of capacity 270 MW for indoor installation with a bypass stack of 50 m high with diverting damper for simple cycle operation, one horizontal type HRSG with main stack 70 m high for outdoor installation, and a heavy duty condensing type steam turbine coupled with a generator of 135 MW capacity for indoor installation in the configuration of 1:1:1.

59. Other auxiliary components are feed water pumps, condensate extraction pumps, air compressor, gas booster, cooling towers, two-three phase step up transformers (from 15 kV to 230 kV) of 360 million volt amperes (MVA) for gas turbine and 180 MVA for steam turbine capacity with one spare, 230 kV switchyard with all electrical components like circuit breaker, isolators,

lightning arrester, the HSD supply facility (two storage tanks with capacity each of 15,000 m^3, the gas supply facility which includes the RMS and gas skid, the water treatment facility which includes river water intake, demineralized water treatment plant, effluent treatment plant, reverse osmosis (plant and sewerage treatment plant. Other common facilities are residential and social activity area, internal roads, greenbelt, etc. There is an existing jetty but a new permanent jetty will be constructed to unload the HSD during operational phase. The design of the new jetty will be finalized in the detailed engineering design stage after appointment of EPC contractor. With the new jetty, localized dredging of small quantity will be carried out in the jetty area. Cast in-situ pile is envisaged for the construction of jetty which will create less vibration during construction. Potential impacts and/or inconvenience will be localized and the stretch in the Bhairab River directly affected is not frequented by the Ganges River dolphins. However, the impacts on the dolphins and required mitigation measures for construction of jetty will be included in the EMP.

60. **Table 3.2** presents the breakdown of component and area allocated.

Table 3.2: Breakdown of components and area

Buildings	**Area**	
	acres	**m^2**
Guard house, dormitory, parking area	0.58	2,361
Admin building and workshop	2.08	8,434
RMS and fuel gas conditioning skid	2.31	9,333
Switchyard	4.13	16,713
GTG 1, HRSG 1 & STG 1	3.18	12,887
GTG 2, HRSG 2 & STG 2	3.19	12,890
Laydown Area	3.30	13,338
Demineralized water treatment plant	2.12	8,597
Cooling water system	2.49	10,082
HSD fuel storage system	2.72	10,993
River water treatment plant	3.49	14,113
Fire-fighting water storage	0.67	2,707
Roads	5.87	23,748
Existing facilities (i.e., buildings that will remain mosque, graveyard &guest house)	1.05	4,252
Spare land	11.65	47,139
Total	48.83	197,587

3.4 Project Activities

61. The major activities of the project during pre-construction, construction and post construction phases are as shown below:

A. Pre-construction phase

1. Appointment of the Engineering, Procurement, and Construction (EPC) Contractor
2. Complete and finalize detailed design of CCPP by EPC Contractor
3. Land ownership transfer by GoB
4. Update/revise the EIA based on detailed design, submit to ADB and repost to ADB website prior to construction works
5. Detailed survey for site development including contaminated land risk assessment and site investigation

6. Assessment for presence of asbestos and asbestos-containing material in the existing structures to be demolished
7. Remedial measures in handling asbestos or asbestos-containing material (if any)
8. Demolition of the existing structures at the project site (151 structures)
9. Implementation of EMP for pre-construction phase

B. Construction phase (after EIA approval by DoE)

1. Civil construction and equipment and machineries erection work
2. Post erection check and pre-commissioning test
3. Environmental and social compliance monitoring of construction work (Implementation of EMP)
4. Commissioning test
5. Reliability test run for Provisional Acceptance Certificate
6. Commercial operation of the plant for Final Acceptance Certificate
7. Overall project management

C. Post construction

1. Commercial operation of the plant
2. Environmental and Social Monitoring during operation phase (Implementation of EMP during operation phase)
3. Proper O&M of the plant for efficient running

3.5 Project Plan and Schedule

62. The project is originally scheduled to be completed on the first block on 31st December 2019 and the second block in June 2020. The feasibility study was scheduled to be completed by end of August 2016. **Table 3.3** and **Figure 3.4** show the project implementation schedule (in months) based on Study team's optimization:

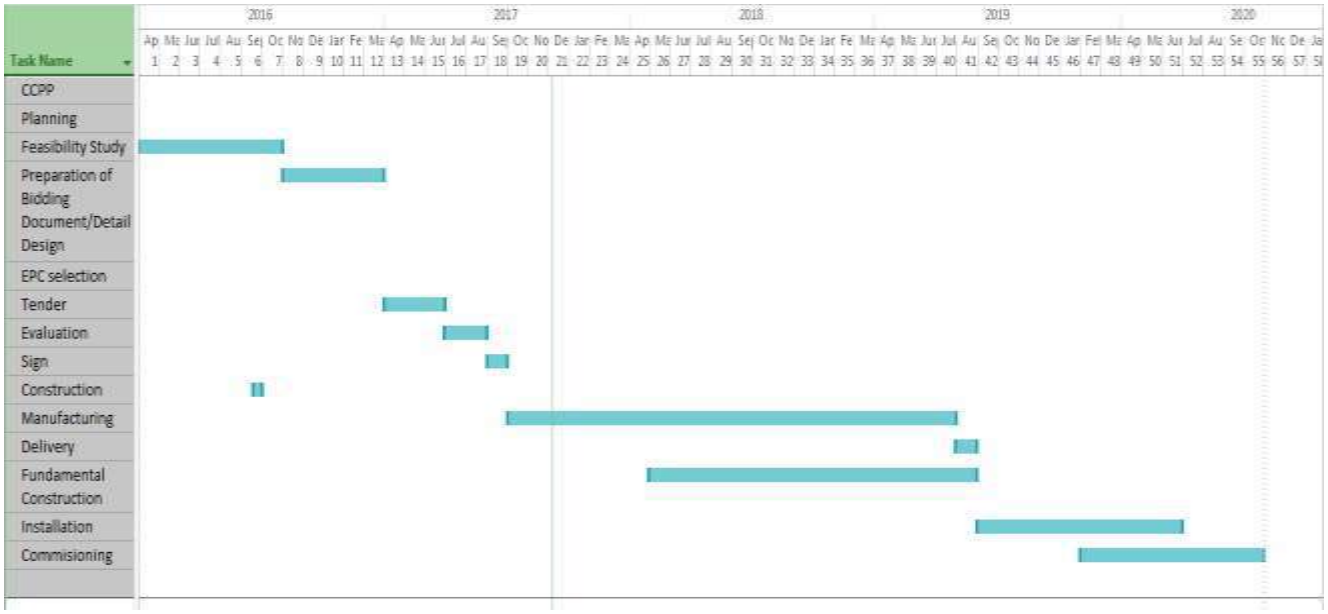
Table 3.3: Project implementation schedule

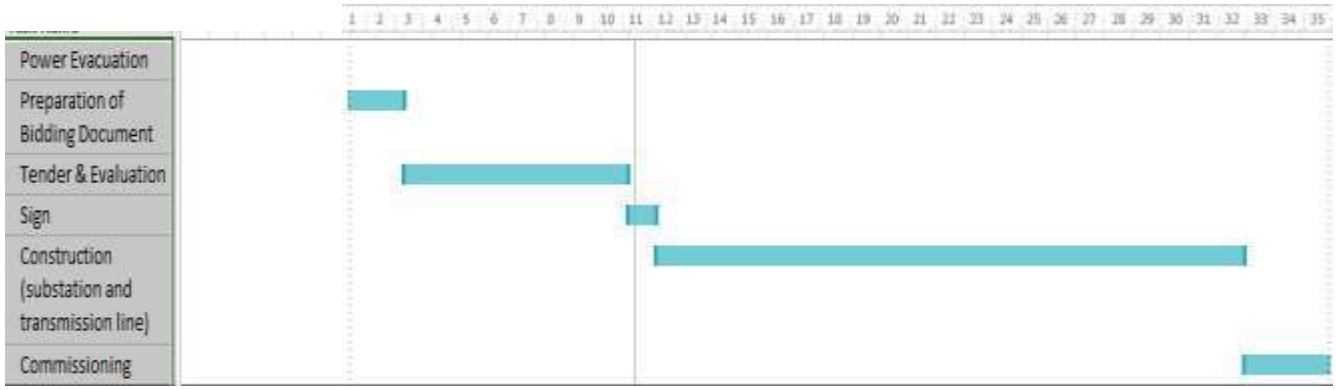
Rupsha 800MW CCPP		
Activity	**Description**	**Number of Months**
Planning	Feasibility Study	5
	Preparation of Bidding Documents/ Detail Design incorporating the EMP of the ESIA report	3
EPC Selection	Tender	3
	Evaluation	2
	Sign	1
Construction	Manufacturing of Equipment	23
	Delivery	1
	Fundamental Construction	12
	Installation	4 (each block)
	Commissioning	4 (each block)
Power Evacuation		
EPC Selection	Preparation of Bidding Documents incorporating the EMP of the ESIA report	2
	Tender and Evaluation	9
	Sign	1
Construction	Construction	21
	Commissioning	3

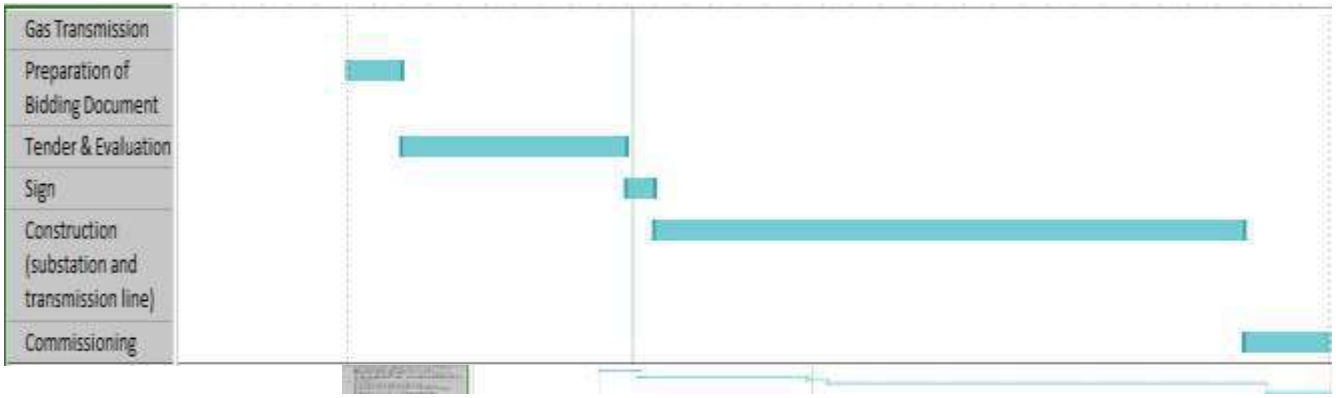
Gas Transmission		
EPC Selection	Preparation of Bidding Documents incorporating the EMP of the ESIA report	2
	Tender and Evaluation	9
	Sign	1
Construction	Construction	21
	Commissioning	3

CCPP = combined cycle power plant, EMP = Environmental Management Plan, EPC = Engineering, Procurement and Construction, ESIA = Environmental and Social Impact Assessment, MW = megawatt.
Source: Feasibility Study 800MW CCPP 2017.

Figure 3.4: Project implementation schedule







3.6 Resources and Utilities Needed

63. Resources and utilities required to develop component 1 include soil, construction materials, manpower, electricity, fuel, water, power plant machineries, etc.

64. The project site needs to be improved to meet the required elevation set by BPDB for their key point installation. Based on the revised estimates in the Feasibility Study (August 2017), about 467,975 m^3 of ground filling will be needed to prevent ponding in the project site. Filling materials may come from the demolition works or sand. Only GoB-approved providers of sand materials will be sourced for the project, no new sources should be opened for the project.

65. The quality of the Bhairab River is influenced by tidal flows as reflected by the salinity content (less than 1 ppt in all the 10 sampling stations in the study area of Bhairab River, Atai River and Rupsha River measured by IUCN from May 2017 until January 2018). Water quality data from the Bhairab River within 2008-2010 showed values of electrical conductivity ranging from 220 to about 22,000 µS/cm (Feasibility Study August 2017). This water quality cannot be used for condenser and for cooling. High salinity water lowers vapor pressure of the water making it slow to evaporate. This makes it less effective as coolant and reduces cooling tower performance.

66. Water from the Bhairab River will require pre-treatment to meet the water quality of the CCPP. The pre-treatment will involve conventional treatment (i.e., aeration pool, coagulation, flocculation, clarification and filtration) to produce treated water that will meet the quality for cooling water. Due to salinity, the treated water will undergo reverse osmosis (RO). Water from the RO process will be further treated into the demineralization plant.

67. Demineralized water will be for continuous make-up of steam turbine cycle, HRSG, gas turbine as well as for gas turbine compressor washing, NOx control during HSD firing, dosing system, and the cooling tower system. The demineralized water treatment plant will consist of multilayer filters, cation/anion exchangers, mixed-bed polishers, a regeneration system, demineralised water storage tank, and all the piping, valves, and automatic control system.

68. Potable water for domestic use will be provided by the Khulna Water Supply and Sewerage Authority.

69. Electricity. There is a local electrical distribution system which can be used during pre-construction, construction, and operation stage.

70. It is anticipated that about 3,000-3,500 workers will be employed (skilled, unskilled, supervisors, engineers, management staff, etc.) at the peak of construction to accelerate work. NWPGCL employees will be around 30 during the construction phase. Local hiring will be given priority and there will be transparent recruitment process. Majority of the workers to be recruited will be local people who would likely stay or go home to their houses or may rent in the immediate vicinity if they live far from the site.

71. For foreign workers, the EPC Contractor will make arrangements for their accommodation. No dormitory or labour camp will be built within the 50 acre-site due to space constraints. The EPC Contractor can either negotiate with the KNM authority for the remaining space or other area to construct temporary living quarters for their foreign staff. The EPC Contractor will provide the necessary labour camps. Labour camps should be located 500 m from residential properties and at least 100 m from waterbodies or groundwater wells. Adequate facilities should be provided for

workers in accordance with national requirements and acceptable best international practice.[23] Two temporary stacked, steel container shed can be converted into construction site office. These container shed can accommodate about 8-10 workers.

72. During O&M phase, EPC Contractor will employ three persons for the warranty period (i.e., 2 years from plant takeover) and NWPGCL employees are expected to be around 175. Feasibility study consultant has proposed 11 persons during engineering phase, 19 persons during construction phase, and 18 persons during operation phase. All these persons are the regular employee of NWPGCL who will be accommodated in the new NWPGCL's residential dormitory for Component 1.

3.6.1 Water Demand and Source

73. In a gas based CCPP, water is mainly required for steam generation, condenser and other auxiliary equipment cooling, HRSG makeup, service water, domestic purposes etc. Major part of water is required for condenser cooling. Water from the Bhairab River will be used for cooling system but will require pre-treatment. The Feasibility Report (August 2017) indicates that a one-time abstraction of water to fill the cooling tower is 60,000 m^3. A make-up water of 2,010 m^3/h will be needed which is only 0.12% of the total discharge of the Bhairab river. Thus, the water requirement for Component 1 from the Bhairab River it is not expected to cause conflict in water uses during the dry season.

3.6.2 Sources and Transportation of Construction Material

74. Construction materials generally include land filling material (sand, earth), cement, brick, mild steel road, shuttering material, etc. Most of these construction materials will be available in the local markets of Khulna and its surrounding area and can be brought to the site by road or river transport. Land filling materials will be taken by the Contractor only from GoB-approved site/providers and no new sources should be opened for the project.

3.6.2 Transportation of Equipment, Machinery, etc.

75. Heavy machineries and equipment like HRSG, turbo- generator rotor, transformer, switch yard equipment, etc. will come from abroad. The equipment can be shipped to the Mongla Port then transferred to barges or lighter vessels. Navigation and river transport of equipment and construction materials will consider the movements of the Ganges River dolphins based on the results of the assessment done by the IUCN for component 1.

76. The maximum carrying limit for transportation by road is 70 tons and if by railway, it would require transport by road from the railway station. Thus, the best option that will cause less disturbance and inconvenience to local people, will be through river navigation. The weight of the major equipment that will be transported to the site ranges from 50 tons (transformer) to 320 tons (gas turbine transformer). Equipment will be unloaded to barges from the main vessel at Mongla Port and will be carried through the river in smaller vessels to the project site. Bhairab River is classified as Class II by the Bangladesh Inland Water Transport Authority (based on minimum depth, length of route, and minimum vertical and horizontal clearance). Atai River and Rupsha River are Class III. Barges/cargo boats that will deliver equipment to the site will have a vertical clearance of 12.2 m and horizontal clearance of 76.22 m.

[23] http://www.ebrd.com/downloads/about/sustainability/Workers_accomodation.pdf.

77. There are two jetty left from the operations of KNM but only one is within the 50 acres earmarked by the GoB for Component 1. The condition of the existing jetty will be assessed by the EPC Contractor for safety and stability, and if it needs refurbishment or rebuilding. A new jetty will be designed and constructed fit for the purpose of handling heavy equipment transport.

3.6.3 Requirement, Source and Composition of Fuel for Plant Operation

78. Natural gas will be the primary fuel and will require a maximum of 125 million cubic feet per day (MMCFD). This will be supplied by the SGCL from the Khulna CGS in Aronggatha through a 10 km, 24-inch gas distribution pipeline terminating to the regulation and metering station (RMS) at the power plant site. The pipeline will be constructed following the requirements of the Natural Gas Safety Rules 1991 (amended 2003) and the relevant industry-codes and international standards. Composition of natural gas required will be a minimum of 85% mole methane (CH4). The following sources from imported regasified liquefied natural gas (R-LNG) and domestic supply will provide adequate supply of natural gas for Component 1.

- FSRU Moheskhali - 500 MMSCFD of R-LNG will be made available by April 2018 developed by Excelerate Energy, USA-Bangladesh
- Summit LNG Terminal Company Limited – 500 MMSCFD R-LNG will be made available by October 2018
- GoB and RasGas (Qatar) has signed a deal in September 2017 for a 15-year LNG sales and purchase agreement to supply 1.8 million (M) tons LNG/year for 5 years and 2.5 M tons/year for the next 10 years
- According to Petrobangla, there will be additional supply (domestic) of 2,750 MMSCFD
- By 2021, Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) will have 55 exploration wells and 31 development wells

79. The natural gas produced in Bangladesh is “sweet gas” (does not contain hydrogen sulphide) and thus, all the existing natural gas transmission and distribution pipeline networks are designed for high quality natural gas.

80. The use of HSD as secondary fuel will be required in case of emergency and is estimated to be about 500 hours maximum per year (or about 21 days annually assuming continuous operation of 24 hours, or less than 2 days per month). HSD requirement will be about 2,773 kiloliters (KL or m^3) per day. Two HSD storage tanks with a capacity of 15,000 cubic meter (m^3) will be constructed within the power plant site. Each storage tank can supply about 5 days of continuous operation on HSD. Fuel supply agreement between BPC and NWPGCL in November 2015 provides that the HSD will have a maximum sulfur content of 0.25% by weight ($_{wt}$). In practice, BPC has provided NWPGCL with HSD with sulfur content of 0.1% wt analyzed in 2016 by the Chemical Engineering Department of Bangladesh University of Engineering and Technology.

3.6.3 Potential Pollution Sources and Mitigation Measures.

81. Emissions from gas turbine using natural gaswill be NO_x and CO_2, and if run on HSD, it will be NO_x, SO_x, PM and CO_2. Dry low-NOx burner will be used to reduce generation of NO_x during combustion and water dosing if fired on HSD. The sulfur content of HSD will be 0.25% wt and will be used for maximum of 500 hrs per year while gas will run for 5,632 hrs per year on an average plant factor of 70%.

82. There is no requirement from the DoE to replace trees cleared due to the project. However, a greenbelt will be included within the project site which can serve as buffer for noise generated by the power plant. The development of green belt of at least 3.5 m is recommended as noise buffer at the same time, replace the trees cleared. It is strongly recommended to develop regular greenbelt as part of corporate social responsibility. Given the area allocated for Component 1, development of greenbelt to replace the entire vegetation lost in the 30-acre land may not be accommodated in the project site. However, there will be greenbelt development required by BPDB in their key point installation like Component 1.

83. Cooling tower will be used to reduce water requirements compared to once-through cooling systems. There will be three exhaust silencers, low-noise type of fans and cylindrical hood at the air exit of axial air fans from the cooling towers to reduce noise generation.

3.6.5 Tentative Costing and Funding

84. Based on the Final Feasibility Report (August 2017) the estimated cost of the project is about $750M (see **Table 3.4**).

Table 3.4: Tentative cost of the project

Items	Cost (in $ million) (ADB & IsDB)
Plant Cost	630.18
Power Evacuation	23.2
Gas Distribution	6.17
Engineering and Consultancy	11.38
Other Costs	78.94
Total Cost	**749.87**

3.7 Project Site Development

85. The project site is an area formerly used by the Khulna Newsprint Mills (KNM) Limited located in Khalishpur Thana, Khulna Division. KNM was under expatriate management from start in 1959 until the end of 1965 when it was put under the management of the East Pakistan Industrial Development Corporation. KNM was the first and major producer of newsprint paper in Bangladesh using Gewa wood (*Excoecaria agallocha*), a native mangrove species in Bangladesh, as raw material. Sand well and Company, a Canadian firm, was engaged as a consultant in the construction and commissioning of KNM. Beset with problems ranging from market behaviour after the independence, availability of spare parts, low capacity utilization (newsprint production at KNM has not been able to reach the levels achieved prior to independence), operational management, price of oil, interrupted supply of raw material due to security issues, etc., GoB stopped its operations completely in November 2002.

3.7.1 Site Preparation

86. There are about 151 structures standing within the 50 acres consisting of 122 primary residential structures such as bungalow for the Managing Director, dormitories and residences of staff, kitchen and dining, guest house, and Ansar camps, etc. while the remaining 29 structures are non-residential like auditorium/cinema, water tank, fire fighting system, swimming pool and rest house, mosque, boys and girls school, etc. **Table 3.5** presents the inventory of structures

abandoned at the project site. **Figure 3.5** presents the location of the structures, while **Figure 3.6** shows the graveyard marker and the mosque which will be retained.

87. These structures will be demolished but three structures will remain: (i) the mosque; (ii) the graveyard marker (a PCR based on SPS 2009); and (iii) the three-story managing director's guest house. The mosque and the graveyard are beyond the boundary of the power plant, about 200 m. The mosque will be refurbished including renovation and beautification works. New boundary walls will be built around the mosque while the graveyard marker will be also refurbished including renovation and fencing. Final design and extent of renovation works for both the mosque and graveyard marker will be finalized during the detailed engineering design in consultation with the *Imam*, elderly, and other stakeholders. The fence and boundary wall for the mosque will be for security reasons and a separate access will be provided. The three-story guest house would also be refurbished and retained.

88. *Demolition*. The demolition of the existing structures in the project site will not be funded by ADB or IsDB. Based on the inventory of the structures, most of them are made of bricks, reinforced concrete, tin sheets, pacca and semi-pacca ranging from single to three-story buildings. Demolition will be done through tendering process. The winning bidders will take care of the works which would take no more than 4 months. The bidding document which will be tendered by NWPGCL will specify the regulatory requirements and permits/standards/codes relevant to demolition and disposal of material and debris, by which the contractor will be required to comply. Protection measures will include provision of enclosures during demolition works, spraying of water to contain dust, working during daytime only, use of personal protective equipment such as safety belts, boots, masks, etc. Prior to any demolition works, an assessment for asbestos and asbestos-containing material from the structures will be required by NWPGCL. This will be incorporated in the bid documents and a copy of the assessment results will be provided by NWPGCL to ADB. NWPGCL will inform the Contractor that the demolition works will be part of the environmental monitoring of Component 1. As such, the environmental staff of NWPGCL or consultant will oversee and monitor the demolition works.

89. The mosque and the graveyard marker are not close to the buildings that will be demolished. Nonetheless, the Contractor will be required to describe how the remaining structures will be protected. Demolition works will start once the new schools are completed and the children have moved to the new place to minimize disturbance to their school activities. The disposal of debris shall be either carted away to suitably designed and licensed designated disposal area assigned by the Khulna Municipal Corporation or it may also be taken away by third party to be used as backfill material.

90. Demolition works will comply with the Bangladesh National Building Code 2006, and the relevant regulations of Khulna Municipal Corporation, and the Khulna Development Authority (KDA).

91. *Clearing of* trees. The type of trees that will be cleared is mainly fruit trees (1,777 trees). Prior to clearing of trees, a tree cutting permit will be obtained from the DoE by the EPC Contractor, as required by the Forest Act, 1927 (Act No. XVI of 1927).

Table 3.5: Description of Abandoned Structures in the Project Site

SL	Name of Building	No. of. Structure	Type of Bldg.	Type of Structure	Category	Number of Story	Area per structure (m^2)	Total Area (m^2)	Total Area (ft^2)	Construction Year
Residential Structures (primary)										
1	MD's Bungalow	1	P	RCC	R	2	192.57	192.57	2,071.75	1960
2	Junior Colony	1	P	LBWS	R	1	195.17	195.17	2,099.72	1960
3	Junior Colony Building	10	SP	LBWS	R	1	279.75	2,797.50	30,096.62	1960
4	Junior Colony Building	14	TS	LBWS	R	1	17.74	248.33	2,671.63	1960
5	Junior Colony Building	1	P	LBWS	R	1	1354.18	1,354.18	14,568.81	1960
6	Junior Colony Building	1	P	LBWS	R	1	306.70	306.7	3,299.60	1960
7	New Colony Bachelor Quarter	2	P	LBWS	R	1	1962.83	3,925.65	42,233.71	1960
8	New Colony Building	4	P	LBWS	R	1	1177.70	4,710.78	50,680.46	1960
9	New Colony Building	4	P	LBWS	R	1	1491.64	5,966.54	64,190.42	1960
10	New Colony Building	5	P	LBWS	R	1	1318.22	6,591.08	70,909.48	1960
11	New Colony Building	2	P	LBWS	R	1	223.05	446.1	4,799.32	1960
12	Senior Colony Apartment	7	P	RCC	R	2	541.26	3,788.85	40,761.96	1960
13	Senior Colony Bungalow	24	P	LBWS	R	1	172.76	4,146.28	44,607.34	1960
14	Senior Colony Building	2	P	RCC	R	3	1246.83	2,493.66	26,827.79	1960
15	Senior Colony Building	1	P	RCC	R	2	831.23	831.23	8,942.70	1960
16	Senior R House	19	P	LBWS	R	1	196.63	3,736.06	40,194.03	1960
17	Senior R House	1	P	LBWS	R	1	466.54	466.54	5,019.22	1960
18	Senior R House	3	P	LBWS	R	1	263.94	791.82	8,518.72	1960
19	Senior officers Dormitory	1	P	LBWS	R	1	110.59	110.59	1,189.77	1960
20	Senior Officers Hostel	1	P	LBWS	R	1	790.00	790	8,499.14	1960
21	Officers Rest House	1	P	RCC	R	3	1207.81	1,207.81	12,994.10	1960
22	Guest House	1	P	RCC	R	3	1100.00	1,100.00	11,834.24	1990

SL	Name of Building	No. of. Structure	Type of Bldg.	Type of Structure	Category	Number of Story	Area per structure (m^2)	Total Area (m^2)	Total Area (ft^2)	Construction Year
23	Mess No. 10	1	SP	LBWS	R	1	211.89	211.89	2,279.60	1960
24	Rest House Dinning	1	P	LBWS	R	1	98.14	98.14	1,055.83	1960
25	Kitchen	1	SP	LBWS	R	1	21.47	21.47	230.98	1960
26	Ansar Camp x2	2	SP	LBWS	R	1	70.59	141.17	1,518.76	1960
27	Foreman Quarter	10	P	LBWS	R	1	269.52	2,695.17	28,995.72	1960
28	Sweper Colony	1	P	LBWS	R	1	348.51	348.51	3,749.41	1960
Subtotal		122					16467.24	49713.79	534840.84	
Non-Residential Structures (primary)										
1	Office Club	1	SP	RCC	NR	1	563.94	563.94	6,067.09	1960
2	Office Club-2	1	SP	RCC	NR	2	458.09	458.09	4,928.32	1960
3	Colony Electric office	2	SP	LBWS	NR	1	32.02	64.03	688.86	1960
4	Colony Office	1	SP	LBWS	NR	1	100.80	100.8	1,084.45	1960
5	Senior Colony Office	1	P	LBWS	NR	1	79.00	79	849.91	1960
6	Sewing Centre	1	SP	LBWS	NR	1	74.35	74.35	799.89	1960
7	Senior colony Mosque	1	p	LBWS	NR	1	7.60	6.1	499.01	1960
8	Secondary School (Boys')	1	P	LBWS	NR	4	334.45	1337.8	14,399.95	1960
9	Secondary School (Boys')	1	P	LBWS	NR	1	334.45	334.45	3,599.99	1960
10	Secondary School (Girls')	1	P	LBWS	NR	2	334.45	668.9	7,199.97	1960
11	Secondary School (Girls')	1	P	LBWS	NR	3	334.45	1003.35	10,799.96	1960
12	Madrasa	1	p	LBWS	NR	2	18.29	4.57	900.46	1960
13	Madrasa	1	p	LBWS	NR	1	24.39	6.10	1,600.82	1993
14	Auditorium/ Cinema hall	1	SP	LBWS	NR	2	54.9	18.3	10,805.52	1960
15	Auditorium/ Cinema hall	1	P	LBWS	NR	1	15.2	7.6	1,250.64	1960
16	Intake Channel	1	P	LBWS	NR	1	258.75	258.75	2,783.74	1960

SL	Name of Building	No. of. Structure	Type of Bldg.	Type of Structure	Category	Number of Story	Area per structure (m^2)	Total Area (m^2)	Total Area (ft^2)	Construction Year
17	Plyers Room x3	3	SP	LBWS	NR	1	38.10	114.31	1,229.79	1960
18	Water Pump House	2	SP	LBWS	NR	1	18.22	36.44	392.24	1960
19	Overhead Water Tank (pillar)	1	P	RCC	NR	4			14,400	1960
20	Fire Pump House	1	TS	LBWS	NR	1	9.15	4.57	449.92	1960
21	Electric office Garage	1	TS	LBWS	NR	1	4.57	4.57	224.80	1960
22	Swimming Pool RCC	1	P	RCC	NR	1	267.94	267.94	2,882.61	1960
23	Swimming Pool Rest Room	1	SP	LBWS	NR	1	28.25	28.25	303.92	1960
24	Swimming Pool Rest Room	1	P	LBWS	NR	1	24.54	24.54	264.01	1960
25	Toilet	1	P	LBWS	NR	1	12.64	12.64	135.99	1960
	Subtotal	29					3428.56	5479.41	88541.85	
	All Structures	151					19895.8	55193.2	623,382.68	
Secondary structures										
Gate in sqft									Area (sqft)	
1	Gate	1	IS		-		6.10	2.4	160.08	1960
2	Gate	1	IS		-		4.57	2.1	105.05	1960
3	Gate	2	IS		-		2.13	1.1	24.51	1960
4	Gate	4	M		-		3.05	1.8	60.03	1960
5	Gate in MD's Bungalow	1	M		-		3.05	1.5	50.03	1960
	Subtotal	9					18.90	8.99	399.70	
Wall in running feet (rft)									Area (rft)	
1	Wall	1	-	BW	-	-	-	-	600	1960
2	Wall (5 inch)	-	P						4570	1960
	Post in number								Number	

SL	Name of Building	No. of. Structure	Type of Bldg.	Type of Structure	Category	Number of Story	Area per structure (m^2)	Total Area (m^2)	Total Area (ft^2)	Construction Year
3	Lamp post	15	S	S					15	1960
4	Lamp post	40	P	RCC					40	1960
	Water Tank in cubic feet (cft)								Area (cft)	
5	Overhead Water Tank (container)	1	P	RCC	-	-	-	-	10,500.00	1960

BW = Barbed Wire, IS = Iron Sheet, LBWS = Load Bearing Wall Structure, M = Metal, NR = Non-residential, P = Pacca, R = Residential, SP = Semi pacca, TS = Tin shade, S = Steel.

Figure 3.5 Location of existing structures in the project site

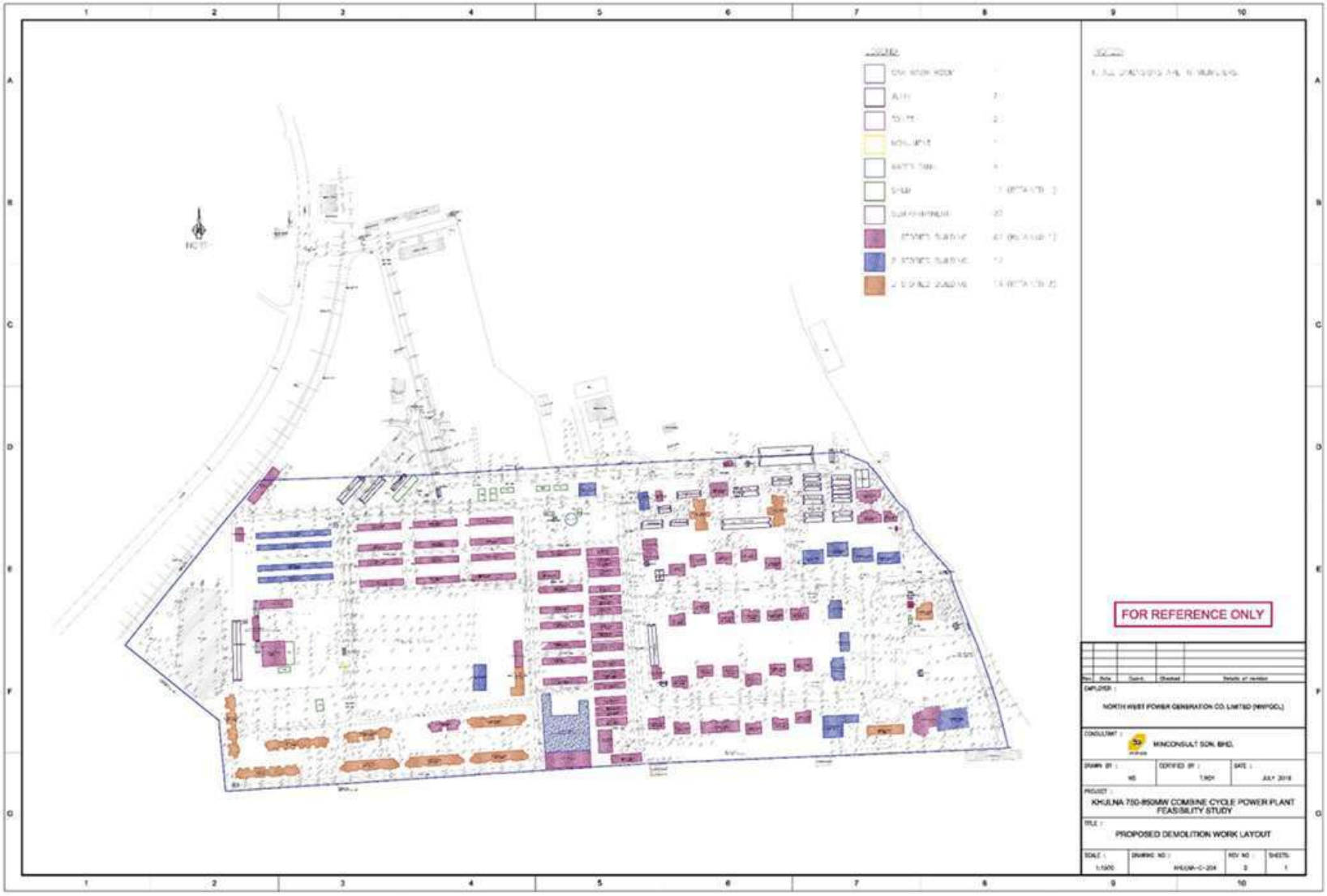


Figure 3.6: Sites to be isolated

Graveyard marker

Mosque

92. Elevation at the project site varies approximately between +3.5 m to +2.3 m while the surrounding area varies about +3.3 m and +3.2 m, and towards the bank of the Bhairab River varies between +2.9 m and +2.1 m. The highest water level in Khulna is 3.86m which occurred in 2005 based on yearly water level recorded by BWDB since 1946. According to the Bangladesh Power cell (Hydrological Investigation and Model Study of Bhairab River, May 2016), maximum flood level is 3.86 m PWD or 4.32 MSL with a return period of 100 years. The BPDB requirement for site formation in its installation should be 0.8 m above high flood level (HFL) or 1 m above the nearest highway whichever is higher. Thus, to meet the requirement of BPDB and to consider the maximum flood level, the site must be at elevation +5.32 m rounded off as +5.5 m. To have this elevation, the amount of filling required will be about 467,975 m^3.

93. *River bank protection at Bhairab River*. The river bank will be protected from erosion by means of rock armour, rock filter and MIRANFI PP200S Fabric Filter Membrane or equivalent. The river bank protection is shown in **Figure 3.7** while **Figure 3.8** shows the project layout with the river bank protection.

3.8 Technology and Process Description of Individual Plant Components

3.8.1 Power generation

94. A CCPP mainly consists of a combustor, gas turbine generators (GTGs), a HRSG and a steam turbine generator (STG), a cooling system and fuel supply system. Natural gas from the RMS via gas booster mixes with compressed ambient air in the combustor and then ignites. The hot flue gas thus produced from the combustor is then directed to the GTG, where it expands, loses pressure and temperature and causes the GTG to spin and generate about two thirds of plant's power at the generator terminal.

95. The exhaust flue gas from the gas turbine at a temperature of 886^{o}C is directed to HRSG, where feed water is converted into steam at different pressures (high pressure - HP, intermediate pressure - IP and low pressure - LP) and is then directed to the STG where it expands and causes the STG to spin and generate one third of plant's power at the generator terminal. The generated power of GTG and STG at 15.75/230 kV and 10.5/230 kV respectively will be stepped up to grid voltage level of 230 kV by step up transformers (240 MVA for gas turbine and 120 MVA for steam turbine) and evacuated to the national grid (Khulna South Sub-station) via plant switch yard

located within the project site. Underground cables will be used for all inter-connections from transformer to the plant's switch yard. The condenser and other components cooling of the plant will be accomplished applying surface water from Bhairab River via cooling tower technology. A typical process flow diagram is shown in **Figure 3.9**.

Figure 3.7: River bank protection, Bhairab River

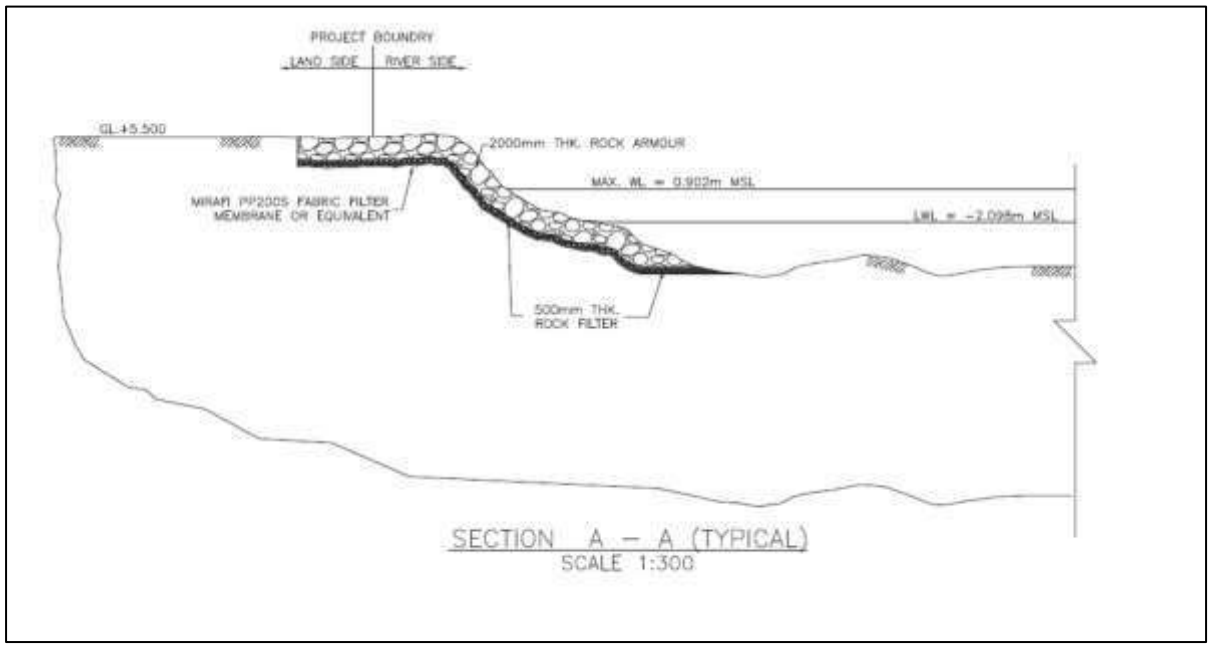


Figure 3.8: Project layout with the river bank protection

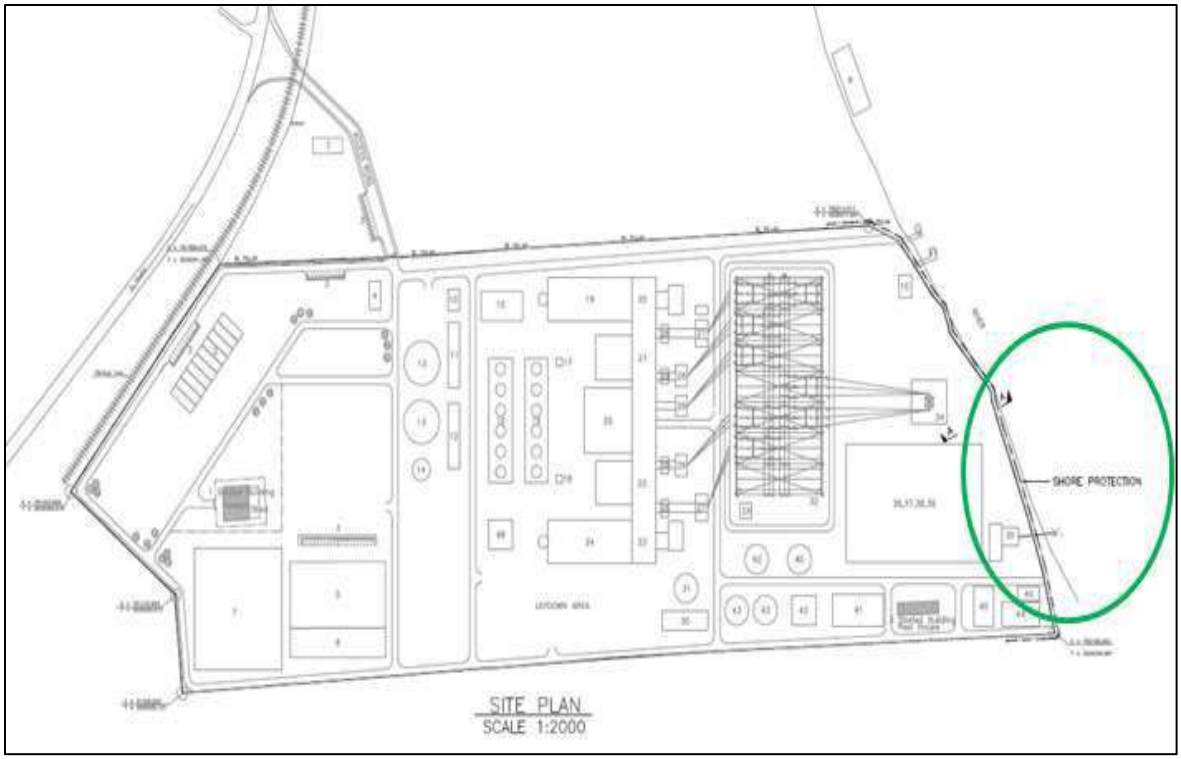
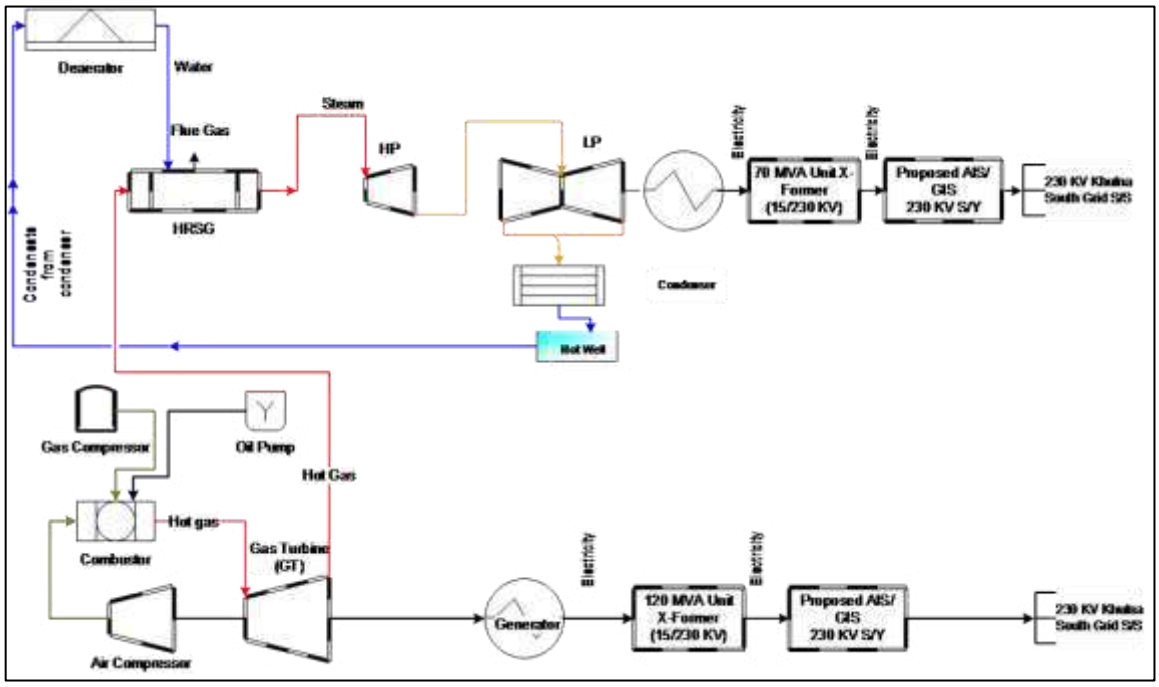


Figure 3.9: Process flow diagram of electricity generation



Source: CEGIS, 2017

3.8.2 Heat recovery steam generator boiler and its auxiliaries

96. The steam generating unit is a heat recovery steam generator (HRSG). An HRSG is an energy recovery heat exchanger that recovers heat from the gas turbine exhaust hot gas stream. It produces steam that can be used to drive a steam turbine by flowing horizontally over the vertical tubes and generates steam at different pressures (dual pressure HSRG). A dual pressure HRSG consists of two sections: a low pressure section and a high pressure section.

97. Each section has a steam drum, economizer, evaporator and a super heater. The primary function of the steam drum is to separate water from steam which prevents carryover of the condensate into to the steam header.

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

99. **Evaporator sections** are those sections where water boiling or steam generation occurs. Feed water coming in through the tubes below absorbs heat from gas turbine exhaust stream and starts evaporating to steam. Through riser tube steam water mixture flows upward and escapes into the steam drum where steam is separated from water and is further heated in the super heater section. This is known as natural circulation loop where thermal head differential between water and steam-water mixture is responsible for the circulation through the system.

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

101. An **HRSG feed water pump** supplies water into the HRSG drum. The water may be freshly supplied or returning condensate from the steam turbine condenser.

3.8.3 Turbine and its auxiliaries

102. A **turbine** is a rotary engine (mechanical device) that extracts kinetic energy of a moving fluid (Steam in this case) and converts it into mechanical energy or useful work. It has a series of higher temperatures withstanding blades (impulse and reaction) mounted on its shaft known as rotor. The fluid (Steam) goes inside through one end, pushing the blades and causing them to spin and finally escapes to atmosphere through stack (in gas turbine) or to condenser for condensation (in steam turbine).

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

104. A **combustor** is a component of a gas turbine where combustion takes place. HP air from the air compressor is fed into the combustion chamber that contains a ring of fuel injectors through which a steady supply of fuel is maintained. The fuel mixes with air and gets ignited. This

combustion produces a high temperature and HP flue gas stream that enters and expands in the gas turbine section and causes the Turbo Generator to spin and thus generates electrical power.

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

3.8.4 Fuel storage and handling system

106. SGCL will supply natural gas at a pressure of about 400psi through a pipeline of around 10km-long with 24-inch diameter. Gas pipeline will connect from the existing Khulna city gate station (CGS) to the RMS of the power plant. From this RMS gas will be supplied at a pressure of 150 psi to the gas booster. Using gas booster gas will be supplied to the gas combustor at a pressure of 330 ± psi.

107. HSD will be supplied by Bangladesh Petroleum Corporation (BPC) from its Daulatpur, Khulna depot. Two options were considered as possible routes for delivery to the CCPP in Khalispur. By road using tankers will be 3.1 km from the BPC depot to the CCPP and through the Bhairab River by barge at 3.3 km. There is an existing jetty, but the stability and condition will be assessed by EPC Contractor if it can handle unloading of HSD. To ensure reliability during operations, a new permanent jetty will be constructed to handle loading and unloading of HSD from barges and for general purposes. Two storage tanks for HSD will be installed at 15,000 m^3 each. These two tanks can handle 10 days of continuous operation on HSD.

3.8.5 Water System and Water Balance

108. According to the Feasibility Report (August 2017), the hourly water requirement of the plant is 2,010 m^3/h as makeup for plant cooling and all other purposes. The required water will be taken from the Bhairab River. A water balance diagram has been developed showing the use of forced draft cooling tower technology with surface water (**Figure 3.10**).

109. **Intake channel.** The use of forced draft closed-loop cooling system, some 4% of the re-circulating water flow rate must be made up to compensate for blowdown water and evaporation, and water drift losses depending upon the design parameters of the tower. The blowdown water flow rate is assumed some 2% to keep the solid concentration in the circulating water within 2 times that in the makeup water. The remaining 2% is required for compensation of evaporation and water drift losses. Therefore, the required makeup water flow rate can be estimated at 2,010 m^3/hr. Intake channel is shown in **Figure 3.11**.

110. The area for the water treatment facility including river water intake facility, demineralized water treatment plant, effluent treatment plant, RO plant and sewage treatment plant is estimated to be approximately 5.61 acres. The area allocated for the other balance of plant including fire water reservoir, potable water tank, CO_2 storage area and hydrogen plant is estimated to be approximately 3.16 acres. The cooling water system (intake from river) shall consist of the intake bay, raw water lift pumps 3x50% duty. The cooling water system shall be equipped with E.O.T

crane (indoor) and an E.O.T crane for the intake bay (outdoor). The power distribution room and maintenance area shall be located in the cooling water pump house.

111. The depth of River Water Intake channel has been decided based on the low water Level and sufficient head to maintain the required velocity and discharge into the river water Intake channel. Thus, the invert level of the intake channel is kept approximately at 2.098 MSL (2.558mPWD) in order to have the required flow even at low water level of the River. The river water will be extracted through an intake which is designed to meet the requirements of the IFC EHS Guideilnes for Thermal Power Plants 2008 including a velocity of <0.5 ft/s, barrier nets and fine mesh screen to prevent entrapment/entrainment of fish and dolphin (if present). Twin cell reinforced concrete culverts are planned with approximate size of 5 mx2.5 m each. Each channel shall be equipped with a steel gate (size of bars <20cm to prevent dolphin entering the channel) and trash rack. The location of the water intake from the Bhairab River are not sites where the dolphins go as shown in the results of the IUCN study. There are six locations identified by IUCN as important dolphins' area and these are nowhere close to the discharge or intake for the project (**Annex 11** Map 3 of IUCN report).

112. The intake water will be filtered first and supplied to the reverse osmosis plant and cooling tower make up water system. The blow down water from all of the machineries, pipelines or other systems except the cooling tower blow down will be collected through drainage network into the ETP for treatment. All oil contaminated drains from process area (HRSG, turbine hall, transformer area, storage tanks, etc.) will be collected in retention basins for treatment by oil separator.

113. According to the water balance diagram, ETP will receive blow down from pipelines, HRSG, water treatment plant, oil separator, brine from the reverse osmosis plant for treatment. The ETP will maintain the more stringent effluent of industrial waste as mentioned in ECR 1997 (Schedule 10) and IFC-WB EHS Guidelines for Thermal Power Plants 2008 (Table 5). The treated wastewater will be disposed of in the monitoring basin. The quality of effluent from the ETP will be monitored to ensure compliance with Schedule 10 of ECR 1997 and Table 5 of IFC-WB EHS Guidelines for Thermal Power Plants 2008. Effluent from the ETP will be discharged to a monitoring basin. CCPP will apply zero discharge technology. Water from the monitoring basin will be used for watering plants, cleaning and other general purpose washing. No discharge of effluent to the Bhairab River will be permitted.

114. The sludge may be generated from a number of sources like clarifier, water treatment plant, ETP, etc. Sludge components may include oil and grease, suspended solid particles, sewage, demineralizers, and other chemicals used to maintain the quality of water in feed water and cooling systems.

115. Sludge generated from the operations of Component 1 will be disposed of following the requirements and/or procedures of the Khulna Water Supply and Sewerage Authority, if disposed of to land, the WHO guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006) will be followed.

Figure 3.10: Water balance diagram of Component 1

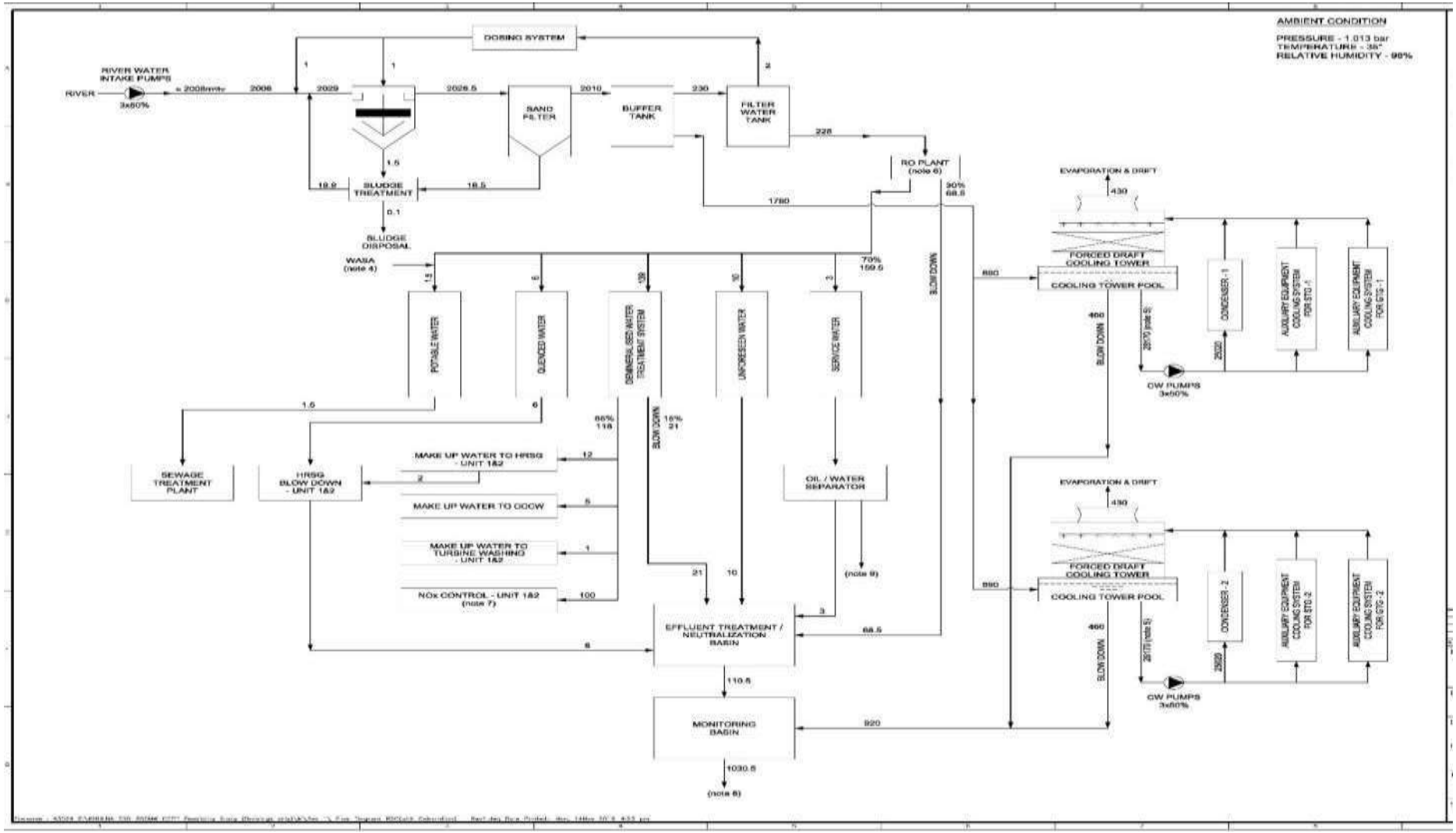
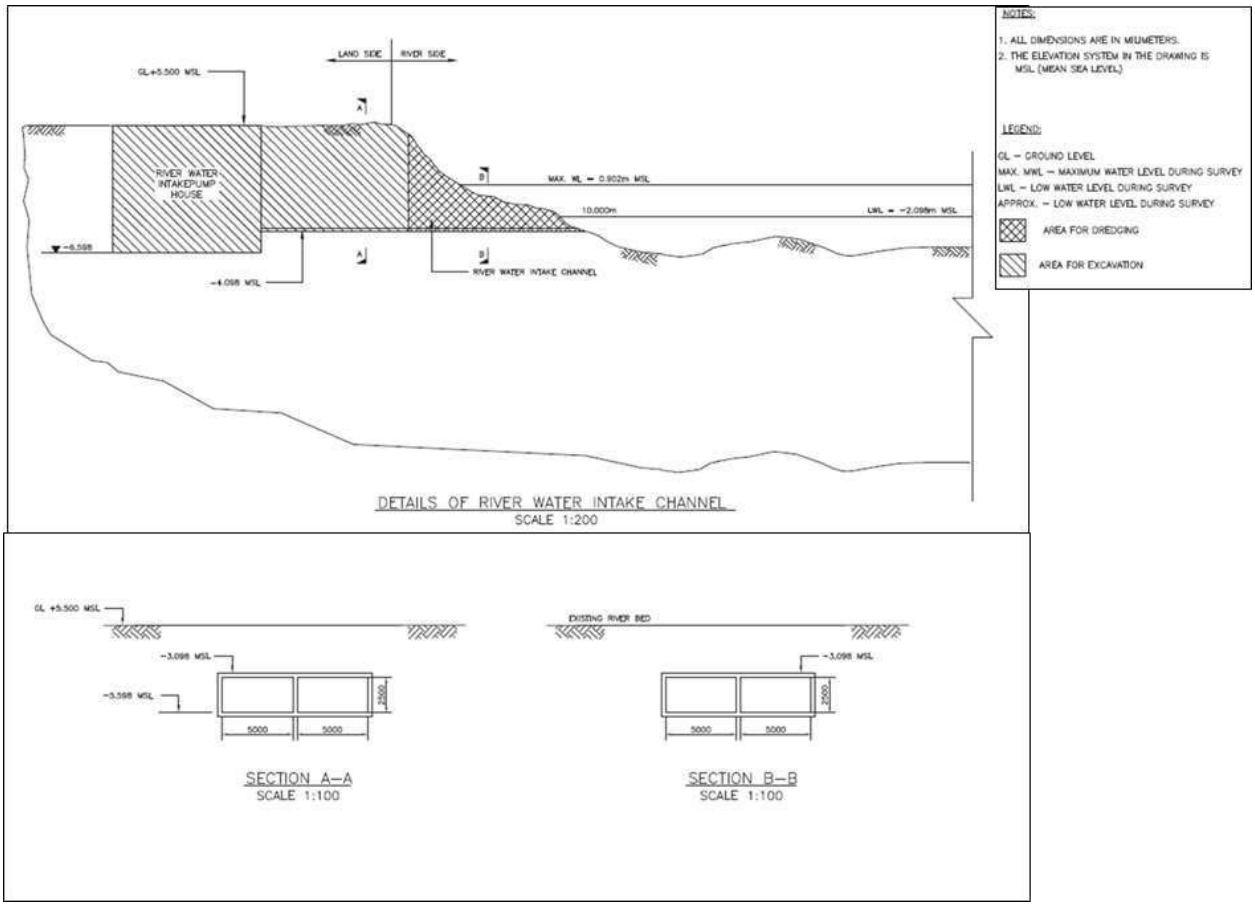


Figure 3.11: River intake channel at Bhairab River



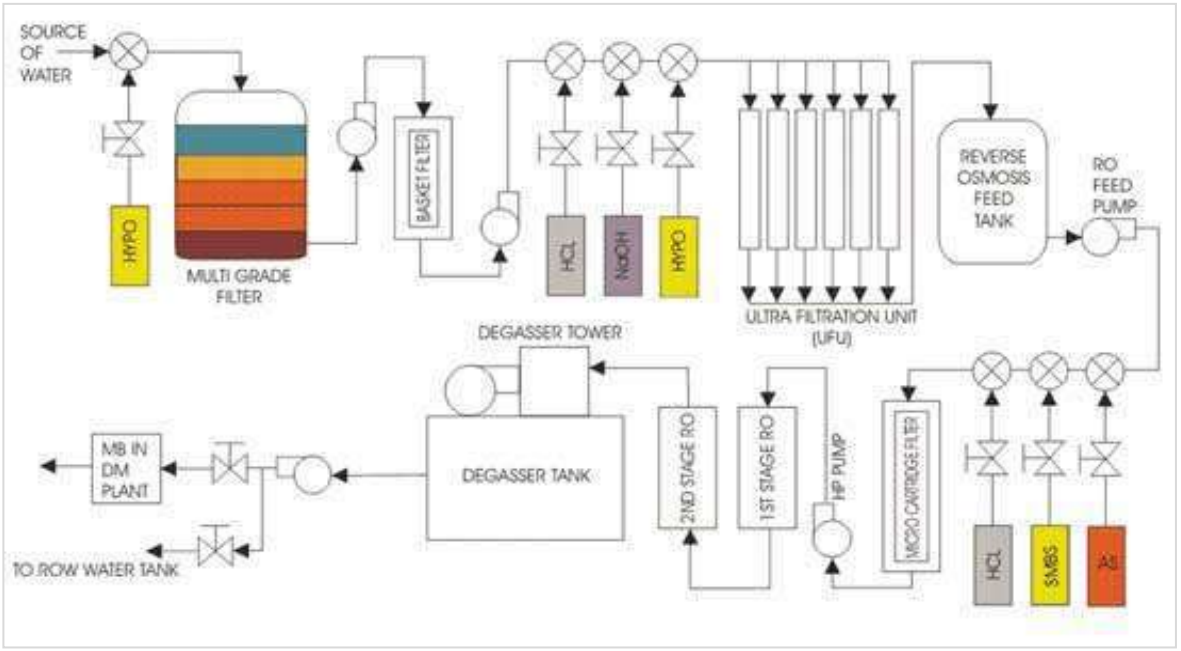
3.8.6 Reverse Osmosis Plant

116. Based on the hydrological report, it is found that the water from the Bhairab River at site location reaches a high salinity range of maximum 25,000 µS/cm. High salinity water lowers vapor pressure of the water, thus the water does not evaporate as readily. This makes it less effective as coolant and reduces the cooling tower performance. Therefore, the water needs to be desalinated and treated at the reverse osmosis plant.

117. Reverse osmosis is a process in which dissolved inorganic solids are removed from a solution/water by pressure pushing the water through a semi permeable membrane. High salinity water contains a number of constituents including metals, salts, and organic compounds. The slightly saline water from the Bhairab River will pass through a reverse osmosis membrane, many of these chemicals are removed, leaving a fresh and purified water product. This water will be used for the plant.

118. The removed constituents, called the concentrate, which is at higher concentration than source water will be blown down to the ETP. The concentrate will be monitored and discharged accordingly. The layout of the reverse osmosis plant is shown in **Figure 3.12**.

Figure 3.12: Flow diagram of a reverse osmosis plant



Source: https://electricalstudy.sarutech.com/boiler-feed-water-treatment-process-demineralization-plant/index.html

3.8.7 Water Treatment Plant

119. The pre-treatment of water from the Bhairab River will be a conventional treatment consisting of aeration pool, coagulation, flocculation, clarification and filtration processes, that will be able to produce treated water that meets the required water quality for the cooling system.

120. Below are the typical chemicals used in a water treatment plant that may also be used for Component 1:

- Caustic Soda
- Sulfuric Acid
- Hydrochloric Acid
- Alum
- Hydrated Lime
- Polymer
- Hydrogen Peroxide
- Sodium Hydroxide
- Ammonium Hydroxide
- Trisodium Phosphate

3.8.8 Cooling System

121. Component 1 is located in the west bank of the Bhairab River. Feasibility Report (August 2017) recommends closed-loop cooling system with two cooling towers using water from the Bhairab River.

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

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

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

3.8.9 Effluent Treatment Plant (ETP)

125. The process wastewater shall be treated in the ETP, after which it shall be discharged into the monitoring basin. Effluent will be tested to ensure that it meets ECR 1997 (Schedule 10) and Table 5 of IFC-EHS Guidelines for Thermal Power 2008. The process wastewater includes waste streams from plant oily waste, plant facilities, drains, and other miscellaneous streams. Wastewater sample points shall be provided in the plant (**Figure 3.13**).

126. The ETP system, which includes the chemical wastewater collection and treatment system, shall have the following units:

- wastewater storage tank
- pH balance tank
- coagulation, sedimentation and flocculation tank
- sludge dehydrator
- filtering system
- monitoring basin
- supply pump
- intermediate pump
- sludge discharge pump
- dehydrator supply pump

127. Wastewater from the water treatment plant shall be routed into the effluent treatment/neutralization basin. Oil-contaminated process water will be passed through the oil/water separator. After oil separation, the effluent shall be routed into the ETP/neutralization basin. Sludge collected from the ETP shall be disposed of according to the requirements or procedures of Khulna Water Supply and Sewerage Authority. ETP sludge may be used in the brick field. If disposed of to land, the WHO guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006) will be followed.

128. Roof drain, storm water and water tanks overflow shall be conveyed into a check pit and discharged into the cooling water discharge line after checking the water quality.

129. The quality of effluent from the ETP will be monitored to comply with ECR 1997 (Schedule 10) and Table 5 of the IFC-EHS Guidelines for Thermal Power Plant 2008. The capacity of the ETP will be 110.5 m^3/hr as indicated in the Feasibility Report (August 2017). Effluent from the ETP will be discharged to a monitoring basin. CCPP will apply zero discharge technology. Water from the monitoring basin will be used for watering plants, cleaning and other general purpose washing. No discharge of effluent to the Bhairab River will be permitted.

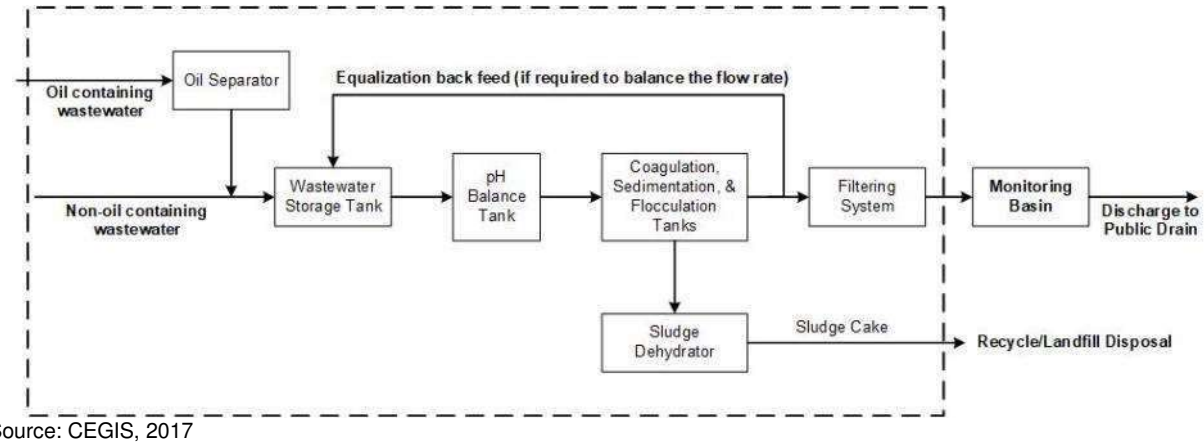
3.8.10 Sewage Treatment Plant (STP)

129. At an estimated rate of 1.5 m^3/hr, the influent sewage from the buildings in the power plant premises enters the STP by passing through a primary and secondary screen for gross solids removal and insoluble particles, respectively (see **Figure 3.14**). This step ensures the mechanical reduction of solids prior to aeration.

130. When the sewage enters the aeration tank, it is subjected to air, which is forced through diffuser into the air chamber. This is done to ensure that sufficient oxygen supply is provided allowing microorganisms to oxidize treatable wastes in to carbon dioxide, water, and stable sludge.

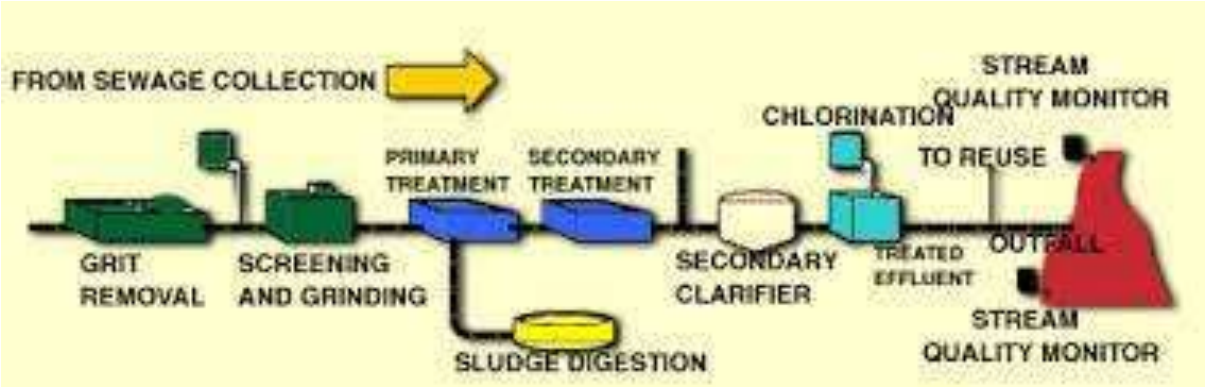
131. Following aeration, the wastewater flows to the clarifier in which, the sewage solids sludge is settled at the bottom. A portion of the sludge, return activated sludge is pumped back to the aeration tank to maintain maximum efficiency of the biological processes that occur within the aeration tank. The remaining sludge, the waste activated sludge is sent to the sludge holding tank for disposal. The treated water then flows into a filtration system in which any residual suspended matter is removed through sand filtration. From the filtration system, the treated water flows from the filter to a disinfection chamber for treatment through the process of chlorination disinfection to remove microbial bacteria in the liquid. Design of STP will comply with the Bangladesh National Building Code 2011 and the quality of water from the STP will comply with Schedule 10 of ECR 1997 and/or Table 1.3.1 of IFC-EHS Guidelines 2007. Treated water can be used for gardening or other general purpose cleaning.

Figure 3.13: Typical Effluent Treatment Plant (ETP)



Source: CEGIS, 2017

Figure 3.14: Typical Sewage Treatment Plant (STP)



Source: http://www.texascenter.org/almanac/QUALITYCH2P4.HTML

3.8.11 Power supply and evacuation system

132. There is an existing low voltage distribution system for domestic power supply. The EPC Contractor, in consultation with BPDB, can re-organize the existing power supply system to get electrical power during the pre-construction, construction, and commissioning phases.

133. The power to be generated from Component 1 will be evacuated at the voltage level of 230 kV to be connected to the plant switchyard through underground cables. From the switchyard, the power generated will be evacuated to the existing 230 kV Khulna South Substation, about 29 km from the site of Component 1.

3.8.12 Control and instrumentation System

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

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

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

136. The DCIS will be provided for control & monitoring of the combined cycle power plant. The manufacturer's standard packaged control system will be provided for GTGs, STG, HRSG, etc. for respective control and monitoring facilities. The standard packaged control system included

instrumentation and alarm system and is integrated with the DCIS for centralized control, monitoring and supervision.

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

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

139. The functions of plant control are as follows:

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

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

141. The Auto Power Regulator (APR) will adjust the generation of the GTG and STG. APR will be designed to accept unit load demand signal (MW) from central load dispatch system, or unit load demand setting by operator. The APR will have provision of automatic control or for manual control of any element of the process equipment. The operator interface will permit the operator to adjust maximum and minimum unit load limits, load change rate, load set points.

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

Plant Automation

143. The process control and monitoring of the CCPP will be performed in the central control room (CCR) through DCS operator and engineer work stations. The degree of automation implemented would enable the plant to be started and shut down, incorporating breakpoints/hold points to allow operator intervention as needed without compromising on personnel and plant safety.

Plant Operation

144. The overall operation of the power plant process, its electrical and mechanical systems are monitored and controlled by the DCS from the CCR. Monitoring of the plant operating conditions would be accomplished at the minimum by LCD screen (with LED backlit) with a DCS

minimum turnaround time of 1 sec. For plant reliability, the CPU shall have duplicate configuration using the standby redundant system.

145. The GTG Control System consists of gas turbine control panel and a generator control panel in the GT local control room (LCR). The GT LCR enables the gas turbine facilities for local control and monitoring of the gas turbine. The control system shall be capable of running independently and reliably in automatic and manual modes.

146. GTG shall be capable of automatic operation i.e. start-up, synchronization, increase and decrease load and shut-down by initiating push buttons on the gas turbine human machine interface (HMI) in the LCR and CCR. The GTG system is interfaced to the plant DCS by hard-wired and redundant Ethernet communication to monitor and control from DCS Operation.

147. The DCS shall also communicate with other sub systems in local control room or equipment marshalling cabinet room as follows:

- GTG
- STG
- Plant Interlock and Protection Control System
- Plant Condition and monitoring System
- Chemical Dosing System
- Demineralized Water System
- Waste Water System
- Instrument and Service Air System
- Air Pollution Monitoring System (Stack Emission)
- Emergency Diesel System
- Substation Control System
- Condenser Tube Cleaning System
- Metering System
- Auto Generation Control System
- Plant Electrical Control System (Switchgear, Power Meter, Protection System)

Power Control (National Load Dispatch Centre)

148. There is a provision in the new CCPP to incorporate automatic generation control (AGC) for future implementation when there is a need to control load of individual power plants from the national load dispatched centre (NLDC) by means of SCADA. When the scheme is available, the new CCPP load can be automatically controlled from the NLDC, after setting the load demand into the DCS through the operator console.

3.9 Material Balance

149. Natural gas will be the primary fuel and will require a maximum of 125 million cubic feet per day (MMCFD). This will be supplied by SGCL from the Khulna CGS in Aronggatha through a 10 km, 24 inch gas distribution pipeline terminating to the regulation and metering station (RMS) at the power plant site. The pipeline will be constructed following the requirements of the Natural Gas Safety Rules 1991 (amended 2003) and relevant industry codes and international standards. Composition of natural gas required will be a minimum of 85%mole methane (CH4). The following sources from imported regasified liquefied natural gas (R-LNG) and domestic supply will provide adequate supply of natural gas for Component 1.

- FSRU Moheskhali - 500 MMSCFD of R-LNG will be made available by April 2018 developed by Excelerate Energy, USA-Bangladesh
- Summit LNG Terminal Company Limited – 500 MMSCFD R-LNG will be made available by October 2018
- GoB and RasGas (Qatar) has signed a deal in September 2017 for a 15-year LNG sales and purchase agreement to supply 1.8 million (M) tons LNG/year for 5 years and 2.5 M tons/year for the next 10 years
- According to Petrobangla, there will be additional supply (domestic) of 2,750 MMSCFD
- By 2021, Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) will have 55 exploration wells and 31 development wells

150. The use of HSD as secondary fuel will be required in case of emergency and is estimated to be about 500 hours maximum per year (or about 21 days assuming continuous operation of 24 hours, or less than 2 days per month). HSD requirement will be about 2,773 kiloliters (KL or m^3) per day. Two HSD storage tanks with a capacity of 15,000 cubic meter (m^3) will be constructed within the power plant site. Each storage tank can supply about 5 days of continuous operation on HSD. Fuel supply agreement between BPC and NWPGCL in November 2015 provides that the HSD will have a maximum sulfur content of 0.25%$_{wt}$. As a byproduct, these two units will generate pollutants like CO_2, NO_x, SO_2, CO, and PM_{10} and $PM_{2.5}$. The material balance of this power plant is given in **Table 3.6**.

Table 3.6: Material balance of the power plant project

Input	Quantity	Output	Quantity
Natural gas and HSD and O_2 (15%)	125 MMCFD (92%) 2773 KLD (8%)	Electricity	2x400 MW
		CO_2	4,658 tons/day
		CO	8.9 gm/s
		SO_2	4.8 gm/s
		NO_x	32.6 gm/s
		PM_{10}	1.6 gm/s
		$PM_{2.5}$	3.1 gm/s

Source: Feasibility Report for Proposed Rupsha 800MW CCPP, USEPA- AP-42

3.10 Pollution Prevention Devices and Units

151. The main concerns from burning fossil fuel to generate power are: air pollution, water pollution, noise, and generation of waste. The following describes the pollution prevention measures incorporated in Component 1.

Air pollution

152. Component 1 will generate SO_x, NO_x, CO_2, CO, and suspended particulate matter (SPM). When burning natural gas, it does not generate SPM, and SO_x. while burning HSD will generate SO_x, NO_x, CO, CO_2 and SPM. Natural gas does not contain sulfur thus, no SO_2 will be generated. HSD will have a maximum sulfur content of 0.25%$_{wt}$. Water injection of about 100 m^3/hr will be used when firing HSD to further reduce the formation of NO_x. Modern gas turbine manufacturers guarantee the formation of less than 25 ppmv of NO_x due to their improved firing system like dry low- NO_x burners, lean pre-mix firing etc. and the modern digital DCS maintains combustion air

about 1% (excess air) above the “stoichiometric” F/A ratio. Hence, formation of CO due to incomplete combustion is not expected. Natural gas will not generate PM_{10} and $PM_{2.5}$.

153. Substantial reductions in emissions of CO_2 could be achieved by increasing combustion efficiency i.e. burning less fuel for same MW of electricity generation, energy efficient resources use, off set technologies etc. The modern GTs are highly efficient compared to their earlier versions. The project overall minimizes GHG emissions by conveting 225 MW power station from HSD to natural gas.

Noise pollution

154. All rotating machines like turbine, pump, fan, etc. generate noise when operated. A hissing noise is also generated in the RMS. During pre-construction and construction phases noise is mostly generated by construction machineries of piling, use of construction vehicles and other civil works. But these are limited to day time activity only. During operation phase noise is generated specially from start-up, shut-down, and from rotating machines. Modern machines are mostly low noise generating machines with built in silencers. Moreover, noise generating machines will be covered with noise proof hoods and workers will be provided with PPE during work. Boundary walls and green belt will also dampen noise for colony residents and surrounding community. Control room is provided with noise proof walls and doors with noise proof seals.

Water pollution

155. Major sources of wastewater from the proposed power plant are blowdown water from HRSG, cooling tower, and backwash, oily water from turbine floor and transformer areas, etc. Oil will be separated from water using oil-water separator. This wastewater along with all others will be conveyed to the ETP/neutralization basin. Quality of discharge water will comply with ECR 1997 (Schedule 10) and Table 5 of IFC-WB EHS Guidelines for Thermal Power Plants 2008. Effluent from the ETP will be discharged to a monitoring basin. CCPP will apply zero discharge technology. Water from the monitoring basin will be used for watering plants, cleaning and other general purpose washing. No discharge of effluent to the Bhairab River will be permitted.

Waste Management System

156. Solid and liquid wastes will be generated during the pre-construction, construction, and operation phases of Component 1. The solid wastes during construction phase are mainly from construction materials like concrete pieces, small cut pieces of MS bars/rods, plastic pieces, empty cement bags, empty cartons, waste papers, waste from worker’s colony, and other construction debris. Sewage will be treated through the STP and will comply with the limits of Schedule 10 of ECR 1997, and Table 1.3.1 of IFC-WB EHS General Guidelines 2007. Solid wastes like metal pieces, empty cartons, etc. will be disposed of in covered plastic containers of different colors specified for different type of wastes kept at designated places. Recyclable and plastic wastes will be sold to the recycling companies and other interested buyers. Other combustible solid wastes like waste paper, wood, etc. will be recycled locally. Organic wastes will be disposed of in covered plastic containers kept at designated places which will be periodically collected by local authority/plant management for final disposal. Wastes generated will be stored in accordance with national regulations and the EHS Guildelines on Waste Management and disposed of by suitably licensed contractor (transfer notes to be retained) to suitably designed and licensed treatment or disposal waste facility following the relevant requirements of the DoE.

157. The liquid waste generated during pre-construction and construction phase will be washwater from construction vehicles, waste water from worker's colony, etc. Wastewater from construction site will be collected in a pool and will be reused in construction activities like spraying to contain dust level. Liquid waste from worker's colony will be treated in septic tanks (located at least 100m from any groundwater wells) to national standards with the wastewater drained to a soak pond/soak pits, a covered, porous-walled chamber that allows water to slowly soak into the ground.

158. During the operation phase, solid waste generated such as used paper, boxes, etc. will be separated at source as biodegradable and non-biodegradable. Dedicated bins will be placed at strategic places within the premises of Component 1. Solid waste generated will be collected and disposed of in coordination with Khulna City Corporation.

159. All liquid waste generated from boiler blow down, cooling tower blow down, water from leaks and vents, waste water from turbine floor will be treated in the ETP/neutralization basin to meet ECR 1997 Schedule 10 and IFC-EHS Guidelines for Thermal Power Plant 2008.

Green initiatives

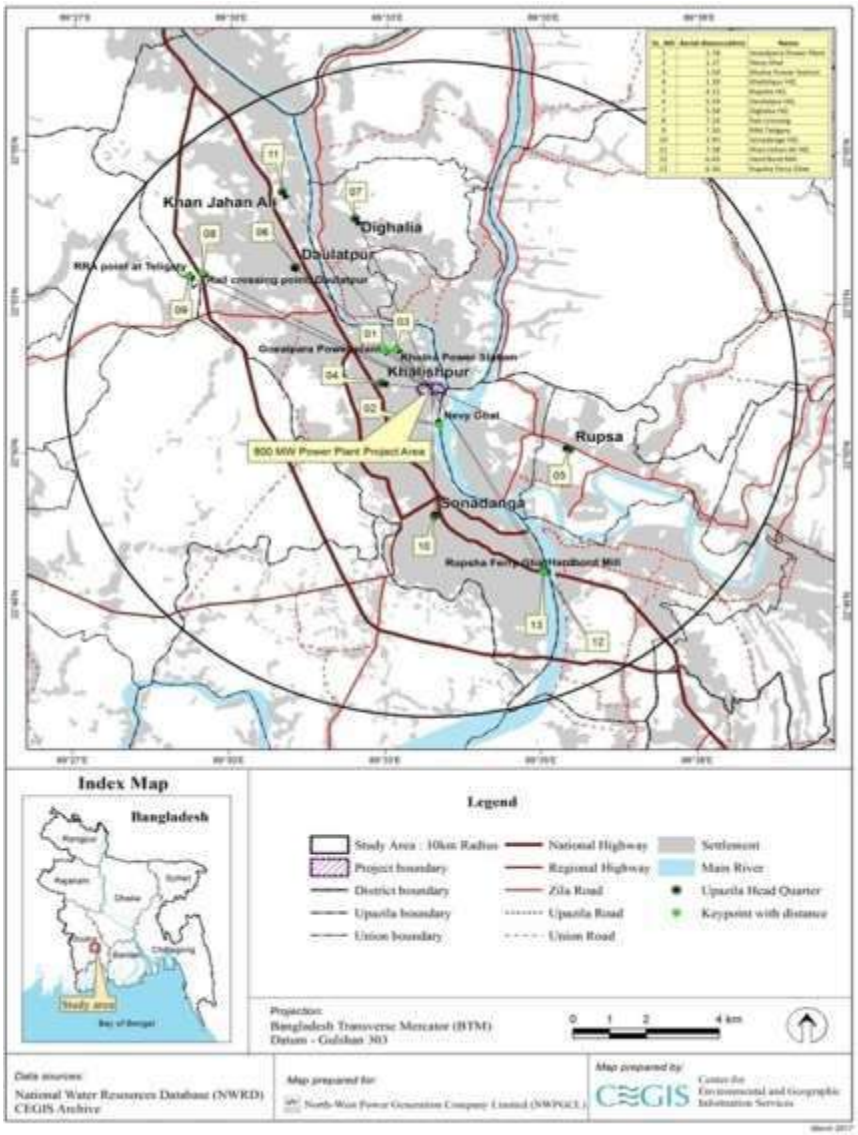
160. There is space restriction in the project site. DoE suggests for greenery (about 33% of the project area) may be maintained. However, plantation in all open space of the plant area excluding the switchyard shall be maintained. The greenery of about 33% of the project area is not required by law. Nonetheless, greenery will be planned, designed, and maintained as required by BPDB.

4.0 DESCRIPTION OF THE ENVIRONMENT

4.1 Project's area of influence

161. The project's area of influence (PAI) covers the project site where Component 1 will be located and the study area which is about 10-km from Component 1 (see **Figure 4.1**).

Figure 4.1: Project's area of influence



4.1.1 Project site of about 50 acres

162. The project site is an area formerly used by the KNM located in Khalishpur Thana, Khulna Division (**Figure 4.2**). The total area occupied by KNM from its previous operations is about 87 acres [or 35.2077 hectares (ha)]. NWPGCL will only require about 50 acres (or 20.2343 ha) to accommodate Component 1.

163. The project site is an area formerly used by the Khulna Newsprint Mills (KNM) Limited located in Khalishpur Thana, Khulna Division. KNM was under expatriate management from start in 1959 until the end of 1965 when it was put under the management of the East Pakistan Industrial Development Corporation.[24] KNM was the first and major producer of newsprint paper in Bangladesh using *Gewa* wood (*Excoecaria agallocha*), a native mangrove species in Bangladesh, as raw material. Sand well and Company, a Canadian firm, was engaged as a consultant in the construction and commissioning of KNM.

164. In 1969, problems were encountered with the steam supply needed to operate the three paper machines. By mid-1973, the Canadian International Development Agency (CIDA) has commissioned studies of KNM in order to define areas where Canadian aid might assist in rehabilitating the mill. A project advisor from CIDA was provided until 1976. However, beset with problems ranging from market behaviour after the independence, availability of spare parts, low capacity utilization (newsprint production at KNM has not been able to reach the levels achieved prior to independence), operational management, price of oil, interrupted supply of raw material due to security issues, etc., GoB stopped its operations completely in November 2002. A total of 2,128 persons are employed at KNM, 472 salaried, 1,506 permanent labour, and 150 casual labour.

165. No newspaper printing was involved in KNM operations but mainly production of newsprint using mechanical pulping from ground wood process as chips is not used for papermaking in Bangladesh. Mechanical pulping involves the use of mechanical energy to weaken and separate fibers from *Gewa* wood through grinding action. The process produces up to 95% pulp, however, since it does not dissolve lignin, fiber strength and age resistance of resulting pulp are low and the product has shorter fibers. Mechanical pulp is used mainly for lower grade papers like newsprint.

[24] The World Bank. Bangladesh: Survey of Steel, Pulp and Paper, and Leather Tanning Industries. Report No. 1219-BD. Industrial Projects Department. 30 November 1976. http://documents.worldbank.org/curated/en/879431468007479695/Bangladesh-Survey-of-steel-pulp-and-paper-and-leather-tanning-industries.

Figure 4.2: Project site location

166. At present, there are about 151 structures standing within the 50 acres consisting of 122 primary residential structures such as bungalow for the Managing Director, dormitories and residences of staff, kitchen and dining, guest house, and Ansar camps, etc. while the remaining 29 structures are non-residential like auditorium/cinema, water tank, fire fighting system, swimming pool and rest house, mosque, boys and girls school, etc. (see Table 3.5 for the inventory of structures).[25] The structures are mainly from brick, reinforced concrete, pacca, and semi-pacca. There is no structure used for the direct operation of newsprint manufacturing. Given that all the structures within the 50-acre project site are residential type, the probability that the land is contaminated from the previous newsprint operation is very unlikely.

167. The project site has two schools (one for boys and the other for girls) which are operating. Some vegetation has grown from the abandoned structures. Some of the abandoned buildings are being used as residence by about 36 people tasked to secure the property (appointed through GoB from Ansar Force), cook and cleaners.26

168. Adjacent to the project site are the mosque and the mass graveyard marker of the freedom fighters who were killed in 1971 during the liberation war of Bangladesh. The mosque is still being used by about 10 local people every day for their prayers. The graveyard marker has a brick fence, is not listed as cultural heritage by GoB, but has a huge cultural value to the people. **Figure 4.3** shows some of the structures at the project site, the mosque and the graveyard marker.

[25] Bangladesh Ansar is a paramilitary auxiliary force responsible for the preservation of internal security and law enforcement in Bangladesh and administered by the Ministry of Home Affairs.

[26] Bangladesh Ansar is a paramilitary auxiliary force responsible for the preservation of internal security and law enforcement in Bangladesh and administered by the Ministry of Home Affairs.

Figure 4.3: Some structures left by KNM

4.1.2 Study area

169. The study area extends from the project site and the area within about 10-km radius from Component 1 (**Figure 4.1**). The description of the existing environment within the PAI is based on primary and secondary data.

4.2 Physical-chemical environment

4.2.1 Topography

170. Component 1 is located at elevation +3.5 m and +2.3 m MSL towards the bank of the Bhairab River (see **Figure 4.4**). while the surrounding area has an elevation of approximately between EL+3.5m and EL+3.2m (MSL). Towards the bank of the Bhairab River is approximately between EL+3.5m and EL+2.3m(MSL). The highest elevated land falls into the area near Khan Jahan Ali bridge (3-4 m PWD).[27]

4.2.2 Geology and Physiography

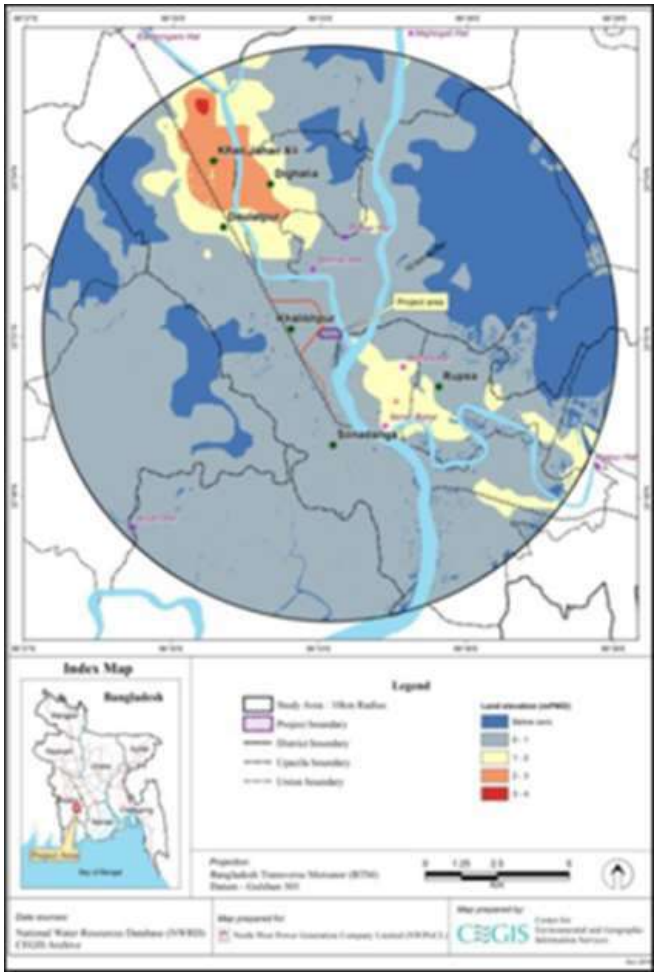
171. Bangladesh is divided into 30 physiographic units and the study area falls within the Ganges Tidal Floodplain and Gopalganj-Khulna Beel (see **Figure 4.5**). This area is situated in southwestern Bangladesh that lies on the Late Holocene- Recent alluvium.

[27] Bangladesh Water Development Board and other government departments refer water levels to the Public Works Datum (PWD). PWD is a horizontal datum believed originally to have zero at a determined Mean Sea Level (MSL) at Calcutta. PWD is located approx. 1.5 ft (or 0.46m) below the MSL established in India under the British Rule and brought to Bangladesh during the Great Trigonometric Survey. http://www.ffwc.gov.bd/index.php/definitions.

172. **Ganges Tidal Floodplain** occupies an area of about 16,410 square kilometers (km^2) southwest of Bangladesh. In most of this region, non-calcareous, tidal clay occupy basin sites and slightly calcareous silty sediments occupy the banks of rivers and creeks. Most parts of the Ganges Tidal Floodplain have a typical tidal floodplain landscape with a close network of interconnected tidal rivers and creeks; and seasonal flooding depths over most of the season are shallow, but they are deeper in some basin centers in the northern part. The courses of tidal rivers and creeks change over time by local river capture, and the courses of several silted-up old channels with adjoining levees area are visible on satellite images. Over the greater part of the region, rivers are non-saline throughout the year, but they become saline inland during the dry season.

173. **Gopalganj-khulna Beel** occupies several large, low-lying basins between the Ganges River Floodplain and Ganges Tidal Floodplain. Their total area is 2,641 km^2. Two sub-regions have been differentiated: peat basins which occupy the lowest-lying areas where peat soils are dominant; and basin margins where clay sediments have buried the peat. Most of the area is deeply flooded in the rainy season. Basins centers are perennially wet for most of the dry season, with the water-table close to the surface.

Figure 4.4: Elevation map of the study area

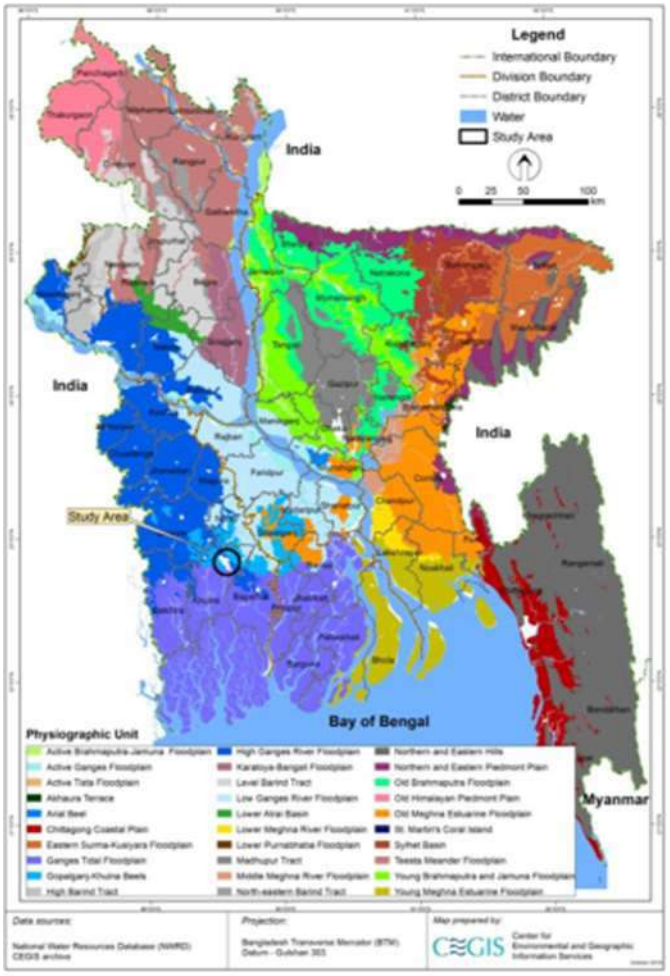


4.2.3 Tectonic Setting

174. Bangladesh consists of six tectonic elements: (1) Himalayan Fore Deep, (2) Bogra Shelf, (3) Faridpur-Sylhet Trough (Separated by Tripura-Madhupur thrash hold), (4) Barisal –Chandpur Gravity High, (5) Hatia Trough, and (6) Indo-Myanmar Ranges.

175. The study area is within the Faridpur Trough of the Bengal Basin. The Faridpur Trough is situated in the south-western part of the Barisal-Chandpur Gravity in close proximity North-West of Hatiya Trough/Patuakhali depression. The Faridpur trough is an elliptical depression almost adjacent to the Eocene hinge belt and are identified geophysically by gravity minima and filled up by enormous amount of tertiary sediments. This can be considered broadly as carboniferous to recent sediments. It is an active deltaic trough with a subsidence rate of2.2 cm/year or higher. In this area, three types of subsidence are recognized which are tectonic subsidence, compaction of peat layers, and human induced subsidence.

Figure 4.5: Physiographic map of Bangladesh



Seismicity and earthquake

176. The Bangladesh Geological Survey has published an Earthquake Zoning Map based on seismic intensity. They have divided the country into three zones depending on the seismic

intensity namely Zone I, Zone II and Zone III. The North and eastern regions of Bangladesh belong to Zone I (seismically most active); the Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt belongs to Zone II (moderately active) while Jessore, Khulna, Barisal, Faridpur, Patuakhali, and Noakhali belong to Zone III (seismically relatively quiet).

177. The study area is located within Zone III with seismic coefficient of 0.04g (see **Figure 4.6**). Component 1 has the least vulnerability to earthquakes but the design of civil structure needs to comply with relevant provisions on earthquake Bangladesh National Building Code 2015. Historical record of major earthquakes for the last 450 years from the Department of Disaster Management (2012) show that from 1762 to 2016, earthquakes originating in Bangladesh had a Richter scale magnitude ranging from 4.2 to 8.8. A maximum of about 8.8 originated from Chittagong-Arakan in 1762.

Figure 4.6: Seismic map of Bangladesh

4.2.4 Climate and Meteorology

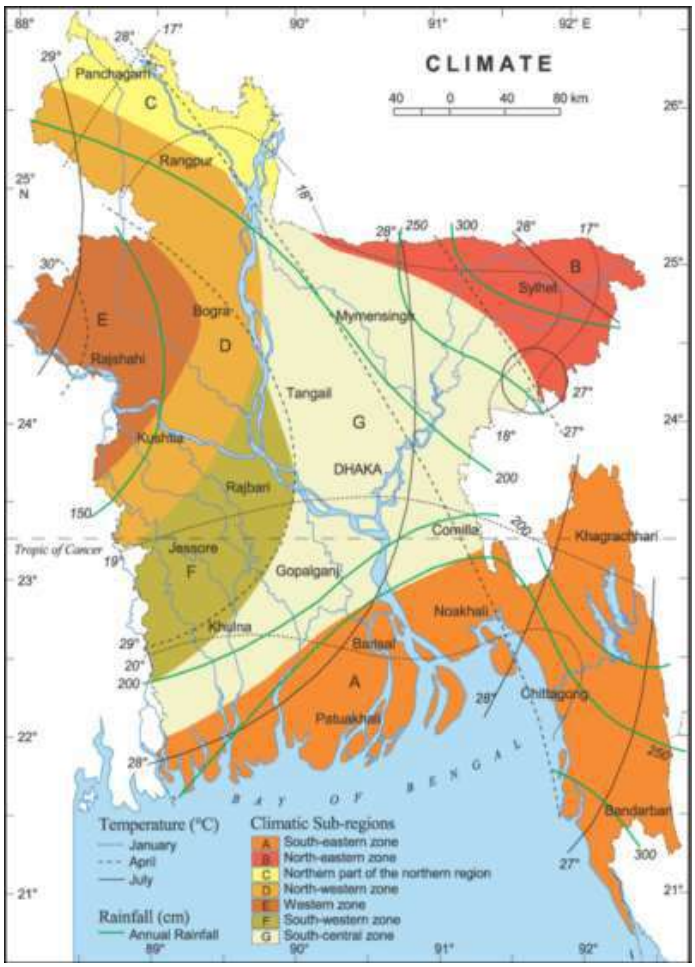
178. This section was based on the meteorological data collected by the Khulna station of the Bangladesh Meteorological Department (BMD) from 1985 to 2015.

Climate

179. According to Köppen climate classification, Khulna division falls under Aw category which is characterized by tropical wet and dry climate resulting to hot and humid summer and dry winter.[28] According to the climatic characteristics, Bangladesh is divided into seven different climatic sub-regions (see **Figure 4.7**).

180. The study area is within category "G" which is the south-central climatic sub-region. In general, this category receives abundant rainfall. This is a transitory zone between the South-eastern, North-western and South-western zones and most of the severe hail storms, nor'westers and tornadoes are recorded in this area.

Figure 4.7: Climatic subregions of Bangladesh

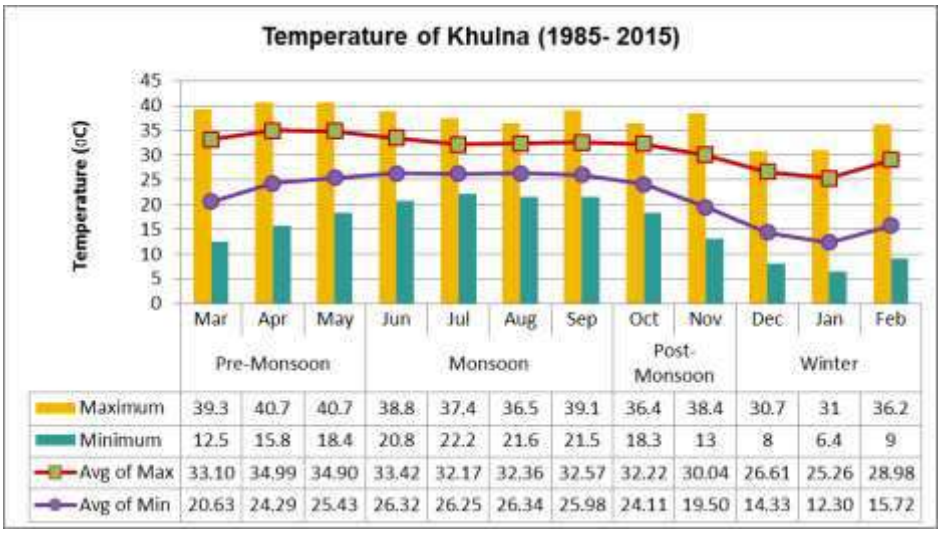


[28] https://en.climate-data.org/region/2263/

Temperature

181. Monthly variation of maximum temperature is 30.7^{0}C to 40.7^{0}C while the monthly minimum temperature varies between 6.4^{0}C to 22.2^{0}C. The monthly variation of maximum and minimum temperature for the last 30 years is presented in **Figure 4.8**. The maximum temperature recorded during this period in Khulna station was 40.7^{0}C in 2014 while the minimum temperature of 6.4^{o}C happened in 2003.

Figure 4.8: Monthly temperature variation from Khulna Station (1985-2015)

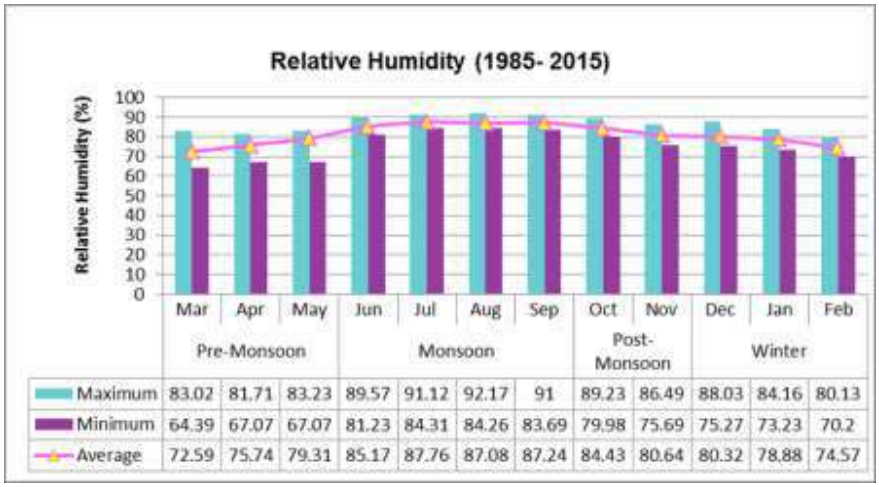


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	39.3	40.7	40.7	38.8	37.4	36.5	39.1	36.4	38.4	30.7	31	36.2
Minimum	12.5	15.8	18.4	20.8	22.2	21.6	21.5	18.3	13	8	6.4	9
Avg of Max	33.10	34.99	34.90	33.42	32.17	32.36	32.57	32.22	30.04	26.61	25.26	28.98
Avg of Min	20.63	24.29	25.43	26.32	26.25	26.34	25.98	24.11	19.50	14.33	12.30	15.72

Humidity

182. Humidity is directly related with temperature fluctuation of a region. The average humidity remains highest from June to October while the monthly variation of the average relative humidity is 72.59% to 87.76%. Monsoon (June to September) is the most humid period, whereas from winter season to pre-monsoon (December to May), the weather remains relatively dry. **Figure 4.9** shows the average humidity.

Figure 4.9: Relative humidity from Khulna station (1985-2015)

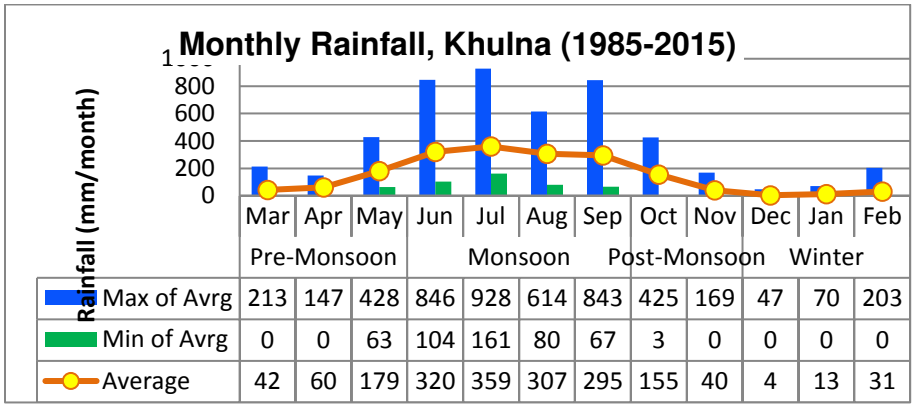


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Maximum	83.02	81.71	83.23	89.57	91.12	92.17	91	89.23	86.49	88.03	84.16	80.13
Minimum	64.39	67.07	67.07	81.23	84.31	84.26	83.69	79.98	75.69	75.27	73.23	70.2
Average	72.59	75.74	79.31	85.17	87.76	87.08	87.24	84.43	80.64	80.32	78.88	74.57

Rainfall

183. Average annual rainfall is recorded as 1,808 mm/yr. Monthly average maximum rainfall occurred in July at 928 mm/month and monthly average minimum rainfall (no rainfall) was recorded during the winter season. This indicates that the rainy season is very prominent in this region. Average monthly rainfall during monsoon in Khulna is 320 mm. The variance in maximum rainfall during monsoon season (June to September) is 614 mm/month to 928 mm/month while the variance in minimum rainfall during monsoon is 67 mm/month to 161 mm/month. Winter (December-February) is the driest season and the average winter rainfall recorded 16.14 mm/month. The highest yearly rainfall was recorded in 2002 at 2,594 mm/year. The minimum, maximum and average monthly rainfall from 1985-2015 is shown in **Figure 4.10**.

Figure 4.10: Rainfall from Khulna station (1985-2015)

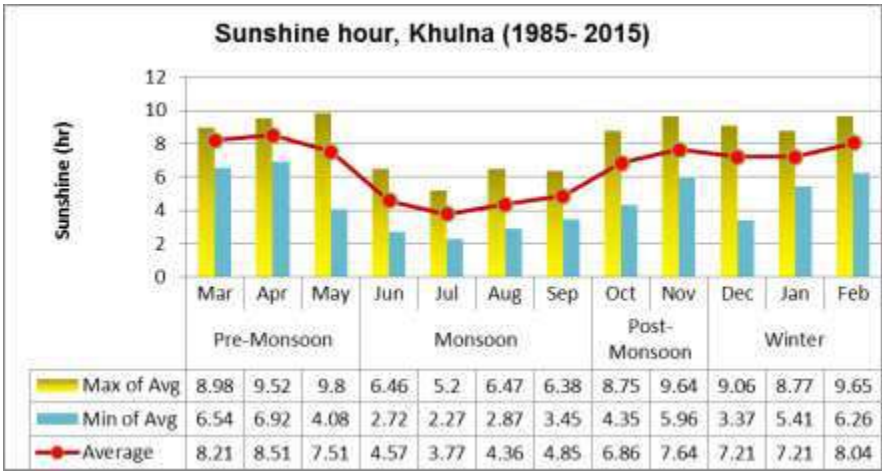


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Max of Avrg	213	147	428	846	928	614	843	425	169	47	70	203
Min of Avrg	0	0	63	104	161	80	67	3	0	0	0	0
Average	42	60	179	320	359	307	295	155	40	4	13	31

Sunshine hour

184. Sunshine hour is a climatological indicator that measures the duration of sunshine for a given location and period indicating the total energy delivered by sunlight. The average sunshine hour varies from 3.77 hrs/day to 8.51 hrs/day in a year. On average, pre-monsoon season gets the highest hours of sunshine followed by late post-monsoon and winter seasons. **Figure 4.11** shows the average sunshine hour for the last 30 years (1985-2015).

Figure 4.11: Sunshine hours from Khulna station (1985-2015)



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Max of Avg	8.98	9.52	9.8	6.46	5.2	6.47	6.38	8.75	9.64	9.06	8.77	9.65
Min of Avg	6.54	6.92	4.08	2.72	2.27	2.87	3.45	4.35	5.96	3.37	5.41	6.26
Average	8.21	8.51	7.51	4.57	3.77	4.36	4.85	6.86	7.64	7.21	7.21	8.04

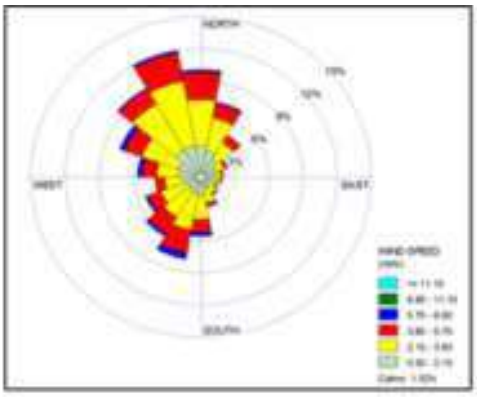
Wind speed and direction

185. The maximum yearly wind speed recorded in Khulna station is 120.38 km/hr during 1997 and 2007. Wind speed recorded from 1985–2015 ranges from 18.52 km/hr to 120.38 km/hr.

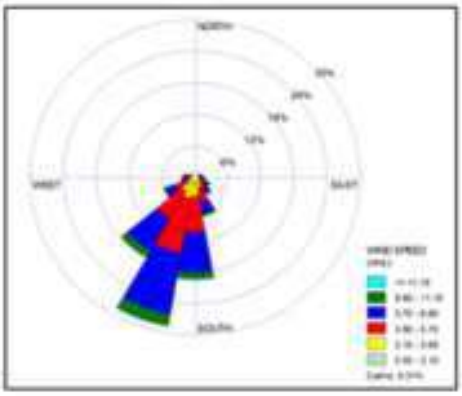
186. Wind direction varies depending on the season. Therefore, the whole year has been categorized into four clusters of months and these are: Cluster-1: January-March, Cluster 2: April-June, Cluster 3: July to September, and Cluster 4: October to December. Wind speed data and direction have been obtained from the analysis of upper atmospheric data collected for the last three years from Lakes Environmental Software (Canada).

187. During clusters 1 and 4 (a and b of **Figure 4.12**) wind direction is predominantly from north and northwest to southeast direction. For clusters 2 and 3 (c and d of **Figure 4.12**), it is predominantly from south and southwest to north and northeast. The annual wind rose diagrams of 8 and 36 directions (e and f of **Figure 4.12**) show the wind direction predominantly towards the northeast. In cluster '1' calm wind prevails for 1.52% of total period, similarly it is 0.31% for cluster '2', 0.72% for cluster '3', and 3.17% for cluster '4'. Calm wind prevails for 1.33% for annual 8-direction and 1.77% for annual 36-direction wind rose diagrams, respectively.

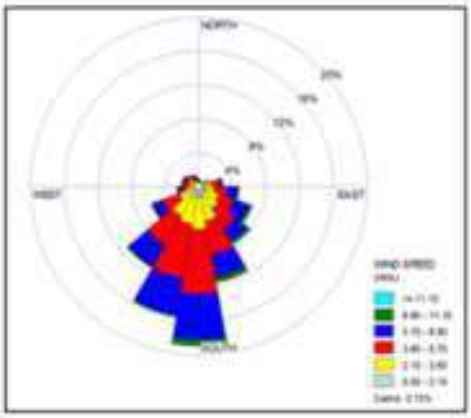
Figure 4.12: Wind rose diagram



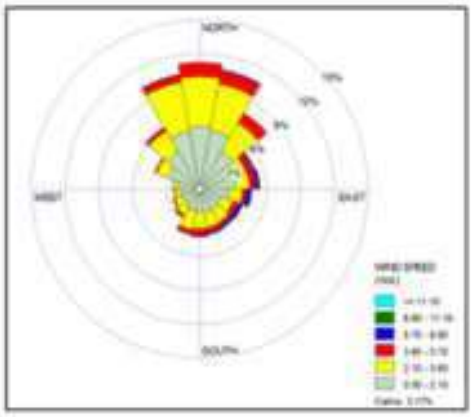
(a) Cluster 1: Wind rose diagram for Jan-Mar



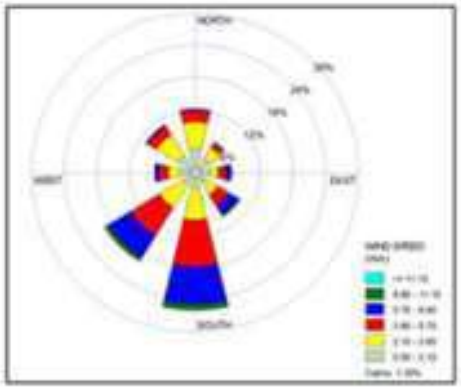
(b) Cluster 2: Wind rose diagram for Apr-Jun



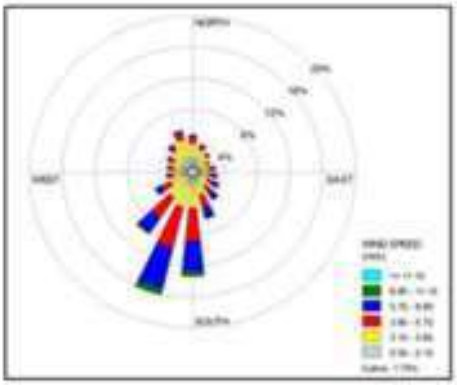
(c) Cluster 3: Wind rose diagram for Jul-Sep



(d) Cluster 4: Wind rose diagram for Oct-Dec



(e) Annual wind rose diagram (8 directions)



(f) Annual wind rose diagram (36 directions)

4.2.5 Ambient air quality and noise

Ambient air quality

188. Air quality is mainly characterized by the presence of criteria pollutants. Major criteria pollutants are particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2) and ozone (O_3). DoE has also set national ambient air quality standards for these pollutants in ECR 2005 (see **Table 4.1**). These standards aim to protect against adverse human health impacts. The WHO air quality guidelines (2005) also provide global guidance on thresholds and limits for key air pollutants that pose health risks.

Table 4.1: Comparison of ambient air quality standards

Pollutant	Averaging Period	Bangladesh Standards[a,b]	WHO Ambient Air Quality Guidelines (IFC-WB EHS General Guidelines 2007) (µg/m^3)
CO	8-hour	10,000 µg/m^3 (9 ppm)	-
	1-hour	40,000 µg/m^3 (35 ppm)	-
Pb	Annual	0.5 µg/m^3	
NO_2	Annual	100 µg/m^3 (0.053 ppm)	40
	1-hour	-	200
Total suspended particulates (TSP)	8-hour	200 µg/m^3	-
PM_{10}	Annual	50 µg/m^3	70 (Interim target 1)
			50 (Interim target 2)
			30 (Interim target 3)
			20 (guideline)
	24-hour	150 µg/m^3	150 (Interim target 1)
			100 (Interim target 2)
			75 (Interim target 3)
			50 (guideline)
$PM_{2.5}$	Annual	15 µg/m^3	35 (Interim target 1)
			25 (Interim target 2)
			15 (Interim target 3)
			10 (guideline)
	24-hour	65 µg/m^3	75 (Interim target 1)
			50 (Interim target 2)
			37.5 (Interim target 3)
			25 (guideline)
O_3	1-hour	235 µg/m^3 (0.12 ppm)	-
	8-hour	157 µg/m^3 (0.08 ppm)	160 (Interim target 1
			100 (guideline)
SO_2	Annual	80 µg/m^3 (0.03 ppm)	-
	10-minute	-	500 (guideline)
	24-hour	365 µg/m^3 (0.14 ppm)	125 (Interim target 1)
			50 (Interim target 2)
			20 (guideline)

[a] S.R.O. No: 220-Law/2005, http://www.doe-bd.org/aqmp/standard.html
[b] Bangladesh has no short-term standard for NO_2, SO_2, PM_{10}, and $PM_{2.5}$

189. Air pollution due to enhanced anthropogenic activities has become an important environmental concern globally as well as in Bangladesh urban areas, in view of its adverse health effects. In this connection, the criteria pollutants of eight major cities in Bangladesh are continuously monitored through the Clean Air and Sustainable Environment (CASE) Project launched by the DoE covering 11 continuous air monitoring stations (CAMS).[29] The eight cities include: Dhaka, Gazipur, Narayagonj, Chittagong, Sylhet, Khulna, Rajshahi, and Barisal. Dhaka has three monitoring stations, Chittagong has two stations and the rest of the cities have one station each. Parameters being monitored in these stations include: PM_{10}, $PM_{2.5}$, CO, SO_2, oxides of nitrogen (NO_x), O_3, and hydrocarbons (HC). The CASE project which started on 12 May 2009 was funded by the World Bank and will be until 15 December 2018.[30]

190. Khulna is the third largest city in Bangladesh and is known as an industrial city. The population of the city, under the jurisdiction of the Metropolitan Area is 1,435,422 living in an area of about 59.6 km^2. It is one of the important industrial and commercial areas of the country. A CASE monitoring station, CAMS-9 (latitude 22.83 N, longitude 89.53 E) has been established in Khulna City to monitor the criteria pollutants. It is located in the Department of Social Forestry Office Campus at Boira and about 2.5 km from the project area (**Figure 4.13**). Because of the topography of the city (flat) and good natural ventilation of the CAMS site representative air pollution levels of the city would be measured at this site. The location is relatively unaffected by nearby air pollution sources.[31]

Figure 4.13: CAMS station of CASE project in Khulna City

191. Ambient air quality monitoring results at the Boira CAMS (CAMS-9) monitoring station of the CASE project from 2013-2015 show that annual average of 24-hr particulate matter (PM)

[29] Ministry of Environment and Forests. Clean Air and Sustainable Environment Project. http://case.doe.gov.bd/index.php?option=com_content&view=article&id=5&Itemid=9.

[30] World Bank. Clean Air and Sustainable Environment Project. http://projects.worldbank.org/P098151/clean-air-sustainable-environment-project?lang=en&tab=documents&subTab=projectDocuments

[31] (source: http://case.doe.gov.bd/index.php?option=com_content&view=article&id=5&Itemid=9).

concentration levels in both $PM_{2.5}$ and PM_{10} are high and exceeded the limits of ECR 2005 for $PM_{2.5}$ and in 2014 for PM_{10}. More recent monthly data for 2017-2018 also shows exceedance of the limits of ECR 2005 for $PM_{2.5}$ and PM_{10}. The WHO SO_2 (24hr) guideline was exceeded in 2013 and 2015 and WHO NO_x (1hr/annual) guideline was exceeded in 2015 but national standards were complied with. Similarly, more recent data WHO SO_2 (24hr) guideline and WHO NOx (annual) guideline was exceeded in 2017-2018. In conclusion, the airshed is considered highly degraded for particulates ($PM_{2.5}$ and PM_{10}) and degraded for SO_2 and NOx. **Tables 4.2A and B** present the air quality monitoring results at CAMS-9.

Table 4.2A: Ambient air quality results at Khulna CAMS-9 station 2013-2015

Criteria Pollutants	ECR 2005 Standards (WHO Standards)		2013	2014	2015
	Averaging Period	µg /m³	µg /m³	µg /m³	µg /m³
CO	8 hr	10,000	1,790	1020	550
	1 hr	40,000	1,590	860	460
SO_2	24 hr	365 (20)	62.45	45.05	117.5
	Annual	80 (n/a)	11.99	8.65	22.56
NO_x	24 hr (1hr)	n/a (200)	32.18	DNA	205.54
	annual	100 (40)	14.4		65.3
Particulate Matter (PM_{10})	24 hr	150 (50)	601.4	688.71	353.44
	annual	50 (20)	132	219	93.5
Particulate Matter ($PM_{2.5}$)	24 hr	65 (25)	309.67	383.15	335.08
	annual	15 (10)	76.0	102	83.6

Orange shading = degraded airshed against national standards
Yellow shading = degraded airshed against WHO guidelines only

Table 4.2B: Ambient air quality results at Khulna CAMS-9 station May 2017-April 2018

Criteria Pollutants	ECR 2005 Standards (WHO Standards)		Monthly Average/24hr Maximum												Annual Average
			May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
	Averaging Period														
SO_2 in ppb	24 hr	140(8)	13.9 / 29.8	DNA	DNA	10.62/ 17.96	DNA	DNA	11.5 / 20.6	16.9 / 37.5	DNA	17.7/ 28.8	DNA	21.3 / 22.6	15.32
	Annual	31 (N/A)													
NOx in ppb	24 hr (1hr)	n/a (106)	16.8 / 60.9	DNA	4.27 / 7.15	2.45 / 3.74	DNA	71.5 /106	53/ 95	68/ 77.9	61.4/ 101	51/ 106	DNA	46.21/52 .48	41.63
	Annual	53(21)													
Particulate Matter (PM_{10}) in ug/m³	24 hr	150(50)	DNA	DNA	DNA	DNA	DNA	DNA	71.19/ 201	117/ 232	DNA	178/ 283	116/ 222	63.88/13 4.21	109.18
	Annual	50(20)													
Particulate Matter ($PM_{2.5}$) in ug/m³	24 hr	65(25)	35.4 /63.8	30.7 /53.3	27.4 /52.0	29.1 / 49.65	30.4 /66.9	51.8 /145	78/ 206	116/ 161	217/29 6	97.5/ 213	44.3 /77.8	25.25/55 .96	65.2
	Annual	15(10)													

Orange shading = degraded airshed against national standards
Yellow shading = degraded airshed against WHO guidelines only

192. For Component 1, six air quality sampling stations were identified to establish the existing environment in the study area (see **Figure 4.14**). Air quality measurements were conducted on 13-19 March 2017 for CO, SO_2, NO_x, TSP, PM_{10} and $PM_{2.5}$. **Table 4.3** presents the 24-hr average results of ambient air monitoring. This data also demonstrates the airshed is degraded for particulates.

Figure 4.14: Air quality sampling stations in the study area

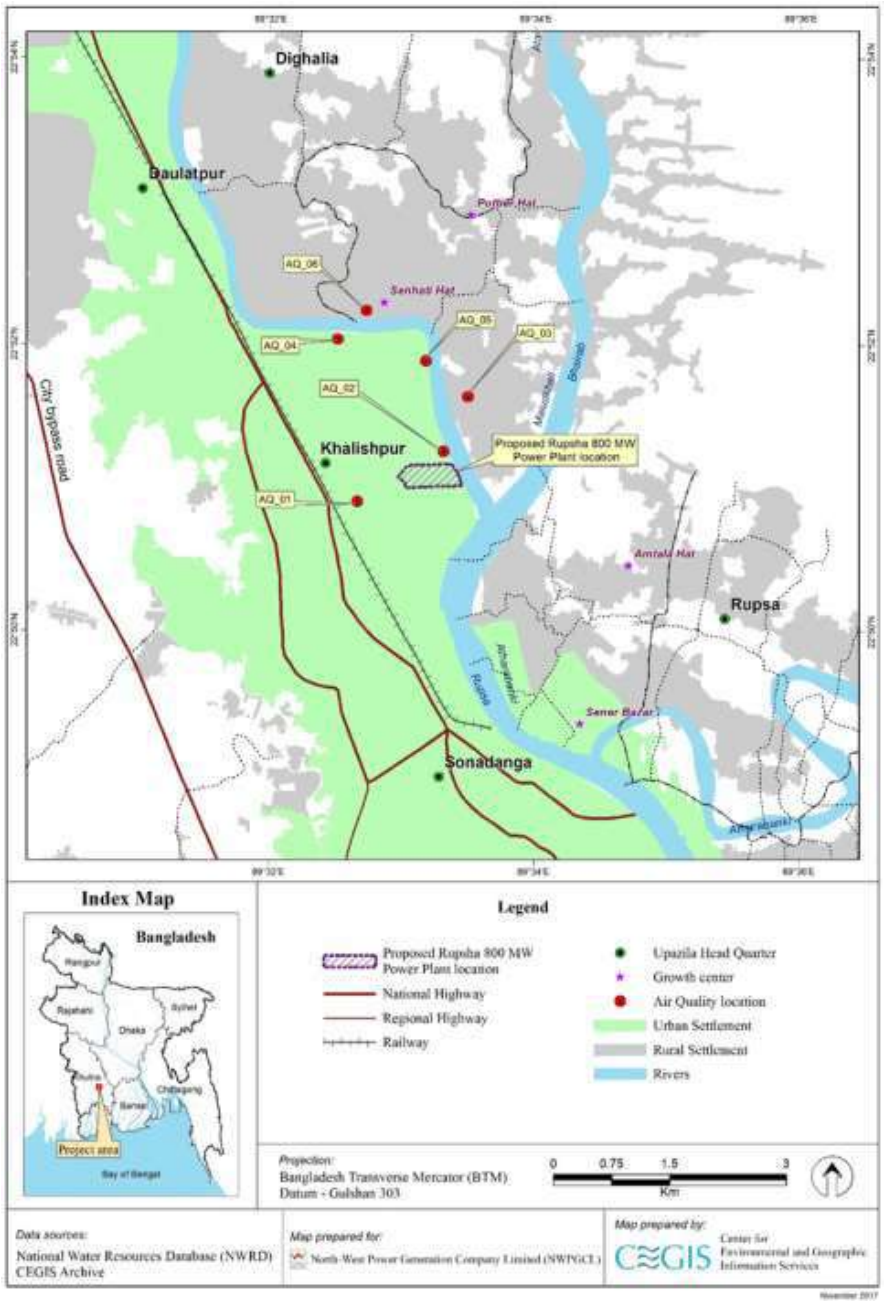


Table 4.3: Average results of ambient air quality measurements in the study area

Sample Location ID		Ambient air quality parameters					
		CO ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_X ($\mu g/m^3$)	TSP ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Methods	Location	CO meter	West-Gaeke	Jacon and Hochheiser	Gravimetric	Gravimetric	Gravimetric
AQ_1	N22˚ 50' 57" E89˚ 32' 30"	64	9.1	15.9	190.2	108.4	38.5
AQ_2	N22˚ 51' 18" E89˚ 33' 09"	65	6.7	11.2	187.1	140.9	37.9
AQ_3	N22˚ 51' 41" E89˚ 33' 20"	57	8.2	12.9	198.3	149.3	39.8
AQ_4	N22˚ 52' 05" E89˚ 32' 21"	61	8.4	11.9	188.3	126.1	29.8
AQ_5	N22˚ 51' 56" E89˚ 33' 01"	51	7.1	9	150	143.2	17.3
AQ_6	N22˚ 52' 17" E89˚ 32' 34"	66	12.1	19.1	192.2	133.4	26.4
ECR 2005 standards		10,000 (8-hr averaging period)	365 (24-hr averaging period	100 (Annual)	200 (8-hr averaging period)	150 (24-hr averaging period)	65 (24-hr averaging period)
IFC/WB EHS General Guidelines (2007)		10,000 (8-hr averaging period)	20 (24-hr averaging period 500 (10 mins averaging period, guideline)	200 (1-hr averaging period, guideline) 40 (1-yr averaging period, guideline)	---	50 (24-hr averaging period)	25 (24-hr averaging period)

Yellow shading = Degraded airshed based on IFC/WB EHS General Guidelines 20074.4
Source: CEGIS Sampling (13-19 March 2017).

Ambient noise level

193. The project area is located in the industrial belt of Khalishpur Thana. There are several point sources, line sources or area sources generating noise and do affect the background noise level in the study area. Some of these sources are commercial areas, industries, vehicular movements, ongoing construction works, etc.

194. Given that there are no activities in the project site except the boys' and girls' schools, the noise level is low. The vegetation within the project site that grew since the 2002 also provides noise barrier. Ambient noise level measurements were conducted on 27 October 2016 until 3 November 2016 for 14 stations within the study area. **Table 4.4** presents the results of ambient noise level where measurements were conducted for 4 hours during daytime and two hours at nighttime. Results show that some daytime and nighttime exceed the national limits and IFC/WB EHS General Guidelines 2007 (highlighted in yellow). A number of factors like vehicular movement (e.g. bus, train), noise from the loud speaker, and construction works contributed to the increase in the noise levels.

Table 4.4: Average ambient noise level measurements within and near project site

SL	Location	GPS coordinate	Status	Day time	Night time	ECR 2006		IFC/WB EHS General Guidelines 2007	
						Daytime	Night time	Daytime	Night time
NL_01	Residential /Hospital (structures in KNM)	N-22°51'12.60" E-89°32'58.40"	Residential	55.2	42.3	55	45	55	45
NL_02	Residence in KNM	N-22°51'12.10 E-89°33'2.50"	Residential	52.2	43.0	55	45	55	45
NL_03	Proposed admin building	N-22°51'4.10" E-89°32'55.10"	Industrial	58.8	45.2	75	70	70	70
NL_04	Admin building of KNM (abandoned)	N-22°51'19.60" E-89°32'59.00"	Industrial	55.5	40.3	75	70	70	70
NL_05	South-west corner Slump	N-22°51'4.90" E-89°32'50.30"	Residential	62.3	53.0	55	45	55	45
NL_06	Near the existing overhead tank (abandoned)	N-22°51'2.40" E-89°33'19.00"	Industrial	70.3	50.1	75	70	70	70
NL_07	Proposed Control Room	N-22°51'1.90" E-89°33'6.80"	Industrial	62	36.7	75	70	70	70
NL_08	Southern side of project boundary (middle)	N-22°51'2.90" E-89°33'2.60"	Residential	54	41.5	55	45	55	45
NL_09	Proposed Residential Area	N-22°51'9.67" E-89°32'52.70"	Residential	57.8	44.6	55	45	55	45
NL_10	Existing Guest room of KNM	N-22°51'4.72" E-89°33'13.40"	Industrial	64.2	43.1	75	70	70	70
NL_11	Premises of Mosque	N-22°51'27.20" E-89°32'53.90"	Silent	55.1	39.1	50	40	55	45
NL_12	Western corner of the Project	N-22°51'19.20 E-89°32'56.50"	Commercial	67.2	52.0	70	60	70	70
NL_13	Proposed new school site	N-22°51'16.80" E-89°33'29.40	Silent	60.1	43.9	50	40	55	45
NL_14	Fisheries Community	N-22°51'11.92" E-89°33'24.69"	Residential	47.3	37.5	55	45	55	45

Note: Values highlighted yellow exceed the limit.

Vibration

195. Vibration consists of rapidly fluctuating motions of the particles without any net movement. Objects can vibrate differently in three mutually independent directions which are vertical, horizontal and lateral. It is common to describe vibration levels in terms of velocity, which represents the instantaneous speed at a point on the object that is displaced. Vibrations are transmitted from the source to the ground and propagate through the ground to the receiver.

196. Measuring the peak particle velocity (PPV) is mostly used for representation of vibrating situation when the pressure wave passes through the particles. Soil conditions have a strong influence on the level of ground-borne vibration. The PPVs are usually expressed in terms of m/s or mm/s. The PPVs were measured in the project area (**Table 4.5**). The Kanomax machine (model 4200) was used to directly obtain the value during field visit on 26 October 2016.

Table 4.5: Vibration levels in the project site

No.	Location	Vibration (mm/s)
1	Near mosque and Graveyard	0.01
2	Near the school	0.01
3	Residential area of KNP	0.02
4	Guest House of KNP	0.01
5	South West Corner of the Project boundary	0.01

Source: CEGIS Field Visit, October 26, 2016

197. Humans are known to be very sensitive to vibration, the threshold of perception being typically in the PPV range is from 0.14 -0.3 mm/s (British Standard BS 5228-2:2009). The level of vibration in the project site is not within the PPV range of human perception.

4.2.6 Water Resources

198. There are several rivers, khals and beels in the study area as the sources of surface water. Ground water is also available.

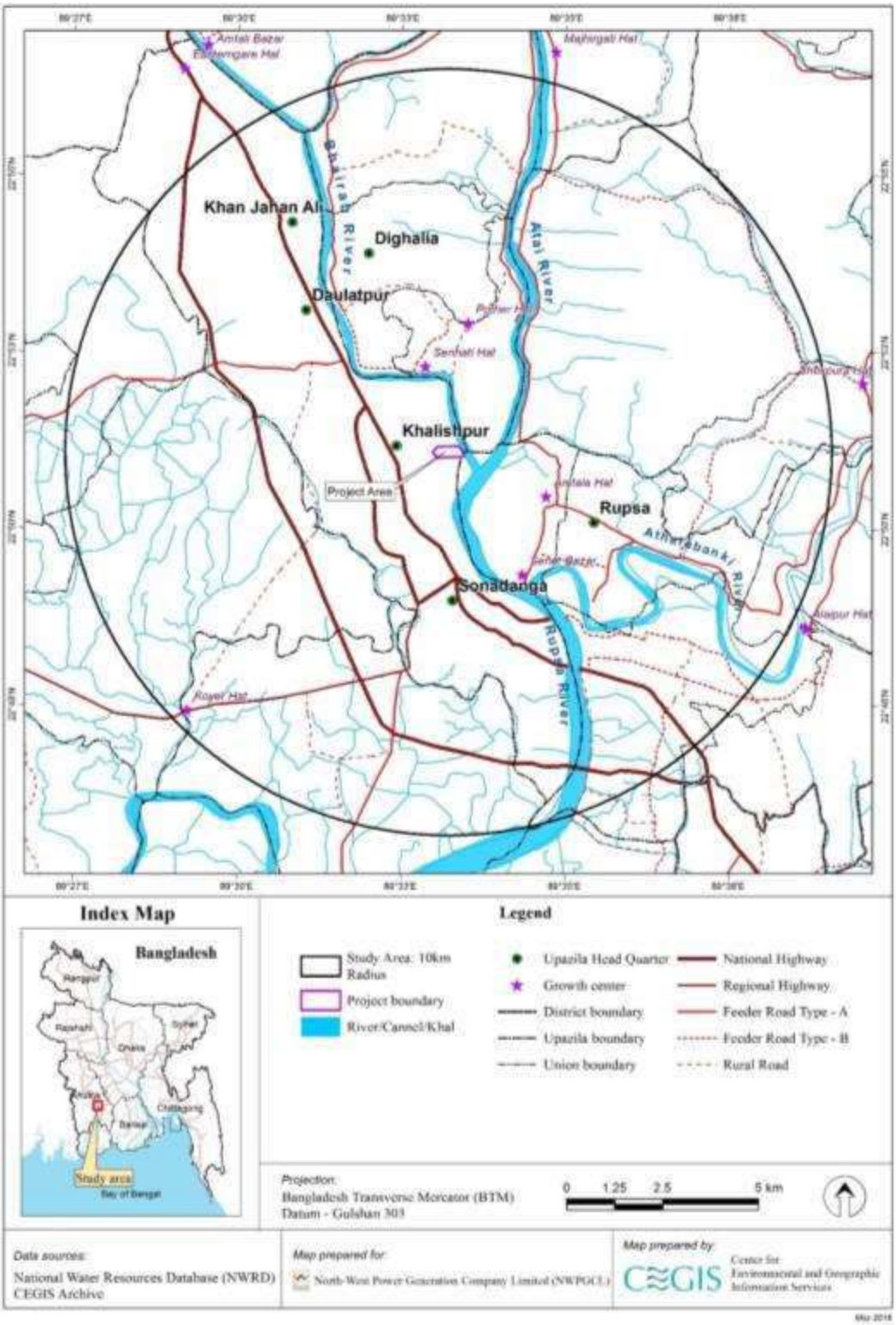
Surface Water

199. The project area is locally known as colony of KNM and is located at the right bank downstream of Bhairab River ultimately draining towards the Bay of Bengal. The main rivers within the study area are Bhairab River, Atai River, and Rupsha River. These rivers are tidally influenced by the Bay of Bengal.

200. The entire south-west region of Bangladesh, located in the right bank of the Ganges-Padma River is known as the Gangetic Delta and has been formed primarily by the alluvium carried by the Ganges River. The north-south flowing rivers in this region are interconnected by smaller tidal creeks which forms the network of rivers. There are large saucer shaped tidal basins between these networks that are flooded and drained twice in a day by the tide. Like any other area within the coastal belt, the proposed area is also a saucer shaped tidal basin. Tide enters into the area from the Bhairab River through the Rupsha River. The Bhairab River has no connectivity with the khals or channels along its right bank in the project site. However, the study area receives a volume of storm water through city drainage and other discharges from the bankside mills and factories.

201. The feature is totally different in the other side of the Bhairab River. There is active connection of Atai River and Rupsha River with the Bhairab River through a number of local beels and channels. Average depth of water in the Bhairab River is 0.5 to 2.3 m during the dry season while during monsoon, it increases toabout4.1 m to 5.6 m. At present, most of the beel areas are used for agriculture, fisheries, shrimp and prawn culture during the dry season through compartmentalization by small dyke in the left side of this river. **Figure 4.15** shows the river connectivity within the study area.

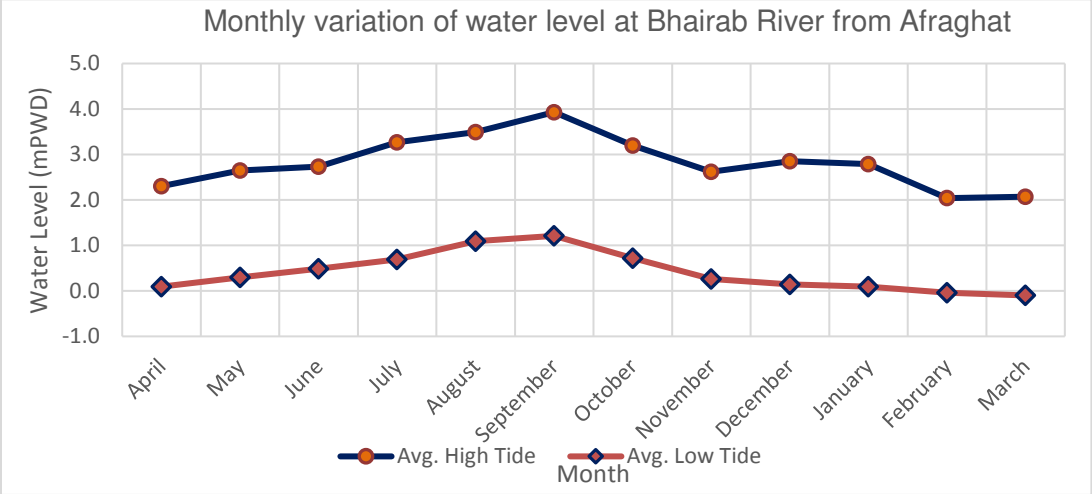
Figure 4.15: River connectivity in the study area



Water level and discharge

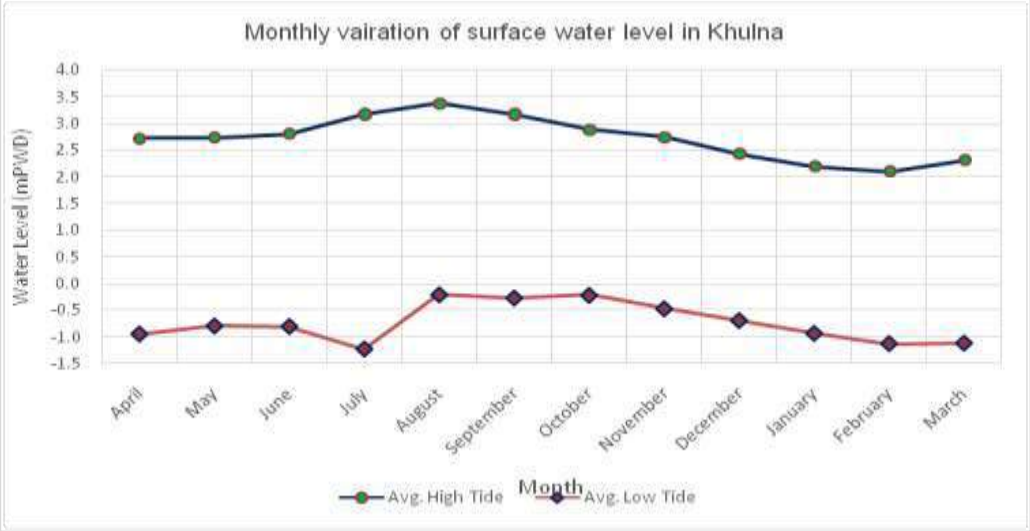
202. Water level data from 1980 to 2016 at the Afraghat station of BWDB for the Bhairab River and from the Khulna station for the Rupsha-Passur River have been used to examine the routing at the project site using the maximum water level to discharge profile. The Afraghat station is located about 4.5 km downstream of Bhairab River while the Khulna station is 32 km upstream from the proposed project site. Average monthly water level during the high tide and low tide are presented in **Figure 4.16** for Bhairab river and **Figure 4.17** for the Rupsha-Passur River. Flooding situation is shown in **Figure 4.18**.

Figure 4.16: Average monthly tide levels of Bhairab River at Afraghat



Source: BWDB

Figure 4.17: Average monthly levels of Rupsha-Passur River



Source: BWDB

Figure 4.18: Flooding situation

During post monsoon

During monsoon

Return period analysis for water level

203. Maximum water level in the Bhairab River has been recorded at 4.14mPWD in 1971 at Afraghat station and 3.86mPWD in 2005 at the Khulna station (**Table 4.6**).

Table 4.6: Return period analysis for Bhairab River

Return Period (T), years	Water level at Afraghat (mPWD)	Water level at Khulna (mPWD)
5	3.61	3.51
10	3.88	3.69
25	4.19	3.90
50	4.40	4.03

Source: CEGIS return period analysis, 2016

Discharge data

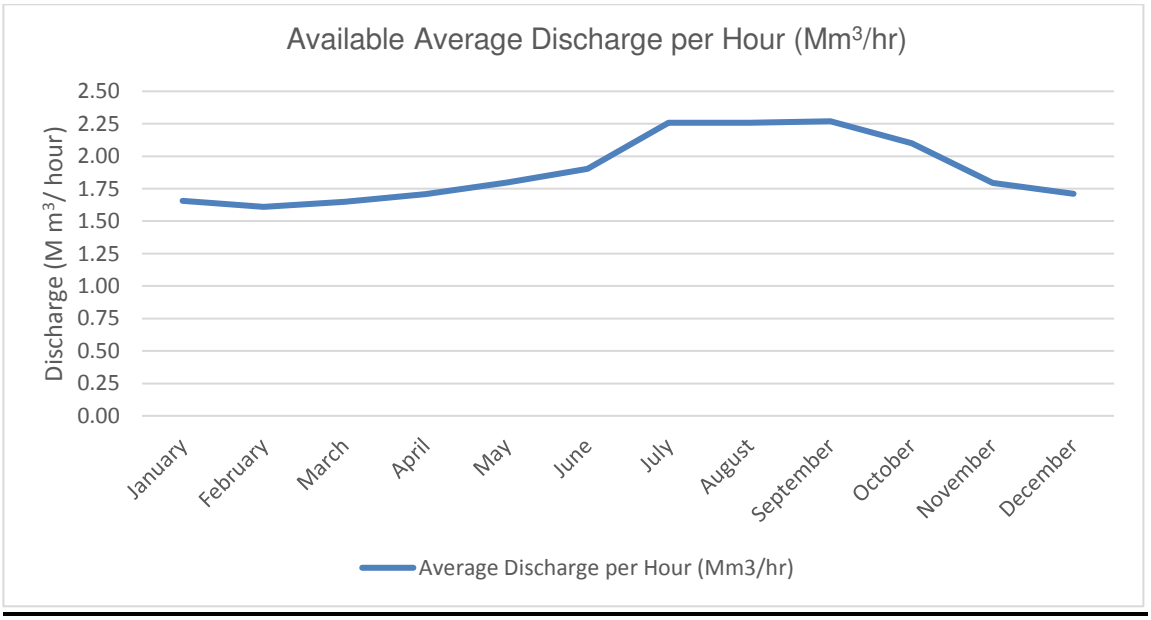
204. Discharge data was based on the Hydrological Investigation and Model Study of Bhairab River (Feasibility Study, March 2016) which shows that the available water from the Bhairab River range from 38.64 million cubic meters (MCM)/day to 54.47 MCM/day. Water requirement for the forced draft cooling system is about 2,010 m^3/hr. Percentage of water required per year will range from 0.089% to 0.125% or less than 1% of the average available discharge (**Table 4.7**). **Figure 4.19** shows the available average discharge per hour.

Table 4.7: Available discharge in Bhairab River

No.	Month	Average Discharge per day (MCM/day)	Average Discharge per Hour (m^3/hr)	Required water for the cooling system (m^3/hr)	Percentage of river water for cooling system (%)
1	January	39.73	1,655,416.667	2,010	0.121
2	February	38.64	1,610,000	2,010	0.125
3	March	39.59	1,649,583.333	2,010	0.122
4	April	40.99	1,707,916.667	2,010	0.118
5	May	43.11	1,796,250	2,010	0.112
6	June	45.67	1,902,916.667	2010	0.106
7	July	54.21	2,258,750	2,010	0.089
8	August	54.21	2,258,750	2,010	0.089
9	September	54.47	2,269,583.333	2,010	0.089
10	October	50.39	2,099,583.333	2,010	0.096
11	November	43.04	1,793,333.333	2010	0.112
12	December	41.08	1,711,666.667	2,010	0.117

Source : Hydrological Investigation and Model Study of Bhairab River, March 2016 (Feasibility report).

Figure 4.19: Available average discharge throughout the year



Surface water quality

205. In-situ surface water quality measurements were conducted in October 2016 for six sampling stations identified within the study area. Water quality parameters include pH, dissolved oxygen, biochemical oxygen demand (BOD), total dissolved solids (TDS), electrical conductivity, salinity, and temperature. Chemical analyses of the surface water samples were done by the central laboratory of the Department of Public Health Engineering (DPHE). Results of analysis are given in **Table 4.8** and **Table 4.9**, respectively. **Figure 4.20** shows the sampling stations.

Table 4.8: Average results of in-situ surface water sampling (October 2016)

Sample ID	Location of Sampling	pH	DO ppm	BOD_5 at 20°C	TDS ppm	EC µS/cm	Salinity (ppt)	Temperature (°C)
SW01	Upstream of project site	8.38	7.8	0.7	100	210	0	36
SW02	Project Intake (Low tide)	8.47	6.89	0.89	117	245	0	32
SW03	Project Intake (High tide)	8.38	5.9	0.7	110	230	0	30
SW04	Downstream of project site	8.45	6.2	0.55	165	320	0	33
SW05	Bhairab-Rupsha Confluence	8.25	6.92	1.02	185	355	0	30
SW06	Rupsha River	8.1	6.48	2.28	130	290	0	34
ECR 1997, Schedule - 3 Standards for Water (see Rule 12)		6.5-8.5	>5.0	6 or less	2,100	1,200	---	---

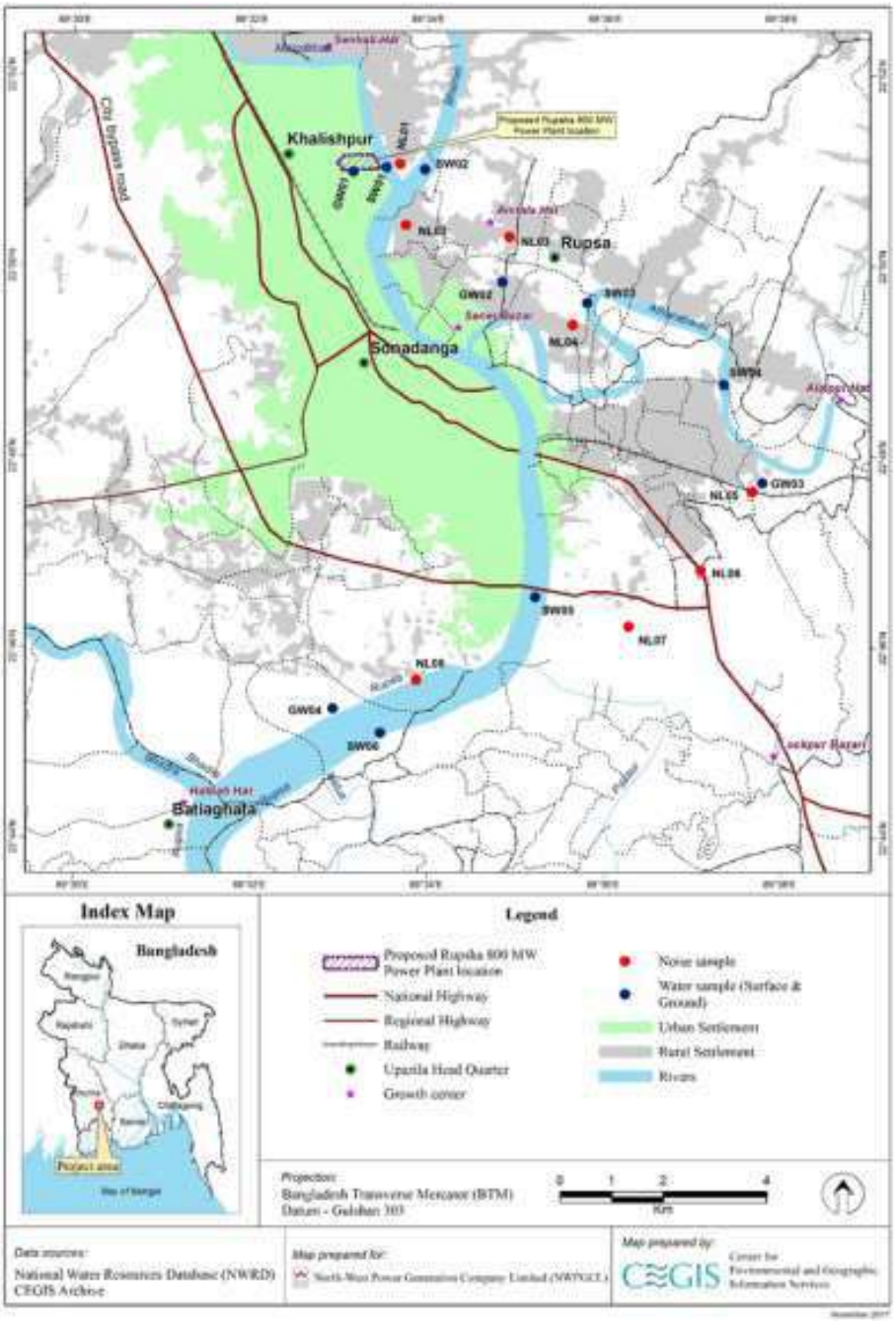
BOD = biochemical oxygen demand; DO = dissolved oxygen; EC = electrical conductivity; ppm = parts per million; TDS = total dissolved solids.
Source: CEGIS study team, October 2016.

Table 4.9: Results of chemical analyses, surface water quality

No.	Water Quality Parameters	Unit	SW01	SW02	SW03	SW04	SW05	SW06	Method of Analysis	LOQ
1	Alkalinity	mg/L	120	123	125	103	153	125	Titrimetric	-
2	Arsenic	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	AAS	0.001
3	Calcium	mg/L	18.68	16.77	15	15.5	16.6	13.6	AAS	0.17
4	COD	mg/L	40	48	20	20	16	32	CRM	-
5	Chloride	mg/L	18	16	20	17	18	16	Titrimetric	-
6	Electrical conductivity	µS/cm	15.5	42.9	34	50	45	37	Multimeter	-
7	Hardness	mg/L	143	185	173	143	158	145	Titrimetric	-
8	Iron	mg/L	2.38	2.32	2.45	3.06	2.85	3.21	AAS	0.05
9	Lead	mg/L	0.008	0.007	0.004	0.003	0.005	0.004	AAS	0.001
10	Magnesium	mg/L	3.4	38	3.6	3.3	3.2	3.4	AAS	0.05
11	Nitrogen	mg/L	3.1	3.8	1.2	0.7	1.3	0.8	UVS	0.10
12	Phosphate	mg/L	1.56	2.02	1.30	2.51	1.24	1.33	UVS	0.98
13	Potassium	mg/L	2	3	3	2	2	2	AAS	-
14	Sodium	mg/L	21	19	18	19	20	16	AAS	0.34
15	Sulfate	mg/L	2	1	1	1	2	4	UVS	1.0
16	TDS	mg/L	6	6	7	6	6	7	Multimeter	-
17	Turbidity	NTU	66	60	65	69	67	59	Turbidity meter	-
18	Oil & Grease	mg/L	<5.0	<5.0	-	<5.0	-	-	APHA 5220.B	10

AAS =Atomic Absorption Spectrophotometer; CRM =Closed Reflux Method; LOQ =Limit of Quantification; NM =not measured; UVS = UV Visible Spectrophotometer.

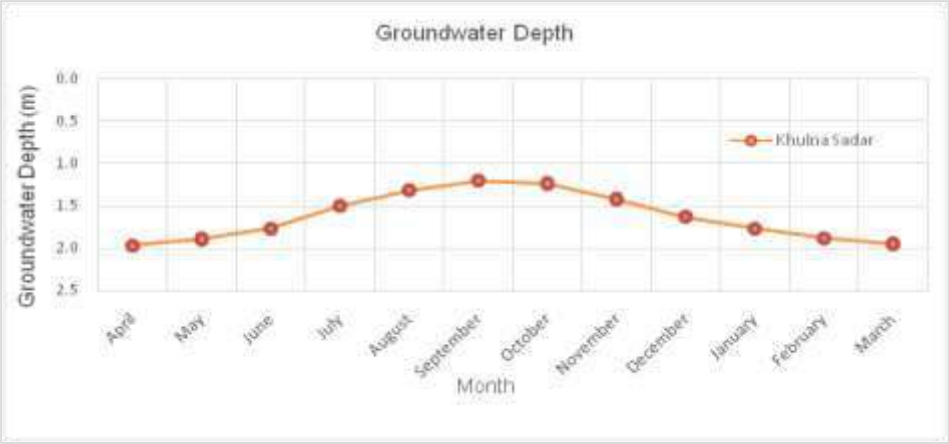
Figure 4.20: Noise sampling stations (Red Spots)



Groundwater

206. Groundwater level data was collected from the Khulna Sadar observation well to examine the status of groundwater availability in the study area. **Figure 4.21** shows the monthly ground water depth from 1978-2013. Based on the available data, groundwater starts to deplete during the later stages of the pre-monsoon (end of April) and continues up to the middle of October. Thereafter, at the beginning of post-monsoon, the aquifer recharge begins.

Figure 4.21: Average monthly groundwater depth (1978-2013)



Source:BWDB

Groundwater quality

207. Four groundwater sampling stations were identified in the study area during the site visit on 26-30 October 2016 (see **Figure 4.22**). Groundwater samples were analyzed by the Central Laboratory, DPHE. Results of groundwater quality sampling are given in **Table 4.10** and **Table 4.11**.

Table 4.10: Average results of in-situ groundwater quality sampling in the study area

Sample Source	Location of Sampling	pH	DO ppm	BOD_5 at 20°C (mg/l)	EC (mS/cm)	TDS ppm	Salinity (ppt)	Temperature (°C)	Time
GW01	Deep tube well of 250 ft depth	7.45	1.7	0.5	1,530	760	2	28	11:20 am
GW02	Deep tube well of 600 ft depth	7.9	5.99	0.64	1,820	910	3	26	10:15 am
GW03	Deep tube well of 400 ft depth	4.51	2.5	0.2	1,260	630	2	27	16:45 pm
GW04	Deep tube well of 500 ft depth	7.75	4.8	0.5	1,570	780	2	26	12:30 pm
ECR 1997 Schedule-3 Standards for Water [See Rule 12] (B)		6.5-8.5	6	0.2	---	1,000	---	20-30	

Source: CEGIS field study, October 2016.

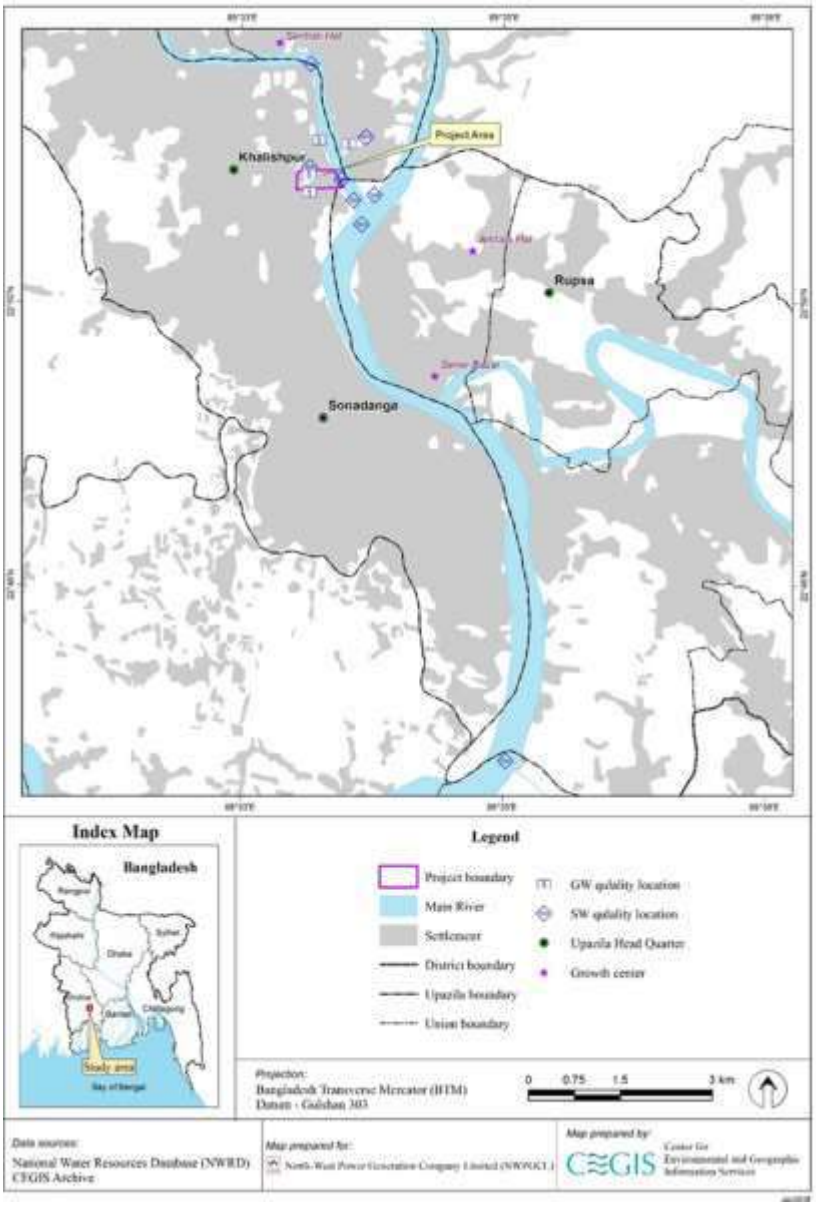
208. Based on the in-situ water quality measurements, groundwater is saline and the electrical conductivity values are high as well as BOD_5.

Table 4.11: Results of groundwater quality analyses

No.	Water Quality Parameters	Unit	GW01	GW02	GW03	GW04	Method of Analysis	ECR 1997 Schedule-3 Standards for Water [See Rule 12] (B)	LOQ
1	Arsenic	mg/L	0.002	0.001	0.001	0.001	AAS	0.05	0.001
2	Calcium	mg/L	29.6	34.7	49.3	48.3	AAS	75	0.17
3	COD	mg/L	4	4	4	4	CRM	4	-
4	Chloride	mg/L	332	461	210	348	Titrimetric	150-600	-
5	Silica	mg/L	31	33	33	42	UVS		
6	Hardness	mg/L	353	315	350	405	Titrimetric	200-500	-
7	Iron	mg/L	3.03	5.37	4.38	6.52	AAS	0.3-1	0.05
8	Lead	mg/L	0.015	0.015	0.013	0.022	AAS	0.05	0.001
9	Nitrogen	mg/L	0.87	1.2	1.6	1.1	UVS	1.0	0.10
10	Phosphate	mg/L	0.16	0.37	1	0.50	UVS	6	0.98
11	Sulfate	mg/L	5	5	3	2	UVS	400	1.0

AAS = Atomic Absorption Spectrophotometer, CRM = Closed Reflux Methods, LOQ = Limit of Quantification, NM = not measured, UVS =UV-Visible Spectrophotometer.
Note: Values highlighted yellow exceed the limit.

Figure 4.22: Water quality sampling stations



Water resources issues and functions

Existing beneficial uses of Bhairab River

209. Bhairab River is used for the fisheries, shrimp and agricultural purposes. The consumption of water mainly takes place at the left bank of Bhairab River. The right bank of the Bhairab River within the study area is an industrial belt which do not use water from the river due to the tidal influence on water quality. Given the existing industries, Bhairab River has become the receiving body of most of the discharges from the industries. For other domestic uses, shallow tube well and surface water sources from perennial creeks are also used. Overall, water availability in the study area is not a major concern of the local people.

Flooding

210. Flooding is a common phenomenon in the study area and like other areas of Bangladesh, this area also experiences yearly flooding. The main causes of flooding are heavy rainfall, tidal water intrusion, and storm surge. Every year, during the high flood, proposed project area is submerged by about 0.5m –1.5m and in some occasion, extends for 7-30 days.

211. Seven major profiles of discharge within the study area have been considered (1969, 1970, 1972, 1974, 1984, 1986, and 1999). **Table 4.12** shows the flood profile in the study area. Secondary data on water level, discharge and land elevation were collected from the National Water Resources Database of Bangladesh and used as inputs to HEC-RAS model in flood risk analysis.[32]

Table 4.12: Flood profile of the study area

Profile	Return Period	Steady flow discharge (m^3/s)	Average Water level (mPWD)	Remarks
Profile 1 (1969)	2	4,261	2.41	Project area inundated fully
Profile 2	5	5,843	2.51	Project area inundated fully
Profile 3	10	4,593	2.76	Project area inundated fully
Profile 4	20	4,423	3.41	Project area inundated fully
Profile 5	25	2,820	3.15	Project area inundated partially
Profile 6	50	3,199	3.26	Project area inundated partially
Profile 7 (1999)	100	2,466	3.19	Project area free from flood

Source: CEGIS estimated HEC RAS model generated data.

[32] HEC-RAS is a software for one-dimension or two-dimensions simulations of the evolution of a flood, which could have a stable or an unstable flow rate, sediment transport, change of the river bed etc. HEC-RAS stands for Hydrologic Engineering Center (US Army Corps of Engineers), River Analysis System.

212. These profiles show that prior to 1999, the project area has been fully and partially inundated during flooding events (**Figure 4.23** and **Figure 4.24**). ADB funded a flood control and urban infrastructure development project on 10 November 2010.[33] This included a subproject in July 2013 on Khulna drainage and flood protection. The project site will be backfilled to a level of +5.5m. Surrounding area now is at elevation +3.3m MSL higher than the average water level based on the flooding profile in 1999 and a return period of 100 years. Therefore, flooding will not be a major risk.

Salinity

213. Saline intrusion is another concern within the study area. According to local people, salinity becomes a concern during the pre-monsoon period. Local pond and ditches are more saline than river as the tidal water velocity gets slower towards the ditches particularly during the dry period. Salinity was detected in all the groundwater samples taken from both the shallow and deep tube wells.

Riverbank Erosion

214. The eastern boundary of the project area located at the right bank of Bhairab River is protected by a sheet pile to avoid erosion of that particular section of the river (see Photo). But erosion and accretion are visible in both banks of the Atai River, Bhairab River and Rupsha River within the study area. For morphological analysis of the study area, satellite images of 1997, 2003, 2008, 2010 and 2015 have been used. Geographic information system (GIS) and remote sensing (RS) tools and technologies have been used for this study. Bank lines of these five years have been delineated following the CEGIS-defined methodologies (**Table 4.13** and **Figure 4.25**).

sheet pile erosion protection

Erosion across the river bank of Bhairab River opposite the proposed project site

215. There are about 15 km of sheet piling existing in the study area including the project's eastern boundary. But erosion becomes prominent at the other side of the river. In the figure above, sheet piling at Rupsha Old Ferry Ghat located 8km south from the project site.

[33]ADB. Loan 2695-BAN: City Region Development Project. $120M, 10 November 2010. https://www.adb.org/projects/39298-013/main#project-pds.

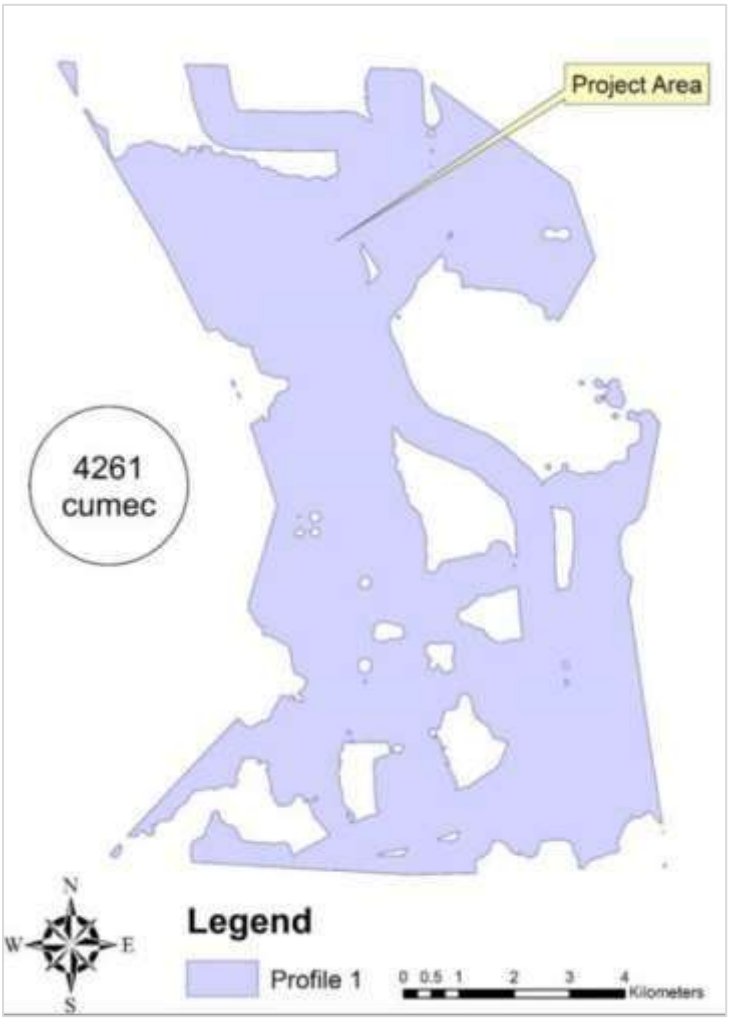
Table 4.13: Summary of erosion-accretion in the study area

Duration	:	Average erosion (ha/year)	Total accretion in the study area (ha)	Average Accretion (ha\year)
1997 - 2003	109.65	18.28	106.18	17.70
2003 - 2008	101.19	22.03	111.67	22.34
2008 - 2010	163.21	81.61	114.28	57.14
2010 - 2015	48.94	9.8	184.40	36.88

Source: Results of CEGIS analysis.

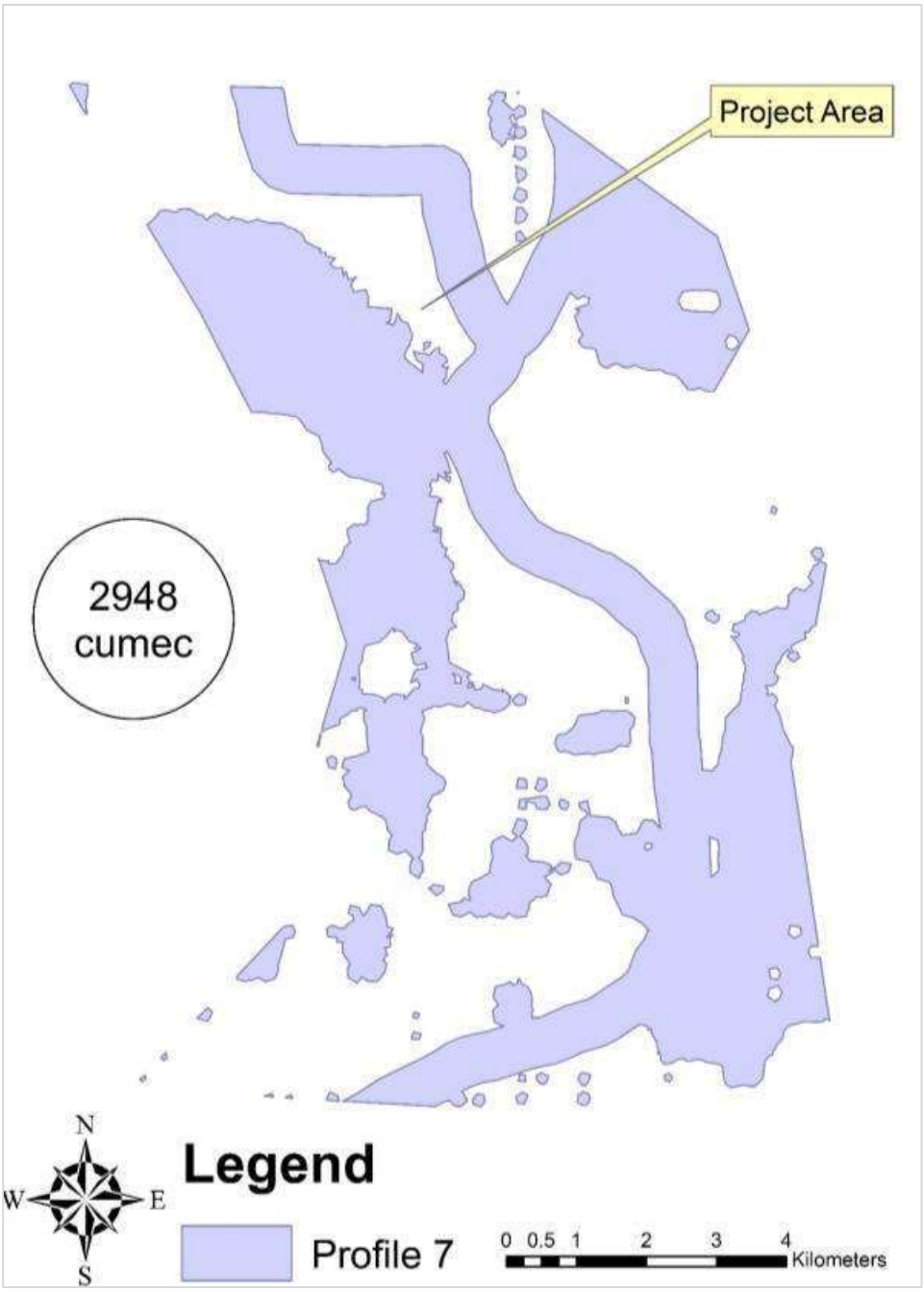
216. Based on the available satellite images during these five years, it appears that the situation has improved from an erosion rate of 81.61 ha/yr (2008-2010) to 9.8 ha/yr (2010-2015). **Figure 4.26** shows the location of the river bank erosion-accretion within the study area.

Figure 4.23: Inundation in 1969 within the study area



Source: HEC-RAS Model Output.

Figure 4.24: Inundation in 1999 within the study area



Source: HEC-RAS Model Output.

Figure 4.25: River bank erosion and accretion in the study area

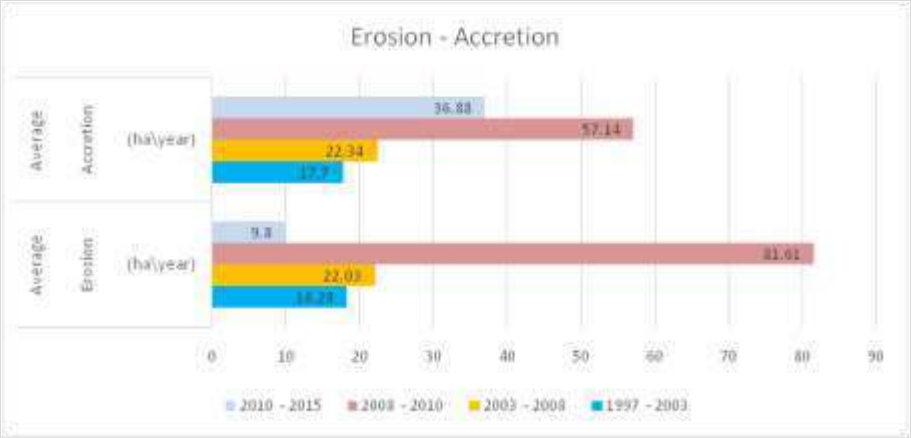
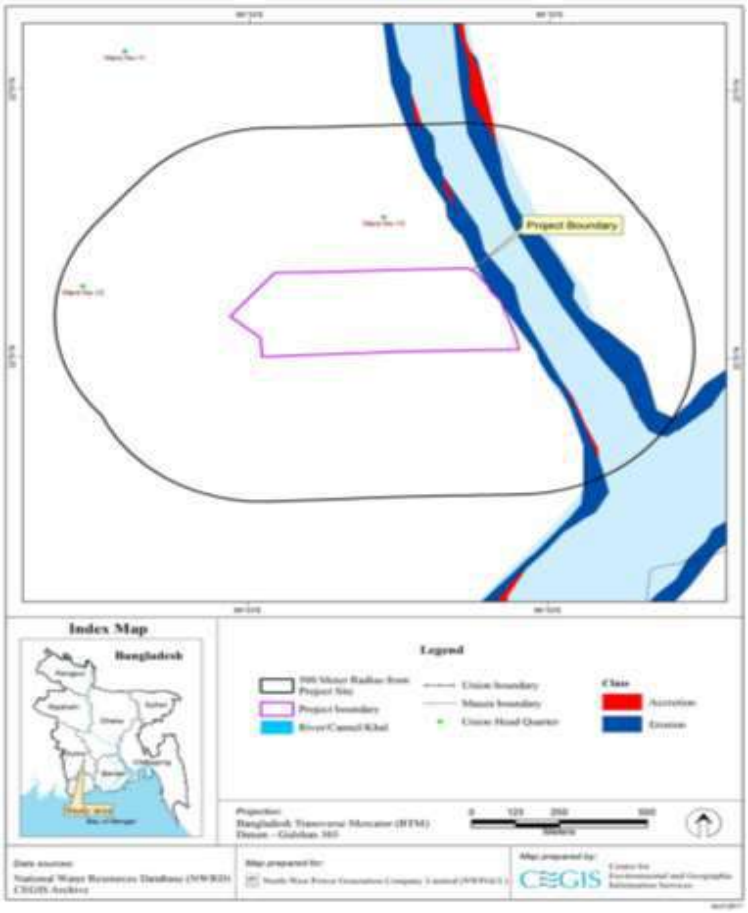


Figure 4.26: Location of river bank erosion-accretion in the study area



Navigation

217. Bhairab River is one of the industrial navigation routes within the study area. The waterways of Bangladesh have been classified by the Bangladesh Inland Water Transport Authority (BIWTA) into four categories depending on least available depth ranging from 3.90 m to 1.50m.[34] **Table 4.14** presents the categories within the study area.

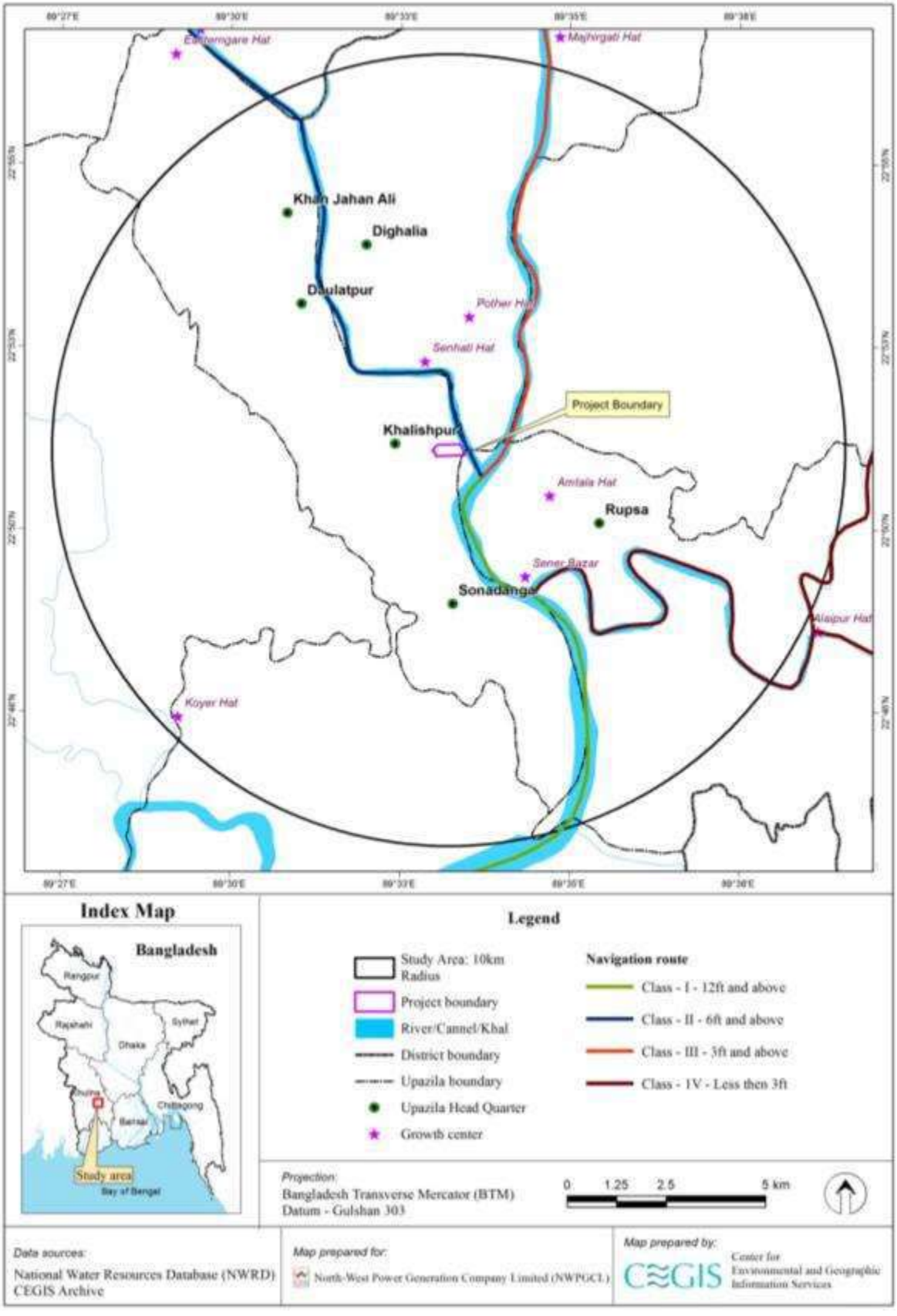
Table 4.14: **Categories of waterways in the study area**

Category	Minimum Depth (m)	Length of Route (km)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)
Class I	3.66	683	18.3	76.22
Class II	2.13	1,027	12.2	76.22
Class III	1.52	1,885	7.62	30.48

218. Based on these categories, Bhairab River is Class II. This route is extensively used for the transportation of goods and passengers. Local people use small boats and trawlers for local transportation of goods and other vessels like ships, barges, cargo for transportation across the country. Rupsha River is Class I while Atai River is Class III. Rupsha River and Atai River are connected with Bhairab River at Aijganti Union of Khulna Sadar (**Figure 4.27**). It is estimated that about 45km navigation route currently exists within the study area.

[34] Bangladesh Inland Water Transport Authority. About us. http://www.biwta.gov.bd/

Figure 4.27: Navigation system within the study area



4.2.7 Land resources

219. This section was based on primary and secondary data. The primary data was collected during the site visit on 26-30 October 2016 while secondary data was taken from Soil Resources Development Institute (SRDI) publications, local offices of the Department of Agricultural Extension (DAE), and Department of Livestock Services (DLS).

Agro-ecological Zone

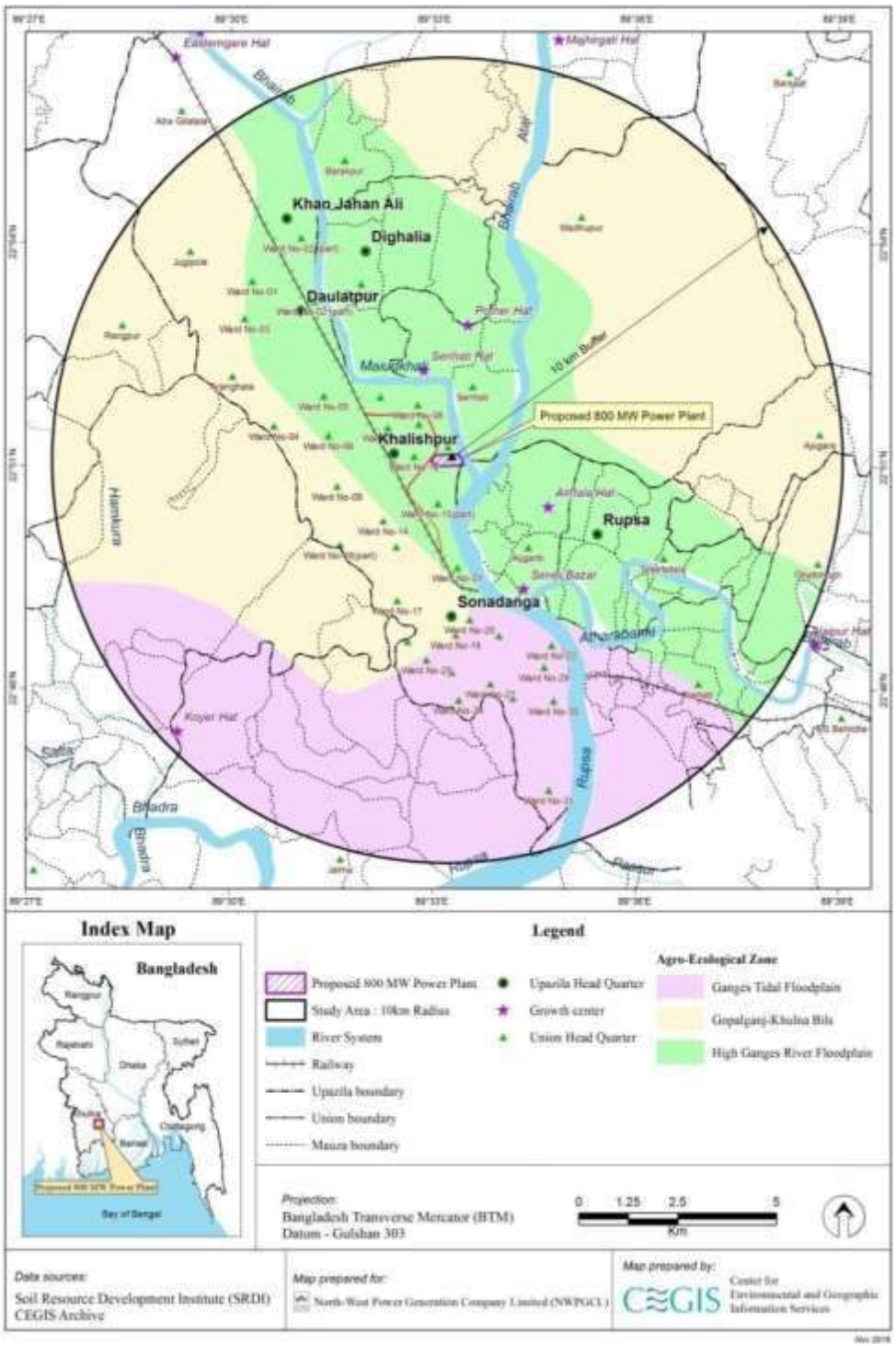
220. The project area is under one agro-ecological zone (AEZ) while the study area is under three different AEZs which are situated in Khulna Sadar District (**Table 4.15** and **Figure 4.28**). The project area is on High Ganges River Floodplain while most of the study area is in Gopalganj-Khulna Beel (almost half of the study area).

Table 4.15: AEZ within the PAI

Name of AEZ	Description of AEZ	Project area (acre)	% of gross area	Study area (acre)	% of gross area
AEZ 11: High Ganges River Floodplain	Top soils are slightly acidic to slightly alkaline in reaction, but there is a significant lowering of soil pH in high land in the recent years and in some places top soils become strongly acidic. Sub-soils are slightly alkaline in reaction. General fertility level is low including N, P, S and B although CEC is medium. The K- bearing minerals are medium to high, but the Zn status is low to medium. Soil texture is generally silty loams to silty clay loams. pH is 4.5-8.1 and organic matter content in soil is low to medium.	49.57	100	23,741	31
AEZ 13: Ganges Tidal Floodplain	Very high CEC and K status. There are limitations of high exchangeable Na and low Ca/Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum. Soil texture is generally silty clay. pH is 4.5-8.4 and organic matter content in soil is low to medium.	-	-	17,070	22
AEZ 14: Gopalganj-Khulna Bils	General Soil Types include mainly Peat and Non calcareous Dark Grey Floodplain soils. They have low bearing capacity when wet, very strongly acidic to neutral in top soil reaction and low in K, B and Zn. Soil texture is generally clayey. pH is 4.0-7.5 and organic matter content in soil is high.	-	-	36,785	47
Total		**49.57**	**100**	**77,596**	**100**

Source: SOLARIS-SRDI-2006.

Figure 4.28: AEZ within the PAI



Land type

221. The basis of land type classification in Bangladesh is depth of inundation during monsoon season due to normal flooding on agriculture land (MPO 1987). According to Master Plan Organization (MPO) 1987, there are five land type classes: F0, F1, F2, F3 and F4. The project area is within the Khulna City Corporation which is a non-agricultural industrial zone (KNM) and hence, the land type in this area is not considered in terms of agricultural point of view. The study area falls within four different land types. Details of the land types are presented in **Table 4.16** and **Figure 4.29**.

Table 4.16: Land type within the study area

Land Type	Flooding depth and characteristics	Study Area	
		Area (Acre)	% of Net Cropped Area (NCA)
F0	The land, which is not generally inundated under normal flood situation. This class has been subdivided into two classes: (i) Land which is above normal flood-level. (ii) Normally flooded from 0 - 30 cm deep where water normally can be stored by constructing ail and Aman can be transplanted.	885	4
F1	Land which normally is flooded between 30- 90 cm deep continuously more than two weeks to few months during the flood season.	11,654	53
F2	Land which normally is flooded between 90 cm -180 cm deep of inundation continuously for few months in flood season.	6,522	30
F3	Land which normally is flooded between 180 and 360 cm deep of inundation continuously for few months in flood season.	2,755	13
	Total:	**21,816**	**100**

F0 = highland, F1 = medium highland, F2 = low land, F3 = medium low land.
Source: Master Plan Organization (MPO), Technical Report No. 1, 1987 and field observation in October 2016

Soil texture

222. Soil texture is the relative proportion of sand, silt and clay. Soil texture is an important characteristic that guides crop selection. The study area contains four soil textural classes, where clay texture dominates over others. Soil texture of the study area is presented in **Table 4.17** and **Figure 4.30**.

Table 4.17: Soil texture in the study area

No.	Soil Texture	Study Area	
		Area (Acre)	% of NCA
1	Clay	12,397	57
2	Clay Loam	1,910	9
3	Loam	1,112	5
4	Muck	6,397	29
Total		**21,816**	**100**

Sources: SOLARIS-SRDI, 2006.

Figure 4.29: Land type within the study area

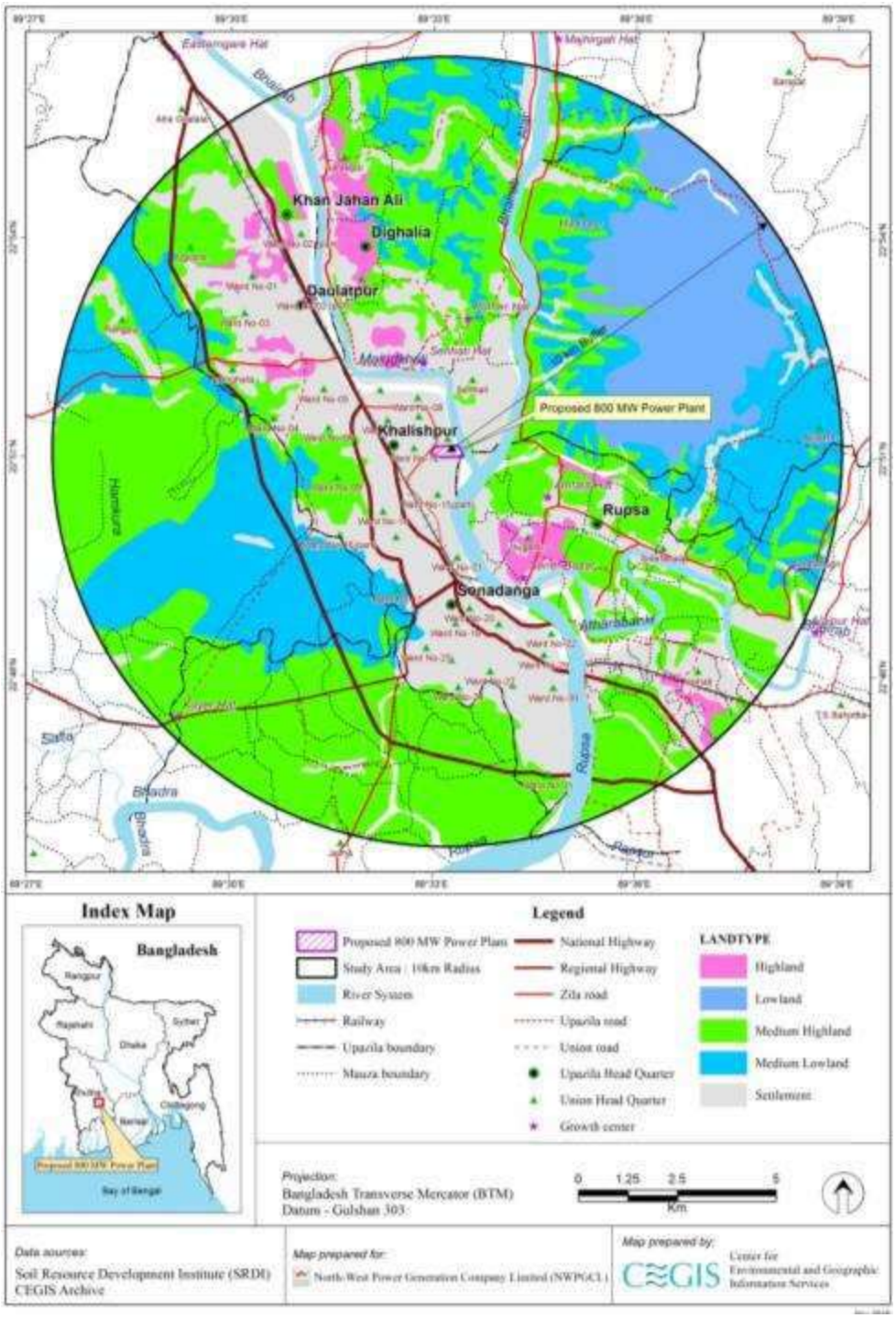
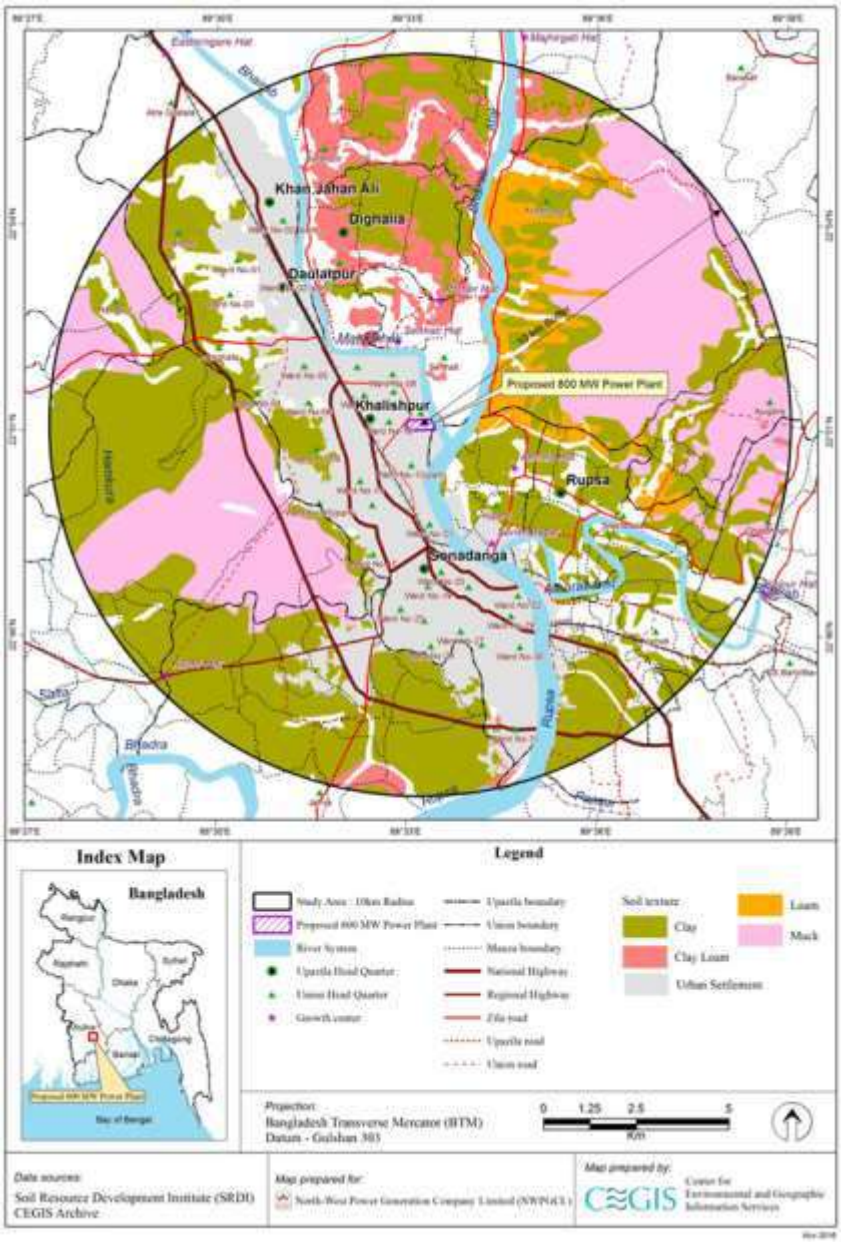


Figure 4.30: Soil texture within the study area



Soil salinity

223. Two major salinity classes cover most of the study area which are: non-saline with some very slightly saline (S1) and very slightly saline with some slightly ones (S2). Details of soil salinity within the study area are shown in **Table 4.18** and **Figure 4.31**.

Table 4.18: Soil salinity within the study area

No.	Soil Salinity Characteristics	Soil salinity class	Project Area		Study Area	
			Area (Acre)	% of NCA	Area (Acre)	% of NCA
1	Non-saline with some very slightly saline	S1(2.0-4.0)	49.55	100	10,011	46
2	Very slightly saline with some slightly saline	S2(4.1-8.0)	-	-	10,979	50
3	Slightly saline with some moderately saline	S3(8.1-12)	-	-	826	4
		Total	**49.55**	**100**	**21,816**	**100**

Source: SRDI,2012.

224. During the field study in October 2016, CEGIS team collected four soil samples: one from project area, and three other soil samples from the study area. All the three locations are selected within one kilometer (km) from the stack of the proposed Rupsha 800 MW CCPP in two depths, 0-15 m and 15-30 m. Soil samples were analyzed by the Soil Science Discipline, Khulna University in Khulna and soil sampling locations is shown in **Figure 4.32**.

225. Results of soil analysis showed that soil salinity class in the project area is S1 while the study area resembled almost similar characteristics. These suggest that it may be due to polderization. Polders protect saline water from regular inundation of tidal effect during the dry season, when water salinity is very high. Details of soil salinity analysis data is presented in **Table 4.19.**

Table 4.19: Results of soil salinity analysis within the study area

Sampling ID	Area	Location	Depth of soil (cm)	Analyzed data result (ds/m)	Standard
01	Project area	In front of main mosque	0-15	0.54	S1 (2.0-4.0)- Non saline with some very slightly saline
			15-30	0.46	S1 (2.0-4.0)- Non saline with some very slightly saline
02	Study Area	Chandanimahal, Senhati	0-15	4.60	S2 (4.1-8.0)- Very slightly saline with some slightly saline
			15-30	4.82	S2 (4.1-8.0)- Very slightly saline with some slightly saline
03		CPI hostel playing ground, Khalishpur, Khulna	0-15	1.52	S1 (2.0-4.0)- Non saline with some very slightly saline
			15-30	1.29	S1 (2.0-4.0)- Non saline with some very slightly saline
04		Daulatpur Jute mills, playing ground	0-15	0.53	S1 (2.0-4.0)- Non saline with some very slightly saline
			15-30	0.55	S1 (2.0-4.0)- Non saline with some very slightly saline

Figure 4.31: Soil salinity characteristics within the study area

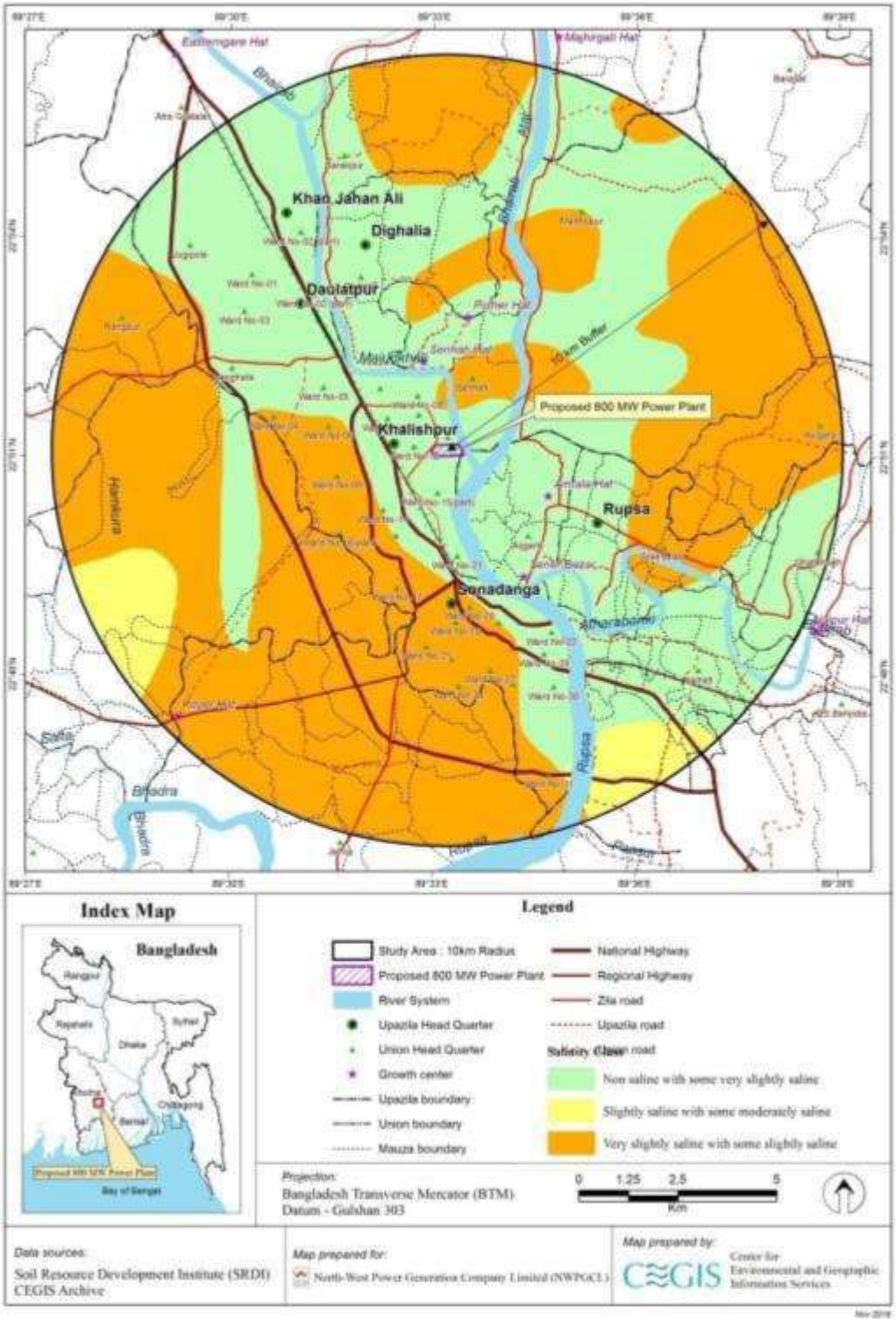
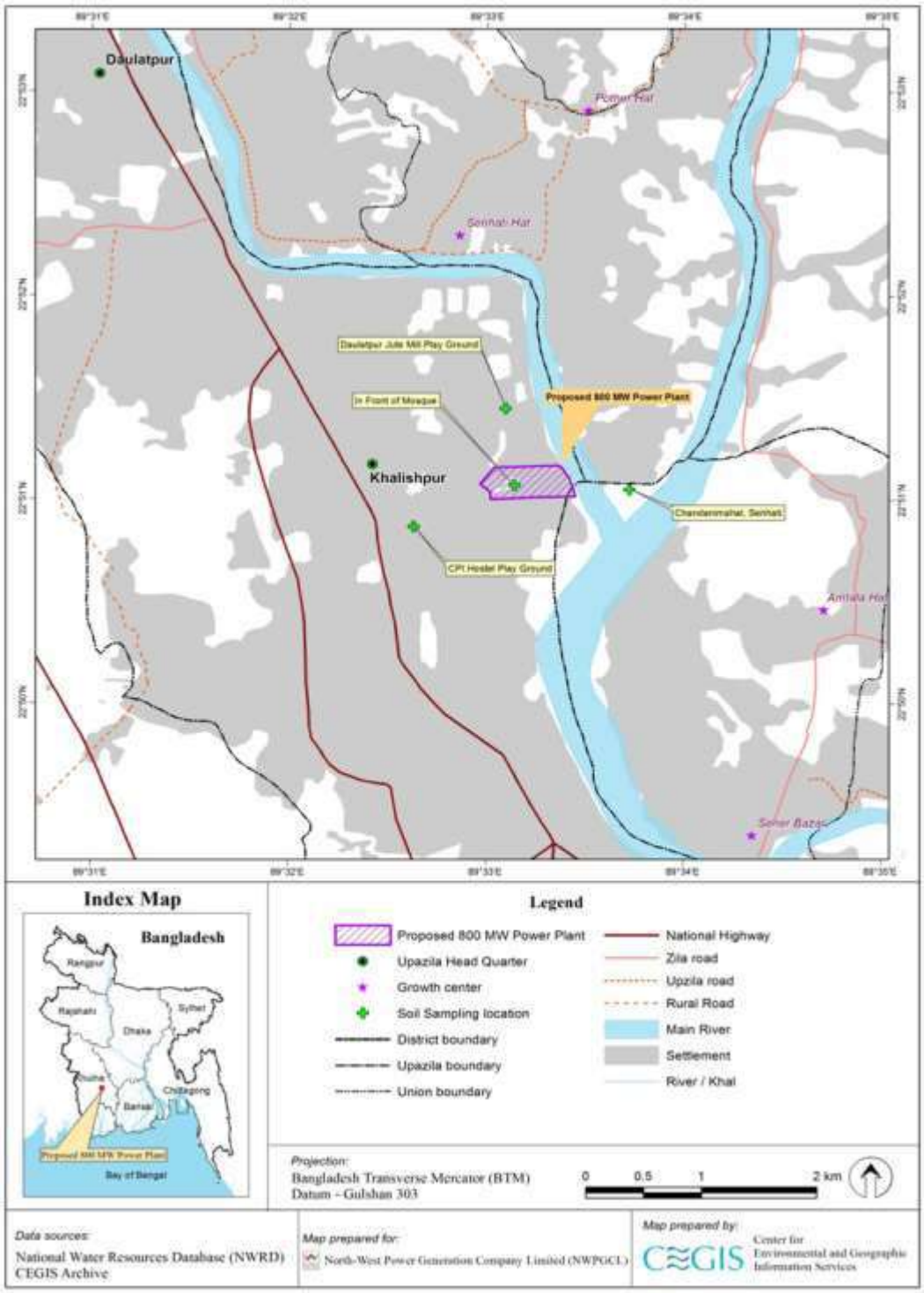


Figure 4.32: Location of soil sampling



Soil quality

226. Results of soil analysis show that top soil organic matter concentrations were higher than the average condition of Bangladesh. The pH levels of the soil samples are slightly alkaline to alkaline. Macro and micro nutrient concentration of the soil samples were also sufficient suggesting that soil quality is good for supporting plant growth. Results of soil analysis are given in **Table 4.20**.

Table 4.20: Results of soil chemical analysis within the PAI

No.	Area	Location	Depth of the soil (cm)	Bulk Density Mg/m3	pH	SOM (%)	Total N (%)	Av P (µg/g	Av K (µg/g)	Av S (µg/g)	Na (µg/g)	Ca (%)	Mg (%)	Av Fe (µg/g)
1	Project area	In front of main mosque	0-15	1.24	7.65	1.55	0.03	46.81	788.20	496.15	653.37	0.05	0.20	25.13
			15-30		7.78	1.14	0.05	19.45	751.90	707.36	518.55	0.03	0.16	11.58
2	Study Area	Chandanimahal, Senhati	0-15	1.37	7.55	1.38	0.10	71.85	933.39	354.86	943.76	0.10	0.22	6.27
			15-30		7.95	0.67	0.02	48.94	1140.81	637.05	1037.10	0.15	0.19	2.71
3		CPI hostel playing ground, Khalishpur, Khulna	0-15	1.60	8.35	0.74	0.01	26.69	163.86	213.20	757.08	0.25	0.17	7.04
			15-30		8.55	0.67	0.03	14.96	456.32	637.05	871.16	0.49	0.02	7.62
4		Daulatpur Jute mills, playing ground	0-15	1.51	7.45	4.81	0.02	12.08	601.52	496.15	513.36	0.45	0.18	9.98
			15-30		7.85	1.01	0.03	7.94	487.44	566.64	471.88	0.10	0.08	4.19

Av Fe =available iron; Av P =available phosphorus; Av S =available sulfur; Ca =available calcium; K =water soluble + exchangeable potassium; Mg =available magnesium; Mg/m^3 = megagram per cubic meter; Na =water soluble + exchangeable sodium; pH =soil pH; SOM =soil organic matter; Total N =total nitrogen; µg/g =microgram per gram.
Source: Soil Science Discipline laboratory, Khulna University.

Existing land use

227. The project area is 49.57 acres which was previously an industrial zone for the KNM. At present, this area hosts abandoned structures and vegetation that grew since 2002 when the newsprint operations were discontinued by the GoB.

228. Based on the project layout of Rupsha 800 MW CCPP, the location of the power plant used to be the residential areas of the staff and officials from the previous KNM and separated by a boundary wall from the KNM. As such, it is unlikely that the soil was contaminated by ink or dye. As well, the project area was not used as dumping site after the operations were completed. GoB ensured no unauthorized access and that security of the property is maintained by deploying security personnel from the Ansar Force.

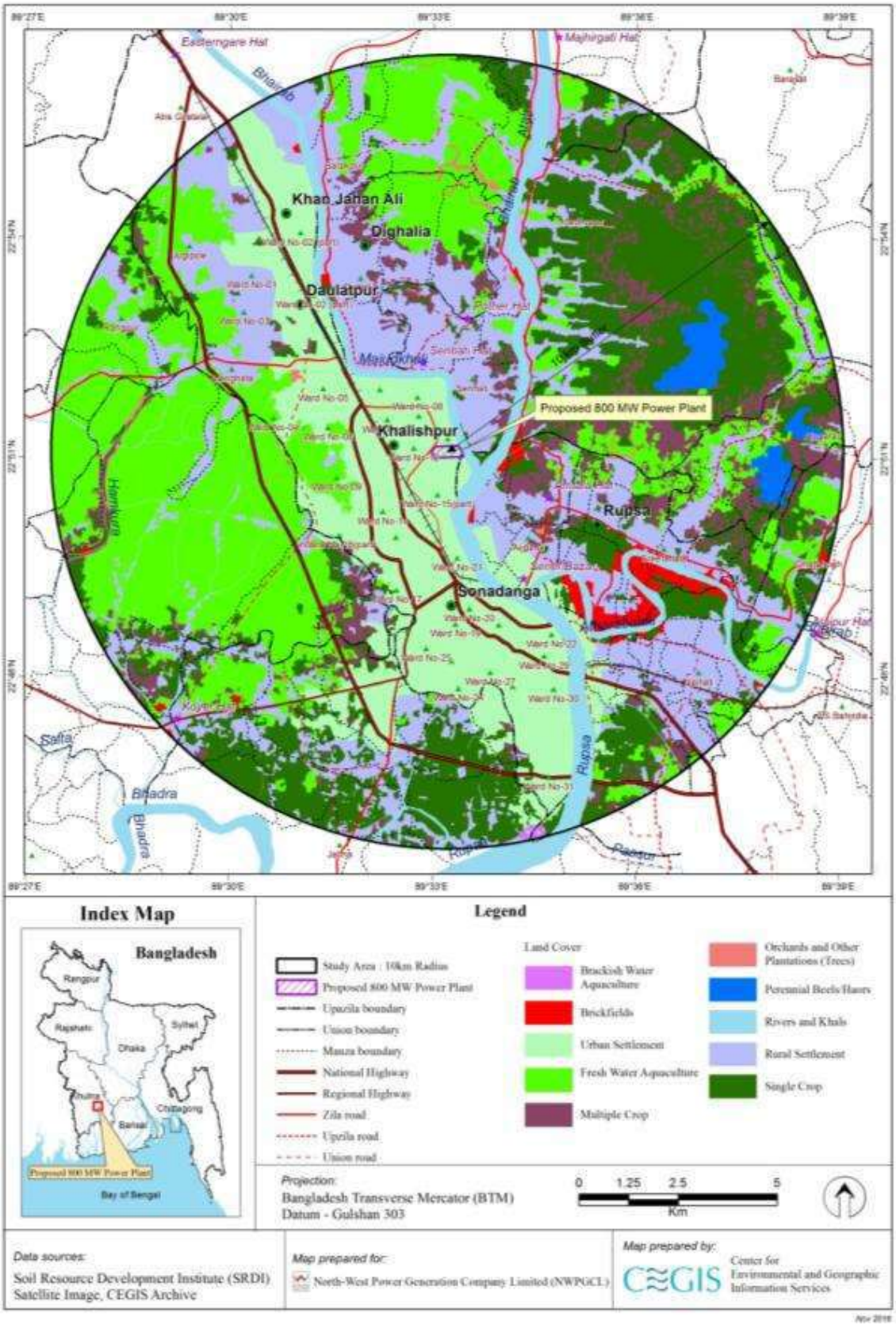
229. The study area consists mostly of brickfields, aquaculture (both fresh and brackish water), urban settlements, agricultural area, etc. **Table 4.21** and **Figure 4.33** present the land use within the PAI.

Table 4.21: Land use within the PAI

Project area		
Land Use	**Area (acre)**	**% of Total area**
House with homestead vegetation	38.24	77.1
Road Island	0.22	0.4
Road	5.19	10.5
Play ground	2.84	5.7
Pond	0.92	1.9
Grassland	2.17	4.4
Total	**49.55**	**100.0**
Study Area		
Land Use	**Area (acre)**	**% of Total area**
Agriculture	21,816	28
Brickfields	932	1
Urban Settlement	12,668	16
Rural Settlement	17,451	22
Rivers and Khals	3,210	4
Perennial Beels/Haors	919	1
Pond (both fresh and brackish water aquaculture)	20,273	26
Orchards and Other Plantations (Trees)	325	1
Total	**77,596**	**100**

Source: Rapid eye image analysis and field visit in October 2016.

Figure 4.33: Land use map within the PAI



4.2.8 Agricultural resources

230. During the field visit in October 2016, some questionnaires were filled up in four locations namely, Khulna metropolitan, Sirgati, Shenhati and Vuipara under Khulna sadar, Rupsha and Khalishpur Upazilas of the Khulna district.

Farming Practice

231. Farming practices largely depend on the cropping seasons. In Bangladesh, there are three main cropping seasons in a year. These are Kharif-I, Kharif-II, and Rabi seasons. The Kharif-I season starts from March and ends in June which is characterized by the uncertainty in weather of alternating dry and wet spells. The Kharif-II season starts in July and ends in October which is characterized by wet and cloudy environment, heavy rainfall but uneven distribution, low solar radiation, and high temperature and humidity. The Rabi season starts from November and ends in February during which crops are favored with high solar radiation, low humidity and temperature, but the lack of adequate soil moisture reduces crop yield.

232. The study area is dominated by Kharif-II season with high-yielding variety (HYV) Aman. Kharif-I is not found within the study area. During Rabi season, mustard and wheat are grown in the study area. The only year-round crop in this area is betel leaf.

Cropping patterns and cropping intensity

233. The project area is an industrial zone and was not used for agricultural purposes. In the study area, the dominant cropping pattern is Fallow-Aman-Fallow (40% of NCA). In Kharif-I season, most of the agricultural land remains fallow except betel leaf covering a narrow area (1,091 acre). In Kharif-II, almost all the area goes under cultivation, where HYV Aman (66% of NCA) is the major crop. In Rabi season, only 35% land of the NCA is being covered under cultivation and rest remains fallow due to non-availability of fresh water (**Figure 4.34**). Cropping intensity in the study area is 126%, where single and double cropped areas are 74%, and 26% of NCA, respectively (**Table 4.22**).

Table 4.22: Cropping pattern in the study area

Study Area				
Kharif-I	**Kharif-II**	**Rabi**		
(March-June)	**(July-October)**	**(November-February)**	**Area(acre)**	**% of NCA**
Fallow	Fallow	Boro	1,963	9
Fallow	Lt. Aman	Fallow	4,363	20
Fallow	HYV Aman	Fallow	8,726	40
Fallow	HYV Aman	Mustard	3,054	14
Fallow	HYV Aman	Wheat	2,618	12
Betel leaf	Continued	Continued	1,091	5
		Total	**21,816**	**100**

Source: CEGIS field visit; October 2016.

Figure 4.34: Agriculture in the study area

HYV Aman of Silgathi village | View of agricultural land in the study area

Area, yield and production

234. The crop area, yield and production of study area were estimated by using primary and secondary data. The secondary data were collected from DAE office in consultation with DAE personnel's and primary data were collected through questionnaire survey in October 2016. No agricultural practice was found in the project area.

235. Total annual crop production in the study area is about 33,741 tons of which rice production is about 23,278 tons (69% of total production) and non-rice crops is about 10,463 tons (31% of total production). The contribution of HYV Aman, Lt Aman and HYV Boro are about 74%, 13% and 13%, respectively over the total rice production. Production of mustard, wheat and betel leaf is 13%, 35% and 52%, respectively of non-rice production. Detailed cropped area and crop production is presented in **Table 4.23.**

Table 4.23: Crop area, yield, and production in the study area

	Study Area			
Crop name	**Crop Area (Acre)**	**Yield (ton/acre)**	**Production (ton)**	**Production Contribution (%)**
Lt. Aman	4,363	0.7*	3,054	13
HYV Aman	14,399	1.2*	17,278	74
HYV Boro	1,963	1.5*	2,945	13
Total Rice	**20,725**		**23,278**	**100**
Mustard	3,054	0.44	1,344	13
Wheat	2,618	1.4	3,665	35
Betel leaf	1,091	5	5,454	52
Total Non-Rice	**6,763**		**10,463**	**100**
G.T.	**27,488**		**33,741**	

Source: CEGIS field visit and DAE; June 2016
Note:*indicates cleaned rice

Use of agricultural inputs

236. Seed, labor, fertilizer and pesticides are the major inputs for crop production. In most of the cases, it was found that farmers use more fertilizer and pesticides than the recommended level. The fertilizer and pesticides use, seed and labor rates are presented in **Table 4.24**.

Table 4.24: Fertilizer and pesticides use in the study area

Crop Name	Use of seeds (kg/acre)	Labor (no/acre)	Use of fertilizer (kg/acre)				Use of pesticides		
			Urea	TSP	MP	Gypsum	No of Application	Liq. (ml/acre)	Gran. (kg/acre)
HYV Aman	18-20	60-65	45	32	20	0	1-2	283	3
Lt. Aman	22-25	65-70	36	28	16	0	1-2	202	0
HYV Boro	25-30	80-85	85	65	32	6	2-3	364	3
Mustard	20-25	30-40	60	40	20	12	2-3	202	3
Wheat	35-40	50-55	72	24	12	10	2-3	202	3
Betel Leaf	16,000-17,000 cuttings	90-100	80	50	30	10	1-2	200	0

Source: CEGIS field visit; October, 2016

Irrigation

237. Irrigation coverage in the study area is 35% of total NCA during the Rabi/dry season. In most of the cases, farmers use surface water (60%) and the rest use ground water for irrigation (**Table 4.25**).

Table 4.25: Land irrigated by type of crop in the study area

Crop name	Irrigation					
	Surface water (Low lift pump)			Ground water (Deep tube well)		
	Area (acre)	% of NCA	Charge (Tk./Acre)	Area (acre)	% of NCA	Charge (Tk./Acre)
Study Area						
HYV Boro	1,178	5.4	2,500-2,800	785	3.6	4,000-4,500
Mustard	1,833	8.4	2,500-2,800	1,222	5.6	4,000-4,500
Wheat	1,571	7.2	2,500-2,800	1,047	4.8	4,000-4,500

Source: CEGIS field visit; October 2016

Crop production constraints

238. According to local farmers the constraints of crop production are: (i) salinity in khals and soils during Rabi/dry seasons, (ii) scarcity of irrigation water during Rabi/dry seasons, and (iii) siltation of the rivers and khals (February-March).

4.2.9 Livestock resources

239. During the field visit in October 2016, some questionnaires were filled up in four locations namely Khulna metropolitan, Sirgati, Shenhati and Vuipara under Khulna sadar, Rupsha and Khalishpur Upazilas of the Khulna district.

Status of livestock and poultry

240. Livestock and poultry are essential to the integrated farming system, playing an important role in the economy of the study area (**Figure 4.35**). Most of the households have poultry and

livestock, which significantly reduce poverty through income generation. **Table 4.26** presents the extent of livestock and poultry in the study area.

Table 4.26: Livestock and poultry in the study area

Name of livestock/poultry	% of H/H having livestock/poultry	Average number of Livestock and Poultry in each household	Number of Livestock and Poultry of the Study Area
Cow/Bullock	50	3-4	366,945
Goat	15	4-5	146,778
Sheep	3	2-3	22,017
Duck	100	5-6	1,223,150
Chicken	100	4-5	1,467,780

Source: CEGIS field visit; October 2016.

Figure 4.35: Livestock in the study area

Poultry (Aijgati, Rupsha, Khulna)

Feed and fodder

241. Owners of the livestock population in the study area face problems due to non-availability of fodder and feeds during the months of July to November. Rice straw is used as the main source of fodder because grazing land is decreasing day by day. Oil cakes and rice husks are also used as fodder. The poultry population at family level survives by scavenging and generally, no feed supplements are provided.

Livestock and poultry diseases

242. Production of livestock and poultry in the study area are mainly constrained due to diseases and death of the population. Outbreak of diseases causes considerable economic loss in livestock farming. Every year, livestock population is affected by different diseases like Foot and Mouth Disease (FMD), Anthrax (Torka), Black leg (Badla), Gola fula (Hemorrhagic Septicemia), Pet fula (Enterotoxaemia), Diarrhea, Mastitis (Olan fula), Peste Des Petits Ruminants (PPR), etc. The goat cyst in head is a common disease of goat. Major poultry diseases are New Castle (Ranikhet), Fowl pox, Duck plague, Chronic Respiratory Disease (CRD) and Dysentery, etc. The outbreak of these diseases starts during the winter season (November-December) and at the start of the rainy Season (June-July).

4.2.10 Fisheries

243. Fisheries sector contributes 3.69% of national GDP (Gross Domestic Product), which is almost one-fourth (22.60 %) of country's agricultural GDP (National Fish Week, 2015). Bangladesh presently stands fourth in producing freshwater fish production (FAO, 2015). So now becoming self-reliant through fish cultivation is no longer a dream.

244. Fisheries information was collected through focus group discussion (FGD) with fishermen community, key informant interview (KII) with persons having significant experiences (more than 10 years), direct habitat observation, and catch assessment survey and market survey from 26-30 October 2016.

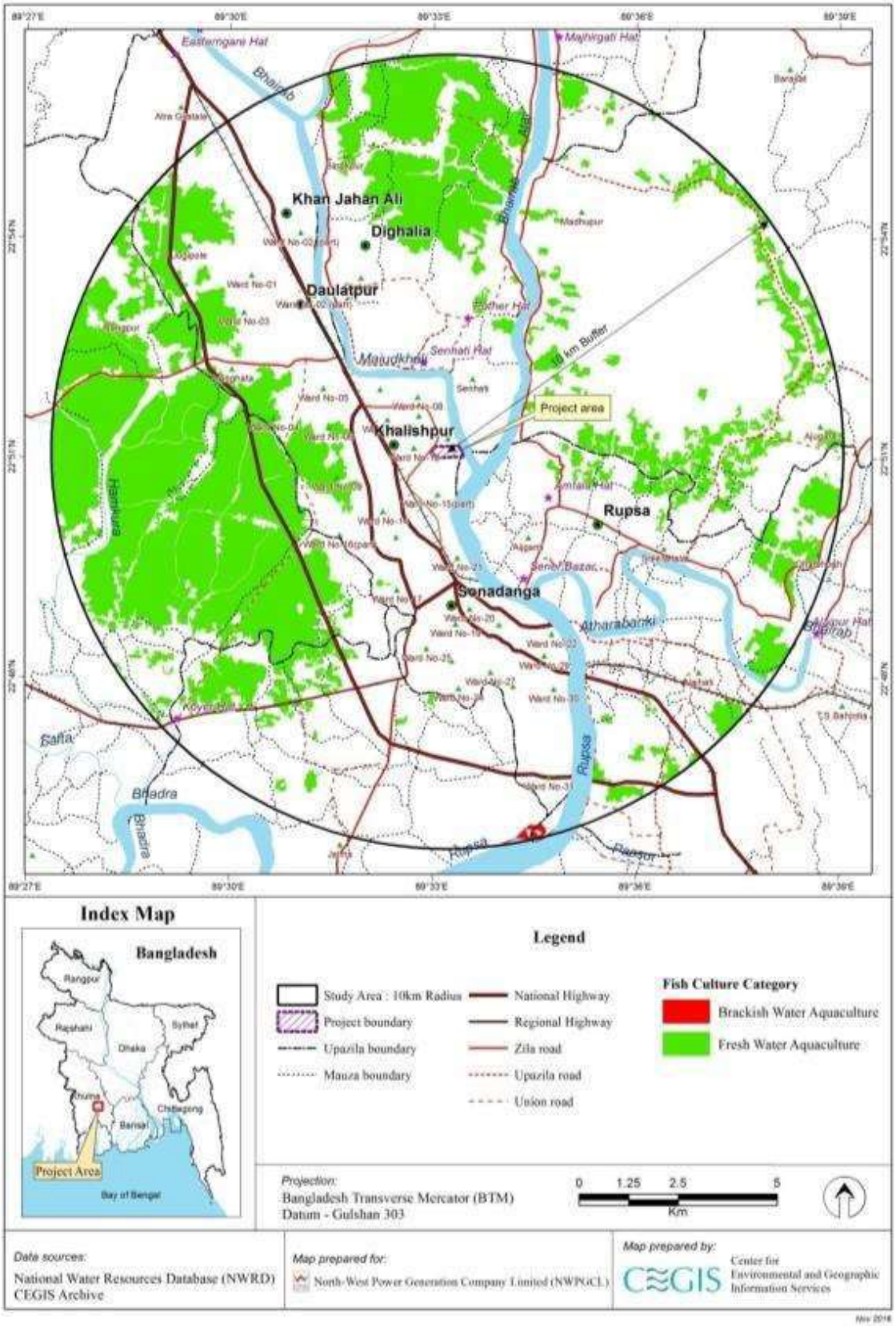
Fish habitat characteristics

245. Fisheries resources in the study area are diverse with different fresh water (east, west and north part) and brackish water (south part) fish habitats. Open water fish habitats include river, khal and beel (deepest portion of the land masses). The rivers in the study area include the Atai River, the Bhairab River, the Atharobanki River, and the Rupsha River.

246. The Bhairab River connects with the Madhumati River upstream of the project area and to the Rupsha River at downstream. These rivers have tidal influence and serve as breeding and feeding grounds for brackish and some fresh water fishes. These habitats also act as important migration route for fish like Ilish, Poma, Phasa, Khalla, Deshi Pangus, Golda Chingri, Bagda Chingri and Ganges River Dolphin, etc. There are drainage khals namely Laskarpur Khal, Mokampur Khal, Mallikpur Khal and Nishipur Khal, etc. and connect with Bashuakhali Beel. These drainage khals act as the major arteries of fish migration into the study area.

247. During the monsoon season around 40% of the study area goes under water due to run-off and tidal river water which allows subsistence fishing for local dwellers. The study area is also important for fresh and brackish water aquaculture practices. This area is common to mixed type of golda and bagda farming and associated white fish species while monoculture practice with golda is prominent. Currently, golda farming is replaced gradually by white fish farming due to disease outbreaks. Bagda ghers are mostly situated in the southern part of the study area while Golda ghers are located in the northern and western part of the study area. Fresh water and brackish water aquaculture including fish catch sites in the rivers are shown in **Figure 4.36**.

Figure 4.36: Fresh and brackish water aquaculture in the study area



Fish habitat assessment

248. The estimated total fish habitat in the study area is about 40,519 acres. Fish habitat distribution covering the study area is shown in **Table 4.27**.

Table 4.27: Fish habitat in the study area

No.	Fisheries Habitat	Habitat Types	Study Area (acre)	Percentage
1	Capture	River &Khal	3,211	7.9
2		Floodplain	16,115	39.8
3		Beel	919	2.2
		Sub-Total	**20,245**	
4	Culture	Golda Gher	3,033	7.5
5		Bagda Gher	55	0.2
6		Cultured Pond	17,185	42.4
		Subtotal	**20,273**	
		Grand Total	**40,518**	

Source: CEGIS estimation using field data, land use data prepared using Rapid Eye image, October 2016.

249. Among the fish habitats, the capture fisheries contribute about 50% area and the rest is culture fisheries. Cultured pond contributes about 42% followed by floodplain and, river and khal. **Figure 4.37** shows the fish habitat in the area.

Figure 4.37: Fish habitat in the study area

Fish production assessment

250. The estimated total fish production in the study area is about 24,069 metric tons (MT). Culture fisheries contribute bulk of the total production which accounts for about 21,732 MT and the rest is contributed by the capture fisheries (**Table 4.28**). Aquaculture in the large ponds are conducted by applying semi-intensive culture technology with different species compositions such as poly- and mix-culture with Indian major carps (Rui, Catla, Mrigel), Chinese carps (Grass carp, Silver Carp, Bighead Carp) and mono culture with mono sex Tilapia, Pangas Culture, etc. About 87% of the fish production in the study area comes from cultured fisheries.

Table 4.28: Fish production in the study area

No.	Type of Fisheries	Habitat Types	Fish Production (MT)	Percentage
1	Capture	River and Khal	267	1.10
2		Floodplain	1,768	7.34
3		Beel	302	1.25
		Subtotal	**2,337**	
4	Culture	Golda Gher	860	3.57
5		Bagda Gher	8	0.03
6		Cultured Pond	20,872	86.71
		Subtotal	**21,732**	
		Grand Total	**24,069**	

Fishermen status and effort

251. Among the fisher households of Mokampur and Mallikpur villages, about 5% and 40% are involved in commercial and part-time fishing, respectively. There are two types of fishing community: Nikari who live in Deyara Jugiyati, and Jele who live in Malupara, Chandinimohon village, respectively. Nikari community is mainly engaged in fish trading, labor and other fish related activities. About 100 Jele families depend on catching fish and around 20 families have their own boats for catching fish in the rivers and khals. The professional fishermen spend 4-10 hours/day in fishing activities while part-time fishermen spend about 4-6 hours/day. The daily catch varies with seasonal change of catchability in the river system. During the dry season (December-April), the catch per day ranges from 2 to 10 kg which increases up to 400 kg during monsoon (June-October). These fishermen made a group for sharing the costs of effort and benefit from catch in case of commercial fishing activities as a single fisherman household cannot afford the total fishing cost.

Fishing gears

252. Gears used in the study area and gear-specific fish species include: (i) Current jal, used to catch Ilish, Koi, Taki, Shol, Puti, etc., (ii) Tonajal, used to catch Bata, Khalla, etc., (iii) Poajal, used to catch Bata, Poa, Ramsoch, etc., (iv) Behundijal, used to catch Ilish, (vi) Thelajal, used to catch chingri, and small indigenous fish species, (vi) Net jal, used to catch golda and bagda post larva (PL), (vi) Jhaki or Khepla jal used to catch all types of fresh water fish, and (vii) Berjal, used to catch all types of fresh and brackish water fish, etc. Different types of fishing net and craft are shown in **Table 4.29** and **Figure 4.38**.

Table 4.29: Catch per unit effort

Habitat	North	East	Tide Condition	Gear Name/Type	Haul Duration (hr)	Total Catch (kg)
Bhairab River	22^0 52’ 13.7”	89^0 32’ 23.5”	Low and High	Muia Jal	4	2.5
	22^0 53’ 9.4”	89^0 31’ 18.3”	Low	Behundi Jal	6	4
	22^0 55’ 31.5”	89^0 30’ 48.1”	High	Khepla Jal	0.5	0.5
Rupsha River	22^0 46’ 41”	89^0 34’ 57”	Low	Spear	1.5	0.9
	22^0 47’ 25.1”	89^0 35’ 10.5”	Low	Muia Jal	1	0.6
	22” 48’ 21.8”	89^0 34’ 53.1”	High	Muia Jal	2	0.4

Source: CEGIS Catch Assessment Survey, 26-30 October 2016

Figure 4.38: Fishing gears and craft

Source: CEGIS Catch Assessment Survey, 26-30 October 2016

Collection of shrimp and prawn post larva

253. The Rupsha River and the Bhairab River are important sources of post larva (PL) for Bagda and Golda PL. Bagda PL is collected from mid-February to mid-May (Falgun-Boishak) when water salinity is relatively high while Golda PL is collected from mid-May to mid-August (Joistho - Srabon) when water salinity is very low. There are around four hundred Bagda and Golda PL collectors in the study area and their average income per year is about Tk30,000–Tk40,000. Golda PL is shown in **Figure 4.39**.

Figure 4.39: Prawn post larva collectors

Source: CEGIS Catch Assessment Survey, 26-30 October 2016

Fish migration

254. The Atai River and Rupsha River serve as major corridor for Hilsa, Poma, Topse, Bele, Golda, Bagda and other fresh and brackish water fish migration in the study area (**Figure 4.40**). These rivers play an important role in fish migration from estuary to inland water bodies. Both anadromous and catadromous fishes migrate through these rivers for meeting different biological requirements throughout the year at each stage of their life cycle. Aside from this, the major migratory fish species in the study area are: Deshi Pangus, Bata, Hilsa, Khalla, Poma, etc. (**Table 4.30**). Two endangered species (*Pangasius pangasius*) and (*Mastacembalus armatus)* were noted in the study area. *Pangasius* uses a long extent of migration route from downstream (at Harbaria and Chandpai) and upstream of Passure River system (at Mongla-Passure confluence and at Rupsha-Passure confluence point) to Atai River through the using Rupsha River. *Mastacembalus armatus* is considered as a major black fish (moves from core habitat including beels and floodplain habitat to river system) using the Atai River and upstream of Bhairab River.

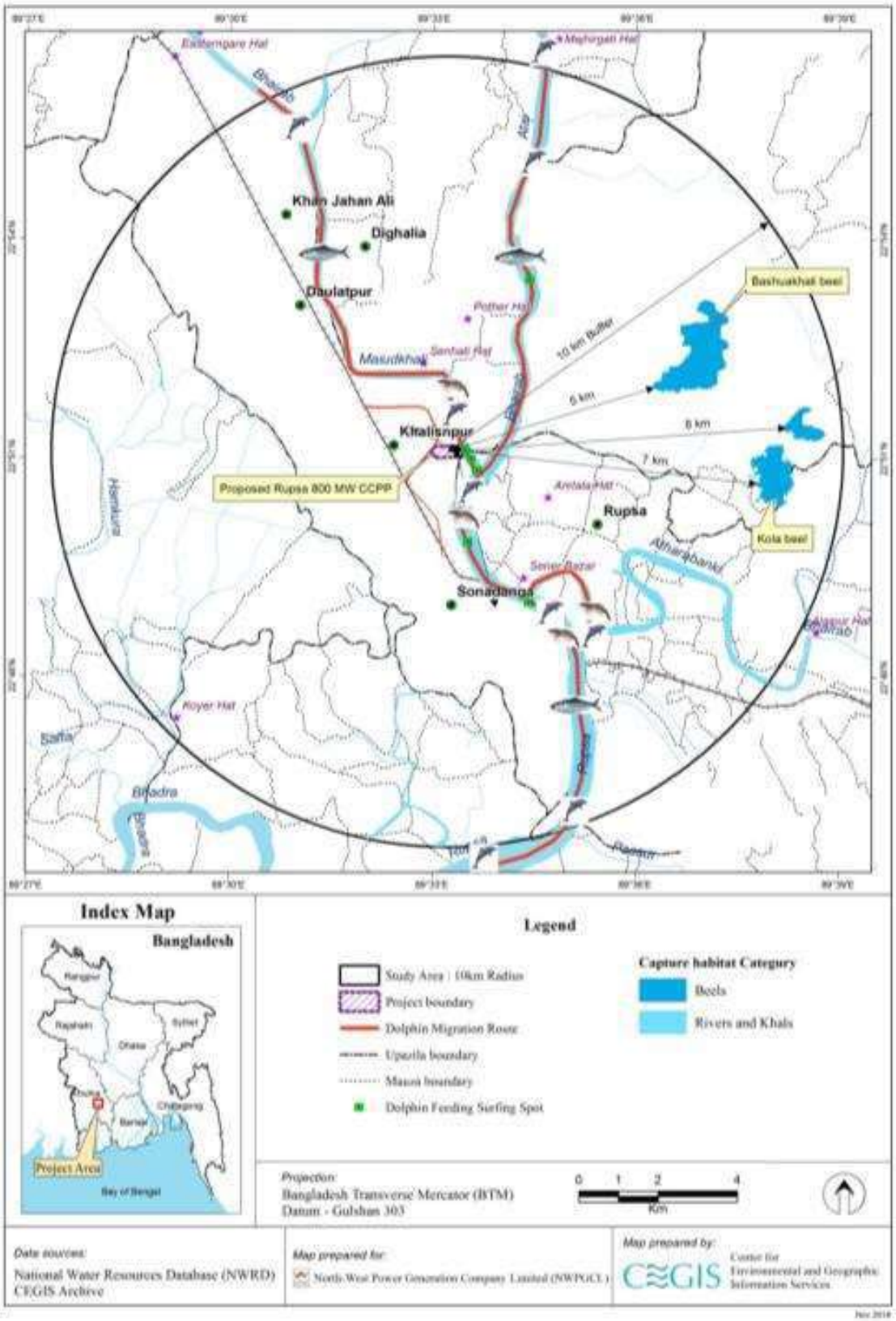
Table 4.30: Migratory fish species in the study area

Migratory Fish Species	Year Class	Akram Point	Harbaria	Chandpai	Mongla-Passure Confluence	Rupsha-Passure Confluence	Occurrence in Study Area
Banspata	Adult	+	+	+	+	+	+
	Fry	-	-	-	+	-	-
	Juvenile	+	-	+	-	-	+
Bele	Adult	+	+	+	+	+	+
	Fry	-	-	+	+	+	-
	Juvenile	+	+	+	+	-	+
Gulsha Tengra	Adult	+	+	+	+	-	+
	Juvenile	-	+	+	+	+	-
Hilsa	Adult	-	-	+	+	-	+
	Brood Fish	+	+	+	+	+	+
	Juvenile	-	-	-	-	-	-
Paissa	Adult	-	+	+	+	-	+
	Juvenile	+	+	-	+	-	+
	Brood	+	-	-	-	-	-
	Fry	-	-	+	+	-	-
Phekssa	Juvenile and Adult	+	+	+	-	+	+
Poma	Adult and Brood Fish	+	+	+	+	+	+

Migratory Fish Species	Year Class	Akram Point	Harbaria	Chandpai	Mongla-Passure Confluence	Rupsha-Passure Confluence	Occurrence in Study Area
	Fry	-	+	+	+	+	+
	Juvenile	-	+	+	+	-	+
Tapsi	Adult	+	+	+	+	+	+
	Brood Fish	-	+		-	+	-
	Juvenile	+	+	+	-	-	+
Pangas	Adult	-	+	+	+	-	+
	Juvenile	-	+	+	+	-	-

Source: CEGIS Catch Assessment Survey, 26-30 October 2016

Figure 4.40: Fish migration routes in the study area



Fish diversity and composition

255. During consultations at Deyara Jugiyati and Chandimohan Villages (across the project area), local fishers and elderly people reported that the fish biodiversity is declining over the years. It is reported that the Rupsa River and the Bhairab River once were available with large fish species like Ilish, Khalla, Boal, Pangus, etc. but the catch is now rather meager. Major factors responsible for declining fish diversity and fish abundance are: (i) fishing by destructive gears; (ii) increasing fishing pressure; (iii) collection of Golda and Bagda PL which causes the mortality of other fish fauna, (iv) obstruction of fish migration routes; and (v) over harvesting of the natural resources, etc. The indicative fish species from different habitats of the study area are presented in **Table 4.31** and shown in **Figure 4.41.**

Figure 4.41: Fresh and brackish water fish species in the study area

Assemblage of Hilsa (*Tenualosa ilisha*)

Assemblage of Bagda (*Penaeus monodon*)

Assemblage of Rui (*Labeo rohita*)

Assemblage of Poa (*Otolithoides pama*)

Table 4.31: Indicative fish species diversity in the study area

Scientific Name	Local Name	IUCN Global Status	Habitat Type			
			Capture			Culture
			River/ Khal	Floodplain	Beel	Pond/ Gher
Tenualosa ilisha	Ilish	LC	P	A	A	A
Otolithoides pama	Poma	LC	P	A	A	A
Setipinna phasa	Phasa	LC	P	A	A	A
Rhinomugil corsula	Khalla	LC	P	A	A	A
Polynemus paradiseus	Topse	LC	P	A	A	A
Sperata aor	Aor	LC	P	P	P	A
Wallago Attu	Boal	NT	P	P	P	A
Pangasius	Deshi Pangas	LC	P	A	A	A
Plotosus canius	Gang Magur	Not assessed	P	A	A	A
Apocryptes bato	Chiring	Not assessed	P	A	A	A
Penaeus monodon	Bagda Chingri	Not assessed	P	A	A	P
Metapenaeus monoceros	Harina Chingri	Not assessed	P	A	A	A
Macrobrachium rosenbergii	Golda Chingri	LC	P	P	A	P
Channa punctatus	Taki	Not assessed	P	P	P	A
Channa striatus	Shol	Not assessed	A	P	P	A
Heteropneustes fossilis	Shing	LC	P	P	P	A
Mastacembalus armatus	Guchi	Not assessed	P	P	P	A
Macrognathus pancalus	Baim	LC	P	P	P	A
Clarias batrachus	Magur	LC	P	P	P	A
Anabas testudineus	Koi	DD	A	P	P	A
Nandus	Bheda	LC	P	A	P	A
Colisa fasciata	Khalisha	Not assessed	A	P	P	A
Puntius spp	Puti	Not assessed	P	P	P	A
Labeo rohita	Rui	LC	P	P	P	P
Catla	Katla	Not assessed	P	P	P	P
Cirrhinus cirrhosus	Mrigel	VU	P	A	P	P
Exotic species						
Oreochromis niloticus	Nilotica	Not assessed	A	A	A	P
Hypophthalmichthyes molitrix	Silver carp	Not assessed	A	A	A	P
Pangasius sutchi	Thai pangus	EN	A	A	A	P

A = absence, DD = data deficient, EN = endangered, LC = least concern, NT = near threatened, P = presence, VU = vulnerable.

Source: CEGIS field data, Oct 2016.

Fisheries management

256. Community-based fisheries management (CBFM) is done in Dighalia Upazilla for beel management. Local government offices lease out beels and other government water bodies among the local fishers for CBFM. The Department of Fisheries (DoF) has limited initiatives for fisheries resource conservation and management (e.g., enforcement of Fish Conservation and Protection Acts, training on aquaculture, etc.) except fry release program in the study area. Some NGOs (BRAC, ASA, PROSHIKA, CARE, WORLD FISH and SHUSHILAN)[35] are working in the study area on extension services and aquaculture training.

4.3 Biological resources

Bio-ecological zone

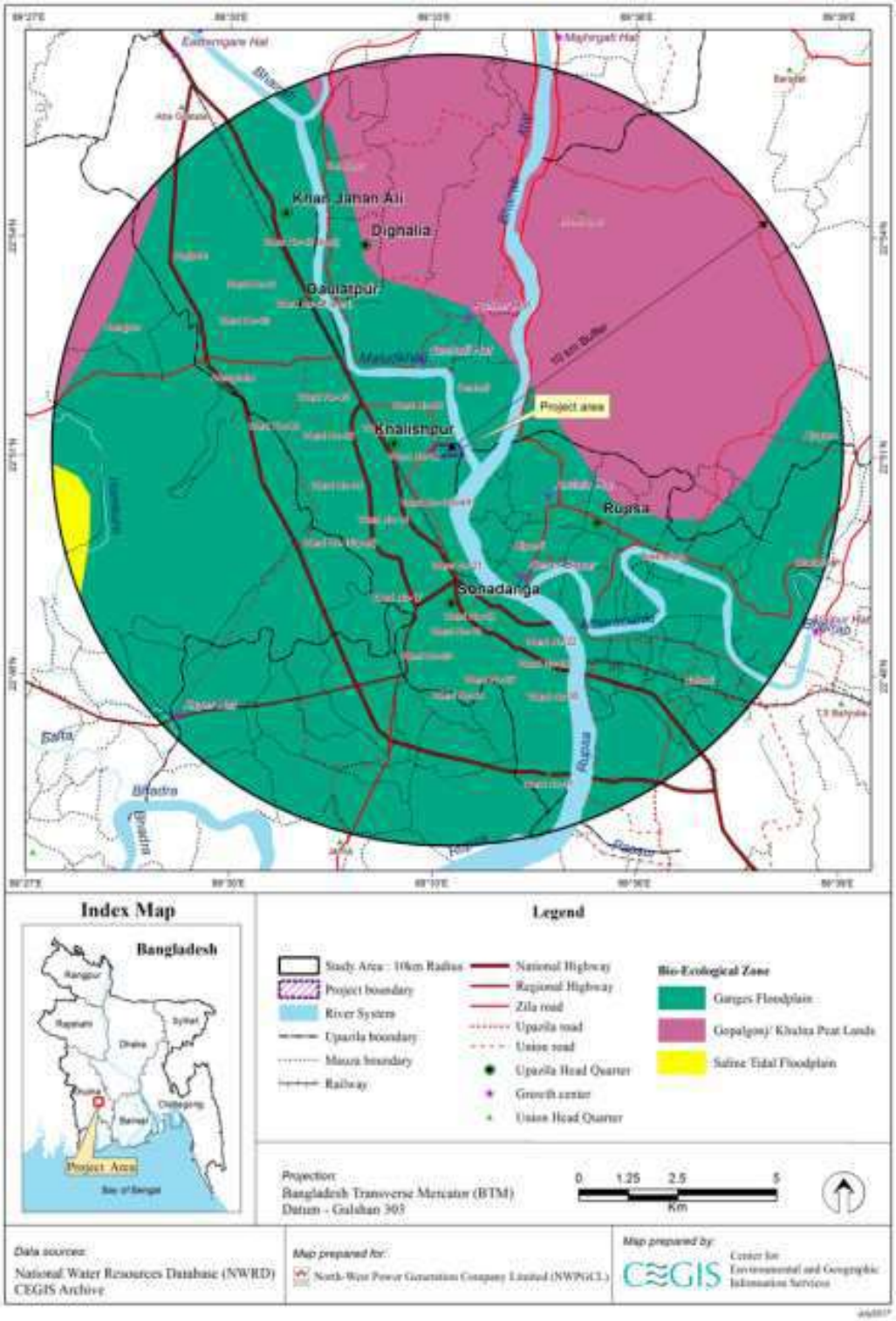
257. IUCN has divided Bangladesh into 25 Bio-ecological Zones (Nishat et al, 2002) with respect to physiographic units and biological diversity. Each of the bio-ecological zones represents overall ecological situation of an area of the country. The areas covered by bio-ecological zones in the study area are given in **Table 4.32** and shown in **Figure 4.42.**

Table 4.32: Bio-ecological zones in the study area

Location	Name of zone	Area (Acres)	Percent (%)
Project area	Ganges Floodplain	49.57	100
Study area	Ganges Floodplain	54,123	69.7
	Gopalgonj/ Khulna Peat Lands	23,037	29.7
	Saline Tidal Floodplain	469	0.6

[35] ASA is a microfinance institution established in 1978; BRAC is also doing microfinance among others; PROSHIKA deals with education and training to facilitate income and employment of rural poor through selforganization; *Shushilan* is a Bengali name that refers to initiatives for a better future, an NGO set up in 1991.

Figure 4.42: Bio-ecological zone in the PAI



Ganges floodplain

258. The Ganges floodplain is an active floodplain of the Ganges River and the adjoining meandering flood plains and is mostly situated in the administrative districts of greater Jessore, Kushtia, Faridpur and Barisal. The adjoining meander floodplains mainly comprise of a smooth landscape of ridges, basins and old channels. Noteworthy aspect here is that the Gangetic alluvium is readily distinguishable from the old Brahmaputra, Jamuna and Meghna sediments by its high lime content. Besides, the relief is locally irregular alongside the present and former river courses, especially in the west, comprising a rapidly alternating series of linear low ridges and depressions. The Ganges channel is constantly shifting within its active floodplain, eroding and depositing large areas of new char lands in each flooding season, but it is less braided than that of the Brahmaputra-Jamuna.

259. This floodplain is characterized by mixed vegetation. Presence of a lot of stagnant waterbodies and channels, rivers and tributaries in this zone support a habitat of rich biodiversity to some extent. In the beels and other waterbodies, free-floating aquatic vegetation is prominent. Homestead forests, on the other hand, include both cultivated and wild plant species. The dominant floral types are: the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana, (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Shada shapla (*Nymphaea nouchali*), Keshordam (*Ludwigia adscendense*), Kolmi (*Ipomoea aquatica*), Dhol kolmi (*Ipomea. fistulosa*), Hijal (*Barringtonia acutangula*), Tamarind (*Tamarindus indica*), Panibaj (*Salix tetrasperma*), etc. Moreover, grasses are most abundant in the Ganges floodplain and begin to grow as soon as the floodwater begins to recede. Nearly all the major groups of the oriental birds are represented in this zone by one or more species. In addition, a large number of migratory birds are found here during the winter. Besides, different species of freshwater tortoises and turtles are also found in the rivers and ponds. The amphibian species found in this zone include a few species of toads, frogs and tree frogs. Among the mammalian fauna are foxes, jackals, rats, mice, squirrels, bats, etc. are seen everywhere.

Gopalgonj/ Khulna Peat Lands

260. Gopalgonj-Khulna peat land occupies a number of low-lying areas between the Ganges River floodplains and the Ganges tidal floodplains in the south of Faridpur region and the adjoining part of Khulna and Jessore districts. Thick deposits of peat occupy perennially wet basins, but they are covered with clay around the edges. The soil in this zone is potentially strong acidic and low in essential plant nutrients. Basins are deeply flooded by rainwater monsoon however in close to Khulna, water is brackish in some degrees. The floral diversity in this zone is quite limited. Due to lack of diversity in vegetation, the variety in faunal species and the population size in this zone are also less than enviable, of which, the diversity of bird species is relatively better in this zone.

Saline Tidal Floodplain

261. The saline tidal floodplain has a transitional physiography which is located at the south portion of southwest and south central region. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Soils are non-saline throughout the over substantial amount of areas in the north and east. but they become saline to various degrees in the dry season in the south-west and are saline for much of the year in the Sundarbans. The river carries fresh water throughout the year to the east and north-east, but saline water penetrates increasingly further inland towards the west. Of the floral diversity, this zone has innumerable indigenous weeds that grow in beel areas. Several types of palms and bamboo clumps grow in almost all the villages. This zone affords a very lucrative place for game birds include goose, duck, cranes, spine, jungle

fowls, etc. both in Sundarbans and the beels and char areas. Moreover, the river network and expanses of beels are abound with different species of fishes.

4.3.1 Ecosystem in the project area

Terrestrial flora

262. Floral survey was conducted on 26-30 October 2016 through direct observation and quadrat application. A total of 20 plots (10mx10m) were surveyed. Based on field observation and survey, the project area can be classified in two major categories of ecosystems such as terrestrial and wetland ecosystems. The terrestrial ecosystems of the area were comprised of homestead, field, undergrowth and grassland vegetation. The site was visible with vast number of planted tree and plenty of wild herbs and shrubs species (**Figure 4.43**). Among the dominant tree species are coconut, mango, jackfruit and mahogany.

Figure 4.43: Vegetation in the project area

263. The homestead areas (including old buildings area and surroundings) are covered with planted trees, wild shrubs and herbs. Scattered low bush grassland was seen along the roads, field and river side which was restrained with creepers, climbers, grass and frequently contain hedge-like shrub. The growth of vegetation was due abandonment of the area since 2002.

264. A total of 60 species of trees was found within the project area consisting of about 2,614 trees that are mostly planted with few species regenerating naturally. There is no endangered, protected, or threatened plant species in the project area. The West Indian Mahogany (*Swietenia*

mahagoni) was found in the project area and is assessed globally by IUCN as endangered but this species is widely cultivated in Bangladesh as timber plant, non-native species to Bangladesh and is not included in the Red List of IUCN Bangladesh. **Table 4.33** gives the list of tree species in the project area.

Table 4.33: Tree species within the project area

No.	Scientific Name	Local Name	IUCN (Global status)	IUCN Bangladesh status	Number
1	*Abroma augusta*	Ulatkambol	Not Assessed	Not Assessed	2
2	*Acacia auriculiformis*	Akashia	Least Concern		10
3	*Aegle marmelos*	Bel	Not Assessed		23
4	*Albizia lebbeck*	Karoi	Not Assessed		6
5	*Alstonia scholaris*	Chatim	Lower Risk		6
6	*Annona reticulata*	Ata	Not Assessed		48
7	*Areca catechu*	Supari	Not Assessed		77
8	*Artocarpus heterophyllus*	Khanthal	Not Assessed		213
9	*Artocarpus lakoocha*	Dewa	Not Assessed		4
10	*Averrhoa carambola*	Kamranga	Not Assessed		4
11	*Averrhoa bilimbi*	Bilombi	Not Assessed		6
12	*Azadirachta indica*	Neem	Not Assessed		30
13	*Bombax ceiba*	Shimul	Not Assessed		16
14	*Borassus flabellifer*	Tal	Not Assessed		6
15	*Carica papaya*	Papya	Not Assessed		12
16	*Cascabela thevetia*	Halda Karobi	Not Assessed		6
17	*Citrus grandis*	Batabilebu	Not Assessed		21
18	*Cocos nucifera*	Narikel	Not Assessed		613
19	*Dalbergia sissoo*	Sisso	Not Assessed		10
20	*Delonix regia*	Krishnochura	Least Concern		14
21	*Dillenia indica*	Chalta	Not Assessed		8
22	*Diospyros blancoi*	Bilati Gab	Not Assessed		3
23	*Eucalyptus sp*	Eucalyptus	Not Assessed		23
24	*Ficus benghalensis*	Bot	Not Assessed		15
25	*Ficus racemosa*	Pakur	Not Assessed		11
26	*Ficus religiosa*	Ashwattha	Not Assessed		10
27	*Gmelina arborea*	Gamari	Not Assessed		6
28	*Lagerstroemia indica*	Furush	Not Assessed		4
29	*Lagerstroemia speciosa*	Jarul	Not Assessed		21
30	*Lannea coromandelica*	Ziga	Not Assessed		22
31	*Leucaena leucocephala*	Ipil ipil	Not Assessed		10
32	*Litchi chinensis*	Lichu	Not Assessed		4
33	*Litsea monopetala*	Menda	Not Assessed		5
34	*Mangifera indica*	Aum	Data Deficient		360
35	*Manilkara zapota*	Safoda	Not Assessed		11
36	*Millettia pinnata*	Karnaga	Least Concern		2
37	*Moringa oleifera*	Sajna	Not Assessed		136
38	*Musa sapientum*	Kala	Not Assessed		64
39	*Neolamarckia cadamba*	Kadam	Not Assessed		17
40	*Olea europaea*	Jalpai	Not Assessed		5
41	*Phoenix sylvestris*	Khegur	Not Assessed		27
42	*Pithecellobium dulce*	Dakhina Babul	Not Assessed		11
43	*Plumeria rubra*	Khatgolap	Not Assessed		14

No.	Scientific Name	Local Name	IUCN (Global status)	IUCN Bangladesh status	Number
44	*Polyalthia longifolia*	Debdaru	Not Assessed		70
45	*Psidium guajava*	Peara	Not Assessed		34
46	*Putranjiva roxburghii*	Putranjib	Not Assessed		2
47	*Roystonea regia*	Royel Plam	Not Assessed		35
48	*Samanea saman*	Raindee Kory	Not Assessed		53
49	*Senna siamea*	Minjira	Not Assessed		20
50	*Spondias dulcis*	Amra	Not Assessed		3
51	*Swietenia mahagoni*	Mahogonii	Non-native and cultivated species in Bangladesh (not listed in the IUCN red list for Bangladesh)		272
52	*Syzygium cumini*	Jum	Not Assessed		18
53	*Syzygium samarangense*	Jamrul	Not Assessed		30
54	*Tamarindus indica*	Tentul	Not Assessed		6
55	*Tectona grandis*	Sagun	Not Assessed		18
56	*Terminalia arjuna*	Arjun	Not Assessed		18
57	*Terminalia bellirica*	Bohara	Not Assessed		2
58	*Terminalia cattapa*	Khatbadam	Not Assessed		7
59	*Trema orientalis*	Jibon	Not Assessed		74
60	*Ziziphus mauritiana*	Baroi	Not Assessed		36
				Total	**2,614**

Plant biodiversity index

265. The plant biodiversity in the project area was determined using the Shannon's diversity index method. The Shannon's diversity index (H) is commonly used to characterize species diversity in a community. It accounts for both abundance and evenness of the species present and the typical values range from 1.5 to 3.5.A total of 15 plots (5mx5m) were considered for the estimation of plant biodiversity. The estimated Shannon's diversity index in the project area is 3.15 suggesting that diversity is high (**Table 4.34**).

Table 4.34: Diversity of plant species in the project area

Species Name	IUCN Global status	IUCN Bangladesh status	Shannon diversity Index (H')	Relative Density (%)	Relative Frequency (%)	Relative Abundance (%)
Acanthus ilicifolius	LC	Not Assessed	3.15	1,506.66	1.68	5.79
Achyranthes aspera	Not assessed			506.66	1.68	1.94
Acrostichum aureum	LC			66.66	0.84	0.25
Annona reticulata	Not assessed			20	0.84	0.07
Areca catechu	Not assessed			26.66	0.84	0.10
Artocarpus heterophyllus	Not assessed			20	1.68	0.07
Azadirachta indica	Not assessed			33.33	1.68	0.12

Species Name	IUCN Global status	IUCN Bangladesh status	Shannon diversity Index (H')	Relative Density (%)	Relative Frequency (%)	Relative Abundance (%)
Bombax ceiba	Not Assessed			13.33	1.68	0.051
Cayratia trifolia	Not Assessed			206.66	1.68	0.79
Cerodendrum inerme	Not Assessed			66.66	0.84	0.25
Citrus limon	Not Assessed			6.66	0.84	0.02
Clerodendrum infortunatum	Not Assessed			2,333.33	5.04	8.96
Clitoria ternatea	Not Assessed			80	1.68	0.30
Coccinia grandis	Not Assessed			86.66	1.68	0.33
Cocos nucifera	Not Assessed			13.33	1.68	0.05
Colocasia esculenta	LC			426.66	3.36	1.63
Commelina benghalensis	LC			200	0.84	0.76
Crinum defixum	Not Assessed			6.66	0.84	0.02
Crotolaria pallida	Not Assessed			20	0.84	0.07
Cullen corylifolium	Not Assessed			413.33	1.68	1.58
Cynodon dactylon	Not Assessed			266.66	0.84	1.02
Cyperasus sp.	Not Assessed			666.66	0.84	2.56
Derris trifoliata	Not Assessed			686.66	1.68	2.63
Desmodium dichotomum	Not Assessed			66.66	0.84	0.25
Dryopteris sp.	Not Assessed			246.66	1.68	0.94
Eclipta alba	LC			400	0.84	1.53
Ficus benghalensis	Not Assessed			20	0.84	0.07
Ficus hispida	Not Assessed			2026.66	6.72	7.78
Ficus racemosa	Not Assessed			133.33	2.52	0.51
Ficus sp.	Not Assessed			46.66	2.52	0.17
Hyptis capitata	Not Assessed			2706.66	4.20	10.402
Imperata cylindrica	Not Assessed			53.33	1.68	0.20
Ipomea sp.	Not Assessed			133.33	0.84	0.51
Ipomoea sagittifolia	Not Assessed			333.33	0.84	1.28
Ixora sp	Not Assessed			100	0.84	0.38
Justicia gendarussa	Not Assessed			146.66	0.84	0.56

Species Name	IUCN Global status	IUCN Bangladesh status	Shannon diversity Index (H')	Relative Density (%)	Relative Frequency (%)	Relative Abundance (%)
Lagerstroemia speciosa	Not Assessed			6.66	0.84	0.02
Leucaena leucocephala	Not Assessed			46.66	0.84	0.17
Mangifera indica	Data Deficient			46.66	1.68	0.17
Manilkara zapota	Not Assessed			6.66	0.84	0.02
Mikania scandens	Not Assessed			233.33	5.04	0.89
Millettia pinnata	LC			20	0.84	0.07
Mimosa pudica	LC			86.66	0.84	0.33
Moringa oleifera	Not Assessed			33.33	0.84	0.12
Musa sapientum	Not Assessed			140	1.68	0.53
Operculina turpethum	Not assessed			66.66	0.84	0.256
Oxalis corniculata	Not assessed			133.33	0.84	0.51
Peperomia pellucida	Not Assessed			133.33	0.84	0.51
Phoenix sylvestris	Not Assessed			20	0.84	0.076
Phyllanthus reticulatus	Not Assessed			266.66	2.52	1.024
Polyalthia longifolia	Not Assessed			133.33	0.84	0.51
Samanea saman	Not Assessed			26.66	1.68	0.10
Scoparia dulcis	Not Assessed			466.66	0.84	1.79
Senna simea	Not Assessed			33.33	0.84	0.12
Sida cordifolia	Not Assessed			66.66	0.84	0.25
Solanum nigrum	Not Assessed			400	0.84	1.53
Sphagneticola trilobata	Not Assessed			3,333.33	0.84	12.81
Spilanthes calva	LC			2,666.66	0.84	10.24
Swietenia mahagoni	EN			20	0.84	0.07
Syzygium cumini	Not Assessed			1,333.33	0.84	5.12
Trema orientalis	Not Assessed			33.33	1.68	0.12
Urena lobata	Not Assessed			53.33	1.68	0.20
Unknown herb	---			886.66	2.52	3.40
Vernonia patula	Not Assessed			1200	1.68	4.61
Ziziphus mauritiana	Not Assessed			40	3.36	0.15

Fauna in the project area

Mammals

266. According to the interview of local people conducted during the field survey from 26-30 October 2016, the terrestrial mammal species diversity is not high within the project area. During the daytime, visual observation and line transect survey method was used to record diversity of the species. During the field survey, no big mammals were found except the call of Golden Jackal and Small Indian Mongoose and field rat. Without longtime nocturnal survey and camera trapping, it is not possible to detect the accurate number of species.

267. Based on interviews of local people, it was reported that few mammal species temporarily visited the project areas in some occasions for hunting of preys and this include: Fishing Cat (VU), Jungle Cat (LC), Small Indian Civet (LC), Large Indian Civet (LC) according to IUCN Red List (global). Based on the IUCN Bangladesh Red List (2015), the conservation status of these mammals are: Fishing Cat (EN), Jungle Cat (NT), Small Indian Civet (NT), Large Indian Civet (NT).

268. However, none of these species were seen during the field visit probably since they are temporary visitor. The Indian flying fox (Least Concern) and Indian Pipistrelle (Least Concern) were seen in the afternoon to nighttime. No bat colonies were found in trees and old buildings in the project site.

269. The fishing cat (*Prionailurus viverrinus*) is a fish eater along the beels, rivers and water ways distributed throughout the study area and moves from place to place for hunting of preys like other animals, and also supplements its diet with shrimp/crayfish, crab and insects, and other vertebrates such as frog, mudskippers, birds and rats from the adjacent similar habitat. It is EN in Bangladesh but is only vulnerable globabally with Bangladesh considered as a stronghold. According to the IUCN red list it is widespread in Bangladesh being present in the protected areas of Sundarbans, Brahmaputra river basin, and in Chittagong hill tracts. Given interviewees report the species as a temporary visitor to the study area, it is considered highly unlikely that the study area holds a nationally-important concentration of this species. As such, it cannot be considered as a critical habitat for this species.

Birds

270. Bird species observed during the field visit and their conservation status according to IUCN Bangladesh 2015 were Black Drongo (LC), Brown Shrike(LC), Jungle Myna(LC), Rock pigeon(LC), House crow(LC), House Sparrow(LC), Common Myna(LC), Large-billed crow(LC), Spotted Dove(LC), Little Cormorant(LC), Long tailed Shrike(LC), Pied Myna(LC), Black Crowned Night Heron(LC), etc. **Annex 3** gives the list of species found in the study area.

271. Water birds are important component of most aquatic ecosystems, as they form vital links in the food web and nutrient cycles. Some water bird species noted in the pond area including their conservation status based on IUCN Bangladesh 2015 were little cormorant (LC), Indian pond heron (LC), Common kingfisher (LC), White breasted water hen (LC), etc. A total of 45 Black headed ibis (VU, NT globally) were seen as temporary visitor for feeding, roosting during the field visit at project site in the afternoon. All of these above bird species are very common to other parts of Khulna District except the urban area.

Reptiles

272. Reptiles were quite common inside the project area due to the dense undergrowth vegetation. The following species and their conservation status according to IUCN Bangladesh 2015 are: Keeled Indian Mabuya (LC), Garden lizard (LC), and Bengal Monitor (NT nationally but LC in global IUCN status) were found in project site. Some snake species were observed by locals in this area and these are: common vine snake(LC), Painted Bronze back tree snake(LC), Common Bronze back Tree Snake(LC), Common Wolfe Snake(LC), Indo-Chinese rat snake(LC) and Checkered Keelback(LC). These species are very frequent during monsoon and common to other parts of Khulna District except urban area. With the temporary habitat created as a result of the abandonment of KNM, these species use the project site temporarily for feeding, roosting, and nesting.

Amphibians

273. Skipper frog (LC) is a common amphibian found throughout the year. They have been the most successful fauna in adapting to all kinds of wetlands. Abundance of Bullfrogs (LC) is increased during the rainy season at ditches and other marshy places. Common Toad (LC) and Cricket frog (LC) were commonly found within the project area. These amphibian species are very common to other parts of Khulna District except urban areas.

Butterflies

274. A total of 32 species were observed in the project area (**Table 4.35**) during the field study in October 2016. The presence of butterflies indicates that the environment is generally healthy and good. There is no species that is endemic, migratory or listed in the IUCN Red List (**Figure 4.44**). The species found in the project area are common throughout the country. These collectively provide a wide range of environmental benefits, including pollination and natural pest control.

Table 4.35: List of butterfly species in the project area

No.	English Name	Status of Conservation	
		IUCN Bangladesh (2015)	IUCN (Global)
1	Blue tiger	Least Concern	Not Assessed
2	Chestnut Bob	Least Concern	Not Assessed
3	Common Emigrant	Least Concern	Not Assessed
4	Common Baron	Least Concern	Not Assessed
5	Common Crow	Least Concern	Not Assessed
6	Common Evening Brown	Least Concern	Not Assessed
7	Common Grass Yellow	Least Concern	Not Assessed
8	Common Jay	Least Concern	Not Assessed
9	Common Jezebel	Least Concern	Not Assessed
10	Common Leopard	Least Concern	Not Assessed
11	Common Mormon	Least Concern	Not Assessed
12	Common Palmfly	Least Concern	Not Assessed
13	Common Pierrot	Least Concern	Not Assessed
14	Common Rose	Least Concern	Not Assessed
15	Common Sailor	Least Concern	Not Assessed
16	Common Sergeant	Least Concern	Not Assessed
17	Common Silverline	Least Concern	Not Assessed
18	Dark-branded Bushbrown	Least Concern	Not Assessed
19	Dark Grass Blue	Least Concern	Least Concern

No.	English Name	Status of Conservation	
		IUCN Bangladesh (2015)	IUCN (Global)
20	Great Eggfly	Least Concern	Not Assessed
21	Grey Pansy	Least Concern	Not Assessed
22	Lime	Least Concern	Not Assessed
23	Pale Grass Blue	Least Concern	Not Assessed
24	Peacock Pansy	Least Concern	Least Concern
25	Plain Tiger	Least Concern	Not Assessed
26	Psyche	Least Concern	Not Assessed
27	Spotted Pierrot	Least Concern	Not Assessed
28	Striped Albatross	Least Concern	Not Assessed
29	Striped Pierrot	Least Concern	Not Assessed
30	Striped Tiger	Least Concern	Not Assessed
31	Tailed Jay	Least Concern	Not Assessed
32	Yellow Pansy	Least Concern	Least Concern

Figure 4.44: Butterfly species in the project area

4.3.2 Ecosystem in the study area

Terrestrial Flora

Homestead vegetation

275. Density and diversity of homestead plants depends on flood level and soil characteristics. Some trees occupy top of the canopy level such as, *Albizia richrdiana*, raintree (*Samanea saman*), and areca nut (*Areca catechu*). Most of the houses have locally-cultivated plants and most of the coverage is wild shrubs and herbs. Common planted tree species are Supari (*Areca catechu*),

coconut (*Cocos nucifera*), Eucalyptus (*Eucalyptus sp.*), mango (*Mangifera indica*), Mahogany (*Swietenia mahagoni*), banana (*Musa sp*), etc. Homesteads are commonly found near the wetland which favor good growth of wetland trees like *Trewia nudiflora*, *Crataeva nurvala*, *Barringtonia acutangula*, etc. Bamboo (*Bambusa spp.*) and shrubs like *Ficus hispida* and *Ficus heterophylla*are the most common species. **Table 1** of **Annex 2** gives the list of 52 species of homestead vegetation.

Crop field vegetation

276. Crop fields contain weeds such as *Amaranthus spinosus*, *Cynodon dactylon*, *Alternanthera sessilis, Polygonum sp*, *Oxalis corniculata*, etc. Along the river side, *Saccharum spontaneum*, *Xanthium indicum*, *Rumex maritimus*are commonly seen. Crop field vegetation provides not only food for human but also habitat for insects, reptiles, and various avifauna. **Table 1** of **Annex 3** lists the species in crop field vegetation.

Roadside vegetation

277. Vegetation along the roadside consists of herbs, shrubs, and trees. Species include raintree, mahogany, Indian lilac, acacia, banana, etc. Some plants also grow naturally in-between the planted trees and remain at the bottom levels on either side of the road and function as barrier of soil weathering. Common shrub species along the road side are minnie-root (patpati), ivy wood rose (halud kalmi), flannel weed (sida), dodder (swarnolata), crown flower (akando), hairy fig (dumur), sickle senna (kalasunda), orange berry (daton), hill glory bower (Bhant), etc.

Terrestrial fauna

278. Presence of dense vegetation supportsa variety of terrestrial fauna from different communities. Among the mammals are: Golden Jackal, Large Indian Civet, Jungle Cat, Fishing cat, Indian flying Fox, Grater bandicoot rat, and Small Indian mongoose.

279. Birds species found in village groves and homestead include: Black Drongo, Common Myna, Asian Pied Starling, Spotted Dove, Red-vented Bulbul, House Sparrow, Brahminy Kite, Black headed ibis, Black-winged Kite, Long tailed shrike, House crow, Common Kestrel, Oriental Magpie Robin, etc. Black headed ibis was also noted within most places of study area. Grass land support good number of avifauna like cisticola, prinia, warblers, larks, pipits and munias.

280. Common Toad (*Duttaphrynus melanostictus*) and Cricket frog (*Fejervarya limnocharis*) are commonly found in the study area.

Wetland ecosystems

281. The study area and its tributaries support wetlands both perennial and seasonal. The major sub-units of aquatic ecosystem are:

- Floodplains
- River
- Canals
- Ponds
- Beels
- Fresh water aquaculture

282. Floodplains are landforms in the study area that are inundated twice in a day due to tidal influence. Vegetation of the floodplains is changing its forms with fluctuation of water level and salinity. This type of wetland is dominated by grasses and rooted-floating plants. Canals are connected with surrounding river most of the year. Within the study area, ponds are found on homestead platforms and had been used for domestic purposes or fish culture. Ditches found inside the agricultural field natural wetland that contains water until winter.
283. The Bhairab River is alongside the project area. It has valuable biological resources which include the benthic community and planktons. Benthos and planktons on Bhairab River was collected during the field survey and is presented in the **Table 4.36**.

Table 4.36: Benthos and planktons in Bhairab River

Date	Location	Benthos (Unit/M)	Plankton		Total Plankton Count (Number/ m^3)
			Phytoplankton (unit/L)	Zooplankton (unit/L)	
29/10/2016	Bhairab River (along the bank of project site)	0	0	Arcella- 2 Keratella-1	1,396
29/10/2016	Bhairab River (along the opposite bank of the project site)	Polychaeta- 2 Annelida- 2	0	Arcella- 2 Keratella-1 Vorticella-1 Diaptomus-2	3,150
29/10/2016	Bhairab River (500 m downstream from the project site)	Polychaeta- 3 Annelida- 3	0	Arcella- 2 Diaptomus-1 Naupleus-2 Philodina-1	3,710
29/10/2016	Bhairab River (500 m upstream from the project site)	0	0	Philodina-3	1,005
29/10/2016	Pond (near the project site)	-	0	Arcella-2 Streptocephalus- 2 Cyclops- 1 Diaptomus- 2 Brachionus- 1 Neumania- 1	5,175

Sample during post monsoon (October 2016) analyzed by Zoological Laboratory, University of Dhaka

Wetland flora

284. Water hyacinth (*Eicchornia crassipes*) is the most common free-floating hydrophytes that cover maximum portion of the water of internal canals and ditches. Water lettuce (*Pistia strateotes*) is found in most of the ditches as well as in ponds mixed with water hyacinth. Sedges are quite common during monsoon inside all types of wetlands.

285. Along the shore line of the Bhairab River are a few mangrove vegetation which include Holy mangrove (Hargoja), Golden leather fern (Hoda). These species are listed as Least Concern in the global IUCN Red List.

Wetland fauna

286. Different species of resident and migratory aquatic birds are noted in the beels and mudflat of Rupsha River and Atai River.

287. Indian softshell turtle (*Nilssonia gangetica*) assessed as VU by the IUCN (global) and EN (IUCN Bangladesh 2015) and Spotted Flapshell Turtle (LC) were found in the rivers of the study area. According to IUCN Bangladesh Red List 2015, the Indian softshell turtle is distributed in Bangladesh, India, Nepal and Pakistan. In Bangladesh, the main habitats are the major river systems such as Ganga-Padma, Jamuna-Brahmaputra and Surma-Kushiara-Megna, and flood-plains without rivers in the north-northeastern hilly regions of the country.[36] Given this, it is considered highly unlikely that the study area holds a nationally-important concentration of this species. As such, it cannot be considered as a critical habitat for this species. The Indian roofed turtle (LC) is also noted in the ditches, ponds and beels. Common aquatic snakes include the checkered keelback (NA) and smooth water snake (LC).

288. Among the amphibians, the skipper frog (*Euphlyctis cyanophlyctis*) is commonly found throughout the year. They have been the most successful fauna in adapting to the all kinds wetlands. Abundance of Bullfrogs (*Hoplobactruchus tigerinus*) is increased during the rainy season at paddy fields, ditches and other marshy places.

289. **Ganges River dolphin**. The proximity report generated by the Integrated Biodiversity Assessment Tool (IBAT) on 30 January 2017 indicates that there are no protected areas and key biodiversity areas within 5 km and 10 km from Component 1. The proximity report listed 33 species from the global IUCN Red List of Threatened Species that may be potentially found close to the project site. Of these 33 species, the main important species is the Ganges River dolphin (*Platanista gangetica*) which is listed as EN (globally) and VU by IUCN Bangladesh. Ganges River dolphin is frequently observed in Bhairab River within the study area along the project site (**Figure 4.45**).

Figure 4.45: Sightings of Ganges River dolphin close to project site

290. Officially discovered in 1801, the Ganges River dolphin is known as an obligate freshwater dolphin and is essentially blind. According to IUCN, *Platanista gangetica* is the only species in the family Platanistidae (Rice, 1998). While the Indus and the Ganges populations were regarded as identical, Pilleri and Gihr (1971) divided them into two species (*P. gangetica* and *P. minor*). The *Platanista gangetica* is commonly known as the Ganges River dolphin (or Ganges *susu*) while the *Platanista gangetica minor* is known as the Indus River dolphin (or Indus bhulan).

[36] IUCN Bangladesh. Red List of Bangladesh (2015). Volume 4: Reptiles and Amphibians. p65.

291. **Distribution and population.** Their distribution is throughout the Ganges-Brahmaputra-Meghna (GBM) and Karnaphuli-Sangu River systems of Bangladesh, India and Nepal and may be potentially present in Bhutan (**Figure 4.46**).[37] GBM is a transboundary river basin with a total area of about 1.713 km^2 distributed among India (64%), People's Republic of China (18%), Nepal (9%), Bangladesh (7%) and Bhutan (3%). According to IUCN, the current estimated global population (GBM) is 3,607 dolphins which include 3,025 dolphins in India, 451 dolphins in Bangladesh (1998-2012), and 50 dolphins in Nepal.[38] The estimated population in Bangladesh covers the river system and Sundarbans area only and does not include other dolphins survey in other river system like the Turag River in Dhaka where maximum encounter rate was 0.49 sightings per km in October 2013 and in Buriganga River located in southwest outskirts of Dhaka City where encounter rate was 0.48 sightings per km in November 2013.[39,40]

Figure 4.46: Global distribution of Ganges River dolphins

Source: IUCN, www.iucnredlist.org

292. In 2012, the IUCN classified the Ganges River dolphin as EN globally.[41] In Bangladesh, they are considered VU and is placed in the Third Schedule of Bangladesh Wildlife (Preservation) Order 1973, also listed on Appendix I of the CITES in 1981 as well as on Appendix II of Convention

[37] Sinha, Ravindra and KurunthachalamKannan. Ganges River Dolphin: An Overview of Biology, Ecology, and Conservation Status in India. *Ambio*.2014, 43:1029-1046.Royal Swedish Academy of Sciences.

[38] Sinha, R. K. and Ahmed, B. (eds.) (2014). Rivers for Life - Proceedings of the International Symposium on River Biodiversity: Ganges-Brahmaputra-Meghna River System, Ecosystems for Life, A Bangladesh-India Initiative, IUCN, International Union for Conservation of Nature, 340 pp.

[39] Alam, Shayer Mahmood Ibney, Hossain, Md. Muzammel, Baki, Mohammad Abdul and Naser Ahmed Bhouiyan. (2015). Status of Ganges Dolphin, *Platanista Gangetica Gangetica* (Roxburgh, 1801) in the River Buriganga, Dhaka. Bangladesh J. Zool. 43(1): 109-120.

[40] Baki, Mohammad Abdul, Bhouiyan, Naser Ahmed, Islam, Md. Saiful, Alam, Shayer Mahmood Ibney, Shil, Shibananda, and Md. Muzammel Hossain. Present Status of Ganges River Dolphins *Platanista gangetica gangetica* (Roxburgh, 1801) in the Turag River, Dhaka, Bangladesh. Int. Journal of Zoology, Vol 2017, Article ID 8964821, 7p.

[41] Smith, B.D. and Braulik, G.T. 2012.*Platanistagangetica*. The IUCN Red List of Threatened Species 2012: e.T41758A17355810. http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T41758A17355810.en. (Accessed 24 April 2017)

on the Conservation of Migratory Species in 1991 and Appendix I in 2002.[42,43] There has been considerable efforts made to document the status of *Platanista gangetica gangetica* since the early 1970s, yet thus far, a rigorous quantitative data on numbers, mortality, extent of occurrence, and area of occupancy are still lacking for much of the species' range particularly in India and Bangladesh.There has been no study done on this species in the Bhairab-Atai-Rupsha river system.

293. **Habitat.** Its primary habitat is characterised by an eddy counter-current system in the main river flow caused by a fine sand/silt point bar formed from sediment deposits of a convergent stream branch or tributary while marginal habitat may be a smaller eddy counter-current system caused by an upstream meander. The IUCN assessment in 2017 indicates that the Ganges River dolphins are generally concentrated in counter-current pools below channel convergences and sharp meanders (Smith 1993, Smith, et al.,1998) and above and below mid-channel islands, bridge pilings, and other engineering structures that cause scouring. In addition, several studies have demonstrated that they are concentrated into deep pool habitat in the dry season, which increases their conflict with fisheries that also concentrate in these productive areas (Kelkar *et al.* 2010, Bashir, *et al.* 2012). Their fidelity to counter-current pools is probably greatest in fast-flowing channels. Isolation in seasonal lakes sometimes occurs (especially in the Brahmaputra basin). Deltaic (brackish) waters are a major component of the total range of this subspecies, but they are not generally known to occur in salinities greater than 10 ppt, although they have been observed in waters as saline as 23 ppt. According to Smith et al. 2009, the Ganges River dolphin distribution is conditionally dependent on relatively low salinity, high temperature, moderate depth with significant dependence on high turbidity.[44] Wakid (2009) mentioned that dolphins prefer the water depth between 4.1 and 6.0 m.[45]

294. **Biodiversity study in the PAI**. There have been considerable efforts made to document the status of Ganges River dolphin since the early 1970s, yet thus far, a rigorous quantitative data on numbers, mortality, extent of occurrence, and area of occupancy are still lacking for much of the species' range particularly in India and Bangladesh. Population in other rivers has not been estimated yet.[46]There has been no study on Ganges River dolphins within the PAI.

295. To establish baseline, two initial dolphin surveys were done following the land-based sighting survey method and direct counting survey through line transect using a local engine boat.[47] On 29-30 October 2016, a land-based sighting survey was conducted within the Bhairab-Atai River confluence area. The survey only counted the dolphin while they surfed (i.e., dolphins came to water surface to get oxygen). A total of 33 times surfing occurrences were recorded within a total of 4 hours and 46 minutes observation for the 2-day survey. Of the 33 surfing occurrences, 11 occurred at the confluence while the rest occurred along the Bhairab River. These occurrences do not reflect size of the population as the same adult, juvenile and calf may have surfed several times.

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42 http://bdlaws.minlaw.gov.bd/pdf/452___Schedule.pdf. (Accessed 31 March 2017)

43 https://speciesplus.net/#/taxon_concepts/12356/legal. (Accessed 31 March 2017)

44 Smith, B. D., Braulik, G., Strindberg, S., Mansur, R., Diyan, M.A.A, and B. Ahmed. Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquatic Conserv: Mar. Freshw. Ecosyst. 19: 209–225 (2009).

45 Wakid, A. 2009. Status and distribution of the endangered Gangetic dolphin (Platanista gangetica gangetica) in the Brahmaputra river within India. Current Science 97: 1143–1151.

46 IUCN Red List of Bangladesh, Volume 2: Mammals, 2015, p.107.

47 Aragones, L. V., Jefferson, T. A., & Marsh, H. (1997). Marine mammal survey techniques applicable in developing countries. *Asian Marine Biology*, 14, 15-39.

296. A direct counting survey was done through the line transect method in March 2017. About 20 km stretch of the Bhairab River from the confluence of Bhairab-Madhumati Rivers (covering 10 km upstream) to the confluence of Bhairab-Atai Rivers until the Rupsha River at Khanjahan Ali Bridge (covering 10 km downstream) was covered using a local engine boat. The Rupsha River drains south towards the Sundarbans and on to the Bay of Bengal.

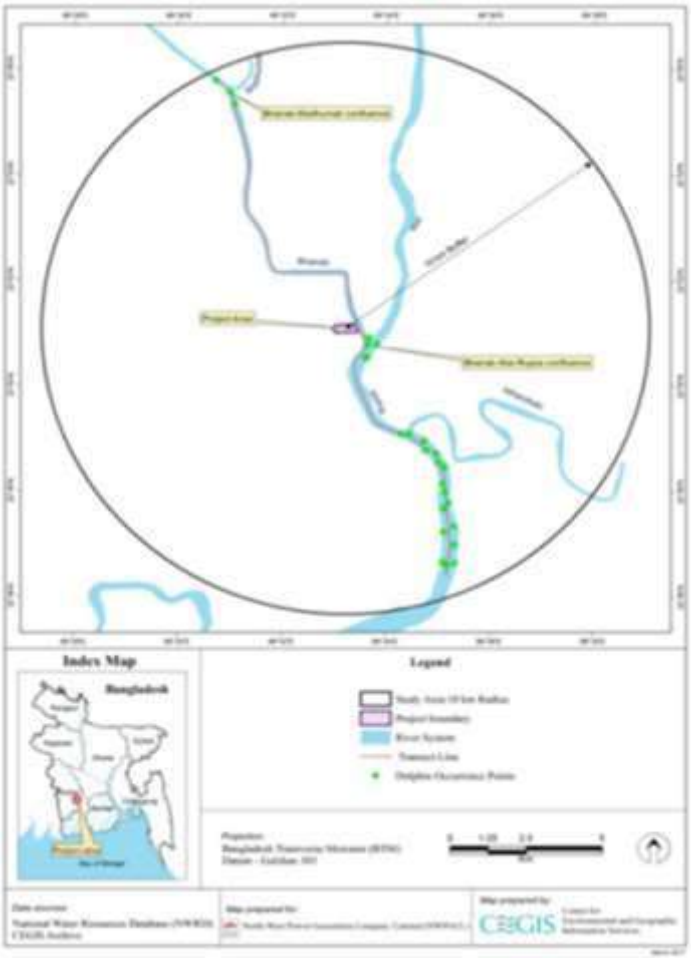
297. A total of 25 occurrences of Ganges River Dolphins were recorded at different locations of the transect for over a 5-hour survey. Out of the 25 occurrences, 22 occurrences were recorded from the Bhairab-Atai River confluence and towards the Rupsha River (downstream of project site) and only three occurrences upstream of the project site at the Bhairab-Madhumati River confluence (**Figure 4.47**). Average encounter rate was estimated at 0.44 individual/km. A similar survey approach was used by Alam et al (2015) for Ganges dolphin in Buriganga River in Dhaka.[48]

Table 4.37: Land-based sighting survey of Ganges River dolphin

Date	Time of Surfing (local)	Population Surfing Count			Total	Location
		Adult	Juvenile	Calf		
29/10/16	9:15	1			1	Bhairab River
	9:52	1			1	Bhairab River
	9:53	1		1	2	Bhairab River
	9:55		1		1	Confluence
	9:56	1			1	Bhairab River
	10:10	1			1	Bhairab River
	10:13		1	1	2	Bhairab River
	10:22	1			2	Bhairab River
	10:28	1		1	2	Confluence
	10:32	1			1	Bhairab River
	10:50		1		1	Bhairab River
	10:53		1		1	Bhairab River
	10:57	1			1	Confluence
	11:03	1			1	Confluence
	11:06	1			1	Bhairab River
	11:14		1		1	Bhairab River
	11:22	1			1	Confluence
	11:26	1			1	Bhairab River
	11:33	1	1		2	Confluence
	11:49	1			1	Bhairab River
	11:58			1	1	Bhairab River
30/10/16	5:25		1		1	Bhairab River
	5:27	1			1	Bhairab River
	5:31			1	1	Bhairab River
	5:32	1		1	2	Confluence
	5:36		1		1	Confluence
	5:39	1		1	2	Confluence
	5:40					Bhairab River
	5:42	1			1	Bhairab River
	5:46			1	1	Bhairab River
	5:48	1				Bhairab River
	5:52		1		1	Confluence
	6.10	1				Confluence
Total 33 times in 4h and 46 minute- observation		**21**	**9**	**8**	**38**	

[48] Alam, Shayer Mahmood Ibney, Hossain, Md. Muzammel, Baki, Mohammad Abdul and Naser Ahmed Bhouiyan. (2015). Status of Ganges Dolphin, *Platanista Gangetica Gangetica* (Roxburgh, 1801) in the River Buriganga, Dhaka. Bangladesh J. Zool. 43(1): 109-120.

Figure 4.47: Dolphin occurrences in the study area



298. **Dolphin survey in the study area**. Given the conservation status of Ganges River Dolphins, NWPGCL engaged IUCN Bangladesh in May 17 to conduct a biodiversity assessment (**Annex 11**) in a study area that will cover the following stations: (1) 10 km of Rupsha River (downstream of the power plant site); (2) 10 km of Bhairab River (upstream of the power plant site); (3) confluence of Bhairab-Atai-Rupsha Rivers, (4) 10 km of Atai River (upstream from the confluence of Station 3). **Figure 4.48** shows the study area.

299. A total of seven surveys were completed from May 2017 until January 2018 covering the pre-monsoon (one survey), monsoon (two surveys), post-monsoon (two surveys) and winter (two surveys). Surveys include the Ganges River dolphins, presence of other animals, fish and fishing gear, fishing areas, physical and chemical water quality analysis, vegetation, plankton, watercrafts, water depth, and existing pollution sources.

300. **Dolphin survey methodology.** The dolphin surveys follow the standard methodology set by Smith *et al.* (2006 and 2009).[49] The first four surveys (pre-monsoon, first and second monsoon and first post-monsoon) were conducted to calculate encounter rate, and the last three surveys (second pre-monsoon, first and second winter) were conducted using the Mark-recapture method.

To analyze encounter rate

301. To conduct the survey, three transects were set (1) the Bhairab River transect; (2) the Atai River transect; and (3) the Rupsha River transect. Each transect is 10 km-long. Three observers stand and actively search for dolphins along transects at all times and record sighting data. One observer is stationed on the port and one on starboard side of the vessel. These two observers search with handheld binoculars and naked eye from the beam to about 10˚ past the bow. The third observer stands in the centre and scans with the naked eye in about a 20˚ cone in front of the bow. This observer also keeps records in specialized data sheets. The observers are rotated through the three positions every half an hour. The height from the water level to the observer is approximately 3 meters. The boat speed is set to 10 km/hour.

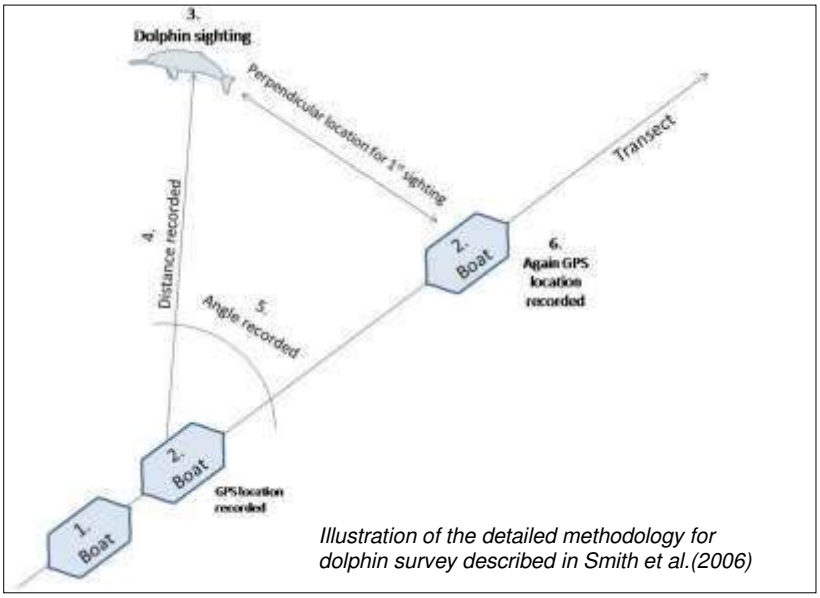


Illustration of the detailed methodology for dolphin survey described in Smith et al.(2006)

302. Once dolphins are spotted, the GPS coordinates of the exact spot where the animals were seen is recorded. The group size and the age class are then estimated.

To Calculate Population Number using Mark-recapture Method

Teams	1. A primary observer team will be stationed on the upper deck (approximately 4.4 m above the waterline)

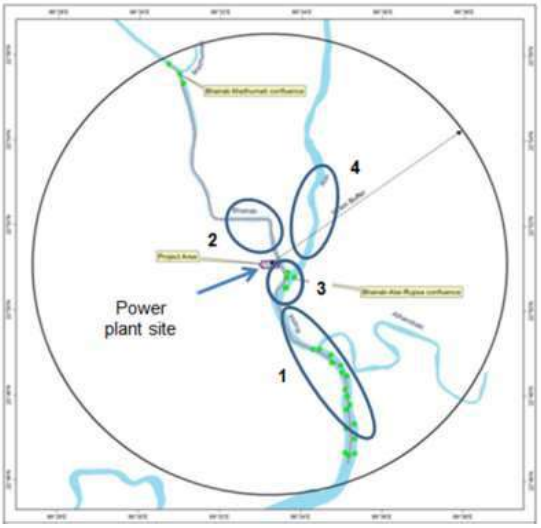
[49] Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B. and Mansur, R. 2006. Abundance of Irrawaddy dolphins (Orcaella brevirostris) and Ganges river dolphins (Platanista gangetica gangetica) estimated using concurrent counts from independent teams in waterways of the Sundarbans mangrove forest in Bangladesh, Marine Mammal Science 22(3): 527-547.
Smith, B.D., Braulik, G., Strindberg, S., Mansur, R., Diyan, M.A.A. and Ahmed, B. (2009). Habitat selection of freshwater dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquatic Conservation: Marine and Freshwater Ecosystems, 19, pp. 209-225.

	2. A secondary observer team will be stationed on the lower deck (c.2.3 m above the waterline) 3. The two independent observer teams will not be in visual contact and observers will be instructed to avoid alerting the other team about dolphin sightings. (Note: this will maintain the independence of results.)
Observer position	1. Three observers will stand watch at all times while "on-effort" (i.e., actively searching for dolphins along the transect line and recording effort and sighting data) 2. One will be stationed on each the port and starboard sides, searching with handheld binoculars and naked eye from the beam to about 100 past the bow 3. One in the centre searching by naked eye in about a 200 cone in front of the bow 4. The centre observer will also serve as the data recorder. Both primary and secondary teams will be comprised of the same structure.
Transect and boat speed	1. Transect will start from the lower part of Rupsha river and finish at upper part of Bhairab river. We will cover a total 20 km in favor of the tide. We will then move into Atai river where we will not be in favor of the tide. Then we will cover the last 10 km of Atai river. The boat speed will be controlled accordingly. 2. Boat speed will be on average 10 km/hour.
Channel width	Channel width will be recorded according to the sum of distance measurements to the right and left banks using a laser range finder, if less than 500 m, or the sum of estimates will be made by naked eye, if greater. We can also use satellite image to measure the channel width according to the GPS coordinates if both options are not feasible.
Dolphins data record	1. Species 2. Time 3. Radial distance to the first dolphin sighted 4. the location of the estimated position (GPS) where the dolphins located when first observed; and 5. Group size (according to best, high and low).
Model used	The following models were used for analysis and estimation of population size: 1. A stratified Lincoln-Petersen model 2. Huggins conditional likelihood model 3. Horvitz-Thomson Estimator (to obtain the abundance)

Smith et al, 1994; Smith 2000; Smith *et al.* 2006

303. Along with this, weather conditions (wind, glare, and rain/fog) are recorded as well. These factors are given codes of 0, 1, or 2, where '0' corresponds to good (no effect on sighting conditions), '1' corresponds to fair (small effect on sighting conditions), and 2 corresponds to poor (large effect on sighting conditions) conditions, respectively.

Figure 4.48: Study area for the dolphin survey



Survey findings

304. *Dolphin population.* Survey results show a total of 284 sightings with an overall encounter rate of 1.18 individual per km including 13.76% calves (see Table. The most important area determined from the surveys is the confluence of Atai-Bhairab-Rupsha Rivers where feeding behavior was recorded and a large number of calves were seen. Results of the three surveys (second post monsoon, and two winter) using the revised methodology (mark-recapture method) showed an average of 34 dolphins. The results were based on the Huggins conditional likelihood model.[50]

Table 4.38: Encounter rate of dolphins

Survey season	Encounter rate (High Tide)	Encounter Rate (Low Tide)	Encounter Rate (Average)
Pre-monsoon survey	1.40	0.93	1.16
First monsoon survey	1.33	0.33	0.83
Second monsoon survey	1.03	1.03	1.03
First post-monsoon survey	1.23	2.16	1.70
Total	4.99	4.45	4.72
Average	**1.24**	**1.11**	**1.18**

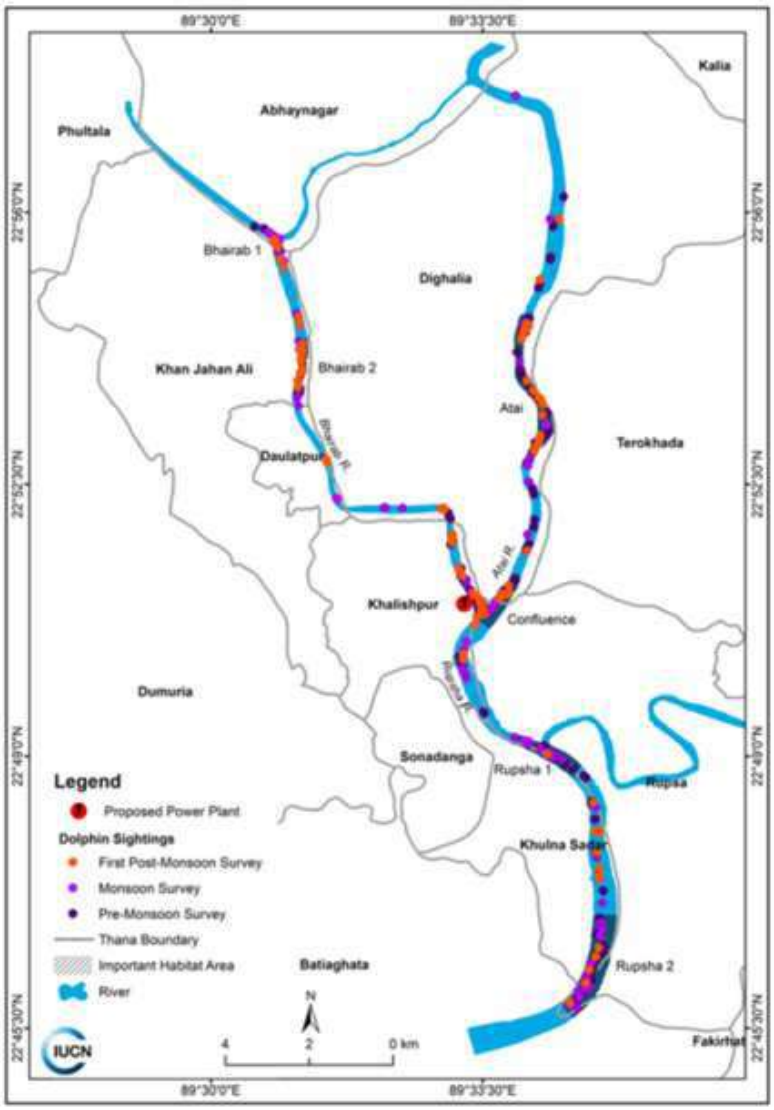
305. *Important dolphin areas.* Specific areas within the study area that have high concentration of dolphin sighting including calves were identified. The areas can be considered as important dolphin areas based on the number of sightings and considering the channel width and other parameters. Of all the surveys, the most important area is the confluence of Atai-Bhairab-Rupsha Rivers. In one hour, the total dolphin sighting was 367 in the confluence. The details of the important dolphin areas are given in **Table 4.39** and shown in **Figure 4.49**.

[50] IUCN Bangladesh. Final Report, Biodiversity Assessment for Rupsha 800 MW Combined-Cycle Power Plant Project. February 2018.

Table 4.39: Details of important dolphin areas

Rank	Name of important dolphin site	Location in Figure 4.45	Total number of sightings in pre- monsoon, monsoon and post monsoon surveys
1	Confluence of the Bhairab- Atai-Rupsha	Confluence	75
2	Atai river	Atai	59
3	Near Rupsha bridge	Rupsha 2	47
4	Bhairab-Madhumati Confluence	Bhairab 1	27
5	Jelkhana Ghat confluence	Rupsha 1	20
6	Near Daulatapur	Bhairab 2	17

Figure 4.49: Important dolphin areas



Surfing of a Ganges River Dolphin at the confluence of the Bhairab, Atai and Rupsha Rivers on 31 May 2017. © IUCN/ Kazi Zenifar Azmiri

Dolphin survey at the Rupsha River, 22 October 2017. ©IUCN/ A.B.M. Sazzwat Alam

306. *Other wildlife*. A total of 40 bird species and three other species (Water Monitor, Indian Flying Fox and Smooth-coated Otters) were recorded during the survey period. The highest number of species recorded was from monsoon (28 species) followed by post-monsoon (26 species) and pre-monsoon (11 species). The highest number counted was of Little Cormorant with 241 individuals.

307. Of the 40 bird species, only the black headed ibis (*Threskiornis melanocephalus*) is of conservation status (VU in IUCN Bangladesh, NT in IUCN global). This bird species was observed only during the post-monsoon survey. The rest of the bird species are LC.

308. The conservation status of common water monitor (*Varanus salvator*) and the Indian flying fox (*Pteropus giganteus*) are LC while the smooth-coated otter (*Lutrogale perspicillata)* is VU from the IUCN Red List (global) and listed as CR from the IUCN Bangladesh.

309. *Fish species*. A total of 50 fish species were recorded based on direct field visit and questionnaire survey. Of these species, 17 species are of conservation status based on IUCN Bangladesh Red List (2015). **Table 4.40** gives the list of the fish species. Out of 50 species, 39 species of fishes were sighted by using the method of direct sighting and 11 species of fishes were recorded using questionnaire surveys. In terms of season, 22 species were recorded in the monsoon, 45 species in the post-monsoon and 36 species in the winter.

Table 4.40: Fish species of conservation status

No.	Common Name	Scientific Name	Monsoon	Post-monsoon	Winter	IUCN Bangladesh (2015)
1	Long-whiskered Catfish	*Sperata aor**	—	√	—	VU
2	Tire-track Spinyeel	*Mastacembelus armatus*	—	√	√	EN
3	Freshwater shark	*Wallago attu*	√	√	—	VU
4	Indian river shad	*Gudusia chapra*		√	√	VU
5	Humped Featherback	*Chitala chitala**	—	√	√	EN
6	Grey Featherback	*Notopterus*	—	√	—	VU
7	Giant Snakehead	*Channa marulis**	—	—	√	EN
8	Menoda Catfish	*Hemibagrus menoda*	√	√	√	NT

No.	Common Name	Scientific Name	Monsoon	Post-monsoon	Winter	IUCN Bangladesh (2015)
9	Kuria labeo	*Labeo gonius*	√	√		NT
10	Gangetic Mystus	*Mystus cavasius*	√	√	√	NT
11	Canine Catfish Eel	*Plotosus canius**	—	√		NT
12	Himalayan Glassy Perchlet	*Pseudambassis baculis*	√	√	√	NT
13	Mottled Nandus	*Nandus*	√	√	√	NT
14	Mrigal Carp	*Cirrhinus cirrhosus*	√	√	√	NT
15	Pabda catfish	*Ompok pabda*	—	—	√	EN
16	Pungas Catfish	*Pangasius*	√	√	√	EN
17	Rita	*Rita rita**	—	√	√	EN

Fisherman catches Ilish fish from the Atai River, 8 August 2017. © IUCN/ Sultan Ahmed

310. *Watercrafts*. A total of 676 watercrafts comprised of mechanized and non-mechanized type were recorded. The highest was mechanized boats with a total of 373. Rupsha River is the busiest water way with a total of 253 watercrafts followed by Atai River at 225 watercrafts and Bhairab River with 198 watercrafts. Of the four seasons, monsoon and post-monsoon have the highest number of watercrafts navigating the river system in the study area.

Survey season	Cargo	Non-Cargo		Total
		Mechanized	Non-mechanized	
Pre-monsoon survey	11	32	19	62
First monsoon survey	20	53	62	135
Second monsoon survey	8	71	15	94
First post-monsoon survey	40	90	42	172
Second post-monsoon survey	19	30	9	58
First winter survey	06	52	11	69
Second winter survey	36	45	9	86
Total	**136**	**373**	**167**	**676**

An anchored cargo vessel in the Rupsha River, 26 September 2017. © IUCN/ A.B.M. Sarowar Alam

311. *Water depth*. This was measured along transects every 1km intervals using an echo-sounder and results are given below. Results show that the highest level at Rupsha River is 34.4 m during the pre-monsoon at lowest at 3 m. At the Bhairab River, highest level is 20.1 m (pre-monsoon) and lowest at 5.2 m during the post-monsoon. In Atai River, the highest level is at 42.9 m during the monsoon and 6.6 m in post-monsoon.

Transect	Tide	Pre-monsoon		Monsoon (1st& 2nd monsoon average)		Post-monsoon	
		Max	Min	Max	Min	Max	Min
Rupsha River	High	34.4	3	22.75	8.8	30.8	8.2
	Low	23.9	10	27.1	8.8	29.3	11.9
Bhairab River	High	20.1	6.6	12.65	6.45	13.5	5.2
	Low	17.3	6.3	12.95	5.65	19.5	5.9
Atai River	High	30.4	18.7	32.1	8.65	27.6	6.8
	Low	24.3	6.6	43.9	9.8	34.6	10

312. *Eddy current*. Eddies were recorded in five surveys. The number of eddies found in each river in high and low tides is presented below.

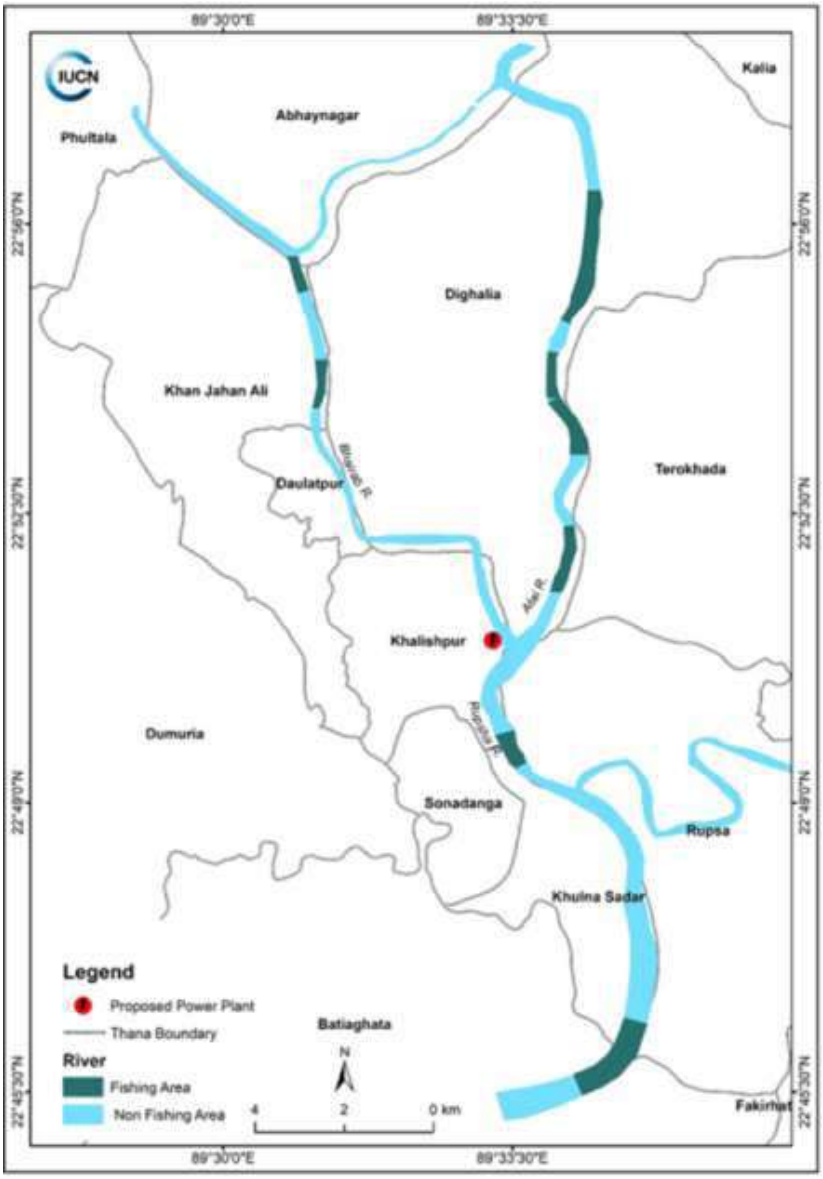
Transect	Tide	Pre-monsoon	First monsoon	Second monsoon	First post-monsoon	Second post-monsoon
Rupsha River	High	0	0	0	0	0
	Low	0	1	0	0	0
Bhairab River	High	0	0	0	0	0
	Low	0	0	0	2	0
Atai River	High	0	0	0	0	0
	Low	4	3	4	6	5

313. Results show that it is only in Atai River where eddy currents occur in all seasons.

314. *Fishing gear and fishing area*. A total of 19 types of fishing gears were recorded in the three seasons that were surveyed (i.e., monsoon, post-monsoon, winter). Fishermen catch fish in the rivers by using these different types of fishing gears. Among these, the small-mesh drifting gill net (*jatka ilish jal*), monofilament gill net (*current jal*), set bag net (b*heundi jal*) and long shore net (*charpata jal*) are widely and illegally used for fishing. The mesh size of small-mesh drifting gill net and monofilament gill net is very small. The set bag net and long shore net are zero mesh

size fishing net. These nets are used to catch eggs, spawn and larvae of all the fish species along with adult fish. Seven fishing areas have been identified (**Figure 4.50**).

Figure 4.50: Identified fishing areas



Fishing nets kept for drying on the bank of the Atai River, 31 May 2017.

Fishermen using a large lift net (veshal) to catch fish from the Bhairab River 8 August 2017. © IUCN/ Sultan Ahmed

Fishing at the Bhairab River 26 September 2017. © IUCN/ A.B.M. Sarowar Alam

315. *Vegetation.*A total of 29 species consisting of 117 individuals were counted from six sample plots. Jam (*Syzygium cumini L),* Supari (*Areca catechu L.*), Narkel (*Cocos nucifera L.)*, Jial (*Lannea coromandelica Merr).* and Aam (*Mangifera indica L.)* are the five most abundant species in the study area.

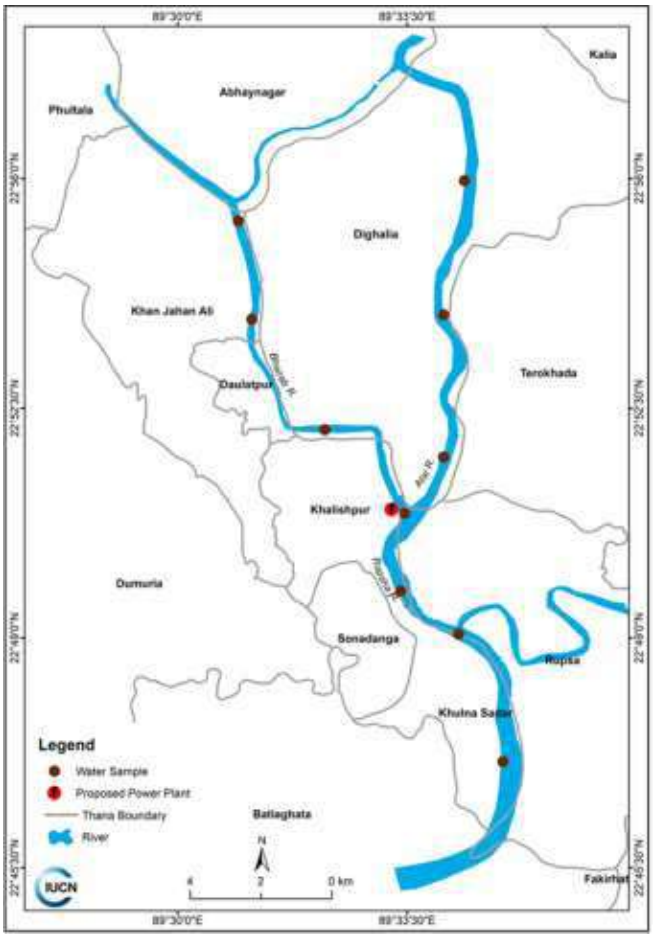
Ranking	Species name	Tree/ha
1	Jam (*Syzygium cumini L.*)	317
2	Supari *(Areca catechu L.)*	233
3	Narkel *(Cocos nucifera L.)*	200
4	Jial (*Lannea coromandelica Merr)*)	167
5	Aam (*Mangifera indica L)*	133

316. *Water quality* Ten water quality sampling stations were identified. **Table 4.41** describes the sampling station and **Figure 4.51** shows the location.

Table 4.41: Water quality sampling stations

Stations	GPS Co-ordinates		Major infrastructures in the River bank
	Latitude	Longitude	
Station 1 (Rupsha)	22°47.115' N	89°34.958' E	Khulna shipyard, Seven ring cement industry, Fish processing zone
Station 2 (Rupsha)	22°49.060' N	89°34.281' E	Jelkhana ghat, Purobi Salt Factory
Station 3 (Rupsha)	22°49.719' N	89°33.400' E	5 no. fishery ghat, goods load and unload zone
Station 4 (Confluence)	22°50.898' N	89°33.459' E	Brick field, Khalishpur ghat, Power plant
Station 5 (Bhairab)	22°52.174' N	89°32.243' E	Padma, Meghna and Jamuna petroleum industry, Jute mill
Station 6 (Bhairab)	22°53.857' N	89°31.130' E	CSD ghat, F.R. jute mil
Station 7 (Bhairab)	22°55.352' N	89°30.921' E	Sheikh cement industry, Brick field
Station 8 (Atai)	22°55.968' N	89°34.370' E	Human settlements
Station 9 (Atai)	22°53.924' N	89°34.051' E	Human settlements, Brick field
Station 10 (Atai)	22°51.758' N	89°34.052' E	Brick field, human settlements

Figure 4.51: Map of water quality sampling stations



317. Results of water quality sampling show the following:

- Temperature ranges from 27°C to 31°C
- pH – the values range from 6.75 to 8. pH values during the monsoon season are slightly higher than the values during the post-monsoon but still within the ECR 1997 limits
- Electrical conductivity (EC) – values range from 243 to 470 mS/cm. The EC valuesare slightly higher in monsoon than post-monsoon season value.
- Dissolved oxygen, mg/l (DO) – Level below 1.0 mg/l will not support fish; thus, at least 5 mg/l to 6 mg/l will be required to support aquatic life. DO levels are generally within the limits of ECR 1997. However, during the monsoon the stations, CSD ghat and Sheik cement recorded a low value of DO (below 3 mg/l). These areas may not support aquatic life.
- Turbidity (NTU) – all the stations recorded high levels of turbidity ranging from 76 NTU to 238 NTU. The river waters are highly turbid during the monsoon season.
- Nitrate, mg/l – levels during monsoon are quite low ranging from 1.42 mg/l to 1.79 mg/l, and from 1.82 mg/l to a maximum of 5.86 mg/l in post-monsoon. Nitrate limit is 10 mg/l. The nitrate level during the post-monsoon was recorded at 5.86 mg/l at Jail Ghat.
- Hardness – level ranges from 88 mg/l to 148 mg/l

- Suspended solids, mg/l – levels are all higher than 150 mg/l
- BOD_5, mg/l - limit in surface water is 50mg/l. Levels ranges from 4.62 mg/l to 7.3 mg/l. Post monsoon values are higher than monsoon. Results show that organic pollution loading is low.
- COD, mg/l – values range from 49.5 mg/l to 64 mg/l suggesting a load of slightly high organic pollutants
- Coliform, CFU/100 ml – values range from 360 to 469. River water may contain disease-causing bacteria and may not be fit for swimming or recreation.
- Iron, mg/l – values during monsoon season range from below 1 mg/l to 2 mg/l while during post monsoon, the values range from 8.7 mg/l to 19 mg/li.
- Cadmium, mg/l – average value is 0.06 mg/li slightly above the limit of 0.05 mg/l
- Chromium, mg/l – average value is 0.33 mg/li during the dry season, above the limit of 0.5 mg/l
- Salinity, ppt – values are all below 1 ppt in both seasons suggesting no saline intrusion or tidal influence from Bay of Bengal at the time of sampling.

318. Overall, the water quality within the study area is not so degraded given the number of industries along the river banks of Bhairab River and Rupsha River, and the volume of watercraft navigating these areas to move goods and people. Iron is slightly high during post monsoon. Sources that contribute to increase in the iron level can be investigated.

319. Biological parameters. Six sampling stations were established for biological parameters. These are: Rupsha bridge, Rupsha Jail ghat, Rupsha 5 no. fishery ghat, Rupsha Khalispur Confluence Power plant, and Bairab CSD ghat, Bairab.

320. A total of 15 genera of phytoplankton and two unknown genera of zooplankton were found in the 6 study sites. Among the plankton, Oscillatoria and Melosira were found in all the 6 study sites indicating that these two genera are common in the study area. On the other hand, Nostoc, Pediastrum, Cymbella and Volvox were found only in single site indicating that these genera are less common in the study area. Maximum number of genera (10) were found in 5 No. Fishery ghat, Rupsha and minimum number of genera (4) were found in the site of Rupsha bridge, Rupsha. Microsystis sp. is considered an indicator of water pollution. This genus was found to have more abundantly in 5 No. Fishery ghat, Rupsha than other sites indicating that water of this site might be polluted.

Assessment on the presence of critical habitat within the PAI

321. Para. 24, 28, and 29 of SPS 2009, Appendix 1 (p34-35) set the guidance on critical habitat assessment.[51] The IFC Performance Standard (PS) 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (1 January 2012) and the IFC's Guidance Notes: Performance Standards on Environmental and Social Sustainability (1 January 2012) also

[51] The criteria for critical habitat are: (i) required for the survival of critically endangered or endangered species; (ii) having significance for endemic or restricted-range species; (iii) sites that are critical for the survival of migratory species; (iv) areas supporting globally significant concentrations or numbers of individuals of congregatory species; (v) areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and (vi) areas having biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats may also include areas either legally protectedor officially proposed for protection, such as areas that meet the criteria of the World Conservation Unionclassification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

provides guidance in determining the critical habitat.[52] Given the sightings of the Ganges River dolphin relatively close to the project area, an IUCN endangered and migratory species, this could potentially trigger criteria (i) and (iii) of SPS 2009 and criteria (i) and (iii) of IFC PS 6.

Criterion 1: Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species

322. For any given discrete management unit[53], there are two tiers with sub-criteria under Criterion 1 as follows:

Tier 1 critical habitat is an area that:

- Has known, regular occurrences of a CR or EN species or subspecies; and either
- Sustains 10% or more of the global population of that species/subspecies; or;
- Is one of 10 or fewer discrete management sites globally for that species/ subspecies.

Tier 2 critical habitat is an area that:

- Has regular occurrences of a single individual of a CR species, or contains regionally-important concentrations of an EN species; or
- Is of gignificant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of the area could potentially impact the long-term survivability of the species; or,
- Contains nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.

323. Based on the results of the dolphin survey, the study area has an estimated population of 34 dolphins. If the study area is considered a discrete management unit, it does not meet Criterion 1 Tier 1 thresholds for Critical Habitat as there are more than ten discrete management units globally for this species and this site holds far less than 10 percent of the global population of this Endangered species; it holds less than 0.68% (Table 4.42) of the global population. The project site cannot be considered Critical Habitat under Tier 2 sub-criteria of Criterion 1, as it does not support a regionally-important concentration of this species (in comparison to densities of the species elsewhere in Bangladesh and beyond), nor is there any other reason to consider the area of significant importance to the species. Finally, the loss of this habitat will not significantly impact the long-term survivability of the species owing to the small population at the project site compared to the global population. The area does not contain nationally important concentration of CR or EN species, as the species is considered nationally Vulnerable.

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[52] IFC criteria under PS6 are: (i) habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) 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, (vi) areas ssociated with key evolutionary processes.

[53] "discrete management unit," an area with a definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas (adapted from the definition of discreteness by the Alliance for Zero Extinction). A discrete management unit may or may not have an actual management boundary (e.g., legally protected areas, World Heritage sites, KBAs, IBAs, community reserves) but could also be defined by some other sensible ecologically definable boundary (e.g., watershed, interfluvial zone, intact forest patch within patchy modified habitat, seagrass habitat, coral reef, concentrated upwelling area, etc.). The delineation of the management unit will depend on the species (and, at times, subspecies) of concern. (PS 6 GN65)

Table 4.42: Results of dolphin survey

Species Name	Global Status	National Status	Global Population	National Population	Population in Project Site	% of Global Population	% of National Population
Ganges River Dolphin	Endangered	Vulnerable	<5000	Unknown (225 in Sundarbans, 125 in Karnaphuli River, 38–58 in Jamuna River and 34–43 in nine groups in Kushiyara River)	34	<0.68%	<7.5%

Source: (i) Braulik and Smith (2017), IUCN Bangladesh (2015).

Criterion 2: Endemic and/or restricted-range species

324. The project site cannot be considered as Critical Habitat under Criterion 2, as there was no record of any endemic or restricted-range species from the surveys.

Criterion 3: Migratory and/or congregatory species

325. The project site cannot be considered as Critical Habitat under Tier 1 of Criterion 3 as no migratory or congregatory species were recorded whose ≥ 95% population relies on this habitat. The project site cannot be considered as Critical Habitat under Tier 2 of Criterion 3, as the project site has fulfilled the requirements of Tier 2. (In Tier 2 of Criterion 3 what applies to the project is defined as, “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’ lifecycle 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.” The project site does not fall under Tier 2 of Criterion 3.)

Criterion 4: Highly threatened and/or unique ecosystems

326. The project site cannot be considered as Critical Habitat under Criterion 4, as it cannot be considered as a highly threatened and/or unique ecosystem under the given standards.

Criterion 5: Key evolutionary processes

327. The project site cannot be considered as Critical Habitat under Criterion 5, as area does not fulfill the standards set under criterion.

Critical Habitat for Fish and Other Wildlife

328. A total of six species of fish are included in the National IUCN Redlist (2015). These six fish species are considered nationally EN status, but globally four are Least Concern (LC) and two Near Threatened (NT). Data collected on these species during current EIA surveys is inadequate to assess the species’ abundance in the study area. Due to the lack of data, a Critical

Habitat assessment was conducted using the national ranges of these species as proxies for their presence/status in the area (see table below). Most of the species are widely distributed in Bangladesh, and there is no reason to suspect the study area is of specific importance to them (owing to ecology, distribution, habitat, etc.). As such, the study area cannot be considered critical habitat for these species.

Species Name	Status and distribution in Bangladesh (2015 national Red List)	Remarks
Tire-track Spinyeel (*Mastacembelus armatus*)	Nationally Endangered. Found in rivers, canals, beels, ponds and inundated fields throughout Bangladesh.	Although nationally threatened, the species has a large area of occupancy throughout Bangladesh. There is no reason to expect the study area to be of specific importance for it, and so the area cannot be considered critical habitat for this species.
Humped Featherback (*Chitala chitala*)	Nationally Endangered. A widely-distributed species in rivers, beels, haors, reservoirs, canals and ponds.	The species was recorded through interview survey (two of three surveys), rather than through direct evidence. Although nationally threatened, the species has a large distribution throughout Bangladesh. There is no reason to expect the study area to be of specific importance for it, and so the area cannot be considered critical habitat for this species.
Giant Snakehead (*Channa marulius*)	Nationally Endangered. Known from the Padma, Padma distributaries, Borulia haor (Nikli, Kishorganj), Mahananda, Choto Jamuna, Ichanoi Beel (Gaibandha), Dogger Beel (Chandpur), Titas, larger haors in Greater Sylhet and Mymensingh Districts, beels, and larger water bodies in Dhaka, Manikganj and Tangail Districts.	The species was recorded through interview survey (one of three surveys), rather than through direct evidence. Although nationally threatened, the species has a fairly large distribution in Bangladesh. There is no reason to expect the study area to be of specific importance for it, and so the area cannot be considered critical habitat for this species.
Pabda catfish (*Ompok pabda*)	Nationally Endangered. Reported from the Chalan Beel and Medha Beel in the Northern region, the Surma, Kushiara and Manu River of Sylhet Division. It is also found in the Baikka Beel and Tanguar Haor of Sunamgon District.	Although nationally threatened, the species has a fairly large distribution in Bangladesh. There is no reason to expect the study area to be of specific importance for it, and so the area cannot be considered critical habitat for this species.

Species Name	Status and distribution in Bangladesh (2015 national Red List)	Remarks
Pungas catfish (*Pangasius pangasius*)	Nationally Endangered. Found in estuaries, large rivers, haors, baors, beels and floodplains throughout Bangladesh.	Although nationally threatened, the species has a large distribution througout Bangladesh. There is no reason to expect the study area to be of specific importance for it, and so the area cannot be considered critical habitat for this species.
Rita (*Rita rita*)	Nationally Endangered. Apparently only known from north of the study area, in the Padma River, Arial Kha River, Chalan Beel, Barnai River of Rajshahi, Bangali River of Bogra, Baral River of Natore, River Choto Jamuna, Brahmaputra, Turag River, "Ichhanoi Beel" at Palashbari Upzila of Gaibandha, Mahananda River at Chapai Nawabganj District, Medha Beel,Upazilla of Kolmakanda, Netrokona, Someshari and Kangsha River of Netrakona, Kritonkhola, Barisal, Surma River in Sylhet, Surma River, Sunamganj, Surma River, Rupsha River (Khulna), Meghna river Chandpur and Bhairab, Baleswar River (Pirojpur).	Although nationally threatened, the species has a fairly large distribution througout Bangladesh. As the study area is at best at the edge of this species' range in Bangladesh, it is unlikely to be nationally important for it, and so the area cannot be considered critical habitat for this species.

329. There was no direct evidence/sighting of Smooth-coated Otter during the field survey period, and only one interviewee (from six interview surveys) claimed the species was present in the area. Due to the lack of data, a Critical Habitat assessment was conducted using the national range of this species as a proxy for its presence/status in the area. According to the national Red List, this nationally Critically Endangered species is restricted to the hilly areas of the northeast and southeast and the coastal districts, where its largest population possibly still thrives in the Sundarbans forest in the southwest corner of the country. Given the limited evidence for the species in the study area, and other areas of the country being considered as the sole, or at least most important, areas for the species nationally, it is considered highly unlikely that the study area holds a nationally-important concentration of this species. As such, it cannot be considered critical habitat for this species.

330. Regarding Irrawaddy Dolphin, only one sighting of a group consisting of four individuals was recorded. This sighting was only during the second winter survey. There was no other sighting from previous six surveys. Although the species is globally Endangered, and nationally Near Threatened, the population in the project area is not large enough to fall under any criterion of Critical Habitat. The national population of this species is around 6,000 individuals (IUCN 2015).

331. Therefore, while there are sightings of the Ganges River dolphins, an endangered species, the project site is not a critical habitat. However, their presence will be carefully considered in planning for the transport of goods and equipment along Bhairab-Rupsha River system and construction works. Monitoring will be included in the environmental management plan (EMP).

4.4 Socio-economic condition

332. Primary data was collected using tools and techniques such as Rapid Rural Appraisal (RRA) KII, observations and informalconsultations. Secondary data was gathered from the Population and Housing Census 2011 published by the Bangladesh Bureau of Statistics (BBS) in 2012 and other relevant sources.

333. **Area and location.** According to Spatial GIS Analysis of CEGIS (2016), administratively the study area consists of 15 unions and 33 wards under the Khulna City Corporation either partially or fully. The upazilas are: Batiaghata, Dighalia, Dumuria, Phultala, Rupsha and Terokhada.

334. **Population.** There are 244,630 households in the study area with a total population of 1,038,877 of which 535,780are males and 503,097are females. The female population is found to be lower than male population (**Table 4.43**). The male-female ratio is 108 which is higher than the national figure of 100.3 (BBS, 2012).

Table 4.43: Demographics in the study area

Households	Population			Sex ratio
	Total	Male	Female	
244,630	1,038,877	535,780	503,097	108
	100 (%)	51.6 (%)	48.4 (%)	

Source: Population Census 2011 (BBS, 2012)

335. **Household size.** About 27% of the households comprisesof 4 persons, 22% comprises of 3 persons, 7% comprises of 7 persons, and 5% comprises of 8 persons. The average household size is 4.2 whereas the national average is 4.4 (BBS, 2012).

336. **Age structure.** The highest number of population (about 26.8%) belongs to the age group, 30 to 49 years while the lowest number (about 2.6%) belongs to the age group, 60 to 64 years old. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-59 years as prime working age, above 60 and over as elderly people. This classification is important as the size of young population (under age 15) would need more investment in education while size of older populations (ages 65 and over) would need for investment in the health sector.

337. **Land holding.** Based on the Census of Agriculture (2008), about 63% of the households are non-farm holders and 37% farm-holders. The farm-holders are mainly small (30%) with only 1% represents large farm-holder.

338. **Housing condition.** On average, 30% of the households live in pucca houses, 38% in kutcha, 30% in semi-pucca, and about 2% in Jhupri houses.

339. **Economy and employment.** About 41% is employed in different sectors represented by 34% male and only 7% female. Population engaged in household work is about 34% while 24% of the population is not working. Only 1% of the population is looking for work.

340. **Occupational pattern.** Main occupation in the study area is service (55%), about a quarter (23%) of the population is engaged in agriculture, and 22% in industrial work. Of the 55% engaged in the service group, 42% are male and only 13% female.

341. **Labor availability and wage rate**. The wage rate varies between Tk250 to Tk500 per day. Few migrant laborers tend to stay in the study area most of the year but return to their home at the end of the year with all their income. Women's participation in the agricultural sector is negligible (**Table 4.44**).

Table 4.44: Labor availability and wage rate in the study area

Type		Male			Female		
		Labor Availability	Average Wage Tk/day		Labor Availability	Average Wage Tk/day	
			Max.	Min.		Max.	Min.
Farming	Skilled	High	350	250	Nil	-	-
	Non-Skilled	High	250	200	Low	200	150
Non-Farming	Skilled	Medium	500	400	Low	350	300
	Non-Skilled	High	350	300	Medium	250	200

Source: CEGIS fieldwork, 2016.

342. **Population migration.** Migration is common in the study area in terms of seasonal labor. During the rainy season, they remain without work and thus, migrate temporarily to other districts for livelihood. They normally migrate to Dhaka, Sylhet and Mymensingh where they work as labourers, rickshaw pullers, and small-scale businessman, etc. The migration status in the study area is shown in **Table 4.45**.

Table 4.45: Migration status in the study area

Type of Migration	Labor Migration-Out		Labor Migration-In	
	Place of destination	% of total population	Place of origin	% of total population
Seasonal labor migration	Dhaka, Chittagong, Bagerhat	8	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	15%
Permanent household migration	Dhaka, Chittagong, Bagerhat	2%	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	1%

Source: CEGIS fieldwork, 2016.

343. **Drinking water facility.** According to BBS 2012, drinking water supply is predominantly tube well (95%). About 4% of the households depend on tap water whereas only 1% of the household rely on some other sources (i.e., pond, river and canal) which are about 7 km to 8 km from the project area (**Figure 4.52**).

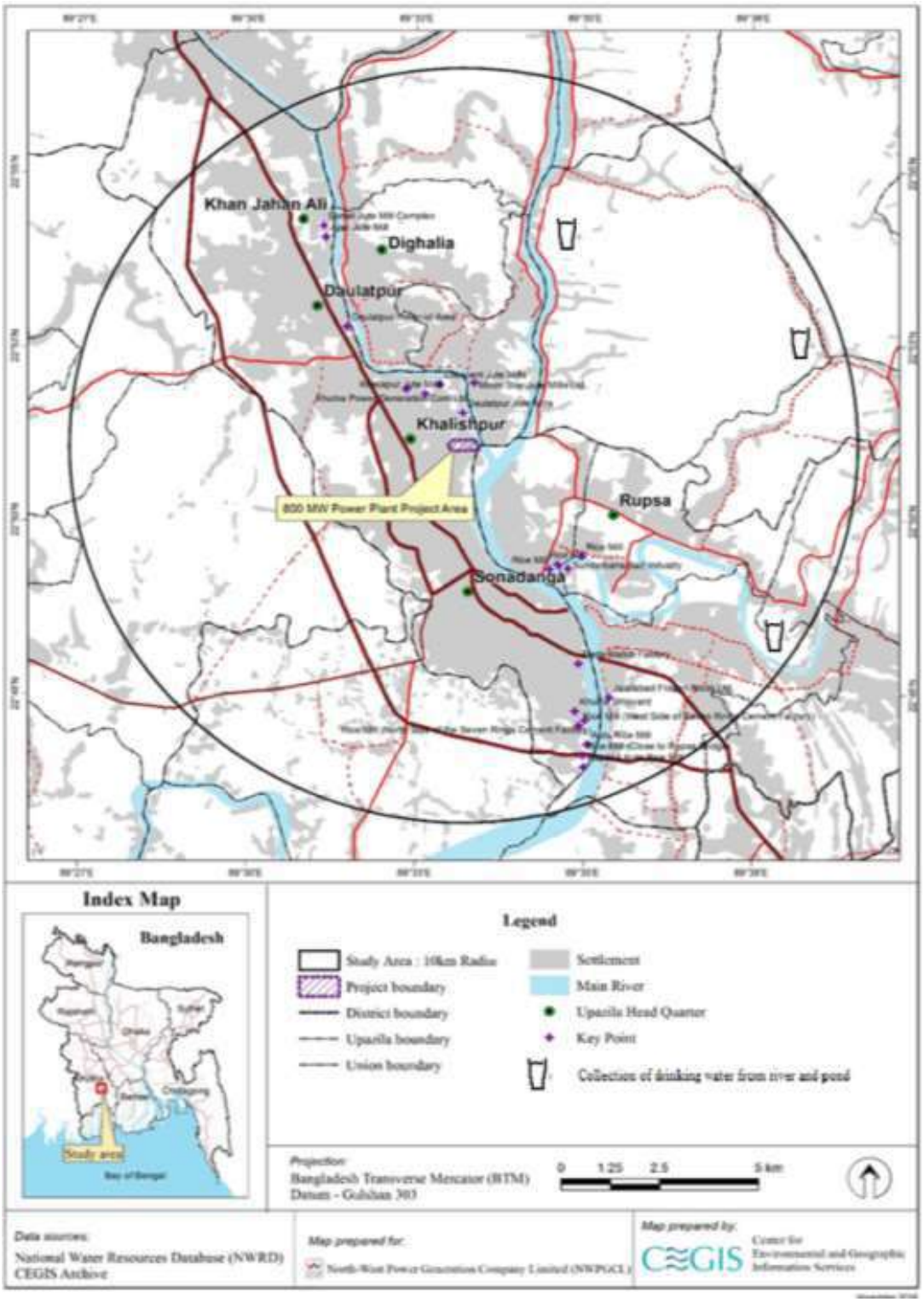
344. **Sanitation.** About 87% of the population in the study area has sanitary toilet facilities but still about 12% use non-sanitary toilet. Of the sanitary toilet facilities, 42% are water sealed and 46% are non-water sealed.

345. **Electricity coverage.** About 86% of the households are grid-connected to meet their daily demand. This rate is high compared to the national coverage of 53%.

346. **Road networks.** Transport connectivity in the study area includes roadway, railway and waterway. The main roadway to the project area is from Jessore-Khulna highway road at Notun Rastar to Khalishpur. The Khulna railway station is not very far, about 5 km from Rupsha 800 MW CCPP. The nearest airport is in Jessore district. Water connections are mainly throughout the

Bhairab River, Rupsha River and Poshur River. These are tidal rivers with significant contribution to the industrial development in the area due to ease of moving goods and people.

Figure 4.52: Areas of river and pond water drinking people



347. **Community health condition.** Local people in the study area reported that prevalent diseases are water borne like diarrhea, typhoid, pneumonia, jaundice, skin diseases, etc. Children are mostly affected by water borne diseases.

348. Instant health facility is inadequate in nearby areas except the Khulna City corporation area. Hyper tension/high blood pressure is also increasing among the people. Disability is also found in the study area (less than 1% of the population). Most common type of disability is physical followed by vision, mental, and speech (Sadar Hospital 2015). In Khulna district, most common illness is pneumonia, bronchial asthma, chronic obstructive pulmonary disease, and whooping cough. These illnesses can be aggravated by poor air quality, nutrition, and smoking.

349. **Health service facility.** There is an existing 250-bed health complex in Boira. Patients from different districts go to this facility to avail of better medical treatment. There are a number of private clinics in Khulna city also.

350. About 48% of patients go to trained physician as people have easy access to the trained physician in Khulna city. A quarter of the population (25%) go to paramedic doctor, still 22% go to quack doctor or informal treatment, and about 5% do not have access to medical treatment. Local people are nowadays much more aware about their health. They are eager to receive health treatment from trained physicians but most of the patients are not able to do that due to lack of financial capacity and road accessibility.

351. **Literacy rate** is 68% in the study area compared to the national rate of 52% and divisional rate of 53%. Literacy is higher in males (71%) compared to females (65%). There are two schools in the project site: KNM Secondary Boys School and KNM Secondary Girls School (**Figure 4.53**). These structures will be affected by Component 1, and thus, will be relocated prior to any construction works. The relocation of the schools will be based on the outcome of consultations among the school authority, NWPGCL, and school committee.

Figure 4.53: Boys and girls school at the project site

352. The school is on 1.81 acre. The number of total students is 450 (i.e., 150 girls and 300 boys) and the total number of teachers is 23.

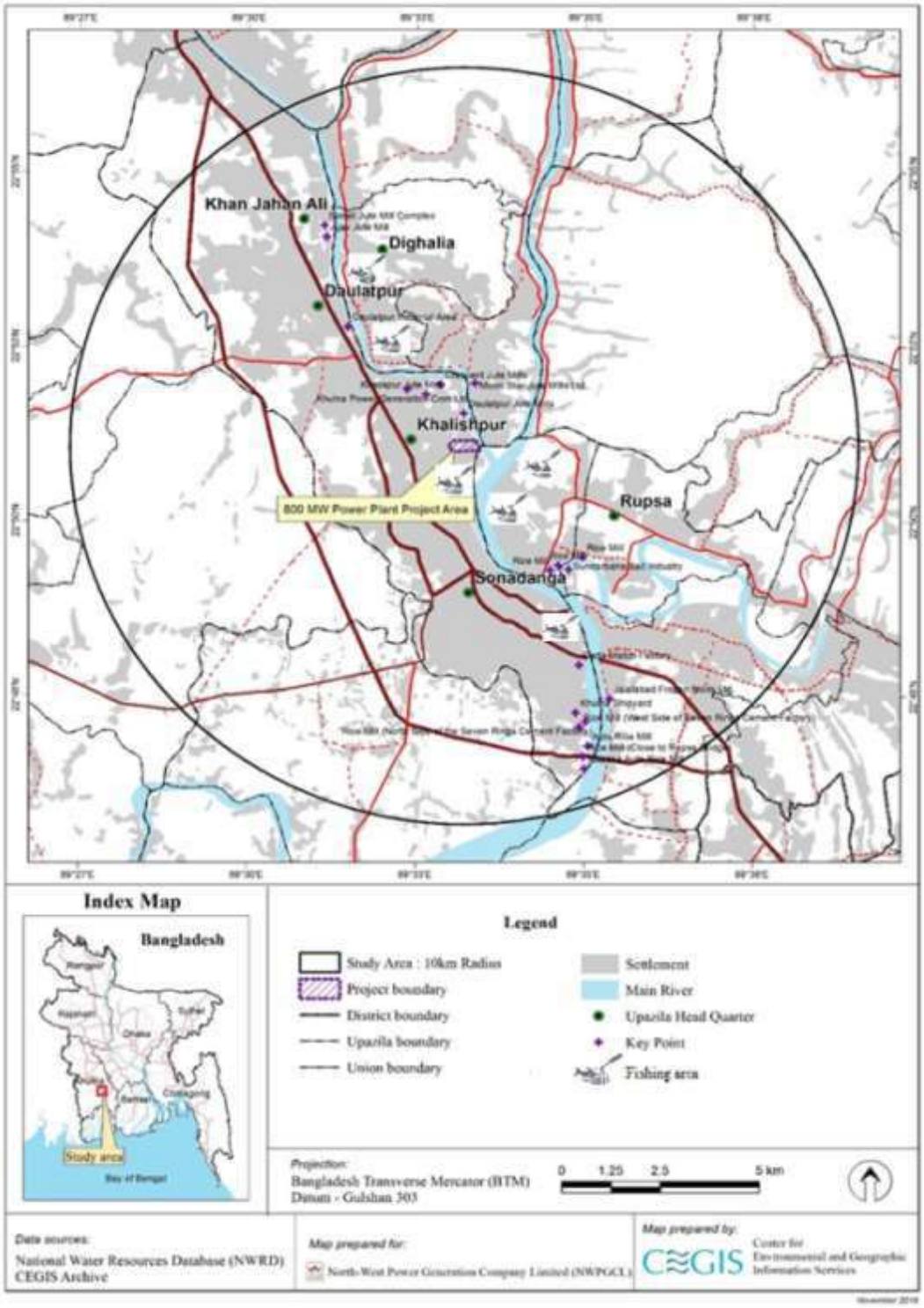
353. **Vulnerability to natural disaster.** Khulna is situated in the natural disaster-prone area geographically. Local people indicate that waterlogging, salinity intrusion, cyclone, surge, river erosion are the main problems where in the study area where these occur almost every year. River erosion is observed in the opposite river bank of Bhairab River from the project site. Salinity intrusion occurs 3 to 5 months a year.

354. **Safety nets.** There are several social safety nets and poverty reduction programs in the study area which include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to the local people, these programs have created food security as well as social security among the targeted poor households and vulnerable communities. A number of local, national and international NGOs are also working in the study area. The main activities of these NGOs are operating microcredit programs among the rural poor and landless women/men.

355. **Tourist attractions spots, religious, cultural heritage and archaeological sites.** There are different tourist spots. Some of these tourist attractions include: botanical garden, Dakatia Bil (Fhultala-Dumuria), graveyard of Birshresta Ruhul Amin, Hardboard Mill, Kalibari Temple, Khulna University, Khulna Shipyard, Khulna Stadium, Khulna Hadis Park, Khan Jahan Ali Bridge (Rupsha Bridge), Khalishpur Wonderland Shishu Park, Jahanabad Cantonment Zoo, Rabindranath Tagore's father-in-law's house (Dakkhindihi, Phultala).

356. **Fishermen community adjacent to the project site.** There is a fishermen community in the Chandonimahal village within the study area (**Figure 4.54**). The community is across the Bhairab River from the project site. Administratively, it is in the Senhati union under Dighalia upazila, Khulna. Field survey shows that there are about 100 fishermen households in this area. For fishing activities, they have 20 boats. The average income for each boat is Tk400/day. The average manpower in each boat is 3 to 5 persons. The fishing areas are more or less 5 km upstream and 5 km downstream in the Bhairab River with respect to the project site. The average fish catch per day during the dry season is about 2 kg to 10 kg and about 10 kg to 400 kg during the wet season. These fishermen mainly depend on the Bhairab River, but some are partially involved as day laborer, rickshaw puller, and boatman. Some of them work with the local businessman (mohajon) and go out to sea to do fishing. Women are mainly engaged in household chores. On some occasions, the women get involved in preparing and repairing of fishing nets for their own family, sewing clothes, etc.

Figure 4.54: Fishing catchment area of Chondoni mohal fishermen



5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

357. The project area will require extensive site preparation due to the presence of abandoned buildings left from the closure of the KNM operations in 2002.The proposed major activities will involve demolition of the existing abandoned brick buildings, construction of labor camps, cutting of trees, site preparation, transportation of machinery and ancillaries, storage of equipment and materials for construction, erection of all equipment and machineries, construction of gas pipelines, etc. The project-related activities will have diversified impacts on the environment and socio-economic conditions of the local people. Among the impacts from the proposed activities, some are temporary in nature and limited to pre-construction and construction period, and others are continuous until the operation phase.

358. Based on the experience from other similar power generation projects, many of the environmental issues are addressed through technological intervention in the project design (e.g., minimize NO_x emission by using low NO_x burner, condenser cooling tower, decrease specific-relative fuel requirement, etc.) and some of the impacts will be minimized within permissible limits by following site-specific mitigation measures as required. Demolition of the existing leftover brick buildings, clearing of bushes and felling of trees during site preparation and labor camp induced sanitation and social stress are the most significant impacts of the construction works. Clearing of vegetation and tree cutting will have ecological effect as the habitat is destroyed or fragmented.

359. Technological improvement is expected to reduce the generation of solid and liquid waste which will facilitate management of such wastes within the environmental limits. The overall positive impacts of the project are as follows: the enhancement of the generation capacity of the electricity and improving the socio-economic conditions and lifestyle of the local as well as of the people of this country.

5.2 Impact Assessment Methodology

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

5.2.1 Impact Magnitude

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

362. The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 5.1**.

Table 5.1: Parameters for determining magnitude

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

5.2.2 Sensitivity of Receptor

363. The sensitivity of a receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of the features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 5.2**.

Table 5.2: Criteria for determining sensitivity

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

5.2.3 Assigning Significance

364. Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in **Table 5.3**.

Table 5.3: Significance of impact criteria

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

5.2.4 Summary of Assessed Impacts

365. The project's potential impacts and their significance have been assessed using the methodology described above. A summary of these impacts and their significance is presented in **Table 5.4**.

Table 5.4: Potential impacts and their significance

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
Environmental impacts during pre-construction and demolition stage					
A. Ambient Air					
A1. Dust particles from brick buildings located at the demolition site	Emissions of dust will be generated from demolition of the existing buildings, transportation of the rubbish materials. SPM will be the major pollutant during the demolition works. Dragging of the trees (cutting or falling) over the roads will also generate dust into the ambient environment	Medium	Moderate	Moderate adverse	ECR 2005 IFC-WB General EHS Guidelines, 2007
B. Ambient Noise					
B1. Noise pollution	Noise will be generated during demolition of the existing buildings. Manual destruction of the	High	Major	Major Adverse	Noise Pollution Control Act, 2006 of Bangladesh including IFC-WB EHS General

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	buildings will generate high impulse noise to the surrounding environment.				Guidelines 2007 (same comments apply for all H&S and pollution risks in this table)
B2. Vibration	Demolition works may generate vibration which may cause annoyance from the community	High	Moderate	Major	
C. Water Resources					
C1. Surface water availability	Navigation to transport machineries and other heavy equipment	Low	Minor	Minimal	ECP3
C2. Salinity	Drinking water may be affected by level of salinity	Low	Minor	Minimal	ECP 3
C3. Erosion and accretion of soil, debris, contaminants, unvegetated soil, including suspended sediment in the runoff and accretion	Erosion of river bank within the study area that is protected by the sheet pile	Medium	Minor	Minor	ECP6
C4. Flooding	Potential flooding in the project site	High	Moderate	Major	ECP 3 and Performance Standards on Environmental and Social Sustainability
C5. Intake channel outlet	Adequate depth available for the intake at the eastern boundary	Low	Minor	Minimal	ECP 3
D. Land Resources					
D1. Land Type	Land previously used for industrial purposes will be raised to avoid flood risk	Low	Minor	Minimal adverse	
D2. Soil Quality	During pre-construction stage, earth works will be initiated (approach road, land development, etc.). As a result, top soil quality may deteriorate and contaminants will be mobilized through source-pathway receptor and may also contaminate ground water as well	Low	Minor	Minimal adverse	ECP 7
E. Livestock Resources					
F. Fisheries Resources and possible contamination	During demolition, backfilling, and river bank protection activities fisheries may be affected.	Medium	moderate	minimal	

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	Ships and vehicles carrying demolished materials may have oil/fuel spills which may contaminate water and fisheries including food chain				
G. Ecological Environment					
G1. loss of plant and wildlife	During clearing and demolition process, some of the common lizards, frogs may be affected. Clearing of trees and riverbank works may affect fish	Medium	Moderate	Minimum	ECP 13
G2. Dust and noise impact on vegetation and wildlife	During demolition of buildings, it is expected to create sound pollution and dust which may affect surrounding vegetation and wildlife.	Medium	Moderate	Minimal	ECP 11, ECP 13, ECP 12
G3. Clearing of terrestrial vegetation	Cutting of trees to prepare the project site will reduce carbon sequestration of about 6,880.480046 for 30 acres of land cover	High	Major	Moderate	ECP 12
G4. Habitat, life loss and relocation of mammals, birds and other wildlife	Vegetation clearing may cause damage to habitat of some animals.	Medium	Moderate	Minimal	ECP 13
G5. Riverine, dolphin habitat and benthic community	Bhairab river habitat may be impacted due to discharge of oil and other wastes. Under water noise during transport of construction materials and machineries may affect aquatic biota.	High	Minor	Moderate	ECP13
H. Socioeconomic Condition					
H1. Demolition of buildings, trees and other structures	Demolition of structures may generate dust, create noise and thus, may cause some environmental and aesthetic impact	Medium	Medium	Moderate adverse	Labor Law, 2006, ECP17
H2. Worker's health	Worker's exposed to dust and noise during pre-construction may affect their health	Moderate	Moderate	Moderate adverse	WHO Guidelines, ECP18, ECP16, Labor Law, 2006. In addition, demolition works to be conducted by

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
					experienced and qualified contractor.
I. Non-Hazardous Waste Generation					
I1. Solid Waste	Aesthetic degradation due to negligence in management of waste generated from vegetation clearance, land development and domestic activities	Moderate	Minor	Minor adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
I2. Liquid Waste and Sewerage	Aesthetic degradation due to negligence in management of waste	Low	Minor	Minor adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
I3. Leaching of generated wastes to nearby environment	Generated waste can be washed away and pollute Bhairab River affecting aquatic ecosystems. Wastes generated may also lead to the spread of various pathogens if not properly managed	Moderate	Moderate	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Environmental Impacts during construction stage					
J. Ambient Air					
J1. Dust and gases from construction equipment and vehicles	Emissions of dust and gases will be generated from excavation of trenches, operation of construction equipment and vehicles, and material transport, which may cause injurious to health and ecosystem	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 2007
K. Ambient Noise					
K1. Noise pollution	Noise would be generated from the moving and idling vehicles and heavy machineries, which may cause disturbance, increased stress level, increased blood pressure, etc. on the people who are susceptible to the generated noise.	Moderate	Medium	Moderate adverse	Noise Pollution Control Act, 2006 of Bangladesh
K2. Vibration	Vibration will be generated from the machines and equipment	Moderate	Medium	Moderate adverse	
L. Water Resources					

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
L1. Surface water availability and possible contamination	Water will be required for construction activities such as curing, mixing of concrete, etc.	Low	Moderate	Minimal	ECP3
L2. Salinity	Workers and other professional will face difficulty to drink and use of groundwater	High	Moderate	Major	ECP 3 and Performance Standards on Environmental and Social Sustainability
L3. Erosion and Accretion	High flood water may erode the east boundary of project during construction. Loading and unloading of machineries and equipment from waterway may create additional damage of river bank.	High	Major	Major	ECP6, BWDB river protection works and ECR 1997, Performance Standards on Environmental and Social Sustainability
L4. Flooding	Flooding onsite may delay project	Low	Moderate	Minimal	ECP 4
L5. Intake channel outlet	Land development works may decrease the depth of Bhairab River for intake	Low	Moderate	Minimal	ECP3
M. Land Resources					
M1. Soil Quality	Site preparation works may impact on the fertile topsoil	Low	Minor	Minimal adverse	ECP 7
N. Livestock Resources					
N1. Fisheries Resources	River bank protection may impact fisheries due to soil run off. Fuel leak from vehicles and river transport of construction materials may affect aquatic biota.	Medium	Medium	Minimal	
N2. Habitat condition and quantity	Bhairab River is rich in Hilsa, Deshi Pangus and Shrimp PL, which may be affected due to disposal of wastewater like ballast and bilge water from the ship/cargo carrying machinery and ancillaries having oil and grease contaminants. Open water fish habitat may be affected also due to washing of various solid waste such as sand particles, food wastes,	Medium	Moderate	Moderate adverse	ECP 14

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	cans, and bottles etc. generated by workers.				
N3. Fish species diversity and composition	Alien species may be introduced through ship carrying heavy machineries from abroad that may cause adverse impacts on pelagic and benthic communities	Medium	Minor	Minor adverse	ECP 14
N4. Fish production	With the consequence of aforesaid reasons, fisheries resources may cause decline in fish productivity of the river and its connectivity.	Medium	Minor	Minor adverse	ECP 14
O. Ecological Environment					
O1. Riverine, dolphin habitat and benthic community	Construction of new jetty and repair of the old one may temporarily disturb dolphins' movement as well as the benthic community.	Low	Minimal	Low	ECP 13
P. Socio-Economic Condition					
P1. Worker's exposed to dust and noise during pre-construction may affect their health	Worker's exposed to dust and noise may affect their health	Moderate	Moderate	Moderate adverse	Labor Law, 2006, ECP17, ECP18. In addition, all demolition activities to be conducted by experienced qualified contractors.
Q. Non-Hazardous Waste Generation and Hazardous Materials					
Q1. Solid Waste	Aesthetic degradation due to negligence in management of waste generated from construction activities, soil contamination and also water contamination due to demolished hazardous materials and also from labor sheds	Medium	Moderate	Moderate adverse	ECR 1997, ECP 1, ESMS
Q2. Leaching of generated wastes to nearby environment	Large amount of generated waste may be washed away towards the Bhairab River affecting aquatic ecosystems. Wastes generated may also lead to the spread of various pathogens if not properly managed	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Environmental impacts during operation stage					
R. Ambient Air Quality					

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
R1. Maximum ground level concentration of pollutants	Emission of exhaust gas from the stack may contribute to elevated ground concentration of CO, SO_2, NO_x, $PM_{10,}$ and $PM_{2.5}$ downwind of the power plant	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 200
S. Ambient Noise					
S1. Noise Pollution	Noise generated by the RMS, gas turbine and HRSG units cumulatively would have a tendency of exceeding the noise level standard in some places. This might result in hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the site engineers, technicians and workers and surrounding communities.	Major	Medium	Moderate adverse	Noise Pollution Control Act, 2006 of Bangladesh
T. Water Resources					
T1. Surface water availability	Extraction of water for one time and also regular extraction for make -up water from adjacent Bhairab River (source-surface water) particularly in dry season may have potential impact on availability of water resources for other users.	Medium	Moderate	Minimal	ECP3. In addition, about 0.12% of water against discharges of the Bhairab river will be extracted for this power plant
T2. Salinity and other contaminants	Level of salinity may increase due to low infiltration at ground water table. In addition, fuel, oil and runoff from contaminated soil may also impact ground water	Medium	Moderate	Moderate	ECP 3 and ECP4
T3. Erosion and Accretion	Damages due to anchoring, unloading goods and materials and other natural disasters.	Low	Moderate	Minimal	ECP6
T4. Flooding	Designed land level may not be suited for flooding	Medium	Moderate	Moderate	ECP 4 and Performance Standards on Environmental and Social Sustainability
T5. Intake channel outlet	Continuous loading and unloading of goods and equipment by jetty may reduce the depth of water	Low	Moderate	Minimal	ECP 6

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	due to wave action induced by the cargo boats during anchor				
U. Fisheries Resources					
U1. Fish habitat condition and quantity	Abstraction of river water at the rate of 2010 m^3/hr for operating power plant may affect availability during dry season which may alter the capture fish habitat condition.	High	Major	Major adverse	ECP 14
U2. Fish species diversity and composition	Water intake from the Bhairab River may entrap fish, crustaceans and other aquatic organisms Predator-prey relationship might be affected due to spread of invasive species through ballast water. Integrated impact may be caused by withdrawal of water at the rate of 2010 m^3/hour may alter fish diversity due to salinity intrusion.	Very High	Critical	Major adverse	ECP 14
U3. Fish production	Due to impacts identified , fish production may be affected.	High	Major	Major adverse	ECP 14
U4. Fisheries Based Livelihood.	Associated livelihood would be affected due to the reduction of catch per unit area and effort and may narrow down the fishing area.	High	Major	Major adverse	ECP 14
V. Ecological Environment					
V1. Impact on terrestrial vegetation	The emission of SO_x, NO_x and SPM including noise level may have significant impact on vegetation and other sensitive receptors around the project and study area.	Low	Minimal	Low	NCS, 1992
V2. Riverine, dolphin habitat and benthic community	Transportation of power plant equipment, other materials including fuel during operation period along the river ways, may degrade the riverine water and habitat quality of aquatic species due to	High	Minor	Moderate	ECP 13

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	movement, creation of underwater noise, and discharges of waste and oil spill from all these river transports. Water extraction from Bhairab River particularly during dry season for cooling and make-up process may affect aquatic ecosystem, aquatic species including dolphin and their prey. Some of the benthic community may be trapped in the water extraction pipe and get killed.				
W. Socio-Economic Condition					
W1. Noise pollution	Excessive noise may be generated during the trial period of commissioning of new unit that may affect hearing, annoy communities, and other health risks.	Medium	Moderate	Minor	ECR, 1997 WBG General EHS Guidelines, ECP18
W2. Fisheries activities may be hampered due to heavy river traffic	Increase in river water traffic may hamper fish habitats, leading to a decline in fishing activities. Fishermen community may need to look elsewhere for job opportunity.	Medium	Moderate	Minor	ECP15
X. Non-Hazardous Waste Generation					
X1. Liquid Waste and Sewerage	Aesthetic degradation due to negligence in management of waste	Moderate	Minor	Minor adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
X2. Leaching of generated wastes to nearby environment	Generated waste can be washed away and pollute the Bhairab River affecting aquatic ecosystems. Wastes generated may also lead to the spread of various pathogens if not properly managed	Moderate	Minor	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Y. Hazardous Waste Generation					
Y1. Use of Hydrazine in feed water for oxygen scavenging	Hydrazine is genotoxic carcinogen. Exposure to hydrazine is hazardous to health. The boiler blow-down may contain	Very High	Moderate	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, ECR 1997, The International

IECs/Issues	Potential Impacts from Various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to relevant regulations/laws
	residual hydrazine which may reach the Bhairab River affecting				Conference on Chemicals Management in 2006 IFC's Performance Standards on Environmental and Social Sustainability
Y2. Hazardous sludge from water pre-treatment and treatment plant	Contamination of surface water, ground water and soil if not properly managed	High	Major	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability

5.3 Environmental Impacts during Pre-Construction and Demolition Stage

366. The major activity during this stage is the demolition of the 151 structures within the 50 acres to be occupied by Component 1. The structures to be demolished consist of 122 primary residential structures previously used as dormitories and residences of staff, bungalow of the Managing Director of KNM, kitchen and dining, guest house, and military camps assigned to maintain security within the premises of KNM. The other 29 structures are non-residential like auditorium/cinema, water tank, fire-fighting system, swimming pool and rest house, boys and girls schools, etc. The structures to be demolished are made from reinforced concrete, wood, tin sheets, pacca, and semi-pacca generally used in Bangladesh. There will be a separate contractor for demolition works which will be selected through a bidding process. Prior to any demolition works, NWPGCL will require the contractor to appoint a suitably qualified surveyor to conduct an assessment for any presence of asbestos or asbestos-containing materials in the structures that will be demolished. A site demolition plan outlining procedures and guide for safe demolition shall be prepared by the contractor as part of the bidding document. The demolition plan will generally cover the following key elements:

- *Scope* Identify the roles, the procedure, structures and systems it applies to, when it is to be enacted, what safety rules apply during demolition, when safety rules cease to have authority and when the procedure ceases to have authority. The procedure shall also contain Method Statements including all major items to be demolished.

- *Definition* Ensure that all the terminology, titles and reference to other bodies, rules and companies are defined such that they are unambiguously understood and consistently used throughout the procedure.

- *Planning* – preparation of the demolition program, including objective; strategy; support service requirements; liaison with other parties; legal insurance and regulatory compliance issue; and event sequence and timing shall be basic requirements. The planning will have need to craw upon the information contained in the separate documents covering list of equipment, register of external service connections, plant insulation issues and hazard identification study, plant item check list and identification of structure hazarded in order for the strategy and program to be defined.

- *Strategy*- may take the shape of 'phased' or 'total' demolition with implications as to the need for physical barriers defining operational and demolished areas of the site. The extent and period of requirement for site demolition electrical supplies will also need to be defined as a matter of policy in the strategy.

- *Practical stages of demolition* - specifications of the practical stages of demolition of plant items and/or systems from handover of site to the issue of the closure report need to be defined. The stages would include receipt of the clearance of plant/system final operation and of plant system terminal isolation signaling the final operation of the plant or system; receive permission to operate within the demolition area; identification of asbestos boundaries if any; removal of residual dangers where possible – drawing upon the detail of the hazard study, plant item check lists and identification of structural hazards. Asbestos or other toxic waste should be removed before starting demolition of any structure; and affixing barriers and notices as appropriate to identify demolished plant and systems.

- *Clearance of Plant/System Final Operation* - confirm that identified plant and/or systems ceased operational duty and can be released for the terminal isolation stage of the demolition program.

- *Clearance of Plant/System Terminal Isolation* -To confirm that identified plant and/or systems have been securely terminally isolated with safety precautions and notices applied under authority's site safety rules.

- *Closure Report* - When the demolition is complete, the contractor shall prepare a closure report. The acceptance of the closure report shall not discharge the contractor from any further liability in the area covered by the closure report.

- *Nomination of Staff* -The nomination, by accountable senior management, together with any associated authorization, of staff charged with specific roles and responsibilities for carrying out the planned demolition program shall be established. The site procedures and standards used for nomination and authorization of activities under site safety rules should be considered as an option for enacting the discipline of the demolition process. The nominations of accountability must be for all levels of involvement and activity of staff during the demolition period, including who shall: be in charge as manager of the demolition activities; be required to formulate the planned program declare final operation of plant and/or systems; be in control of execution of the program with responsibilities to initiate and instruct the activities of each stage; have authority to sign associated certificates; and have accountability for notifying interested parties of completion of the objectives set for demolition.

5.3.1 Ambient air quality

367. At this stage, clearing and demolition of abandoned buildings at the project site will cause increased dust level and vehicular emissions. Demolition works during the dry season especially from December to May can worsen the generation of dust. Presence of vegetation (trees of different types and sizes) along the project boundary will reduce the dispersion of dust particles into the locality during demolition process.

5.3.2 Ambient noise

368. Demolition activities may increase ambient noise level, particularly during day time. On top of that, heavy movement of traffic and machineries would collectively raise the noise level significantly. Unless the situation is mitigated, this increased noise level due to demolition and construction activities could lead disturbances to the community. Exposure to elevated noise levels may pose health risks to residents living close to Component 1.

5.3.3 Vibration

369. Demolition works will generate vibration. Effects of ground borne vibration. The effects of ground – borne vibration include discernable movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. The vibration from the construction-related activity agitates the ground, create vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. The damage of the buildings depends of the intensity of the sources, transmitting media and vulnerability of the structures.

370. Thus, it is necessary to assess and regulate the amount of allowable vibration on the southern side of the power plant where the RMS will be located to prevent building damages and avoid unnecessary disturbance to persons living close to the vicinity. Demolition works will be done both manually and mechanically to minimize the generation of vibration. The demolition plan will be prepared by the Demolition contractor with requirements and specifications included in the Bid documents. The structures to be demolished are generally bricks, pacca, semi-pacca, etc. Given the length of abandonment and lack of maintenance, demolition may not cause strong vibration. Nonetheless, the demolition works will be part of the environmental monitoring.

5.3.4 Flooding

371. Flooding from Bhairab – Rupsa River system is major and significant for the study area. According to the baseline study on flood water level analysis, the average land elevation of the project area is 2.0 mPWD towards the Bhairab River which at times submerge some parts of the study area by about 0.5-1.5m every year during the wet seasons. This indicates that site development will be required. There have already been seven profiles of flooding.

372. HEC-RAS steady model is used to delineate the inundations surrounding the project area. Based on model results, about 82 ha is considered as cumulative patches of inundated land distributed in the form of depressed land over a wide area outside of the project site but within the study area. This is also based on the DEM developed from the 1997 database (FAP-19 and LANDSAT images). This 82 ha of cumulative patches has been elevated and reclaimed. With this development, site preparation to reclaim or elevate surrounding area will not cause flooding in adjacent area. The basis of simulation was the flooding level in 1999 with return period of 100 years. There will be no more flooding as the areas have been raised already. Prone to erosion will be close to the river banks in all the rivers within the study area. Bhairab River will have additional erosion protection works.

373. Based on the Feasibility Study (August 2017), the current elevation at the project site is +3.5m and +2.3m MSL while the surrounding area is at elevation +3.5m and +3.2m MSL. The seven profiles show that the highest water level during the flooding in 1999 is 3.19m PWD. The project site will be backfilled up to a maximum of +5.5m which considered the highest water level recorded by BMDB since 1946, elevation in surrounding area, and the BPDB requirement for site formation of power plants. Thus, the risk of flooding will be low.

5.3.5 Land Resources

Land type

374. Land type of the area will be changed after the initiation of the project. Most of the land will be raised above the normal flood level. But this area is previously used as an industrial area. As a result, this situation is considered as a Minimal Adverse.

Soil quality

375. During pre-construction stage, earth works will be undertaken (approach road, land development, etc.). As a result, top soil quality would be hampered. But due to non-agricultural land in the project area this situation is considered as Minimal Adverse.

5.3.6 Ecological Environment

Loss of life of plants and wildlife

376. The abandoned buildings and cultivated trees at the project site will be cleared during pre-construction period as per layout plan of the power plant. During this clearing and demolition process, some of the common lizards, frogs may be affected. Demolition and clearing activities will be conducted cautiously to avoid any loss of animals. In this regard, an Ecologist will be appointed as per EMP to avoid any loss of animals. They will survey the project site prior to clearance and will have the authority to halt the removal of vegetation if species need to be rescued or nesting birds are present. The environmental unit of NWPGCL will monitor the demolition works. Chance find and faunal rescue procedures will be followed to prevent damage to wildlife.

Dust and sound pollution impact on vegetation and wildlife

377. During demolition of buildings, it is expected to cause elevated noise and dust levels which may affect surrounding vegetation and wildlife. Areas that will be demolished will be enclosed to minimize dust and noise.

Clearing of terrestrial vegetation

378. The project area is comprised of dense vegetation including large old trees. Clearing of vegetation will be required to initiate land development process. It is estimated that about 2,614 trees will be cleared and overall carbon sequestration loss will be approximately6880.480046Mg (for 30 acres vegetation coverage which include trees, shrubs and under growth weeds/grasses). The plant biodiversity index of the project area is also found to be high. Lush vegetation in the project site is due to the years abandoned/non-disturbance by the KNM.

Loss of wildlife habitat

379. Removal of terrestrial vegetation (trees, shrubs, herbs) may cause damage of habitat of some mammals, reptiles etc., which may create pressure on other species. The land development activities would also impact to other micro wildlife, invertebrates at the project area.

Disturbance to aquatic biota

380. The existing Bhairab river habitat may be slightly impacted due to discharge of oil spill and under water noise created during transportation of ship along the river for carrying of construction and demolished materials, machineries to the project site. The project planned to renovate existing jetty for loading and unloading of heavy equipment. Renovation activities may have impact on the benthic community, but no impact is expected on the River dolphins as they are located and surfing in different locations across all connected rivers (Bhairab, Rupsha, Atai and also Modhumoti-Bhairab confluences).

5.3.7 Socio-Economic Condition

Disturbance during shifting period

381. A number of activities will be done before the beginning of construction period. Relocation of the school, demolishing the existing abandoned buildings, clearing the trees, renovation of mosque etc. are the main activities during the pre-construction stage. The students, teachers, guardians may face difficulties during the transition period when they will be shifted to the newly constructed school building.

Community safety risks

382. Demolition of brick buildings and frequent movement of the heavy equipment's work will create dust, noise and wastage that would be harmful for the people. Handling of construction machineries, accident transportation of dispose materials, debris and other wastages may create health injury to the labours, adjacent community, and also land of the project sites. Unsafe and unhygienic labour shades may create heath risks.

Employment opportunity

383. As a result of implementing Component 1, jobs will be created from pre-construction/demolition stage, construction, and operation phase.

Non-Hazardous Waste Generation

384. During pre-construction, land development would generate large amount backfilling soil. Other wastes like food waste, plastic, papers, metal or plastic binders, etc. may also be generated. Solid waste generated during this stage if not properly handled, may cause health and safety risks to workers and laborers including adjacent communities in the southern side of the project site.

5.4 Environmental Impacts during Construction Stage

5.4.1 Ambient air

385. Fugitive dust particles may be generated due to site preparation, material transport, piling up of construction materials, excavation of trenches, batch mixing plant, etc. In addition to these, operation of construction equipment and vehicles may generate PM, CO, CO_2, NO_x, SO_x, etc. Prolonged exposure to this working environment and inhalation of dusts may pose health risks. Workers assigned in dust and noise- generating activities will be provided with personal protective gear such as googles and mask.

5.4.2 Ambient Noise

386. The noise level at and around the project site will be increased depending on the factors such as type of equipment, methodology of using receiver distance etc. At present the noise level of project area is about 43-62 dBA within the 24 hrs. Ambient sound is the major contributor and main reason for this noise level. The project will involve noisy equipment for about 2-3 years. The noise level will be received from the construction yard stationary and mobile sources. Stationary equipment operates in one location for one or more days at a time, with either a fixed-power operation (such as pumps, generators, and compressors) or a variable noise operation (such as pile drivers, rock drills, and pavement breakers). Mobile equipment moves around a construction site with power applied in cyclic fashion (such as bulldozers, graders, and loaders). Noise impacts from stationary equipment are assessed from the center of the equipment, while noise impacts for mobile construction equipment are assessed as emanating from the center of the equipment activity or construction site. To determine the Leq of the equipment's operation, the power variation is accounted for by describing the noise at a reference distance from the equipment operating period.

387. Settlements are located in the southern boundary of the RMS. A high concrete fence separates the project site from these settlements. Employees of KNM also stay outside the southern boundary. Women and children reside round the day of those households. Increased noise levels may pose health risks to workers as well as to the residents living near the construction site. Noise level at the construction site will be monitored to ensure compliance to the Noise Pollution Control Rules 2006 and IFC-WB EHS General Guidelines 2007.

388. According to data provided by US Federal Bureau of Highway, noise levels from different construction equipment are summarized in **Table 5.5**.

Table 5.5: Noise produced by construction equipment

No.	Plants/Equipment	Traffic Vehicles Noise Level (US Standard) dBA
1	Machinery Hammer	95
2	Drilling Machine	75
3	Truck	75
4	Bulldozer	75
5	Compaction Roller	75
6	Tug Plant	75
7	Leveler	75-80
8	Pave Machine	80
9	Concrete Mixer	75
10	Generator	75
11	Vibrator	75

389. The equipment and machineries will produce cumulative noise depending on source type, number, weather condition, distance and duration of working period. If a single equipment will produce 90 dBA within 1m, it would be reduced gradually to its movement. The noise propagation method has been documented by the International Energy Agency. It is simple process for assumes spherical spreading from a point sources. The model presents a 'worst-case scenario' as it does not take into account factors like topography, large obstructions in the propagation path, e.g. barriers etc., refraction of noise, wind speed or direction effects and changing frequencies. The equation followed for the analysis is described below:

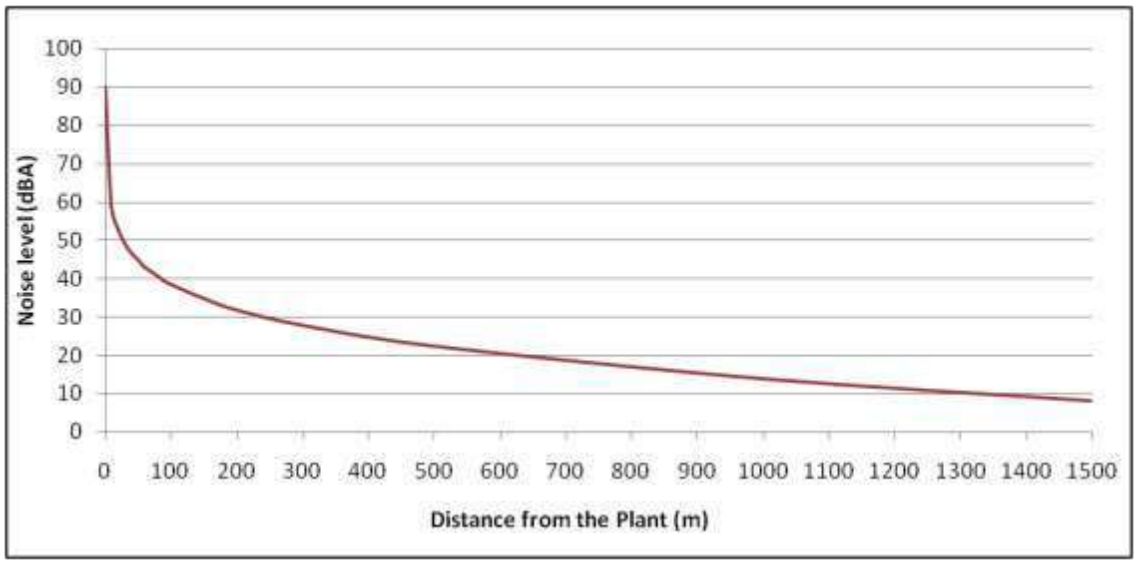
$$\mathrm{Lp} = \mathrm{Lw} - 10\log_{10}(4\Pi r^2) - ar$$

where:

r = distance from source to receiver
a = Atmospheric absorption, (0.005dBA/m)
Lw =Sound power level at the Plant (dBA)
Lp = Output sound power level at different radius from source

390. Without any facility boundary or other barrier/obstructions, the noise level will propagate and attenuate significantly with distance shown in **Figure 5.1**. However, the duration of noise pollution is also important to account the equivalent noise level.

Figure 5.1: Sound pressure level at different distances from the source



391. The proposed project is bounded by brick wall along with trees. Therefore, the generated noise level (Leq) from the construction yard can be attenuated by the boundary wall and vegetation. Most of the construction activities will be conducted around far from settlements southern boundary of the project except the construction of RMS station, buildings and works shops, water treatment chemical plants, etc. At the distance of 10m from 90dBA construction site would reach to 59 dBA at the receptors. Therefore, during construction stage, the resultant maximum noise level would not increase 1.5-2.0 dBA to the nearest residence. However, the impulse noise from the equipment, vehicles or others system will annoy the local communities. Based on the impact magnitude from the potential sources used for this power plant and the sensitivity of nearby structures, the impact is defined as moderate adverse as given in **Table 5.4**.

5.4.3 Vibration

392. During the construction phase, vibration may be generated by some machines, i.e. mainly hammer machines, rammers etc. Operation of construction equipment causes ground vibrations and spread through the media. Buildings nearby the construction site respond to these vibrations in different ways such as no perceptible effects as the lowest levels, or low rumbling sounds and fellable ranges in buildings very close to the site. A possible exception is the case of old, fragile buildings of historical significance where special care must be taken to avoid damage. The

construction activities like blasting or pile drive may create severe impacts. Since the primary concern with regard to construction that vibration can damage building, construction vibration is generally assessed in terms of peak particle velocity (PPV). A typical vibration source level for construction equipment has been shown in **Table 5.6**.

Table 5.6: Vibration sources level for construction equipment

Equipment		PPV at 25ft (in/sec)	Approximate Lv* at 25ft
Pile Driver (impact)	Upper range	1.518	112
	typical	0.664	104
Pile Driver (Sonic)	Upper range	0.734	105
	typical	0.170	93
Clam Shovel Drop (Slurry Wall)		0.202	94
Hydromill (Slurry Wall)	In Soil	0.008	66
	In Rock	0.017	75
Large Bulldozer		0.089	87
Caissson Drilling		0.089	87
Loaded Trucks		0.076	86
Jackhammer		0.035	79
Small Bulldozer		0.003	58
Note: *RMS velocity in decibels (VdB) re 1 μinch/Second			

393. The construction vibration can be measured beside the construction activities which are blasting, pile driving, drilling, excavation, heavy equipment transportation etc. According to the **Table 5.6**, the maximum vibration comes from pile drive. The equation of PPV and vibration level (Lv) for determining the vibration at certain distance from the source following the equation 1 and 2. **Figure 5.2** shows how the vibration reduces with distances.

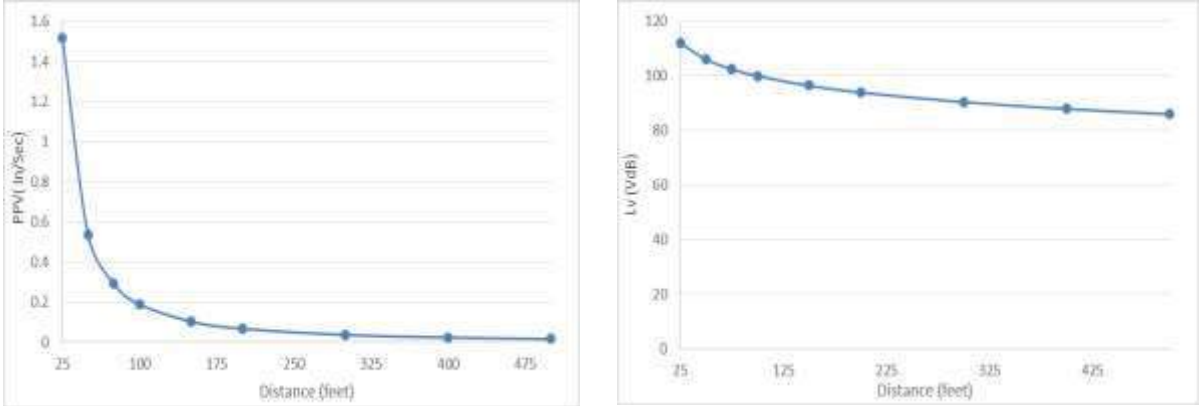
$$PPV_{equip} = PPV_{ref}\ X\ (\frac{25}{D})^{1.5} \ldots\ldots\ldots\ldots (1)$$

$$L_v(D) = L_v(25ft) - 20\log(\frac{D}{25}) \ldots\ldots\ldots\ldots (2)$$

where:

PPV_{equip} is the peak particle velocity in in/sec of the equipment adjusted for distance
$PPV_{(ref)}$ is the reference vibration level in in/sec at 25 feet from Table 7.6
Lvis velocity vibration level in VdB.
D is distance from the equipment to the receiver

Figure 5.2: PPV and Lv with the distance



394. The primary concern regarding construction vibration relates to potential damage effects. The vibration damage threshold with criterion of 0.2 in/sec (approximately 100 VdB) for fragile buildings and 0.12 in/sec (approximately 95 VdB) for extremely fragile historic buildings. Beside the southern boundaries few old buildings were recorded. The PPV of the construction works reduces to 0.2 in/sec within 100 feet or 30.5 meter. One another study, Guidelines on vibration damage criteria are given in **Table 5.7** for various structural categories54. According to layout plan most maximum construction activities will be done at least 50 m distance from the boundary.

Table 5.7: Construction Vibration Damage Criteria[55]

Building Category	PPV (in/sec)
I. Reinforced-concrete, steel or timber (no plaster)	0.5
II. Engineered concrete and masonry (no plaster)	0.3
III. Non-engineered timber and masonry buildings	0.2
IV. Buildings extremely susceptible to vibration damage	0.12

395. Vibration may cause health hazards such as tiredness, insomnia, mental disorder and working ability reduction. The International Organization for Standardization (ISO) adopted in 2003 version of ISO 2361-2 acknowledges that “human response to vibration in buildings is very complex.” It further indicates that the degree of annoyance cannot always be explained by the magnitude of the vibration alone. Other phenomena such as noise, rattling, visual effects (e.g., the movement of hanging objects) and time of day (e.g., late at night) all play some roles in the response. To understand and evaluate human response, which is often measured by complaints, all of these related effects need to be considered. The available data documenting real world experience with these phenomena is still relatively sparse.

396. A number of studies have been conducted to characterize the human response to vibration. One of the studies concluded that continuous vibration from construction equipment such as roadway graders, backhoes, and dozers could be tolerated at higher vibration levels than transient vibration generated by pile driving.

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54 David A. Towers, "Ground-borne Vibration from Slurry Wall Trench Excavation for the Central Artery/Tunnel Project Using Hydromill Technology," Proc. InterNoise 95, Newport Beach, CA, July 1995.

55 Swiss Consultants for Road Construction Association, "Effects of Vibration on Construction," VSS-SN640-312a, Zurich, Switzerland, April 1992.

397. **Table 5.8** summarizes the results that relate human response to transient vibration, which could be generated by any type of impact equipment such as pile driving. These levels of human response are more appropriate for the Project since the highest levels of construction vibration are generated by impact activities such as pile driving and from demolition using hoe rams.

Table 5.8: Human Response to Transient Vibration[56]

PPV (in/sec)	Human Response
2.0	Severe
0.9	Strongly perceptible
0.24	Distinctly perceptible

5.4.4 Water resources

Groundwater salinity

398. Salinity intrusion in the groundwater is major issue in every state of the project development. It appears that the salinity is present at any depth of groundwater including other contaminants around the project area. There will be difficulties to get drinking water from nearby sources for daily consumption due to conflict of interests with the construction workers and local users.

Erosion

399. There is no riverbank protection works present at the right bank of Bhairab River. As such the project area will be vulnerable due to riverbank erosion during monsoon.

5.4.5 Soil Quality

400. During site preparation, earthworks will impact the fertile top soils that are enriched with nutrients required for afforestation and naturally grown plant species. This impact is characterized as Minimal Adverse.

5.4.6 Fisheries and Their Habitat

401. The ship/cargo carrying machineries and ancillaries may discharge ballast and bilge waste water into the river. This ballast and bilge water may have oil, grease, food waste and other contaminants which might affect the fisheries resources and their habitat. Having disposed of such harmful substances into the river water, a localized and temporary disturbance to fish breathing may lead some fishes to death. Discharge of wash water into Bhairab River from the construction site may increase the turbidity. Bhairab River and other rivers are all silted characterized by high turbidity which will affect photosynthesis. The impact is characterized as Moderate adverse.

5.4.7 Aquatic biota

402. Renovation of jetty for anchorage of ship and cargos at the Bhairab River may temporarily disturb dolphin's movement due to under water noise. Excavation and construction activities

[56] Transportation- and Construction Induced Vibration Guidance Manual, California Department of Transportation.September 2013

including bank erosion may disturb benthic community. The riverine water quality may deteriorate due to disposal of waste water and oily waste from the ship during transportation of machinery, materials, etc.

5.4.8 Socio-Economic Condition

Community safety risks

403. Construction activities with different machineries may create excessive noise in the project area. That would be a matter of anxiety including potential health impacts to the people in the project area (school, mosque, rest house) and the people those are residing adjacent to the project area. Handling of heavy construction machineries may create health injury to the labors in the project sites. Unsafe and unhygienic construction camps may create very health problems. Poor sanitation in construction sites will also pose health risks.

Employment opportunity

404. Labour in-migration may be increased due to the opportunities of employment in the power plant. A number of local people will be engaged in project related activities. In addition, skilled workers from different places will also get job opportunities and will be living in the construction camps within project area. An increase in the number of people due to employment opportunities can result to more demand for services such as housing.

Diversity of occupation

405. A segment of traditional occupation/resource user groups may have to adopt alternative occupation while working for the construction of the power plant. This will happen for most of the non-technical local residents having different professional groups (such as local rickshaw pillar, boatman and seasonal laborers). The mode of livelihood will be impacted due to creation of the facilities of new business and services sectors.

Non-Hazardous Waste Generation

406. During construction, large amount of construction waste that includes unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from construction camps, packaging materials, used home appliances, etc. will be produced. Moreover, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc. may be produced as solid waste during this stage. If these wastes are not disposed of and managed properly, it will pose health risks to the workers and communities. Considering the amount and type of waste generated, the impact maybe reversible but may take some time for the conditions to return to normal when mitigation measures are applied. Waste generated may impact surrounding aquatic species and may also lead to the spread of various diseases if not managed properly. Considering all of these, it can be assumed that the magnitude of the impact would be moderate.

407. Unarranged piling up and disposal of construction waste will cause unhealthy situation in the area and will degrade visual aesthetics. If not properly managed, this impact would remain during the life span of the Project but would be extended within the plant premises only. The impact is reversible. It is very likely to take place if proper management is not adopted which is the requirement of national and international environmental regulations. Considering all of these,

it can be assumed that the magnitude of the impact would be moderate. Sensitivity of this impact would be medium as the Project the waste management plan.

5.5 Environmental Impacts during Operation Stage

5.5.1 Ambient air quality

408. The existing ambient air quality was based on the continuous ambient air quality monitoring data (2013-2015) from the CASE Project of the DoE where CAMS-9 is located about 2.5 km southwest of Component 1. During operation stage, the contribution of Component 1 to the existing ambient air quality will be based on the fuel rate and the operating data (see **Table 5.9a**). Component 1 is dual fuel-based power plant that will burn natural gas as the primary fuel and will use HSD during emergency situation for a maximum of 500 hours per year.

Table 5.9a Operating Data for Component 1

Both The Units	Unit	Combined Cycle	Simple Cycle
Number of Stack	Number	2	2
Stack Height	m	70	50
Stack Diameter	m	7.46	6.5
Flue Gas Exit Temperature	^oC	102	886
Flue Gas Exit Velocity	m/s	22	25
Fuel rate (natural gas)	MMFCD	125	
Fuel rate (HSD)	m^3 per day	2,773	
Sulfur content of HSD	$\%_{wt}$ max.	0.25	
NO_x abatement measures	• Low-NO_x burner with guaranteed emission of 10 ppm_v • Water injection at 100 m^3/hr will be used if HSD is the fuel		

409. During start-up, the simple cycle gas turbine will be commissioned using natural gas and can be put into commercial operation within 7 to 8 months prior to completion of the HRSG installation for the combined cycle power plant. This is when the bypass stack of 50 m will be used at flue gas temperature of 886^{o}C. During commissioning the power plant must not be operated using HSD. Simple cycle gas turbine will only be used also in the event of HRSG downtime. It will not be economically feasible to shut down the entire power plant during HRSG downtime when the simple cycle power plant can be operational. This is the high operational flexibility inherent in combined cycle power plant which is an essential prerequisite from economic standpoint. Use of low-NO_x burner in the gas turbine will have a guaranteed emission below 10 ppm_v.

Pollutants of Concern

410. Pollutants of concern, released the power stations are Oxides of Nitrogen (NO_x), Oxides of Sulfur (SO_x), Carbon Monoxide (CO), Particulate Matters (PM) etc. With natural gas and HSD, PM is not a major concern as both fuels do not have ash content responsible for releasing PM, PM_{10} and $PM_{2.5}$. The resulting ground level concentration (GLC) from air quality modeling will be referred to the applicable limits from ECR 2005 of the DoE and Table 1.1.1 of the IFC-WB EHS General Guidelines 2007. A typical natural gas composition that may be used as fuel in Rupsha 800 MW CCPP is given in **Table 5.9**.

Table 5.9: Natural Gas Chemical Characteristics

Properties	Range	Most Onerous Specification	Unit
Gross Calorific Value (60°F)	Minimum	950	Btu/SCF
	Maximum	1,150	Btu/SCF
Methane (CH_4)	Minimum	85	Mole%
Ethane (C_2H_6)	Maximum	6	Mole%
Propane (C_3H_8)	Maximum	3	Mole%
Butane (C_4H_{10})	Maximum	2	Mole%
Pentane and heavier (C_{5+})	Maximum	0.2	Mole%
Carbon Dioxide (CO_2)	Maximum	2	Mole%
Nitrogen (N_2)	Maximum	1.5	Mole%
Oxygen (O_2)	Maximum	1	Mole%
Total Inerts (Nitrogen, Oxygen, CO_2 plus any other inert compounds)	Maximum	5	Mole%
Water Content	Maximum	7	lbs per 1,000,000 SCF
Specific Gravity	Minimum	0.55	
	Maximum	0.67	
Liquefiable Hydrocarbons	Maximum	2	US gallons per 1,000,000 SCF

Source: NWPGCL, Feasibility Report Table-6.5.4, P-33, 2016Note: natural gas of Bangladesh is sweet gas (no sulfur content).

411. Component 1 shall be operated on a specified natural gas which will be supplied through the gas pipeline coming from the existing Khulna City Gas Station at Arongghata to the receiving and metering station within the premises of Component 1 in Khalishpur. Component 1 will be designed to have a fuel rate for natural gas at a maximum of 125 MMCFD. In the event of an emergency such as equipment breakdown causing unplanned downtime, Component 1 will operate using HSD as back-up fuel. Emergency situations are expected to be 500 hours maximum in a year. The chemical compositions of HSD are given in **Table 5.10**.

Table 5.10: HSD Fuel Characteristics

Properties	Method	Limit
Density at 15°C, Kg/L	ASTM D 1298	Min -0.82; Max – 0.87
Color 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
Flash point p.m. (c.c.) F	ASTM D 93 / IP 170	Min-32
Pour point F	ASTM D 97	Max. – 9 (Nov-Feb) Max.-12 (Mar-Oct)
Viscosity kinematic @38°C cst	ASTM D 445	Max.-9.0

Properties	Method	Limit
Sediment %wt.	ASTM D 473	Max.-0.01
Water %Vol.	ASTM D 95	Max.-0.1
Carbon residue, Conradson on 10% bottom, % mass	ASTM D 189	Max.-0.2
Ash %wt.	ASTM D 482	Max.-0.01
Cetane Index (calculated)	ASTM D 976	Min.-45
Cetane Number	ASTM D 613	Min.-45
Sulfur total, % mass	ASTM D 4294	Max.-0.25
Copper Strip corrosion (3 hrs @ 100°C)	ASTM D 130	Max.No.1
Distillation:		
90% recovered (vol) at OC	ASTM D 86	Max.-375

Source: NWPGCL, Feasibility Report Table-6.5.5, P-34, 2016.

412. About 2,773 kiloliters (or m^3) of HSD will be required per day. With sulfur content of 0.25%$_{wt}$, operating Component 1 with HSD will generate sulfur oxides (SO_x) which convert to sulfur dioxide (SO_2). Fuel supply agreement between BPC and NWPGCL in November 2015 provides that the HSD will have a maximum sulfur content of 0.25%$_{wt}$. In practice, BPC has provided NWPGCL with HSD with sulfur content of 0.1%$_{wt}$ analyzed in 2016 by the Chemical Engineering Department of Bangladesh University of Engineering and Technology (BUET).

413. Natural gas that will be used for Component 1 has no sulfur content, and hence will not generate SO_2. The pollutant of most concern from natural gas fired power plants is NO_x. The formation of thermal NO_x is dependent on three factors during combustion; (i) oxygen concentration, (ii) peak temperature, and (iii) time of exposure at peak temperature (USEPA, 1999).

414. Component 1 will follow the national ambient air quality standards set forth in ECR 1997 (and subsequent amendments) and the Table 1.1.1 of the IFC-WB EHS General Guideline 2007. Air quality modeling was undertaken for different scenarios to predict the ground level concentration that may result from the operation of Component 1.

Stack Height

415. Simple cycle operation will be undertaken only until the HRSG is commissioned, and during emergency when the steam turbine for whatever reason cannot be operated. The selection of stack height for Combined Cycle operation is guided by the Good International Industry Practice (GIIP), Annex 1.1.3 of the IFC-WB EHS General Guidelines, and the IFC-WB EHS Guidelines for Thermal Power Plants 2008. There are no high buildings at and around the project site that may cause building downwash.[57] Initial determination of stack height was 60m. However, sensitivity

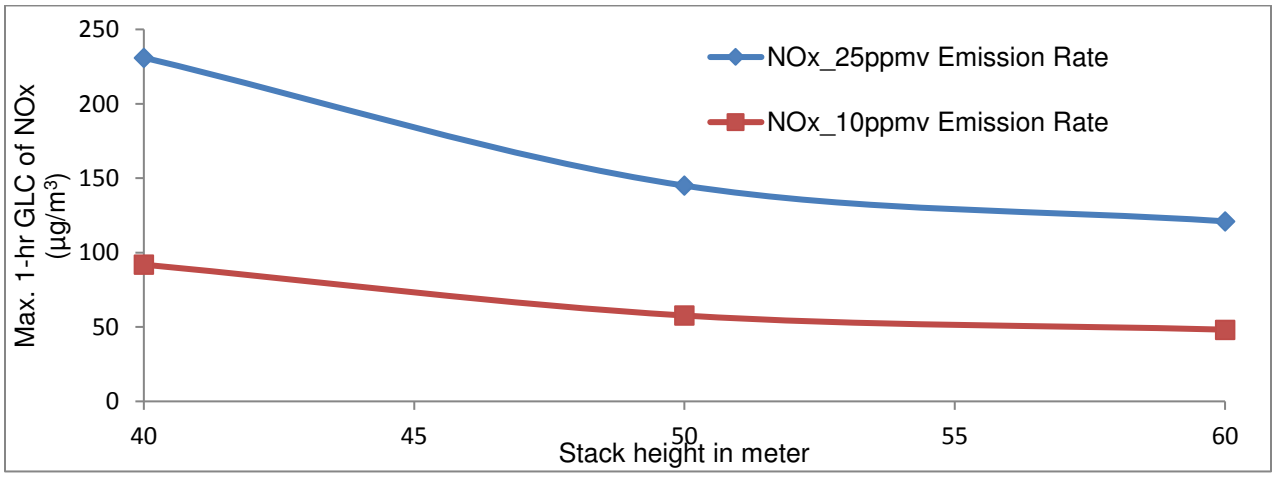
[57] Presence of buildings can affect plume rise and initial dispersion of pollutants within the atmosphere that could force pollutants to the ground instead of allowing them to rise freely within the atmosphere.

analysis for stack height shows that at a height of 70 m, significant reduction to GLC will be achieved (**Table 5.11**). A stack height of 75m and 80 m will not result to substantial reduction compared to 70 m. Therefore, a stack height of 70 m will be adopted. For the simple cycle operation, with a higher exit gas temperature, effective stack height will be higher than for combined cycle operation. The effective stack height (i.e., physical stack height + plume rise) for simple cycle operation will be 513 m. For combined cycle with a physical stack height of 70 m, the effective stack height will be 243.4 m. Provided, an emissions standard of 10ppmv for NOx is adopted, a stack height of 55 m or 60 m appears not to result in substantial reduction compared to 50 m (Figure 5.2a). **Figure 5.2a** presents the sensitivity analysis of stack height selection for simple cycle.

Table 5.11: Sensitivity analysis for stack height combined cycle

Stack Height (m)	USEPA Method of Maximum Average GLC (µg/m³)	
	NO_2 (1hr averaging time) based on 25ppm emission standard	SO_2 (24 hr averaging time)
60	158	105
65	118	83
70	79	71
75	76	70
80	75	68

Figure 5.2a Sensitivity analysis for optimal stack height of simple cycle (GT stack)



Methodology of Air Quality Dispersion Modeling

416. Regulatory agencies rely on dispersion models as part of their approval processes. DoE does not recommend any specific models for the impact assessment study. Therefore, this study has considered the USEPA recommended air dispersion model to assess the ambient air quality impacts during operation.

417. One of the USEPA preferred and recommended models, CALPUFF modeling system (CALPUFF 7.5.3) was used to predict ground level concentrations (GLCs) at selected downwind receptor locations based on emissions and meteorological conditions. Resulting GLCs were determined specifically NO_2 for natural gas while for HSD, SO_2, $PM_{2.5}$ and PM_{10}. The resultant NO_2 concentrations are largely driven by the ambient chemical environment (i.e., the reaction of NO with ambient ozone to form NO_2) and the initial NO_2/NO_x ratio of the emissions. A new Tier 2 method, the Ambient Ratio Method 2 (ARM2), has been introduced based on an evaluation of the ratios of NO_2/NO_x from the USEPA's Air Quality System (AQS) record of ambient air quality data. The default ratio NO_2/NO_x is 0.75 for annual NO_2 (Chu and Meyer, 1991) and 0.80 for hourly NO_2 (Wang, et al, 2011) as recommended in Tier 2 Method (2011) of USEPA.

418. CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, as well as longer-range effects such as chemical transformation, and pollutant removal (wet scavenging and dry deposition). It can accommodate arbitrarily varying point source and area source emissions.

Study Area

419. An area, 50 km x 50 km centering the proposed stack of Rupsha 800MW power station has been selected for the air quality analysis. The plant boundary and air quality-modeling domain are presented in **Table 5.12** and the project 3D layout plan of the major components of the project is shown in **Figure 5.3**

Table 5.12: CALPUFF Study Area Coordinates (UTM Zone: N 45)

Model Domain		Easting (m)	Northing (m)
Project Area	Project Center	761730.13	2529424.98
	Southeast Corner	762168.26	2529300.96
	Northeast Corner	762012.52	2529577.66
	Northwest Corner	761468.48	2529551.35
	South West Corner	761436.83	2529260.12

Source: CEGIS, 2016.

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Figure 5.3: 3D model of major project components

Emissions from the Sources

420. Emission inventories include all major point, area, and line sources within the study area i.e. 50x50 km grid. **Figure 5.4** shows the domain for air quality dispersion modeling while Figure 5.5 presents the existing sources and sensitive receptors.

Figure 5.4: Air Quality Dispersion Modeling Domain

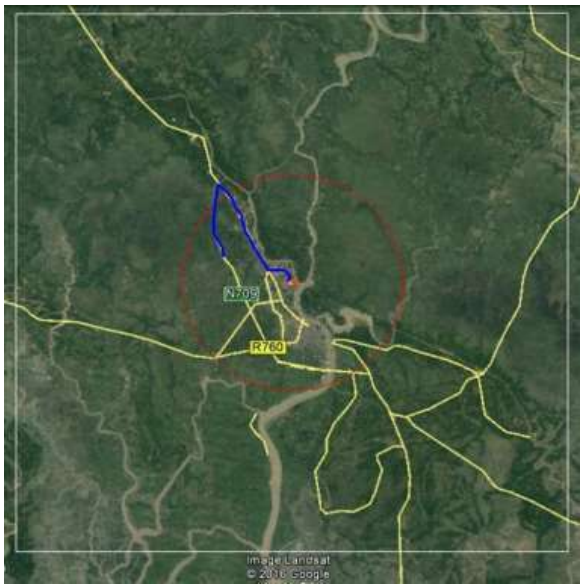
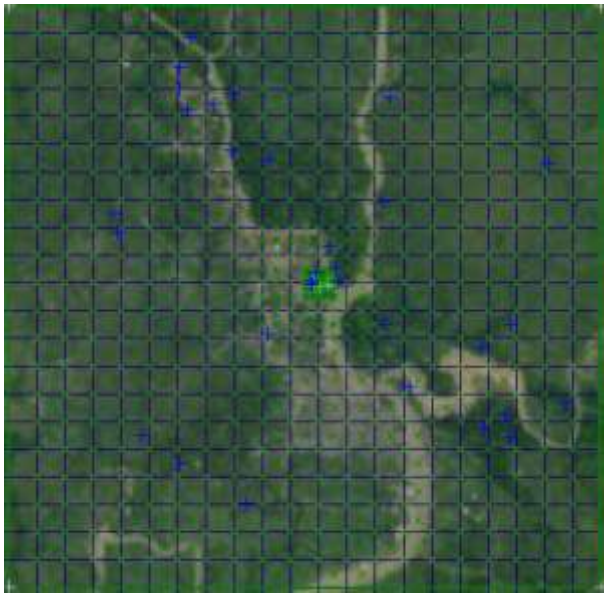


Figure 5.5: Sources and Sensitive Receptors



Note: + Point Sources, - line sources, + Receptors

421. Component 1 can be considered located in an industrial area interspersed with residential and commercial uses. The industries are Jute Mills, Hard board Mills, News Print Mills, Power Plants and Brick Fields etc. At present, the jute mills or other industries are running on electricity supplied by the electric distribution company. There are some brick fields and thermal power plants contributing to emissions within the same airshed as Component 1. There are eight brickfields and six thermal power plants within the 50km x 50km study area (see **Table 5.13** and **Table 5.14**). However, out of the six thermal power plants, two are out of service and there is a possibility that the two KPCL units using heavy fuel oil (HFO) as fuel may be shut down. The emissions given in Table 5.13 and Table 5.14 were based on the emissions inventories from the Bangladesh Air Pollution Studies (2014) and the US EPA AP 42 Volume 1 (1995).

Table 5.13: Emissions from the brick kilns

No.	Name	Emissions Rate (g/s)					UTM Coordinates (Q:45)		Stack Height (m)	Stack Dia. (m)	Emission Rate (m/s)
		CO	SO_x	NO_x	$PM_{2.5}$	PM_{10}	Easting	Northing			
1	Brick Field	0.08	7.2	0.2	2.1	6.4	763633.8	2534390.3	40	1.2	7.40
2	Brick Field (Digholia)	0.08	7.2	0.2	2.1	6.4	758544.5	2533647.3	40	1.2	7.40
3	Brick Field	0.08	7.2	0.2	2.1	6.4	763438.5	2529641.4	40	1.2	7.40
4	Brick Field (Deara)	0.08	7.2	0.2	2.1	6.4	762344.1	2527971.1	40	1.2	7.40
5	Brick Field (Mosarerpur)	0.08	7.2	0.2	2.1	6.4	766109.5	2526703.1	40	1.2	7.40
6	Brick Field (Shingerchar)	0.08	7.2	0.2	2.1	6.4	764833.5	2526310.7	40	1.2	7.40
7	Brick Field (Shingerchar)	0.08	7.2	0.2	2.1	6.4	765002.0	2526089.9	40	1.2	7.40

No.	Name	Emissions Rate (g/s)					UTM Coordinates (Q:45)		Stack Height (m)	Stack Dia. (m)	Emission Rate (m/s)
		CO	SO_x	NO_x	$PM_{2.5}$	PM_{10}	Easting	Northing			
8	Brick Field (Rhimpur)	0.08	7.2	0.2	2.1	6.4	765180.6	2525830.7	40	1.2	7.40

Source: Field Survey 2016 and Emission Inventories: NILU 2014, AP-42,1995

Table 5.14: Emissions from the existing power plants

No.	Name	Emissions Rate (g/s)					Fuel	Stack Height (m)	Stack Diameter (m)	Exit Temp (K)	Exit Velocity (m/s)
		CO	SO_x	NO_x	$PM_{2.5}$	PM_{10}					
1	Goal Para 60 MW HSD Power Plant (BPDB)	Not in Service					HSD				
2	Goal Para 110 MW HFO Power Plant (BPDB)	Not in Service					HFO				
3	KPCL 110 MW (1st Phase) HFO Power Plant	102.18	541.2	241.5	65.55	78.42	HFO	30	1.5	623	22
4	KPCL 115 MW (2nd Phase) HFO Power Plant	106.82	565.4	252.5	68.47	81.91	HFO	30	1.5	623	22
5	Aggreco 55 MW Diesel Power Plant	62.05	38.08	287.96	7.51	11.26	HSD	5	0.6	826	24
6	NWPGCL 225 MW Combined Cycle HSD Power Plant[58]	11.72	80.56	37.01	0.74	1.11	HSD	60	7.5	383	23

Note: AP-42, 1995 USEPA (Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources)

422. Major line sources of pollution considered in the model are traffic along the major roads and highways, which include: R760-1 and N710-1. Khulna Railway station is within the study area and the rail line is passing beside the project area. The traffic data of the adjacent roads R760-1 and N710-1 (**Table 5.15**) was used as line source for air pollution dispersion modeling.

[58] The NWPGCL 225 MW CC HSD Power Plant is the one included to be supplied with NG from the project.

Table 5.15: Traffic Data (AADT) and Locomotives Used for Air Quality Modeling

Road	Heavy Truck	Medium Truck	Large Truck	Large Bus	Medium Bus	Micro Bus	Utility	Car	Auto Ricks-haw	Motor Cycle	Number of Locomotives
Khulna Bustand to Bypass Road R760-1	13	778	586	376	458	279	262	338	4574	3633	18
Ferry Ghat to Dakbangla More N710-1	0	28	71	5	12	484	276	627	4122	1420	

Source: Roads and Highways Department, Bangladesh, 2016

423. There is no supply of natural gas in Khulna City Corporation area. The vehicles run into those roads are mainly fueled by petrol or diesel. **Table 5.16** shows the amount of criteria pollutant emission through the roads and railway.

Table 5.16: Emission Level of the Criteria Pollutants from the Roads and Railway

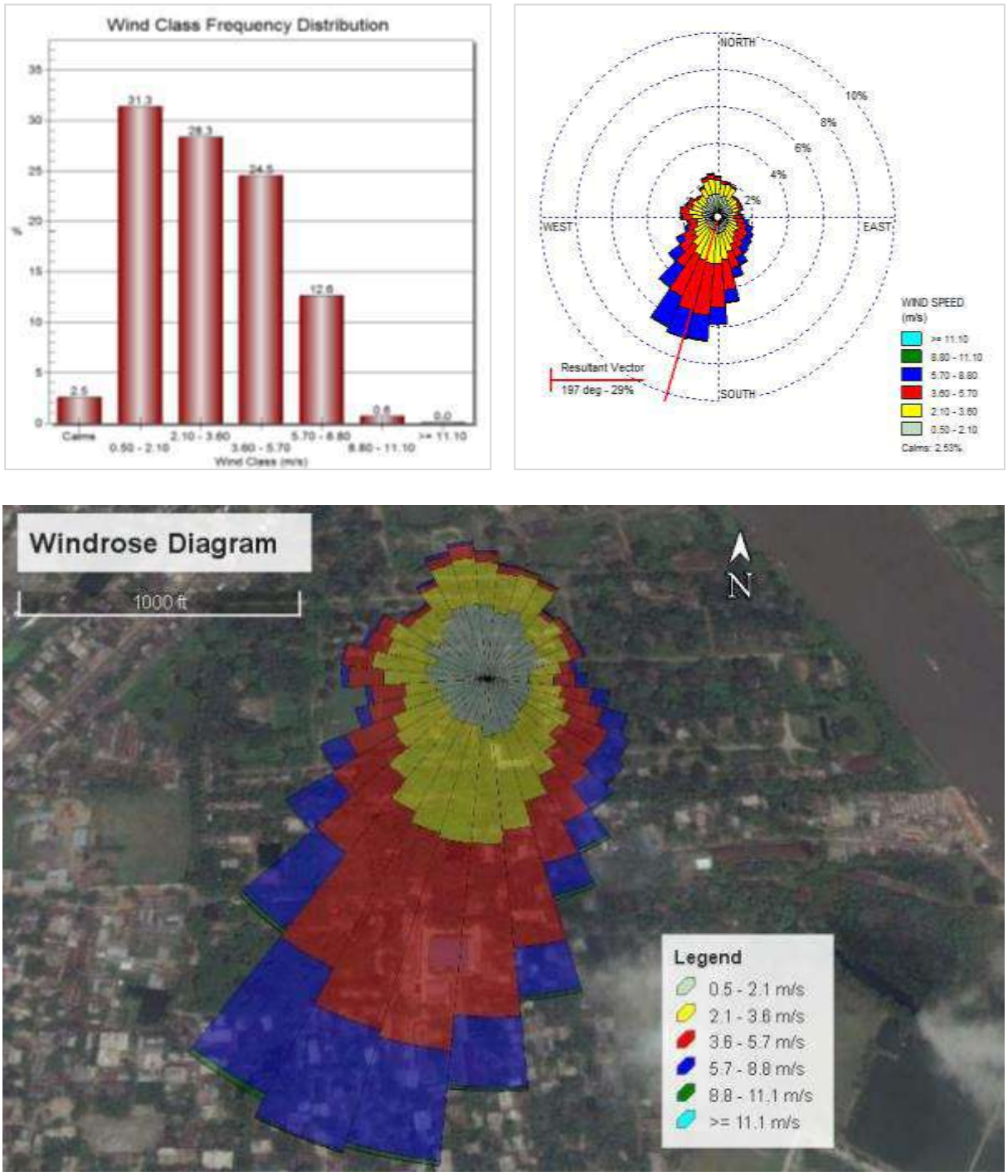
Road Name	Road Width (m)	CO g/s-m^2	SO_2 g/s-m^2	NOx g/s-m^2	PM_{10} g/s-m^2	$PM_{2.5}$ g/s-m^2
R760-1	6.450E+00	1.621E-04	2.120E-07	2.793E-05	4.323E-06	6.585E-07
N710-1	1.179E+01	4.083E-05	3.236E-05	1.184E-04	4.870E-04	2.145E-03
Locomotives		7.6214E-06	1.29E-06	2.58E-05	1.14E-06	1.01E-06

Note: Emission Inventories of MOVES2014a

Meteorological Data

424. Pre-processed hourly 3D meteorological data of the year 2013, 2014 and 2015 was procured from the Lakes Environmental Software (CALMET-Ready MM5, location at761730.13 N, 2529424.98E). This is known as upper atmospheric or air surrounding data which is used in the air dispersion model. The regional meteorological conditions are assessed after analysis of meteorological data of last 3 years (2013, 2014 and 2015) from the BMD station, Khulna. **Figure 5.6** shows the wind rose diagram of the study area related to the dispersion modeling.

Figure 5.6: Wind-Rose Diagram of Last 3 Years (2013, 2014 and 2015)



Receptors

425. Two types of receptors are defined within the model domain. These are: A) Nested Cartesian Grid Points, and B) Discrete Receptors.

426. *Nested Cartesian Grid Receptors.* Cartesian grids are nested into smaller size to capture more precise pollutant concentration after dispersion. The gridded receptors are placing based on the following spacing:

- 50m spacing within the Power Plant Boundary from the stack point
- 250m spacing within 5km from the stack of the Power Station
- 500m spacing within 10km by 10km area

427. *Discrete Receptors.* In addition, discrete locations corresponding to specific sites of interests are included in this assessment. These receptors are located in areas where there are children (i.e., schools) and patients (i.e., clinic and hospitals). They are considered as most sensitive and vulnerable to air pollution. There are 31 air sensitive receptors (ASRs) identified within the study area. The baseline monitoring points are also included as discrete receptors for future comparison. The list of ASRs and their location are given in **Table 5.17**.

Table 5.17: Details of Sensitive Receptors

No.	Air Sensitive Receptors	Location (km)	
		Latitude	Longitude
1	High School	759.163	2521.503
2	High School	756.808	2522.918
3	High School	768.507	2523.868
4	High School	767.608	2524.171
5	High School	755.458	2523.957
6	Family Welfare Centre	768.369	2524.653
7	High School	770.455	2525.082
8	High School	764.949	2525.695
9	Family Welfare Centre	767.516	2527.056
10	Family Welfare Centre	768.526	2527.917
11	High School	764.086	2527.925
12	High School	762.358	2529.968
13	Family Welfare Centre	762.126	2530.762
14	Community Clinic	754.623	2531.246
15	Family Welfare Centre	754.434	2531.928
16	High School	763.99	2532.374
17	High School	769.851	2533.724
18	Hospital	759.974	2533.86
19	Historical Place	758.63	2534.191
20	Hospital	757.075	2535.653
21	Food Godown	757.998	2535.852
22	High School	764.253	2536.084
23	Community Clinic	758.703	2536.248
24	Community Clinic	756.827	2536.426
25	High School	756.787	2537.179
26	Fisheries Village School	762.456	2529.497
27	Family Welfare Centre	757.164	2538.29
28	CAMS station	759.915	2527.578

No.	Air Sensitive Receptors	Location (km)	
		Latitude	Longitude
29	Residence Area of the Power Plant	761.462	2529.471
30	Proposed School of KNP	761.609	2529.805
31	Residential Area of KNA	761.483	2529.391

Source: CEGIS, 2018

Results of air quality modeling

428. The following assumptions were used for the air quality modeling:

a) Background level concentration
The air quality monitoring data from 2013-2015 (**Table 5.18**) of the CAMS-9 of the CASE Project of the DoE were used for NO_2, SO_2, PM_{10} and $PM_{2.5}$. Only data with higher temporal coverage were considered for better data capture.

b) Different scenarios considered -

(1) *Contribution of the project (Project only)* – emission values were initially taken from Table 6(B) of the IFC-WB EHS Guidelines for Thermal Power Plants 2008 for NO_x, and particulate matter (PM). However, as monitoring data from CAMS-9 show that the airshed is degraded on NO_2, emission that will be imposed for compliance to IFC-WB EHS General Guidelines 2007 during operation will be 10 ppmv. The maximum sulfur content of HSD will be 0.25%. The PM emission from Table 6(B) of the IFC-WB EHS Guidelines for Thermal Power Plant 2008 does not give the breakdown of PM_{10} or $PM_{2.5}$. Given that the airshed is highly degraded on PM based on CAMS-9 monitoring data, it was assumed from the health risk perspective that PM, PM_{10} and $PM_{2.5}$ emissions are equal to 30 mg/Nm^3. This conservative assumption accounts an overestimate of PM_{10} and $PM_{2.5}$ for the purpose of project contribution. (**Table 5.17a** shows the emission rate used for Component 1 based on the guidelines from IFC-WB EHS Guidelines for Thermal Power Plants 2008 (Table 6B) and as discussed above)

(2) *Project only + other project + background concentration* – this includes project contribution, background concentration from CAMS-9 of CASE Project by DoE, and other existing projects [8 brick kilns, 2 KPC HFO Power Plant (115 MW and 110 MW using HFO as fuel), 225 MW Khulna Power Plant by NWPGCL using HSD as fuel, and 55 MW Aggreco Power Plant using HSD as fuel]

(3) *Cumulative case* – This considered the closure of 2 KPCL power plants using HFO including the start of 300 MW Goalpara power plant and three brick kilns.

Table 5.17a: Emission rate standard from the stacks

Pollutants	Description	Emission Concentration	Remarks
PM	Particulate Matter	30 mg/Nm^3	IFC 2008 (DA)
NO_x	Oxides of Nitrogen	10 ppm	Site Specific due to DA

SO_2	Sulfur dioxide	S content in HSD will be 0.25%$_{wt}$	Site Specific due to DA

429. Emissions from existing sources depend on the fuel type and time of operation. Use of heavy fuel oil (HFO) will generate high amount of SO_2 compared to HSD. Operation period of pollutant sources varies with diurnal variation as well as seasonality. These include vehicular movement decreasing during late hours at nighttime, brick kiln industries are operated only during the dry season, the power plants reduce electricity production during winter, etc. However, at the air sensitive receptor grids, the level of baseline GLC of the criteria pollutants are estimated through modeling.

430. Baseline concentration of the criteria pollutants is accounted for different duration. It varies from the measured CAMS-9 for a number of reasons such as unaccounted sources of criteria pollutants like cooking, construction works, dust particles from the road, intrusion of pollutants from outside of the domain and monitoring deficiency of CAMS-9 throughout the year. Nevertheless, the background concentration from CAMS-9 was converted into various averaging period for compliance monitoring. **Table 5.18** shows the background concentration from CAMS-9 operated by the DoE in the CASE Project funded by the World Bank and the national ambient air quality standards, ECR 2005.

Table 5.18: Background Level of the Criteria Pollutants from CAMS-9, CASE Project

Criteria Pollutants	Standard Concentration (ECR, 2005)		2013	2014	2015
	Averaging Time	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Carbon Monoxide (CO)	8 Hr	10,000	1,790	1,020	550
	1 Hr	40,000	1,590	860	460
Sulfur Dioxide (SO_2)	Annual	80	11.99	8.65	22.56
	24 Hr	365	62.45	45.05	117.5
Nitrogen Dioxide (NO_x)	Annual	100	14.4	-	65.3
	24 Hr	-	32.18	DNA	205.54
	1 Hr (calculated from annual)	-	182.92	-	829.50
Particulate Matter (PM_{10})	Annual	50	132	219	93.5
	24 Hr	150	601.4	688.71	353.44
Particulate Matter ($PM_{2.5}$)	Annual	15	76.0	102	83.6
	24 Hr	65	309.67	383.15	355.08

431. Data from CAMS-9 are annual average ambient levels and can be converted into 24-hour or 1-hour averaging time using the power law relationship (OMOE, 2014) given below:

$$C_{long} = C_{short} (t_{short}/t_{long})^p$$

where:

C_{long} = the concentration for the longer averaging time
C_{short} = the concentration for the shorter averaging time
t_{short} = the shorter averaging time (in minutes)

t_{long} = the longer averaging time (in minutes)
p = the power law exponent

432. For ambient air assessments a *p* value of 0.28 is used (OMOE, 2014) for gaseous pollutants. In case of dust particle, the *p* value is considered as 0.5 to convert annual or 24 hr concentration of particulate matter in ambient air (Beychok, 2005). This methodology is deemed to give conservative estimates and thus, is appropriate for this case. Emissions from the power plant will increase GLC at a certain distance downwind from the stacks and atmospheric conditions. For a single project, in a non-degraded airshed the maximum GLC of the criteria pollutants should not exceed 25% of the national ambient air quality standard in order to protect the significant deterioration mentioned in the IFC-WB EHS General Guidelines 2007. The ambient air quality standard is given in **Table 5.19** considering a single project in a non-degraded airshed. In a degraded airshed, the project should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment. The overall objective is that the new thermal power plants should not contribute to deterioration of the already degraded airshed. For the purposes of this assessment national ambient air quality standards are used, and a "fraction" is considered to be less than 1% of the annual standard, and less than 10% of the short term (1 hour and 24 hour) standards since at these levels the UK Environment Agency determine that a negligible impact on ambient air quality will result.

Table 5.19: Ambient air quality standard

Pollutants	Duration	PSD value for National Standard (25%)(µg/m3)	Ambient Air Quality Standard for this project (µg/m3)	Remark
CO	8 Hr	2,500	10,000	ECR, 2005
	1 Hr	10,000	40,000	ECR, 2005
SO_2		91.25	365	ECR. 2005
	24 hr	5	20	IFC 2007
	Annual	20	80	ECR, 2005
NO_2	1-hr	50	200	IFC, 2007
		25	100	ECR 2005
	Annual	10	40	IFC, 2007
PM_{10}		37.5	150	ECR 2005
	24 hr	12.5	50	IFC, 2007
		12.5	50	ECR 2005
	Annual	5	20	IFC, 2007
$PM_{2.5}$		16.25	65	ECR, 2005
	24 hr	6.25	25	IFC, 2007
		3.75	15	ECR 2005
	Annual	2.5	10	IFC, 2007

433. During operation of Component 1, the emitted pollutants will add to background level. The project will run for 500 hours on HSD and 5,632 hours on natural gas in a year. Emission rates considered are shown in **Table 5.20.**

Table 5.20: Emissions from Component 1 (70% Plant Load Factor)

2x400 MW	Unit	Combined Cycle	Simple Cycle
Number of Stacks	Number	2	2

Stack Height	m	70	50
Stack Diameter	m	7.46	6.5
Flue Gas Exit Temperature	°C	102	886
Flue Gas Exit Velocity	m/s	22	25
Natural gas as fuel (to be used 5,632 hours per year)			
Emission rate of CO	gm/s	7.2	7.2
Emission rate of SO_2	gm/s	-	-
Emission rate of NO_x	gm/s	65.2	65.2
Emission rate of PM_{10}	gm/s	3.2	3.2
Emission rate of $PM_{2.5}$	gm/s	3.2	3.2
HSD as fuel (will be used during emergency only for a maximum of 500 hours per year)			
Emission rate of CO	gm/s	28.4	28.4
Emission rate of SO_2	gm/s	97.7	97.7
Emission rate of NOx	gm/s	65.2	65.2
Emission rate of PM_{10}	gm/s	42	42
Emission rate of $PM_{2.5}$	gm/s	42	42

Source: CEGIS, April 2018. These emissions are based on 25 ppmv.

434. Criteria pollutant emissions were calculated based on the plant's fuel consumption, sulfur content of HSD, guaranteed emissions for NO_2 (in this case 25 ppmv and 10 ppmv were considered). This is considered as a conservative approach to modeling. Greenhouse gas emissions were calculated using fuel consumption and IPCC greenhouse gas emission factors.

435. Based on the emission rates, operating data, meteorological data as well as the assumptions given above, the following table presents the results of air quality modeling.

Nitrogen dioxide (NO_2)

436. The air quality assessment is made in relation to ensuring compliance with the national standards. Component 1 will contribute maximum GLC of 1.2 µg/m^3 (annual averaging time) of NO_2 to the airshed on a guaranteed emission of 25 ppmv when for simple cycle technology and 2.3 µg/m^3 (annual averaging time) when on combined cycle technology and based on a guaranteed emission concentration of 25 ppmv. With an emissions standard of 25ppmv the emissions from the project alone contribute more than a fraction of the national ambient air quality standards which is not acceptable within a degraded airshed. On a guaranteed emission of 10 ppmv, the contribution of Component 1 to the GLC of NO_2 will be 0.7 µg/m^3 (annual averaging time) on simple cycle and 0.8 µg/m^3 (annual averaging time) for combined cycle. (**Table 5.21**). With an emissions standard of 10ppmv the emissions are considered to have a negligible impact on the national ambient air quality standards, 10ppmv is therefore standard that will be adopted for the project when running in natural gas or HSD mode. Given negligible impact on national ambient air quality standards, and the high costs involved with installing and maintaining selective catalytic reduction to further reduce NO_2 levels, a tigher emission standard than 10ppmv cannot be justified. However, the design will ensure that space is available for it to be retrofitted in future if national emission standards become more stringent. In terms of impact on health, the maximum project contribution to GLC with a 10ppmv emission standard is about 2% of the annual and about 30% of the short term WHO guideline for NO_2. Of the 31 receptors modelled, the maximum annual GLC of 0.74 ug/m3 (1.9%) is recorded at receptor 31 "Proposed School of KNP" and the maximum 1-hr GLC of 52.2 ug/m3 (26.1%) is recorded at receptor 12 "high school". Whilst the project makes a significant contribution to the short term WHO guidelines in a degraded airshed, the project itself does not result in any exceedance of the guidelines. Short term impacts on health tend to be less severe than long term impacts (e.g. eye irritation versus increased mortality) and the maximum short-term concentration from the project whilst significant is unlikely to coincide

with the maximum short-term contributions from other facilities. Furthermore, the project incorporates a partial offset to convert a 225MW power plant from HSD to natural gas which will offset about 193T/yr of residual NO_2 emissions. Health impact assessment will be completed before works commence, to provide a baseline for monitoring health impacts and confirm no significant impact on human health.

Table 5.21 Results of air quality modeling for NO_2 [59]

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Background concentration from CAMS-9 of CASE Project by the DoE – 26.3 µg/m³ (annual average)								
NOx emission rate – 25 ppmv (Conversion ratio of NO_2/NO_x = 1; Tier 1)								
Simple Cycle Operation (50m Stack Height)								
Only Project Contribution run on NG	1-hr	146	-	73	755230	2532925	200	-
	Annual	1.2	1.2	3	755230	2532925	40	100
Only Project Contribution run on HSD	1-hr	146	-	73	755230	2532925	200	-
	Annual	1.2	1.2	3	755230	2532925	40	100
Project contribution + Actual background in worst case on NG	1-hr	975.5	-	487.8			200	-
	Anuual	66.5	66.5	166.3			40	100
Project contribution + Actual background in worst case on HSD	1-hr	975.5	-	487.8			200	-
	Anuual	66.5	66.5	166.3			40	100
Project only + other project including background concentration run on NG	1-Hr	1184	-	592	759230	2530925	200	-
	Annual	35.8	35.8	89.5	762230	2532925	40	100
Project only + other project including background concentration run on HSD	1-Hr	1184	-	592	759230	2530925	200	-
	Annual	35.8	35.8	89.5	762230	2532925	40	100

[59] Modeling results are presented in 4 scenarios: 1. Only project contribution; 2. Project contribution plus actual background value in worst case; 3. Project contribution plus other projects contribution including background concentration; 4. Cumulative including project and other upcoming and closed projects.

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Cumulative including project and other upcoming and closed projects run on NG	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.4	32.4	81	761230	2531925	40	100
Cumulative including project and other upcoming and closed projects run on HSD	1-Hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.4	32.4	81	761230	2531925	40	100
Combined Cycle Operation (70m Stack Height)								
Only Project Contribution run on NG	1-hr	142	-	71	762230	2531925	200	-
	Annual	2.3	2.3	5.8	762230	2529968	40	100
Only Project Contribution run on HSD	1-Hr	142	-	71	762230	2531925	200	-
	Annual	2.3	2.3	5.8	762230	2529968	40	100
Project contribution + Actual background in worst case on NG	1-hr	971.5	-	485.8			200	-
	Anuual	67.6	67.6	169			40	100
Project contribution + Actual background in worst case on HSD	1-hr	971.5	-	485.8			200	-
	Anuual	67.6	67.6	169			40	100
Project only + other project including background concentration run on NG	1-hr	1184	-	592	759230	2530925	200	-
	Annual	36.1	36.1	90.3	762230	2532925	40	100
	1-hr	1184	-	592	759230	2530925	200	-

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Project only + other project including background concentration run on HSD	Annual	36.1	36.1	90.3	762230	2532925	40	100
Cumulative including project and other upcoming and closed projects run on NG	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.7	32.7	81.8	761230	2531925	40	100
Cumulative including project and other upcoming and closed projects run on HSD	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.7	32.7	81.8	761230	2531925	40	100

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Background concentration from CAMS-9 of CASE Project by the DoE – 26.3 µg/m³ (annual average)								
NO_x emission rate – 10 ppmv (Conversion ratio of NO_2/NO_x = 1; Tier 1)								
Simple Cycle Operation (50m Stack Height)								
Only Project Contribution run on NG	1-hr	57.7	-	28.9	761609	2529805	200	-
	Annual	0.7	0.7	1.8	761609	2529805	40	100
Only Project Contribution run on HSD	1-hr	57.7	-	28.9	761609	2529805	200	-
	Annual	0.7	0.7	1.8	761609	2529805	40	100
Project contribution + Actual background in worst case on NG	1-hr	887.2	-	443.6			200	-
	Anuual	66	66	165			40	100
	1-hr	887.2	-	443.6			200	-

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Project contribution + Actual background in worst case on HSD	Anuual	66	66	165			40	100
Project only + other project including background concentration run on NG	1-Hr	1184	-	592	759230	2530925	200	-
	Annual	35.5	35.5	88.8	761230	2531925	40	100
Project only + other project including background concentration run on HSD	1-Hr	1184	-	592	759230	2530925	200	-
	Annual	35.5	35.5	88.8	761230	2531925	40	100
Cumulative including project and other upcoming and closed projects run on NG	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.2	32.2	80.5	761230	2531925	40	100
Cumulative including project and other upcoming and closed projects run on HSD	1-Hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.2	32.2	80.5	761230	2531925	40	100
Combined Cycle Operation (70m stack Height)								
Only Project Contribution run on NG	1-hr	53	-	26.5	755230	2533925	200	-
	Annual	0.8	0.8	2	762358	2529968	40	100
Only Project Contribution run on HSD	1-Hr	53	-	26.5	755230	2533925	200	-
	Annual	0.8	0.8	2	762358	2529968	40	100
	1-hr	882.5	-	441.3			200	-

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Project contribution + Actual background in worst case on NG	Anuual	66.1	66	165.3			40	100
Project contribution + Actual background in worst case on HSD	1-hr	882.5	-	441.3			200	-
	Anuual	66.1	66	165.3			40	100
Project only + other project including background concentration run on NG	1-hr	1184	-	592	759230	2530925	200	-
	Annual	36	36	90	762230	2532925	40	100
Project only + other project including background concentration run on HSD	1-hr	1184	-	592	759230	2530925	200	-
	Annual	36	36	90	762230	2532925	40	100
Cumulative including project and other upcoming and closed projects run on NG	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.2	32.2	80.5	761230	2531925	40	100
Cumulative including project and other upcoming and closed projects run on HSD	1-hr	631.2	-	315.6	760230	2530925	200	-
	Annual	32.2	32.2	80.5	761230	2531925	40	100

Sulfur dioxide (SO_2)

437. The air quality assessment is made in relation to ensuring compliance with the national standards. At present, most of the existing power plants in the study area are operated on HSD or HFO. The major sources of the SO_2 are brick kilns, existing power plants and vehicular movements. If Component 1 is run on natural gas, there will be a negligible contribution to the

GLC of SO_2. However, when it is running on HSD, Component 1 will contribute 54.8 µg/m^3 (24-hour averaging time) on simple cycle and 84 µg/m^3 (24-hour averaging time) on combined cycle (**Table 5.22**). The project alone contributes less than 25% of the national ambient air quality standard but will contribute more than a fraction of the short term and annual national standards. However, the project will not operate full time on HSD thus ensuring any increase in SO_2 pollution is minimised. The amount of time that the project runs on HSD will be kept to an absolute minimum, for emergency situations only totalling no more than 500 hours a year. Thus, in a worst-case scenario (if meterological conditions coincided with HSD operations) SO_2 impacts would occur for a maximum of 21 days or less than 6% of the year. The project also incorporates a partial offset to convert 225MW power plant from HSD to natural gas which will offset about 607 T/yr of residual SO_2 emissions. In terms of impact on health, the project contributes 420% of the 24-hr WHO guideline in HSD mode. Of the 31 receptors modelled, the maximum 24-hr GLC of 57.9ug/m3 (289.5%) is recorded at receptor 12 “high school”. This is a highly significant contribution to the short term WHO guidelines in a degraded airshed albeit as noted above will occur for less than 1% of the year. The WHO has also adopted interm targets since it is recognized the guidelines may be difficult for some countires to achieve, whilst interim target 2 of 50ug/m^3 is also exceeded, interim target 1 of 125ug/m^3 (equivalent to EU SO_2 ambient air quality standards which are 98%iles with the US having a 24-hr SO_2 ambient air quality standard of 365ug/m^3) will be met by the project alone. Health impact assessment needs to be completed before works commence to provide a baseline for monitoring health impacts and confirm that there will be no significant impact on human health.

Table 5.22: Results of air quality modeling for SO_2[60]

Scenario	Concentration (µg/m^3)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m^3)	ECR 2005 Standard Values (µg/m^3)
	Avg. Time	Max Value			East	North		
Background concentration from CAMS-9 of CASE Project by the DoE – 31.4 µg/m^3 (annual average)								
Simple Cycle Operation (50m Stack Height)								
Only Project Contribution run on HSD	24-hr	27.4	7.5	137	762230	2529925	20	365
	Annual	1.7	2.1	-	762230	2529925	-	80
Only Project Contribution + Actual background in worst case run on NG	24-hr	117.5	32.2	587.5	762230	2529925	20	365
	Annual	22.56	28.2	-	762230	2529925	-	80
Only Project Contribution + Actual background in worst case run on HSD	24-hr	144.9	39.7	724.5	762230	2529925	20	365
	Annual	24.26	30.3	-	762230	2529925	-	80
Project only + other project including	24-hr	308.3	84.5	1541.5	760230	2530925	20	365

[60] Modeling results are presented in 4 scenarios: 1. Only project contribution; 2. Project contribution plus actual background value in worst case; 3. Project contribution plus other projects contribution including background concentration; 4. Cumulative including project and other upcoming and closed projects.

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
background concentration run on NG	Annual	48.3	60.4	-	761230	2532925	-	80
Project only + other project including background concentration run on HSD	24-hr	308.3	84.5	1541.5	760230	2530925	20	365
	Annual	50.1	62.6	-	761230	2532925	-	80
Cumulative including project and other upcoming and closed projects run on NG	24-hr	153.4	42	767	765230	2525925	20	365
	Annual	45.5	56.9	-	764949	2525695	-	80
Cumulative including project and other upcoming and closed projects run on HSD	24-hr	153.6	42.1	768	765230	2525925	20	365
	Annual	46.0	57.5	-	764949	2525695	-	80
Combined Cycle Operation (70m Stack Height)								
Only Project Contribution run on HSD	24-hr	38.4	10.5	192	762230	2529925	20	365
	Annual	3.2	3.25	-	762230	2529925	-	80
Only Project Contribution + Actual background in worst case run on NG	24-hr	117.5	32.2	587.5	762230	2529925	20	365
	Annual	22.56	28.2	-	762230	2529925	-	80
Only Project Contribution + Actual background in worst case run on HSD	24-hr	155.9	42.7	779.5	762230	2529925	20	365
	Annual	25.76	32.2	-	762230	2529925	-	80
Project only + other project including background concentration run on NG	24-hr	308.3	84.5	1541.5	760230	2530925	20	365
	Annual	48.3	60.4	-	761230	2532925	-	80
Project only + other project	24-hr	308.3	84.5	1541.5	760230	2530925	20	365

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
including background concentration run on HSD	Annual	50.1	62.6	-	761230	2532925	-	80
Cumulative including project and other upcoming and closed projects run on NG	24-hr	153.4	42	767	765230	2525925	20	365
	Annual	45.5	56.9	-	764949	2525695	-	80
Cumulative including project and other upcoming and closed projects run on HSD	24-hr	155	42.5	775	765230	2525925	20	365
	Annual	46.1	57.6	-	764949	2525695	-	80

Particulate Matter 10 (PM_{10}) and Particulate Matter 2.5 ($PM_{2.5}$)

438. The air quality assessment is made in relation to ensuring compliance with the national standards. Component 1 will have a negligible contribution to GLC of particulate matter (PM) when natural gas is used as fuel. When HSD is used as fuel, the resulting GLC will be 11.8 µg/m^3 (24-hr averaging time) and 0.7 µg/m^3 (annual averaging time) on simple cycle, and 16.5 µg/m^3 (24-hr averaging time) and 1.4 µg/m^3 (annual averaging time) on combined cycle (**Table 5.23**). Given that it was assumed that PM=PM_{10}=$PM_{2.5}$, Component 1 will have the same contribution of $PM_{2.5}$ (**Table 5.24**) as PM_{10}. The project alone contributes less than 25% of the national ambient air quality standard for PM_{10} but contributes more than a fraction of the short term and annual standard when run on HSD. The project alone just exceeds 25% of the short term national ambient standard for PM2.5, it also contributes more than a fraction of the short term and annual standard using HSD. However, the project will not operate full time on HSD thus ensuring any increase in particulate pollution is minimised. The amount of time that the project runs on HSD will be kept to an absolute minimum, for emergency situations only totalling no more than 500 hours a year. Thus, in a worst-case scenario (if meterological conditions coincided with HSD operations) particulate impacts would occur for a maximum of 21 days or less than 6% of the year. The project also incorporates a partial offset to convert 225MW power plant from HSD to natural gas which will offset about 2 T/yr of PM. The air quality assessment is made in relation to national standards, but as the project contributions exceed 25% of the WHO guidelines in HSD mode health impact assessment needs to be completed before works commence to demonstrate that there will be no significant impact on human health. In terms of impact on health, the project contributes 14% of the annual and 66% of the 24-hr WHO PM2.5 guideline in HSD mode. Of the 31 receptors modelled, the maximum $PM_{2.5}$ annual GLC of 1.1 ug/m3 (11%) and 24-hr GLC of 11.5ug/m3 (46%) is recorded at receptor 12 “high school”. Whilst the project makes a significant contribution to the short term WHO guidelines in a degraded airshed, the project itself does not result in any exceedance of the guidelines and, as above, will only operate in HSD mode for less than 6% of the year. The WHO has also adopted less stringent interm annual and 24-hr targets for

particulates since it is recognized the guidelines may be difficult for some countires to achieve (the Bangladesh standards are at least equivalent to interim target 1 for PM_{10} and $PM_{2.5}$). Health impact assessment needs to be completed before works commence to provide a baseline for monitoring health impacts and confirm no significant impact on human health.

Table 5.23: Results of air quality modeling for PM_{10}[61]

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Background concentration from CAMS-9 of CASE Project by the DoE – 132.4 µg/m³ (annual average)								
Simple Cycle Operation (50m Stack Height)								
Only Project Contribution run on NG	24-hr	1.9	1.3	3.8	761609	2529805	50	150
	Annual	0.1	0.2	0.5	761609	2529805	20	50
Only Project Contribution run on HSD	24-hr	11.8	7.9	23.6	762230	2529925	50	150
	Annual	0.7	1.4	3.5	762230	2529925	20	50
Project contribution + Actual background in worst case run on NG	24-hr	690.61	460.4	1381.2			50	150
	Annual	219.1	438.2	1095.5			20	50
Project contribution + Actual background in worst case run on HSD	24-hr	700.51	467.0	1401.0			50	150
	Annual	219.7	439.4	1098.5			20	50
Project only + other project including background concentration run on HSD	24-hr	202	134.7	404.0	763230	2525695	50	150
	Annual	141	282.0	705.0	764949	2525625	20	50
Cumulative including	24-hr	240.3	160.2	480.6	765230	2525925	50	150

[61] Modeling results are presented in 4 scenarios: 1. Only project contribution; 2. Project contribution plus actual background value in worst case; 3. Project contribution plus other projects contribution including background concentration; 4. Cumulative including project and other upcoming and closed projects.

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
project and other upcoming and closed projects run on HSD	Annual	144.2	288.4	721.0	764949	2525695	20	50
Combined Cycle Operation (70m Stack Height)								
Only Project Contribution run on NG	24-hr	1.3	0.9	2.6	762230	2529925	50	150
	Annual	0.1	0.2	0.5	762230	2529925	20	50
Only Project Contribution run on HSD	24-hr	16.5	11.0	33.0	762230	2529925	50	150
	Annual	1.4	2.8	7.0	762230	2529925	20	50
Project contribution + Actual background in worst case run on NG	24-hr	690.01	460.0	1380.0			50	150
	Annual	219.1	438.2	1095.5			20	50
Project contribution + Actual background in worst case run on HSD	24-hr	705.21	470.1	1410.4			50	150
	Annual	220.4	440.8	1102			20	50
Project only + other project including background concentration run on HSD	24-hr	202	134.7	404.0	763230	2525925	50	150
	Annual	141	282.0	705.0	764949	2525695	20	50
Cumulative including project and other upcoming and closed projects run on HSD	24-hr	241	160.7	482.0	765230	2525925	50	150
	Annual	144.4	288.8	722.0	764949	2525695	20	50

Table 5.24: Results of air quality modeling for $PM_{2.5}$[62]

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Background concentration from CAMS-9 of CASE Project by the DoE – 76 µg/m³ (annual average)								
Simple Cycle Operation (50m stack height)								
Only Project Contribution run on NG	24-hr	1.9	2.9	7.6	761609	2529805	25	65
	Annual	0.1	0.7	1.0	76609	2529805	10	15
Only Project Contribution run on HSD	24-hr	11.8	18.2	47.2	762230	2529925	25	65
	Annual	0.7	4.7	7.0	762230	2529925	10	15
Project contribution + Actual background in worst case run on NG	24-hr	385.05	592.4	1540.2			25	65
	Annual	102.1	680.7	1021			10	15
Project contribution + Actual background in worst case run on HSD	24-hr	394.95	607.6	1579.8			25	65
	Annual	102.7	684.7	1027			10	15
Project only + other project including background concentration run on HSD	24-hr	109.6	168.6	438.4	760230	2530925	25	65
	Annual	79.1	527.3	791.0	764949	2525695	10	15
Cumulative including project and other upcoming and closed projects run on HSD	24-hr	111.7	171.8	446.8	765230	2525925	25	65
	Annual	80	533.3	800.0	764949	2525695	10	15

[62] Modeling results are presented in 4 scenarios: 1. Only project contribution; 2. Project contribution plus actual background value in worst case; 3. Project contribution plus other projects contribution including background concentration; 4. Cumulative including project and other upcoming and closed projects.

Scenario	Concentration (µg/m³)		% of ECR 2005	% of IFC-WB EHS Guidelines 2007	GPS Coordinates (UTM:45) (m)		IFC-WB EHS Guidelines 2007 (µg/m³)	ECR 2005 Standard Values (µg/m³)
	Avg. Time	Max Value			East	North		
Combined Cycle Operation (70m Stack Height)								
Only Project Contribution run on NG	24-hr	1.3	2.0	5.2	762230	2529925	25	65
	Annual	0.1	0.7	1.0	761930	2529925	10	15
Only Project Contribution run on HSD	24-hr	16.5	25.4	66.0	762230	2529925	25	65
	Annual	1.4	9.3	14.0	762230	2529925	10	15
Project contribution + Actual background in worst case run on NG	24-hr	384.45	591.5	1537.8			25	65
	Annual	102.1	680.7	1021			10	15
Project contribution + Actual background in worst case run on HSD	24-hr	399.65	614.8	1598.6			25	65
	Annual	103.4	689.3	1034			10	15
Project only + other project including background concentration run on HSD	24-hr	109.6	168.6	438.4	760230	2530925	25	65
	Annual	79.1	527.3	791.0	764949	2525695	10	15
Cumulative including project and other upcoming and closed projects run on HSD	24-hr	112.4	172.9	449.6	765230	2525925	25	65
	Annual	80.2	534.7	802.0	764949	2525695	10	15

Note-*24 Hr Measured Avg. $PM_{2.5}$ concentration at CAMS in 2015

Cumulative air quality impacts

439. GoB has taken the decision to develop a hub of power generation in south-western zone of Bangladesh. Therefore, new power plants are coming into the Khulna city areas. BPDB has already taken a plan to constructing a new 300 MW dual fuel CCPP inside the existing Goalpara

campus. Moreover, a number of brick kiln industries will also run in future which have been stopped for the last couple of years.

440. There are no available emission data for the 300 MW Goalpara CCPP and the brick fields. Thus, emission rates from the AP42 of USEPA (Volume 1; 1995) were used and literature review of other similar types of brick kiln industries in Bangladesh. Operating data given in **Table 5.25** were used. Results of cumulative GLC on criteria pollutants (SO_2, NO_2 and PM) are given in Table 5.21, Table 5.22, and Table 5.23. **Table 5.26** shows the cumulative criteria pollutants GLC for natural gas while **Table 5.27** shows the results for HSD.

Table 5.25: Major Point Source Emission in the Project Area

Name of Industries	No. of Stack	Flue gas Emission Rate	Stack Height (m)	Inner Dia. (m)	Emission Rate (g/s)				
					CO	SO_2	NO_x	PM_{10}	$PM_{2.5}$
Goalpara 300 MW Power Plant	1	300	50	6	15.6	107	49.4	12.3	8.23
Brick Field	1	7.40	40	1.2	0.08	7.2	0.2	6.4	2.1
Brick Field	1	7.40	40	1.2	0.08	7.2	0.2	6.4	2.1
Brick Field	1	7.40	40	1.2	0.08	7.2	0.2	6.4	2.1

Source: Other Power Plants document and AP42

Table 5.26 Cumulative GLC of Criteria Pollutants, Natural Gas

No.	Air Sensitive Receptor	Cumulative GLC			
		NO_2 (10 ppmv)	SO_2	PM_{10}	$PM_{2.5}$
		Annual averaging time	24-hr averaging time	24-hr averaging time	24-hr averaging time
	IFC-WB EHS General Guidelines 2007	40 µg/m³	20 µg/m³	50 µg/m³	25 µg/m³
1	High School	27.0	50.7	148.8	81.5
2	High School	26.9	53.4	150.5	82.1
3	High School	26.9	69.7	162.3	86.1
4	High School	27.0	89.8	180.1	92.0
5	High School	26.8	49.7	147.9	81.3
6	Family Welfare Centre	27.0	66.2	161.1	85.6
7	High School	26.9	61.6	157.9	84.6
8	High School	27.4	121.0	211.7	102.3
9	Family Welfare Centre	27.1	68.6	164.6	86.8
10	Family Welfare Centre	27.0	52.9	151.2	82.3
11	High School	27.5	87.6	179.6	91.8
12	High School	28.4	83.9	175.5	90.5
13	Family Welfare Centre	28.8	67.4	162.3	86.0
14	Community Clinic	26.8	47.3	146.1	80.7
15	Family Welfare Centre	26.8	51.8	149.8	81.9

No.	Air Sensitive Receptor	Cumulative GLC			
		NO_2 (10 ppmv)	SO_2	PM_{10}	$PM_{2.5}$
		Annual averaging time	24-hr averaging time	24-hr averaging time	24-hr averaging time
	IFC-WB EHS General Guidelines 2007	40 µg/m³	20 µg/m³	50 µg/m³	25 µg/m³
16	High School	28.6	55.8	151.1	82.4
17	High School	27.2	52.1	149.9	81.9
18	Hospital	28.0	51.3	147.1	81.1
19	Historical Place	27.3	84.3	178.4	91.3
20	Hospital	26.9	46.3	143.9	79.9
21	Food Godown	27.1	44.9	142.8	79.6
22	High School	28.5	59.4	146.6	80.9
23	Community Clinic	27.3	47.1	143.0	79.7
24	Community Clinic	26.9	43.5	142.4	79.5
25	High School	26.9	46.6	144.9	80.3
26	Fisheries Village School	28.1	86.7	177.9	91.2
27	Family Welfare Centre	27.0	44.0	139.9	78.6
28	CAMS station	27.7	65.9	160.3	85.3
29	Residence Area of the Power Plant	27.9	70.1	166.7	87.5
30	Proposed School of KNP	28.1	67.9	160.3	85.4
31	Residential Area of KNM	27.9	71.3	167.8	87.8

Table 5.27 Cumulative GLC of Criteria Pollutants, HSD

No.	Air Sensitive Receptor	Cumulative GLC			
		NO_2 (10 ppmv)	SO_2	PM_{10}	$PM_{2.5}$
		Annual averaging time	24-hr averaging time	24-hr averaging time	24-hr averaging time
	IFC-WB EHS General Guidelines 2007	40 µg/m³	20 µg/m³	50 µg/m³	25 µg/m³
1	High School	27.0	53.5	149.0	81.8
2	High School	26.9	56.4	151.1	82.8
3	High School	26.9	75.5	163.6	87.4
4	High School	27.0	96.3	181.5	93.4
5	High School	26.8	51.9	148.3	81.7
6	Family Welfare Centre	27.0	78.3	161.4	87.5
7	High School	26.9	62.6	158.1	84.8
8	High School	27.4	122.7	212.0	102.6

No.	Air Sensitive Receptor	Cumulative GLC			
		NO_2 (10 ppmv)	SO_2	PM_{10}	$PM_{2.5}$
		Annual averaging time	24-hr averaging time	24-hr averaging time	24-hr averaging time
	IFC-WB EHS General Guidelines 2007	40 µg/m³	20 µg/m³	50 µg/m³	25 µg/m³
9	Family Welfare Centre	27.1	72.4	165.3	87.5
10	Family Welfare Centre	27.0	62.8	151.3	82.9
11	High School	27.5	90.9	180.4	92.5
12	High School	28.4	90.2	176.8	91.8
13	Family Welfare Centre	28.8	71.9	162.5	86.6
14	Community Clinic	26.8	51.7	146.6	81.1
15	Family Welfare Centre	26.8	59.5	151.5	83.6
16	High School	28.6	70.4	151.8	85.1
17	High School	27.2	53.9	150.1	82.1
18	Hospital	28.0	68.5	148.6	83.9
19	Historical Place	27.3	85.8	178.8	91.7
20	Hospital	26.9	49.6	144.1	80.3
21	Food Godown	27.1	54.1	143.0	80.2
22	High School	28.5	64.4	147.3	82.6
23	Community Clinic	27.3	52.7	143.6	80.8
24	Community Clinic	26.9	51.7	142.6	80.6
25	High School	26.9	50.4	145.2	80.6
26	Fisheries Village School	28.1	91.6	178.9	92.3
27	Family Welfare Centre	27.0	49.3	140.6	79.8
28	CAMS station	27.7	74.7	160.6	86.9
29	Residence Area of the Power Plant	27.9	71.9	167.1	87.8
30	Proposed School of KNP	28.1	82.4	160.6	88.3
31	Residential Area of KNM	27.9	73.3	168.3	88.3

GHG Emissions

441. The use of combined cycle technology will further reduce GHG emissions as the heat coming from the flue gas from the GT is used again in the HRSG to generate power through the steam turbine. This type of power generation increases thermal efficiency, production cost-effective, and reduces GHG emissions. Component 1 demonstrates a case of voluntary GHG emission reduction that may qualify for the Clean Development Mechanism (CDM).

442. The CDM was designed to meet dual objectives: (a) to help developed countries fulfill their commitments to reduce emissions, and (b) to assist developing countries in achieving sustainable development. CDM projects earn tradable, saleable certified emission reduction (CER) credits that can be used by industrialized countries to meet part of their emission reduction targets under the Kyoto Protocol. Benefits of CDM projects include investment in climate change mitigation

projects in developing countries, transfer or diffusion of technology in the host countries, as well as improvement in the livelihood of communities through the creation of employment or increased economic activity.

443. For GHG emission calculation, CO_2 was estimated using the standard process of IPCC (2006). Component 1 is estimated to emit about 1.69 M tons of GHG during 92% operation through natural gas and 8% operation through HSD considering a 70% PLF. In case of operating Component 1 with HSD only, about 1.86 M tons of GHG will be emitted annually. CO_2 emissions reduction will be at least 0.17 M tons annually from providing natural gas to the existing 225 MW Combined Cycle Power Plant also operated by NWPGCL. This will be case of fuel switching from HSD to natural gas for 225 MW Khulna Combined Cycle. Thus, the net contribution to GHG will be 1.52 M tons of GHG. **Table 5.28** shows the estimated CO_2 emissions.

Table 5.28: Annual GHG Emissions from Component 1 (70% PLF)

Parameters of GHG	Operation with dual fuel (70% PLF)		Only HSD 70% PLF	Only natural gas 70% PLF
	natural gas (92%)	HSD (8%)	HSD (100%)	natural gas (100%)
CO_2 (M tons/y)	1.54E+00	1.49E-01	1.86E+00	1.67E+00
Total GHG emission (M tons/year)	**1.69**		**1.86**	**1.67**

Note: Emission factors from 2006 IPCC Guidelines for National GHG Inventories. (Chapter 2: Stationary Sources).

Health implications due to degraded airshed

444. Based on the ambient air quality monitoring data from CAMS-9 of the CASE Project of the DoE (2013 to 2015), the airshed is degraded on PM (PM_{10} and $PM_{2.5}$), short term SO_2 and NO_2. In Khulna district, most common illness is pneumonia, bronchial asthma, chronic obstructive pulmonary disease, and whooping cough. These illnesses can be aggravated by poor air quality, nutrition, and smoking.

445. Except for the identified common illness in Khulna district, there are no data on public health. According to the International Agency for Research on Cancer (IARC), ambient particulate air pollution is now classified as carcinogenic to humans (Group 1).[63] This suggests that long-term exposures to PM (PM_{10} and $PM_{2.5}$) can cause cancer.

446. The European Study of Cohorts for Air Pollution Effects (ESCAPE) has recently found that a 5 µg/m^3 increase in estimated annual mean $PM_{2.5}$ was associated with a 13% increased risk of coronary events (95%CI 0.98 to 1.30) while the lung cancer meta-analysis found a pooled hazard ratio for all lung cancers of 1·18 (0·96–1·46) per 5 µg/m³ $PM_{2.5}$.[64] The combined meta-analysis of ESCAPE for Chronic Obstructive Pulmonary Disease (COPD) showed that there were weak but non-significant positive associations between NO_2, $PM_{2.5}$ and the prevalence/ incidence of COPD. To build confidence in monitoring ambient air quality within the airshed, an additional CAMS will be installed by NWPGCL to complement the existing CAMS-9 of the DoE which is about 2.5 km from the project site. The proposed location of CAMS by the NWPGCL will be at about 800 m

[63] World Health Organization. International Agency for Research on Cancer. Press Release N° 221. 17 October 2013. Group 1. This category is used when there is sufficient evidence of carcinogenicity in humans.

[64] Beelen R, Raaschou-Nielsen O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B, et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet. 2014;383(9919):785-95 (in

NE from the power plant (X:762358, Y:2529968). The location was determined based on the results of CALPUFF. The cost of the additional unit of CAMS is estimated at BDT1,500,000.

447. Given the CCGT stack height of 70 m, NO_x emission control through low-NO_x burner and water injection of 100 m^3/hr to ensure and emission of 10 ppmv, sulfur content of maximum 0.25% by wt for HSD, and PM emission standard of 30mg/Nm^3, the emissions from Component 1 alone on NO_x, SO_x, PM_{10} and $PM_{2.5}$ will meet national ambient air quality standards set by ECR 2005 both for natural gas and HSD.

5.5.2 Ambient Noise

448. It is envisaged that the noise level would increase due to the operation of the two units, RMS, cooling tower, gas transmission line etc. To predict the ambient noise levels due to the operation of these machines and equipment pre-mitigation, SoundPlan software was used.

449. Sound Plan essential 3.00 software, developed by SoundPLAN GmbH is widely used modeling software for noise propagation simulation in research and consultancy field. A number of standard processes can be calculated through this SoundPlan model. The ISO9613 calculation process is used for this modeling purpose. Different factors were considered for predicting the noise level, such as the amount of noise generating from the source, HRSG, two GTs, two STs, RMS and its pipeline inside the project boundary (above ground), ambient environment, etc. For running the model, the average temperature and average relative humidity were considered as 28°C and 80%. Additionally, the considered noise level of GT, ST, and RMS were 90 dBA, 90 dBA and 80 dBA respectively. These noise levels are typically used for noise modeling referred from the other power plant study. The land type of the project site was assumed as flat with lots of forest coverage.

450. The modeling result is presented in **Figure 5.7, Figure 5.8, and Figure 5.9** and the predicted level of noise in different sensitive locations around the plant side.

Figure 5.7: Noise level at different sensitive locations from project operation

Figure 5.8: Noise propagation modeling for daytime

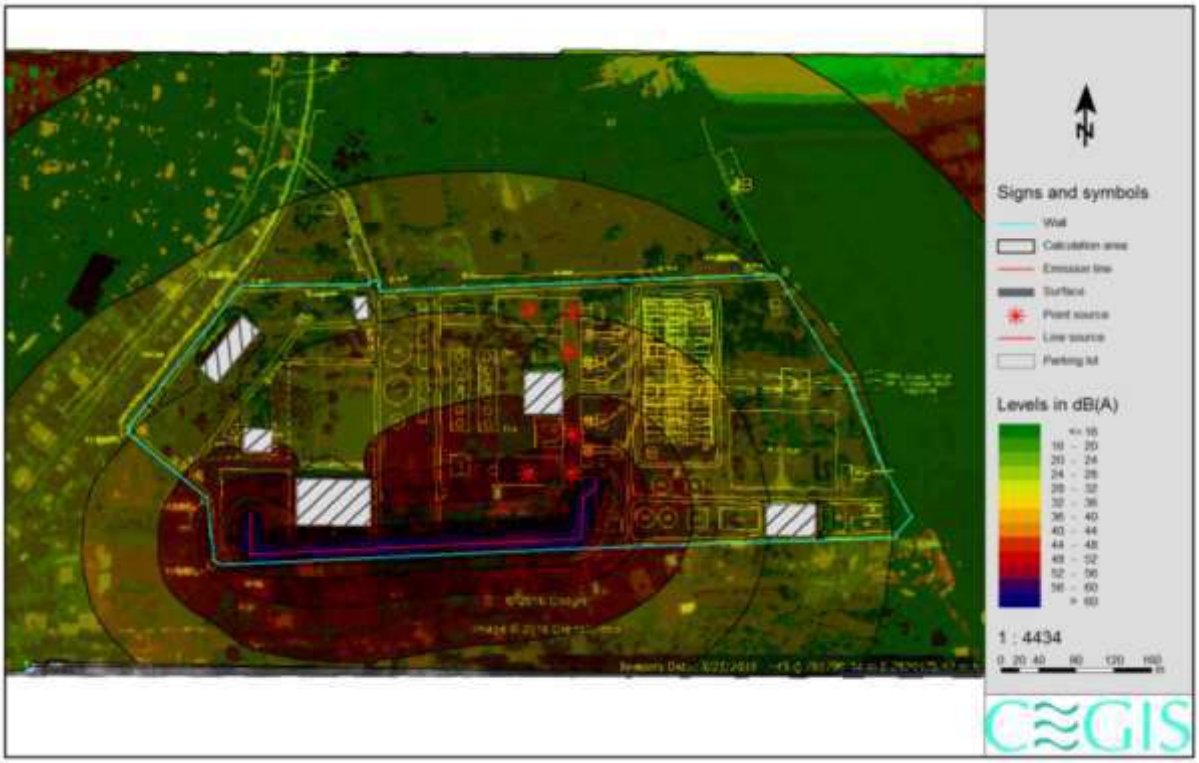
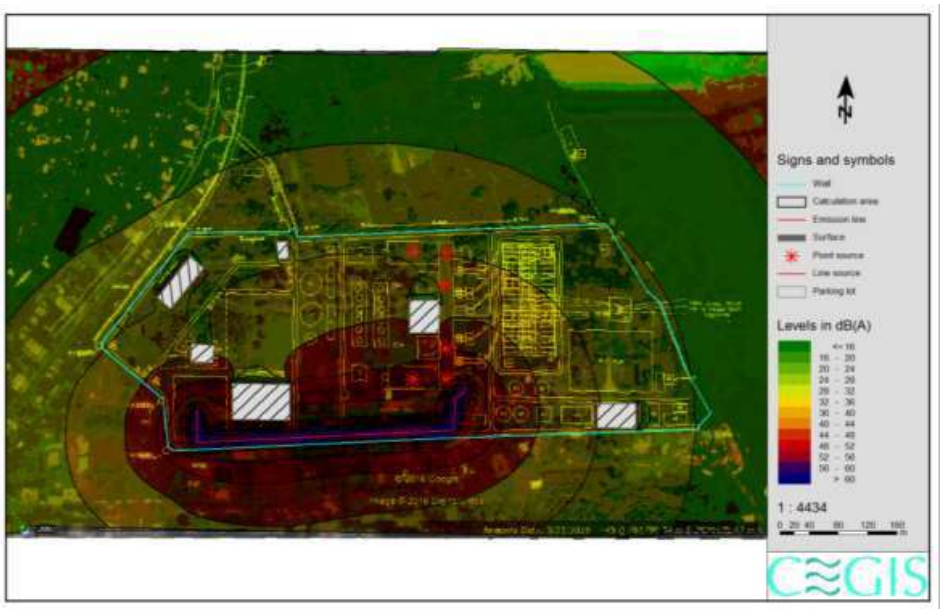


Figure 5.9: Noise Propagation Modeling for nighttime



451. The predicted noise level at the sensitive receptors will increase the baseline conditions. During baseline study, the existing noise level are recorded higher. This baseline will be raised due to the propagated noise generated during the operation period. However, the resultant noise levels of the sensitive receptors are shown in **Table 5.29.**

Table 5.29: Predicted Noise Level in Different Sensitive Locations inScenario 1

No	Location	Predicted Noise Level (dBA)		Baseline Noise level (dBA)		Resultant Noise level (dBA)		Noise Pollution Control Rules 2006 and IFC 2007 (dBA)	
		Day	Night	Day	Night	Day	Night	Day	Night
1	Residential/Hospital (leftover) of KNP	28.4	28.4	55.2	42.3	55.2	42.3	55 55	45 45
2	Control Room (Exposed)	36.0	36.0	62	36.7	62	38.7	75 70	70 70
3	Proposed Residential Area	31.1	31.2	57.8	44.6	57.8	44.6	55 55	45 45
4	Mosque	36.4	36.4	55.1	39.1	55.1	40.6	50 55	40 45
5	Proposed School	25.9	25.9	60.1	43.9	60.1	43.9	50 55	40 45
6	Present Guest Room	31.2	31.2	64.2	43.1	64.2	43.1	75 70	70 70
7	Outside Southern wall (Middle)	45.0	45.0	54	41.5	54.5	46.5	55 55	45 45
8	Existing KNP residential communities	29.8	29.8	52.2	43.0	52.2	43	55 55	45 45
9	Western corner of the Project	29.5	29.5	67.2	52.0	67.2	52.0	70 70	60 70
10	South-west corner Slump	37.9	37.9	62.3	53.0	62.3	53.0	55 55	45 45
11	Near the overhead tank	28.9	28.9	70.3	50.1	70.3	50.1	75 70	70 70

Note: Cell with yellow mark exceeds the IFC standard; Text with red color exceeds the Bangladesh standard

452. It is predicted that the resultant noise level will exceed the limits of Noise Pollution Control Rules 2006 and IFC 2007 on around six locations at day time and two locations at night time. In general, persistence exposure to the high level of noise can have adverse health impacts and can increase the level of stress to the susceptible individuals. It can also cause permanent damage to the hearing ability of the exposed persons.

5.5.3 Water Resources

Salinity in groundwater and river water

453. Storm water infiltration is one of the major sources of groundwater recharge and reduction of groundwater salinity surrounding the coastal belt of Bangladesh. Development the project land by concrete pavement will reduce the chance of infiltration and eventually majority of generated runoff excess of storm water will be drained out so quickly from the project area. Then the only source of groundwater recharge will be compensated by the river.

454. Cooling tower is one of the major consumption units of surface or groundwater but in case of the proposed project cooling tower will extract water from Bhairab River. Every cooling tower will receive individually about 45% of total intake water among the whole operation. By this process, there has to be a generation of 48% of evaporation and the rest 52% of highly denser water going blow down to the river after flowing through a monitoring basin. This process may impact the level of salinity in the river water.

Flooding

455. There may have two major chances of flooding in the project area. One may be urban flooding, due to extensive runoff which couldn't be drained out quickly for the time being and another cause of flood water may be due to uncertainty above the designed flood level. The post project situation in sense of flood surrounding the project area is very important against inundation. For this reason, the two post projects profile out of seven are shown below in the **Figure 5.10** and **Figure 5.11**. If similar floods will occur in the future during the operation phase, the flood inundation profile will be similar as shown in **Table 5.30.**

Table 5.30: Flooding inundation profile surrounding the project area

Profile Name	Year of Flood	Discharge (cumec)	Water Level (mPWD)	Increased Percentage (%) of inundation
Profile 1	1969	4,261	2.41	4.36
Profile 2	1970	3,445	2.39	4.32
Profile 3	1972	4,019	2.41	8.04
Profile 4	1974	6,060	2.61	2.38
Profile 5	1984	4,305	3.28	3.35
Profile 6	1986	3,076	2.94	4.36
Profile 7	1999	2,948	3.44	9.85

Source: CEGIS Analysis, Major flood inundation, 2017

Figure 5.10: Post-project inundation due to river flood in 1969

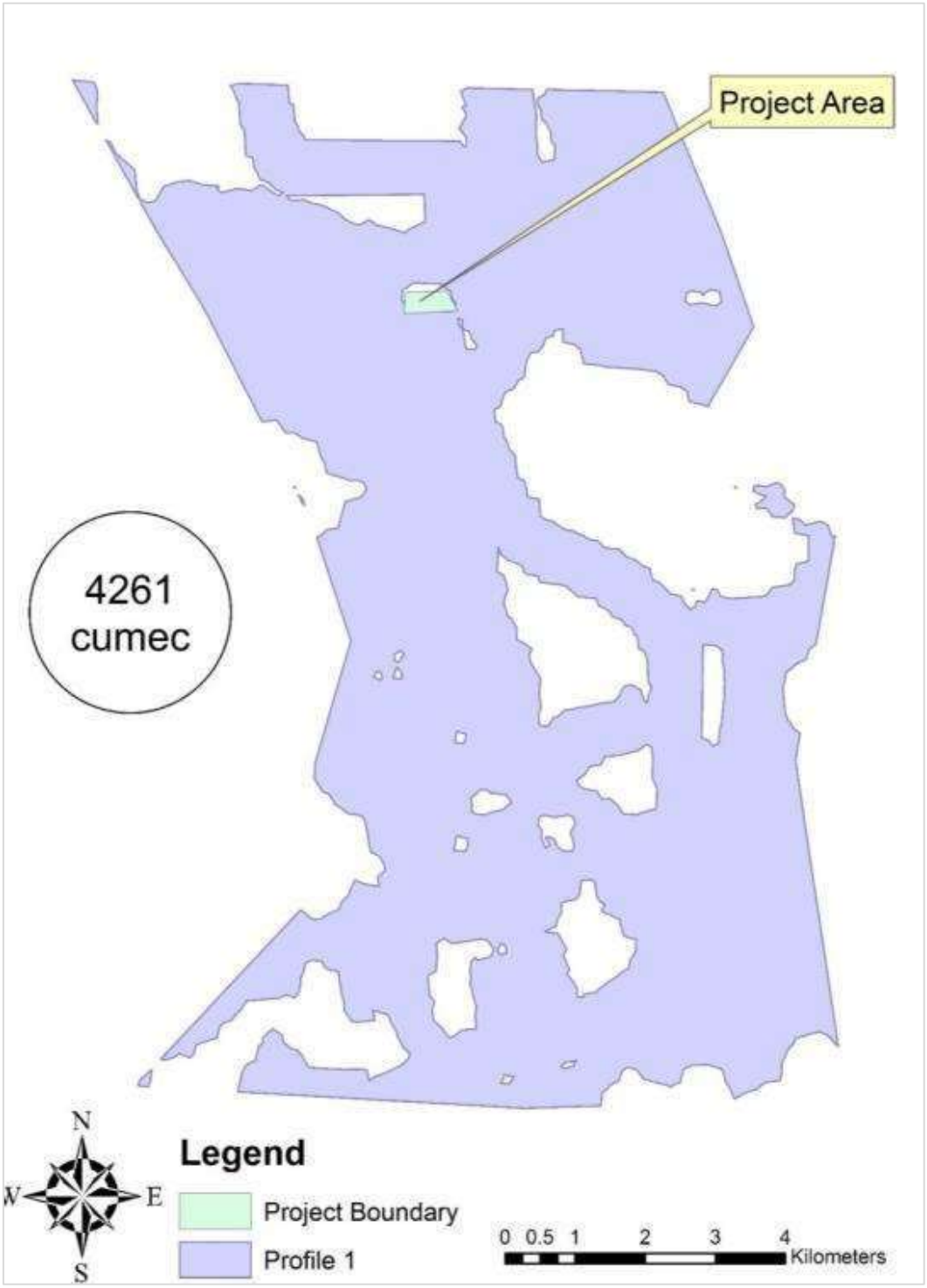
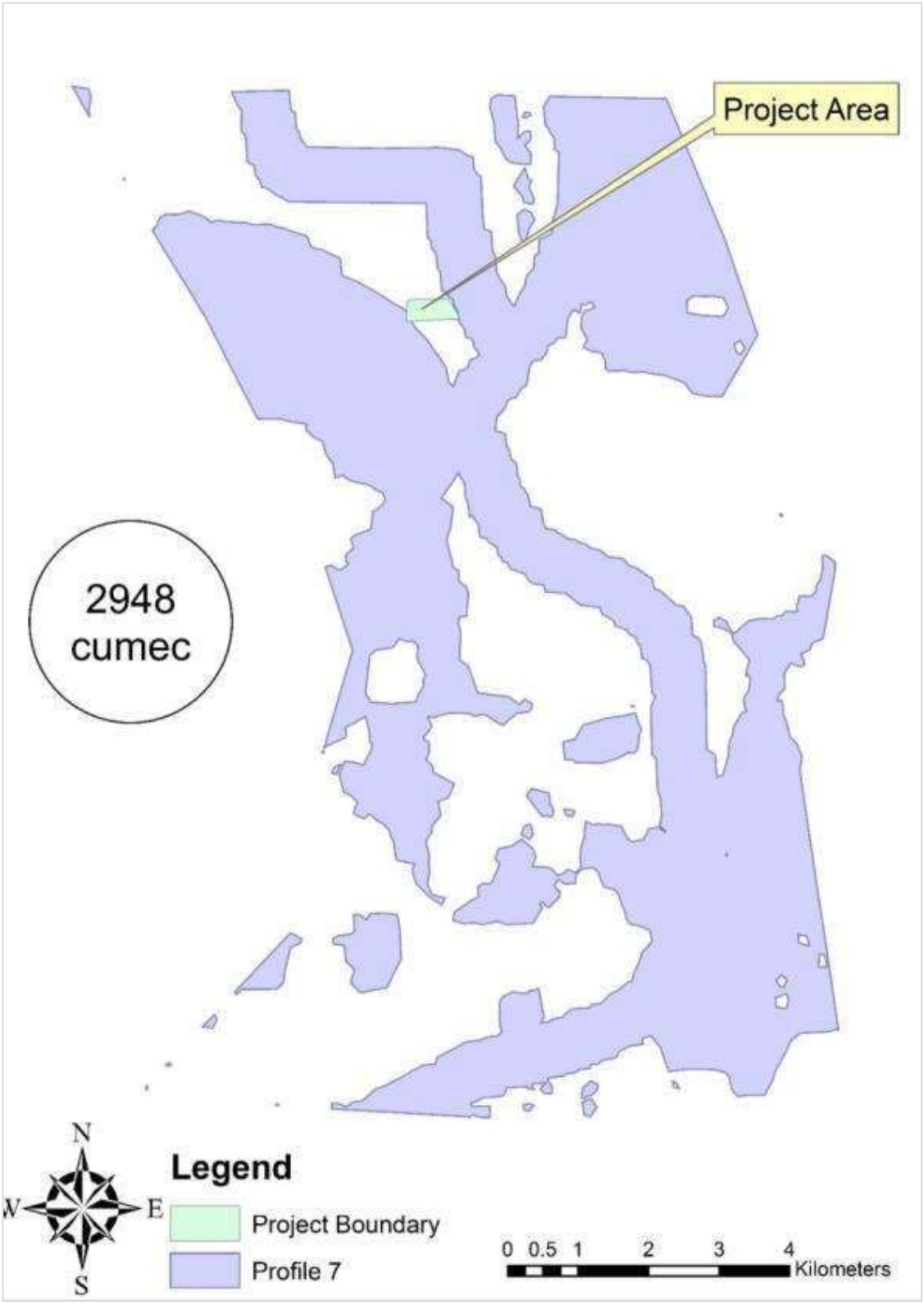


Figure 5.11: Pre-project inundation due to river flood in 1999



Intake channel outlet

456. Maintaining at least 10m scour depth at piles below river bed and In-situ pile will be constructed during low tide to limit noise into the river ecosystem. In order to reduce underwater noise levels, underwater air bubble curtains or similar will be used to reduce noise levels during construction stages.

457. Linear distance of intake channel from the project boundary will be minimum that will not hamper the regular vessels or other country/fishing boat movement. The intake channel will be constructed in such way for maintaining the intake velocity maximum 0.5ft/sec at the impingement. Use of barrier nets or mesh screen in order to block the fish passage. The impingement and entrainment rate will be monitored during operation phase.

458. Use of angled screens with louvers or inclined screen or strobe lights or air bubble curtain will be considered for diverting or repulsing the aquatic organisms. Restrict the construction-related impacts during the seasons like spawning and egg development periods. Construction activities near settlements will be limited to day time only.

459. Embankment is not feasible for this project area. Sheet piling already exist at the eastern boundary of the project. It will be appreciable if the existing bank protection work be improved by constructing dykes.

460. Intake channel is a vital part of this project. The point of intake channel starts from the river to the use through clarifier, sand filter, sludge pit and reverse osmosis water treatment plant requires a free waterway and surety of the continuous water supply for operation. But there have many chances of interrupting the water supply if:

- Accretion occurs at the eastern boundary by monsoon flood.
- Tidal activities carry and deposit clay at the intake point.
- Loading and unloading activities via ships/ Berge break the intake channel accidentally
- Sliding the sand or other land development material over the developed slope to the toe of the slope.

461. The each and every point described above may interrupt the continuous supply of water for cooling and reverse osmosis process. So the outlet of intake channel requires proper mitigation measures according to the probable negative impacts.

5.5.4 Fisheries and Their Habitat

462. During the operation phase of the plant, waste water, waste oil, sludge and other untreated effluent may become harmful for the local capture fisheries. Additionally, the solid waste generated from the workers living within the region such as cans, bottles and food remains discarded by employees may cause degradation of the capture fish habitats

463. River water will be used in the cooling system . The plant will also produce waste, wastewater, and effluent. Accidental spillage of such untreated effluents into river and open water fish habitats may cause degradation of the capture fish habitats. Continuous loading of such contaminated effluent may become harmful for the local capture fisheries.

464. Abstraction of river water at the rate of 2,010m^3/hr for operating power plant may cause reduce of river water availability during dry season around the Project site. This incident may cause the reduction of fish productivity of the capture habitats. This impact is characterized as Major Adverse.

5.4.5 Ecological Environment

Terrestrial vegetation

465. The emission of SO_x, NO_x and SPM including noise pollution may have significant impacts on vegetation and other sensitive receptors around the project and study area.

Aquatic biota

466. Transportation of maintenance related power plant equipment, other materials including fuel during operation period along the river ways, may degrade the river water and habitat quality. Taking water from Bhairab River particularly during dry season for cooling purposes and make-up process may trap invertebrates and other aquatic species to the intake channel which may ultimately get them killed. In addition, collection of fresh water during dry season from Bhairab River may affect the aquatic invertebrates, dolphins and other aquatic organisms in the absence of sufficient water flow. The benthos is sensitive to pollutants and may be affected. The oil spills, waste could harm many sensitive species including benthos.

5.5.6 Socio-Economic Condition

Health and safety

467. Health injury may occur in power plant for handling of heavy machineries. Noise from Regulating Metering Station (RMS) may create problem in the project area and adjacent to the power plant area. Moreover, STD and AIDS may raise by the outside workers.

468. In case of any serious accident, the Plant may become a risk factor for those people who are living/working adjacent to it. Particularly, it may cause safety risk to the nearby residential areas, school and offices.

Disturbance for the fishermen community

469. The fishing activities of the fishermen community in the Bhairab River may be hampered due to the increasing water transportations for the power plant. The fishermen activity will be indirectly affected (water traffic, nets broken). It can happe also by the increasing different industries in this area.

Employment opportunity

470. The project may create new employment opportunities based on the requirements for the semi-skilled workers of the local community. But a skilled training progamme may be initiated through corporate social responsibility (CSR) activities for the local people for future employment opportunity for this power plant and also based on the job vacancy to other industries.

Industrial development

471. This Project will encourage in establishing industries which will obviously provide employment opportunities to a large number of population.

Diversity of occupation

472. Sources of power will ultimately meet power demand and also bring opportunities of other businesses (shops, transportations, small scale industries, local markets etc.) and employment.

Non-Hazardous Waste Generation

473. During operation stage, some solid waste like, food waste, plastic, papers, etc. and some minor amount of bio-waste may also be produced as solid waste but to a minimal amount. There could be possibility that these wastes may leach into the surrounding water bodies via torrential rainwater and subsequently impact on the aquatic ecosystem. However, considering the amount and type of waste generated, the impact can be reversible when proper mitigation measures are applied. Considering these, it can be assumed that both the magnitude of the impact would be moderate. Sensitivity of this impact would be minor as the Project will implement waste management plan and improve drainage system. From the analysis of sensitivity and magnitude, it is apprehended that the significance of the impact would be moderate adverse.

Hazardous Waste Generation

474. Hydrazine is generally added in boiler water to scavenge dissolved oxygen – that may erode away the steel structure of the boiler. However, hydrazine is a known carcinogen and a mutagen. Workers may be exposed to hydrazine from the boiler blow down. There is also a possibility of the boiler blow down water to leach into nearby canal if not managed properly. Considering the sensitive nature of the substance involved, the sensitivity is marked as very high and the magnitude of the potential marked as moderate. Overall, after analyzing both sensitivity and magnitude of the impact, it can be estimated that the significance of the impact would be major adverse.

475. Concentrated sludge would be generated from water pre-treatment plant, demineralization plants, waste water treatment plants and oily water separation unit. This sludge would go to the sludge sump for dewatering and thickening. Disposal of the dry sludge might contaminate ground water of surface water if it is not properly managed. The magnitude of the impact is major and sensitivity is also high. Therefore, significance of the impact is major adverse that calls for adoption of proper EMP.

5.6 Mitigation of Impacts

Modification in the project layout

476. It is proposed to include the following items in the project layout developed by the engineering consultant:

- A storm water drainage system around the proposed Plant and link it with the existing drainage network of KNM.
- Green belt development around project boundary
- Demarcation of onsite solid waste dumping place

- A temporary but arranged storage yard for scrap and demolished materials and their transportation route

Changing the stack height

477. As per sensitivity analysis, the maximum height of the stacks should be 70m. During operation of the power plant, flue gas will be emitted from the HRSG stacks. To reduce the GLC of the pollutants significantly and economically, 70m stack height has been suggested in this EIA study.

Alternative to use of Hydrazine as oxygen scavenger in feed water

478. Hydrazine is generally used as an oxygen scavenger for corrosion control in thermal power plants. Although hydrazine is very effective in this application, it is a genotoxic carcinogen. Instead of using Hydrazine, it is recommended to use alternative oxygen scavenging chemical e.g. Helamin, Diethyl hydroxylamine, etc. in feed water for corrosion protection in HRSG boiler. However, the design of the HRSG and water treatment can also be changed to avoid use of any oxygen scavenger. There are two alternatives for that:

- Combined Water Treatment (CWT) or oxygen treatment for through-flow boilers
- However, freedom can be given to EPC contractor to find an appropriate alternative of using Hydrazine

5.6.1 Mitigation measures for major impacts

Pre-Construction and Demolition Stage

A. Ambient Air quality

479. The demolition of the existing abandoned brick buildings require to follow process which include a detailed pre-demolition preparatory works such as desired equipment, manpower, ruble disposal site including removing of hazardous materials as well. Removal of hazardous materials requires to comply GoB and IFC guidelines as applicable and may also require obtaining necessary permits from the authority. The proposed project site is mainly occupied with abandoned brick buildings and no asbestos. However, before demolition, the demolition contractor shall prepare a demolition plan approved by the project authority which include many activities but not limited to: announcing to the local communities, disconnecting utilities, and development of site-specific safety and work plans for the workforce and vehicles. Extra care should be taken while the demolition is in progress such as each building shall be covered with jute cloth to protect spreading of dust. The contractor will prepare the scrub/demolished materials dumpling areas and transportation route. They will regularly water the unpaved roads and possible sources of SPM. The pre-construction and demolition works should be limited to day time only and dust suppression will be applied by water spray during these activities. Construction materials will be temporarily covered with tripod to avoid dust emission to the surrounding areas. Impact and compliance monitoring will be conducted during the demolition works following GoB and IFC guidelines.

B. Noise Level

480. The existing 151 structures will be demolished following the Bangladesh Building Code 2016, Noise Pollution Control Rules 2006 including IFC standards, as applicable, and Codes of

environmental practice which will ensure structural safety, health safety, fire safety and construction and community safety. The ideal checklist for demolition activities are as follows:

a. Physical Survey for preparing site specific demolition plan
b. Stop all kinds of use of ever buildings before the demolition works begin
c. Debris storage and waste disposal system development
d. Quicker, Quitter and Cheaper demolition.
e. Prefer less noise, vibration and dust fume generating demolition technology and methodology
f. Demolition causing least disturbance in the neighborhood.

481. The abandoned buildings to be demolished in such a way that take minimum time, produce least noise, causes no pollution beyond permissible limit, does not the activity or living in the neighborhood and proves cheaper also.

C. Vibration

482. In order to reduce any kind of accident or annoyance of the local communities, the proponent needs to follow following number of initiatives to reduce the impacts.

a. Vacant all of the buildings inside the project boundary
b. Relocate the school and vacant the areas
c. Quicker, Quitter and Cheaper demolition.
d. Manual process like hammer, chisel or bulldozer might be used for demolition
e. Tree cutting must be done after the
f. Demolition causing least disturbance in the neighborhood.

D. Water Resources

Drainage System

483. Management of imported sand for land filling is to be implemented to avoid major drainage congestion during land filling and River side protection shall be maintained for protecting the sand materials being washed away from the project area to avoid impact on water ways.

Floodplain

484. The existing land elevation is about 2mPWD which becomes inundated due to flooding during wet season and hence required to be grading of land for avoiding inundation. The only possible mitigation to avoid flood plain is shifting the site to another suitable location in the same study area. The demolition of floodplain by the land development works will introduce new environment for the surrounding project area. The design land level will be higher than the HFL.

Riverbank Erosion and Accretion

485. Protecting the toe of all stockpiles providing adequate scouring depth, where erosion is likely to occur. Moreover, silt fences, straw bales or bunds can be provided. In addition, the slope of the River bank along the project site will be maintained following design for protection of any future bank erosion. In addition, the EPC contractor shall consider safe distance for infrastructures installations from river side as per National Building Code (2017) and also International applicable guidelines as appropriate.

Surface Water Quality

486. Management of oily mechanized machineries, discharge of kitchen wastes, discharge of oily water from dredger and other vessels should be ensured. It is to be noted that the provision of slope not towards the channel or river. Reducing the number of unnecessary movement of water transportations. But, the provision of adequate slope for tidal activity and storm water drainage system should be provided. Discharge water monitoring basin must be provided. Prevention of all solid and liquid wastes entering waterways by collecting spoils, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot.

E. Socio-Economic Condition

487. New relocated schools based on the stake holders' discussion meeting and following safeguard guidelines (SPS 2009) should include allied facilities as computer lab, scientific lab, playground, tube-well, sanitation facility etc. before handing over to the school authority. Creating noise shield (to keep within limit of GoB and IFC guidelines). Local labour both for technical and non-technical should be prioritized for the Project related activities. Working code of practice should be developed and maintained properly. The contractor will put in place a referral healthcare facility to deal with medical aspects of HIV/AIDS treatment with specialized services. The in-house medical facility will diagnose for STD/STI and TB infection among the workers and provide treatment as necessary. Ensuring job opportunities for the local people in different sectors. Keeping provision for the rehabilitation of the workers those who are working in the project area temporarily Bangladesh Labor Act, 2006 and ILO act must be followed. Child labor and Forced labor must be abandoned. There are 5-6 workers (such as cook and cleaners) currently staying as squatters within the project area who will be removed during project implementation period. Hence, a compensation is to be arranged for them.

F. Solid Waste/Garbage

488. A good practice of kitchen waste collection and disposal system should be adopted. Some temporary bins with color marking indicating degradable and non-degradable waste might be installed at labor shed to prevent scattered throwing of wastes. There should be a designated bunded storage area with impermeable floor for kitchen waste disposal for controlling bad odour and leachate having susceptibility to contaminate water. This is to be regularly disposed of to a suitably licensed, and designed landfill.

G. Ecological Environment

Mitigations of the impacts on loss of plant and wildlife

489. The existing structures should be demolished one after another cautiously after properly supervised by an ecologist (having plant and wildlife management experience) to avoid any damage of animal (frog, snake, lizard but no bat and birds) and plant life. In addition, appropriate building demolition including clearing of vegetation guidelines to be adopted for sustainable management of environmental quality of life and growth. Much time should be given for safe departure of the visiting animals during demolition activities following Wildlife Act (2012) and also IFC guidelines. In terms of any injuries of sensitive and threatened wildlife species, proper rescued should be taken by wildlife expert and wildlife rehabilitation team.

Mitigation of the impacts of dust and sound pollution on vegetation and wildlife

490. Control moisture content during construction by watering. Stabilize road surface with a suitable stabilizer. Create proper noise barrier and enclose for each building demolition (particularly all sensitive locations on the west and south, mosque area will be excessive noise level protected) to meet Noise pollution control Rules (2006) of GoB and also IFC guidelines as appropriate.

Mitigations for vegetation clearing

491. The Mosque, graveyard and part of the KNM area which is currently outside the proposed power plant lay out plan may be utilize as a green coverage undisturbed land area and religious activities as well. In addition, a significant portion of the proposed power plant area is suggested to develop as green belt to makeup loss of carbon dioxide sequestration due to clearing of existing vegetation at the proposed plant area and also to promote conservation of visiting animals of the project study area and also beyond that area. The cleared undergrowth plants can be converted to compost for application as a soil conditioner.

Mitigations for terrestrial habitat loss

492. The existing Mosque and graveyard including part of the KNM area is outside of the proposed project area, covered with large number of plants which can be utilize as a vegetation resources and also resting place for visiting birds and animals. In addition, a significant portion of the proposed power plant area is suggested to be developed as green belt which will ultimately makeup for the loss of carbon dioxide sequestration due to clearing of existing vegetation at the proposed plant area and also promote conservation of visiting animals of the project study area including beyond that throughout the seasons of the year. During the clearing of vegetation, the existing common wildlife should be allowed to go away under the supervision of an Ecologist through applying popper method (as per Wildlife Act 2012 and international best practices).

Mitigation for disturbance of aquatic biota

493. All the vessels operating for this power plant are restricted for any kind of effluent and hazardous waste discharges in to the rivers for avoiding possibility of impact on the dolphin community. However, all vessels along their RoW on the water ways other than Byhairab-Rupsha and Atai must follow the standard of inland river transportation regulations. For transportation of heavy equipment from abroad to the port, IMO, MARPOL and BIWTA will be followed. Construction discharges from the project site, shall meet regulatory requirements of GoB and IFC guidelines whichever is stringent and appropriate throughout project construction period.

Construction Stage

H. Ambient Air quality

494. Regular watering of the unpaved roads and open areas inside the project boundary which may be increased during high wind and excavation/grading. Dust suppressants should be applied or cover to soil stockpiles and disturbed areas when inactive for more than two weeks. The vehicle speeds will be limited 10 mph during the dry seasons inside the project area. The truck must be covered when hauling material that could be entrained during transit. Diesel-fueled equipment and vehicles should use ultra-low sulfur (15 ppm sulfur). Idling of vehicles to less than 5 minutes will be imposed.

I. Noise Level

495. In order to reduce the impacts of noise on the communities as well as of the project people, a number of ways can be followed –

1. Design consideration and project layout
   - Construct temporary boundary wall or piles of excavated materials between noisy activities and the noise sensitive receptors like Mosque, workers colony and community residence.
   - The existing route of KNM will be used for material transportation by trucks
   - Banned hydraulic horn and use sign in local language at the sensitive places.
   - Try to avoid cutting the trees besides the boundary wall which are being kept as green belt in layout.

2. Sequence of Operation
   - Combine noisy operation to occur in the same time period. The total noise level produced will not be significantly greater than the produced in separate operation.
   - Avoid construction work during prayer and night time. Sensitivity to noise increases during night time hours in the residential area.

3. Alternative construction and equipment use
   - Avoid pile driving which cause high noise and vibration at the sensitive areas. Therefore, use cast in-situ is used for construction of the infrastructure.
   - Use specially quieted equipment, such as quieted and enclosed air compressors, mufflers on all engines.
   - Use suitable PPEs like Ear Plugs for the workers in the project site and they shall maintain the working hour.

J. Vibration

496. In order to reduce the impacts of vibration generated from the construction yard, a number of mitigation or reduction steps should be included during the construction period.

1. Design Consideration and project layout
   - Road route for the loaded truck should be away from the residential area. So use the existing road network for material handlings.
   - Operate earth moving equipment on the construction lot as far away from vibration sensitive's sites especially the southern project boundaries as possible.

2. Sequence of operation
   - Earthmoving, tree cutting and ground –impacting operations should not be occurred at the same time period.
   - Avoid night time activities, kept away the vibration generating equipment like electric generators, machineries from the workers colony and nearest local residential areas. Because, people are more aware of vibration in their residence during the nighttime hours.

3. Alternative construction methods
   - Avoid pile driving and use cast in-situ methods.
   - Avoid vibratory rollers and packers near sensitive areas.

K. Water Resources

Drainage System

497. Provision of alternative drainage network for rainwater will be taken care if the existing drainage line is disrupted due to the construction works/earth-filling activities. Establishing the local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. It should be provided a strong channel protection works over the previous protection given during land development. Building new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensuring the wastewater quality conforms to National Standards and IFC standards as applicable, before it is being discharged into the recipient water bodies. Ensuring that there will be no water stagnation at the construction sites and camps. Protection of natural slopes of drainage channels to be ensured adequate storm water can be drained. Regularly inspection and maintenance of all drainage channels could be initiated to assess and alleviate any drainage congestion problem. Re-excavation of the local channels in between completed land development works and beginning of infrastructural development if required.

Navigation

498. The provision of 24 hour signaling system in the Bhairab River to avoiding accidental events near the project location.

Surface Water Quality

499. Temporary sediment lagoon will be installed if required to capture sediment-laden run-off from the work site. Stockpile materials should be installed providing a minimum distance from drainage lines avoiding the agitates mixing with channel water. Provision of fencing can enhance the protection system as well. It is to be ensured that tires of construction vehicles are cleaned in the washing bay to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean. Both Non-hazardous including municipal and hazardous waste to be temporarily stored in a designated bunded area with impermeable floor for final disposal to the authorized vendors or suitably designed and licensed designated disposal site following GoB and IFC guidelines to avoid any contamination of the any water ways including adjacent Bhairab River. Moreover, storm water drainage network inside the project area ought to be taken under consideration to avoid any kind of contamination of water ways. Managing the harmful chemicals and components carefully is important for aquatic beings. An ETP will be part of the Rupsha 800 MW CCPP.

500. Jetty construction activities should be confined within limited area of the jetty construction site and excavated soil will be utilized for filling of project site avoiding turbidity in the water. All the vessels must follow the Inland water transport regulations of GoB as applicable. However, during transportation of machineries from abroad to the port, IMO and MARPOL will be followed. Construction discharges from the project site and from the vessels or construction equipment during construction period, GoB and IFC guidelines whichever is stringent will be followed.

L. Socio-Economic Condition

501. The labor should follow the environmental code of practice during construction. As in the existing Khulna plant, most of the labours would be sourced from nearby areas and they do not require any housing facilities at the site construction camp, as they prefer to stay in the vicinity areas. If at all, 2 temporary stacked steel container sheds would be provided that can house a maximum of 8 to 10 labours. It is anticipated that about 1,500 manual work forces will be required at the peak construction period for work acceleration. Local people (mostly non-skilled labour) shall be engaged in the project period as needed. In addition, these local people will also be provided with trainings for finding opportunity of jobs in various sectors for upgrading of their livelihood. Most of the local labour will be coming from their residents and few non-resident will have camp facility within project area. Labour working condition must be guided with best practices. The worker colonies must follow good housekeeping.

502. An appropriate noise barrier to be installed to reduce noise level within GoB/IFC (whichever is stringent) limit to avoid impact to the school children, mosque area and neighboring sensitive areas including occupational staff within and adjacent to the project area as applicable. In addition, the construction activities shall be kept stop during the prayer time and exam time in the school. The project affected people due to different Project activities shall be given utmost priority for jobs under the project. There shall be provision for incentives such as training, micro-credit etc. under the rehabilitation programme for the workers who are working temporarily in the project area and also temporary Incentives to be given for alternative livelihood activities to the PAPs.

503. Special attention should be provided for supplying safe drinking water, safe sanitation system for the labour sheds. Registered doctor and assistants should be employed during construction phase. Emergency team and ambulance will be in place to transfer injured people from the accidental spots to the nearest hospitals and clinics. This provision also should be kept for the community people adjacent to the project area who may have chance to fall in accident due to construction activities of the power plant. Special or contingency fund should be created for health and safety management if any accidental incidences occur. Health and safety trainings should be provided regularly.

M. Non-hazardous waste generation

Leaching of generated wastes to nearby environment

504. A designated place for dumping waste should be provisioned. A good practice of waste collection and disposal system should be adopted. Construction waste to be stored temporarily in a designated area before selling to vendors or disposing in a suitably designed and licensed authorized disposal area. Some temporary bins with colour marking indicating degradable and non-degradable waste might be installed at labour shed and work places to prevent scattering of wastes before final disposing to the designated disposal area. There should be a designated bunded area with impermeable floor for kitchen waste disposal for controlling bad odour and leachate having susceptibility to contaminate water. Finally, the land area of the project site should be raised above flood level for preventing wastes to wash away to nearby water bodies.

Operation Stage

N. Ambient Air

505. Built-in Low-NOx burner in gas turbine will reduce the NOx emission below 10 ppmv where the wet injection of 100 m^3/hr will reduce the NOx level below 74 ppmv.[65] When operating on HSD, the sulfur content of HSD will be a maximum of 0.25% by wt. Continuous monitoring will be conducted at the stack, testing stack emission and ambient air quality sampling. Moreover, third party monitoring and auditing will be conducted to identify the changes in ambient air quality and its impact during construction and operation.

506. The project will emit more than 1 million tons of GHG hence, require a number of GHG emission reduction technologies and related policies. In addition, green building concept will be introduced in order to reduce energy consumption and sustainable energy use. Further to that, energy efficient lighting system, rain water harvesting system, roof top solar panel system, biogas system from sewage materials and also green belt shall be adopted as an offset technology for reduction of GHG in the local environment.

O. Noise Level

507. Trees will be planted around the power plant to attenuate the noise generated. The power station will be designed and constructed to minimize generation of excessive noise from the balance of plant and turbine operation as follows:

- The turbine and generator will be housed in soundproof building;
- Diffuser and bottom half of stack will be insulated;
- Additional baffles will be added inside the stack to reduce stack emission noise;
- Noise insulation surrounding turbine casings, and use of rigid foundations
- Insulated and sealing access doors to the turbine building.
- Will require the use of PPEs like ear protectors to employees working at elevated noise environment
- Restriction of worker's prolonged exposure to noise by rotating exposure every 2 hours

508. The machineries should be maintained properly according to the provided instructions as proper maintenance can decrease the level of noise significantly. The rotating machinery, such as turbines, pumps, fans etc. should be covered with noise proof hood to limit the spread of noise. Silencer should be used wherever possible. A green belt consisting of trees of different heights and canopy coverage should be developed along the boundary wall of the power plant area. The green belt should be of at least 3.5m width consisting of two rows of plantation with the gradual increase of height of plant from inside row to outside row.

509. The units operate on an auto-start up and auto-shut down sequence at all times to ensure the fastest, most efficient plant start-up and shut downs;

[65] The Low-NOx burners will be used with 100 m3/hr water injection if HSD will be the fuel. The 10 ppmv guaranteed NOx emission will be followed instead of 25 ppmv for NG and 74 ppmv for HSD as given in Table 6(B) of IFC-WB EHS Guidelines for Thermal Power Plants 2008.

510. The plant will run through operating checklists, and ensuring all doors, vents, louvers are closed as required during operation to limit the releases of noise from the generator/turbine enclosures.

511. Monitoring around the border of the site and residential area and manage the grievance of the local residence. Inform local people of upcoming maintenance program that may result to increased noise level.

P. Water Resources

Drainage System

512. Spoil management plan must be followed during project site land filling by sourcing materials from government approved designated site. No new materials sourcing site will be opened for the project. Monitoring and maintenance the internal drainage system inside the power plant area. It is to be cleaned the storm water drainage channel before monsoon inside the project area.

Surface Water Quality

513. ETP for industrial waste, oil separator for oily waste, STP for sewerage must be installed and functioned properly. Maximizing the reuse and recycling of effluent will meet the zero discharge. Training and awareness-building program to the workers and professionals should be provided.

Provision of bank protection works at the eastern boundary

a. Protection of eastern boundary
b. Provision of entering tidal wave at the intake point that can avoid sedimentation at bottom of the intake channel.
c. Position of jetty have to be located to a place where intake channel remains safe from crushing by the Ship/Barge.

Mitigation of the impacts on Riverine, dolphin habitat and benthic community

514. During the winter there will be sufficient water flow of Bhariab River and the power plant will take maximum 0.12% of the total discharges of the Bhairab River and therefore, there will be no problem for water availability during lean period subsequently no impact on the aquatic species including dolphin. Existing supply water facilities will be used for drinking purposes and therefore, ground water extraction for the power plant will not be required. All the vessels must follow the standard of Inland river transport regulation. In addition, for transportation of maintenance equipment from abroad, IMO, MARPOL shall be followed. Any kinds of alien species must be quarantined before transshipments from abroad for carrying maintenance equipment for the power plant.

Q. Fisheries

515. ETP should be properly functional. Foreign cargo/vessels (ship from abroad caring heavy equipment) must be checked for protecting the migration of invasive species. Continuous monitoring of intake water velocity should be ensured and necessary measures are to be taken if intake water velocity exceeds 0.5 ft/s in the dry season and specially breeding season. Drum

screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible. Temporary water reservoir can be built for water storage rather than direct abstraction from river.

R. Socio-Economic Condition

516. Women and men at the fishermen village should be eligible (and have priority as locals) for project employment during survey activities, site clearance and construction for non-technical roles. These can be as simple as carrying equipment, sewing uniforms, cleaning, helping to prepare food. Facilitate to recruit local people according to their skill. Different types of business will be initiated where numbers of people will be employed. Development of infrastructure, transportation and communication systems and electricity in the area will obviously create business opportunity which will create new employments to a number of local people. Steps should be taken for supplying safe drinking water and Safe sanitation system. Provision for contingency fund should be kept for the fishermen. Health and safety management for the NWPGCL official, workers should be considered.) Keeping provision both for the workers and non-workers who may be affected by the power plant. Thus their family can get facility in any accidental case.

S. Sewage

517. The project will have a sewage treatment plant (STP). The STP might be of biological type or in combination with physical, chemical and biological type. Generally, an STP consists of screening devices, aeration, active sludge treatment, sedimentation, clarification and separation/recirculation of sewage sludge. Membrane bio reaction is a good alternative. The EPC contractor will design and construct the STP including the sewerage collection network. The provision of reusing the treated waste should be considered in the design. The treated water can be reuse for watering to the vegetation in the project area. The sludge from STP will be disposed of in compliance with the IFC-WB EHS Guidelines 2007 and ECR 1997.

T. Sludge from Water Treatment Plant

518. The feasibility study proposes thickening and dewatering of sludge, in the form of dry cake, generated from water treatment plant. The dry cake of sludge should be managed properly so as to avoid leaching of heavy metals in the rainfall run off. Dry cake that would be mostly iron sludge has market potential in steel rolling mill. However, the EPC contractor should consider this issue and propose a sustainable management plan for sludge handling.

U. Hazardous waste generation

Use of Hydrazine in feed water for oxygen scavenging

519. Use alternative oxygen scavenging chemical e.g. Halamine, Diethyl hydroxylamine, etc. in feed water for corrosion protection in boiler. Changing the design of boiler and water treatment system e.g. using Combined Water Treatment (CWT) or oxygen treatment for through-flow boilers and treating using a volatile substance of high pH value instead of Hydrazine.

Hazardous sludge from water pre-treatment and treatment plant

520. The feasibility study proposes thickening and dewatering of sludge, in the form of dry cake, generated from water treatment plant. The dry cake of sludge should be managed properly so as

to avoid leaching of heavy metals in the rainfall run off. Dry cake that would be mostly iron sludge has market potential in steel rolling mill. However, the EPC contractor should consider this issue and propose a sustainable management plan for sludge handling.

6.0 ANALYSIS OF ALTERNATIVES

521. Aside from economic, financial, safety and engineering factors, the potential environmental and social impacts have been carefully considered in selecting the best route for the gas distribution pipeline. Both the "no project" and "with project" options have been studied.

6.1 "No project" option

522. A "no project" option negates the need to meet the future demand for electricity in Bangladesh. This means that the area within the previous site of KNM will remain the same as the current condition. As such, there would not be any additional power generation capacity in southwestern part of Bangladesh to meet the growing demand for electricity. A "no project" option will entail that the planned economic development and business opportunities within southwestern Bangladesh may not altogether happen due to lack of reliable power, and thus, will be an opportunity cost for GoB. **Table 6.1** presents a summary comparison of "with project" and "no project" options.

Table 6.1: Comparison of "with project" and "no project" options

Description	"With Project" Option	"No Project" Option
Additional power generation capacity from 800 MW Rupsha CCPP	• Provides a stable and reliable flow of natural gas for power generation • Achieves the GoB target of additional power generation capacity	No additional power generation capacity
Economic development	Potential for more opportunities in southwestern part of Bangladesh as a result of available and reliable power supply	Minimal, if any, due to lack of reliable power supply
Potential impacts to ecologically-sensitive areas	• Project site is an abandoned area of about 20.234 ha previously used by KNM which ceased operations in 2002. • No protected areas, national parks, or IBAs within 5 km and 10 km radius from the site. • Associated potential impacts can be readily mitigated by adherence to applicable design standards and specifications, compliance to relevant regulations, and implementation of best practice engineering processes and procedures.	None
Potential impacts to terrestrial flora and fauna	• Project site is not known to host endangered or protected species of flora and fauna. • Some trees and other vegetation that grew from the abandoned structures will be cleared.	None

Description	"With Project" Option	"No Project" Option
	• A biodiversity assessment was done by IUCN Bangladesh due to sightings of the endangered species, Ganges River dolphins, within the project site river systems: Bhairab River, Rupsha River, and Atai River. Results of the assessment showed that the project site and the immediate vicinity along the Bhairab River is not a critical habitat based on the criteria set by SPS 2009 and the IFC Performance Standard 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources (January 2012).	
GHG emissions	Combustion of natural gas 92% and HSD 8% will cause GHG emissions like CO_2. Component 1 will contribute 1.69 M tons CO_2/year during operation. However, at full implementation of Component 1, annual net emissions reduction was estimated to be 0.17 M tons CO_2/year by displacing oil-fired power plants.[66]	No GHG emissions contribution
Disruption to local residents within and adjacent to the BCIC property where the project site is located	Potential impacts or disruption to daily activities will be minimal (i.e., temporary and short duration during construction/installation). Any disruption can be mitigated by proper construction planning and scheduling of activities. Transport of heavy equipment and machinery like turbine, HSRG, etc., will be done through the Bhairab River from the Mongla Port which is expected to be about 2-3 deliveries.	None
Employment	Job opportunities will be created. An estimated 58 positions will be created for the Project Management Set-up and 307 positions required for the Operation and Maintenance.	None

[66]Displacing electricity in the grid in Bangladesh was estimated using grid emission factor of 0.67 ton/MWh. Source: DoE, 2013. Grid Emission Factor of Bangladesh. Dhaka.

6.2 "With project" options

6.2.1 Suitability of the site

523. Bangladesh is densely populated with an estimated 2017 population of 164.67 million and area of 144,570 km^2. Thus, population density is 1,139 people per km^2. Aside from this, the geography of Bangladesh makes it difficult for GoB to acquire land for development projects and is now a great concern. The scarcity of land is one of the major obstacles for development of industries like a combined cycle power plant. The abandoned land of about 50 acres previously used by KNM is the best site for Component 1.

6.2.2 Suitability of fuel

524. Considering the issues due to the effects of global warming, renewable energy- based power plants like solar and wind energy are encouraged. Solar power plants require large area of land that is not easily available in Bangladesh.

525. As of January 2018, the total installed capacity in Bangladesh is 13,846 MW with energy mix as follows:[67]

- natural gas – 8,754 MW (63.22%)
- HFO – 2,794 MW (20.18%)
- HSD – 1,158 MW (8.36%)
- Power import – 660 MW (4.77%)
- Coal – 250 MW (1.8%)
- Hydropower – 230 MW (1.66%)

526. Out of this installed capacity, NWPGCL owns 400 MW. Based on the energy mix, the carbon dioxide (CO_2) emission of each fuel type is compared to determine the suitability of natural gas as fuel for Component 1. Hydropower will not have CO_2 emissions.

Table 6.2: CO_2 emissions by type of fuel

Type of fuel	CO_2 emissions lbs CO_2 per million BTU
Coal, lignite	215.4
Coal, anthracite	228.6
Coal, bituminous	205.7
Coal, subbituminous	214.3
Diesel fuel and heating oil	161.3
Natural gas	117.0

Source: Frequently Asked Questions, US Energy Information Administration

527. Based on CO_2 emissions, natural gas is the most suitable fuel. Bangladesh has very limited hydropower potential except for Chittagong and the Chittagong Hill Tracts which may have potential for micro-hydro and mini-hydro.

[67]Bangladesh Power Development Board. Power Generation Units (Fuel Type Wise) http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=150&Itemid=16

528. Given the natural gas reserves of Bangladesh, NWPGCL has the experience to manage a combined cycle power plant using natural gas as fuel. There will be adequate supply of natural gas as Qatar will supply 1.8 million tons of LNG per year to Bangladesh for the first five years beginning 2018 and 2.5 million tons per year for the next 10 years as part of GoB efforts to diversify its export markets.

529. Solar power plants require large area of land that is not easily available in Bangladesh. There is very limited hydropower potential except for Chittagong and the Chittagong Hill Tracts which may have potential for micro-hydro and mini-hydro. Burning of coal, diesel, and natural gas contribute to greenhouse gas (GHG) emissions as carbon dioxide (CO_2) but natural gas contributes the lowest among these fuels at 117 lbs CO_2 per million BTU and is, thus considered more environment-friendly. Natural gas is mainly CH_4 with higher energy content compared to other fuels.

530. Wind resources potential in Bangladesh for generating electricity is limited. 68 available data from measurements and satellite data indicate that onshore wind speeds are below 5 m/sec average a year which is quite low wind speed for the purpose of wind energy. Available satellite data for offshore wind speeds are slightly higher but still relatively low about 6 m/s. Availability of suitable space for wind farm is also a challenge given the population density, and if at all available, it will in in flood-prone areas.

6.2.2 Power generation technology

531. Aside from advancing the recommendations of PSMP 2016, the choice of combined cycle power plant using natural gas as fuel is consistent with the Energy Policy (June 2009) of ADB. In maximizing access to energy for all, “ADB will continue to support financing natural gas-based power plants because of their environmental benefit.”[69]

532. Modern CCPPs have undergone many developments to much more improve its capability in areas such as fuel flexibility, reduce life cycle costs, operational flexibility, low emission levels, operate on a wide range of fuel, rapid ramping rates, higher efficiency, and higher availability. On 28 April 2016, GE Power in partnership with EDF achieved a 62.22% efficiency rating for a combined cycle power plant in Bouchain, France (over 605 MW).[70]

533. While Bangladesh has abundant water resources, it has relatively limited hydropower potential due to its topography where most of the land is spread over the delta along the Bay of Bengal and most of the areas are lower than 9 m above sea level.

534. The existing Karnafuli Hydropower Plant in Chittagong that uses Kaptai Lake is the only hydropower plant in Bangladesh with an installed capacity of 230 MW. The first units (2 x 40 MW) were installed in 1962 and another unit of 50 MW was installed in 1982 with the support of the United States.

535. ***Options for types of gas turbine***. There are several classes of gas turbine in the market. GE Power’s largest 9HA.02 gas turbine is now available at more than 64% net efficiency in combined cycle power plants. The project prefers F-class compared to H-class for the following

[68] Netherlands Enterprise Agency.Baseline Study Wind Energy BangladeshCommissioned by the ministry of Foreign Affairs. 13 April 2017.
[69] ADB. Energy Policy June 2009, p.11
[70] GE Power. Breaking the Power Plant EfficiencyRecord. https://www.gepower.com/about/insights/articles/bouchain-grand-opening

reasons: (i) total net power output falls within the net power output of the proposed gas turbine/CCPP and the maximum block size shall be in compliance with the current limits governing the national grid system security in Bangladesh; (ii) commercial operation is a proven design; (iii) NWPGCL has the ability to cope with F-class gas turbine technology based on experience in terms of operation and maintenance; and (iv) the net power output can be accommodated by the system according to the power load study conducted by PGCB. F-class units provide more flexibility in burning a wide spectrum of fossil fuels including gasified coal. In addition, fuels can be switched after start-up without sacrificing performance.

536. For the H-class gas turbine CCPP, (i) the net power output is higher than the planned new capacity; (ii) it is a relatively new technology; (iii) the higher power output may cause system instability based on the load study conducted by PGCB; and (iv) there is a need to acquire new knowledge and skills in order to effectively and reliably operate and maintain.

6.2.3 Cooling system options

537. Water is mainly used at power plants for cooling. This is accomplished in one of two ways: once through cooling system or closed-loop (recirculating) cooling systems. These systems both withdraw and consume water, but not all water withdrawn is consumed. The once-through cooling abstracts water from a reservoir or a water body (i.e., river or sea) near the power plant through a heat exchanger and discharges spent water to the receiving body of water at a higher temperature. Component 1 considered the following options (**Figure 6.1**).

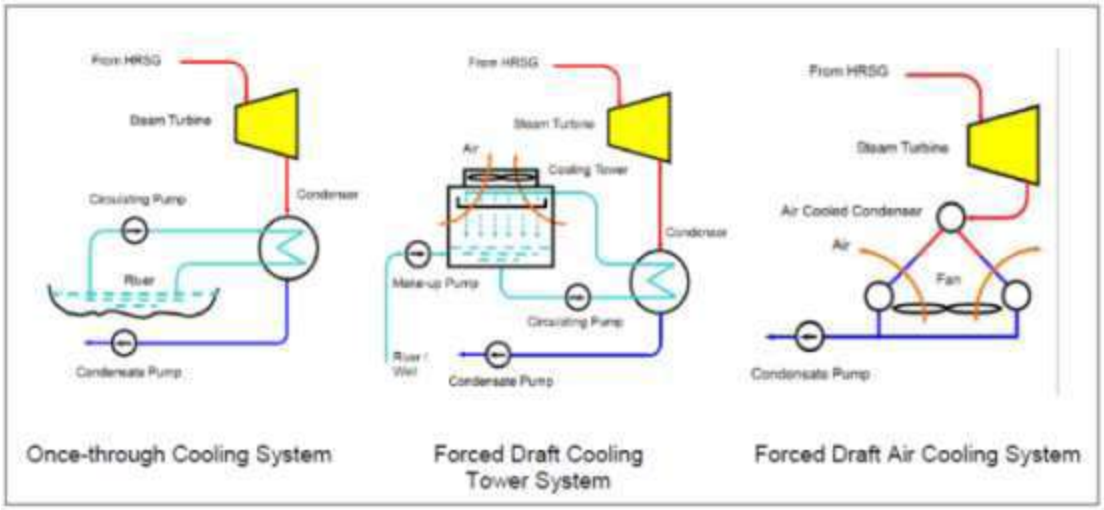
Table 6.3: Analysis of different cooling systems

Type of Cooling System	Description	Advantage/Disadvantage
Once-through cooling system	• This will take water of about 60,000 m^3 per hour from the Bhairab River and will discharge about the same volume with warmer, higher temperature (usually about 3^oC from ambient) to Bhairab River. • Cooling water requirement – very huge • Bottoming cycle performance – best • Land area – base • Noise pollution – base	Advantages are simplicity and low cost while major disadvantage is the disruption to the local ecosystem from the significant water withdrawals involved and the release of warmer water back into the Bhairab River as thermal effluent. Given the presence of fishing village across the project site and the presence of Ganges River dolphins in the river systems, this is not a good option.
Forced draft cooling tower system (or closed-loop cooling system)	• Wet-recirculating or closed loop systems reuse cooling water in a second cycle rather than immediately discharging it back to the original water source. Most commonly, wet recirculating systems use cooling towers to expose water to ambient air. Some of the water evaporates; the rest is then sent back to the condenser in the power plant.	Advantages include lower water withdrawal (about 2,010 m^3 per hour) than once-through system (water only withdrawn to replace any water that is lost through evaporation in the cooling tower).

Type of Cooling System	Description	Advantage/Disadvantage
	• Cooling water requirement – big amount as make-up water only • Bottoming cycle performance – base • Land area – more • Noise pollution – not good	
Forced draft air cooling system (or air cooled condenser)	• Dry-cooling systems use air instead of water to cool the steam exiting a turbine. • Cooling water requirement – negligible • Bottoming cycle performance – not good • Land area – most • Noise pollution – not good	Advantages include no water use for cooling and can decrease total power plant water consumption by more than 90%. Not advisable since it will cause noise pollution and a rise in ambient temperature of the surrounding area of the proposed plant (microclimate). Expensive system compared to other cooling systems. Advisable to use only if water is not available.

538. Based on evaluation and comparison, once-through cooling system cannot be adopted due to environmental impacts of abstracting huge amount of water. NWPGCL will use the forced draft cooling tower system.

Figure 6.1: Schematic diagram of a cooling system



Source: Feasibility Study of the Rupsha 800 MW Combined Cycle Power Plant Project, August 2017 (Minconsult SDN BHD).

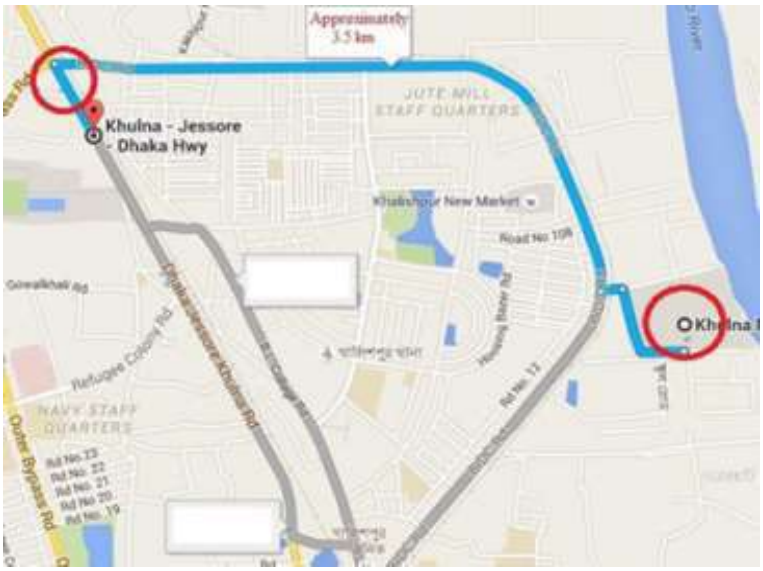
6.2.4 Modes of transporting heavy and oversize equipment to the site

539. Delivery of equipment to the site on time is important in meeting the construction and installation schedule. There are several available modes of transport and the following options were considered in the Feasibility Report (**Figure 6.2**).

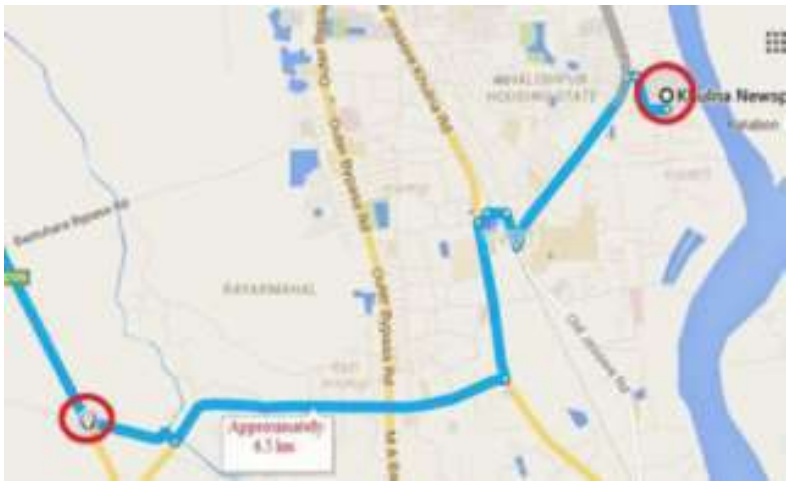
Figure 6.2: Transportation routes for heavy and oversized equipment

Highway:

(1) Khulna-Jessore-Dhaka Highway (Approx. 3.5km away from project site)



(2) Khulna-Mongla Highway which is connected with Khulna city Bypass (Approx. 6.5km from the project site)



(3) There are 3 major bridges from site to Mongla Port. These are:

- Labaochora Bridge over Moyur River, Khulna City Bypass
  Load bearing capacity: 70 tons
  Width of the bridge: 18 m
  No height restriction.
- Rupsha Bridge over Rupsha River, Khulna-Mongla Highway
  Load bearing capacity: 70 tons
  Width of the bridge: 16.50 m
  No height restriction.

- Katakhali Bridge over Katakahli River, Khulna-Mongla Highway
  Load bearing capacity: 70 tons
  Width of the bridge: 12 m
  No height restriction.

Railway:
Daulatpur Railway Station (Approx. 5 km away from project site).

Water Way
Bhairab River is very close to the proposed site and Mongla port can be accessed through this river.

540. Given the route options, the road, railway, and river transport are available. However, since Bhairab River is adjacent to the project site, the most efficient transportation option is by this waterway. NWPGCL estimates that the number of trips for delivery will be twice or thrice per year during construction phase when major equipment like turbine, generator, etc. will be installed.

7.0 INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1 Introduction

541. Consultations for Component 1 were conducted as part of the requirements of the DoE and ADB's SPS 2009. The main objective is to involve stakeholders throughout the project implementation and to know their concerns and perceptions about the project. Specific objectives of consultations include the following:

a) To ensure peoples' participation in the proposed project;
b) To inform key stakeholders about the project, its environmental implications within the project area, potential environmental impacts and mitigation measures, project benefits, and about the "cut-off date" for persons directly affected by the project;
c) To determine the perceptions of the people about the project and share experiences of the participants on similar projects;
d) To understand and create awareness of problems in the project area;
e) To discuss and propose possible solutions to the problems identified;
f) To describe the mechanism for handling potential grievance related to the project; and,
g) To inform stakeholders on access to information about the project.

7.2 Approach and Methodology

542. Stakeholders were classified into primary and secondary stakeholders. These stakeholders are characterized as the following:

a) Primary stakeholders

543. The primary stakeholders are those that may be directly affected by Component 1 during pre-construction, construction, and operation. These are people living within the vicinity of the project site (i.e., within the 10-km radius) which includes teachers and students from the existing boys and girls grade school, guardians of the schools, *Imam* and adherents to the mosque, security personnel at the KNM, and the fishermen community.

b) Secondary stakeholders

544. These are persons or organizations that will not be directly affected but may have interests that can contribute to the projector may affect decision-making in some areas. Secondary stakeholders may include relevant government agencies like Road Development Authority, DoE, Bangladesh Petroleum Corporation, community-based organizations, NGOs, and other interested individuals or groups.

545. Local government officials were invited with hand delivery letter of invitation from NWPGCL. Aside from the list of participants collated by CEGIS and invited through telephone calls, the two formal consultation events were advertised in the local paper to capture a wider audience. **Annex 4** presents a sample advertisement of the consultation in the local paper.

546. Checklists were used to guide the consultations to ensure that the discussions are focused and relevant. A summary includes information about the project, proposed implementation schedule, and potential project impacts. NWPGCL and CEGIS (Consultant of NWPGCL) made a project presentation and a question and answer (Q&A) portion immediately followed. Views and

concerns of the participants were recorded and their questions were properly responded to by NWPGCL, CEGIS, ADB staff (if required) and their consultants.

7.3 Consultations during the preparation of the EIA

547. During the initial preparation of the EIA, a total of six consultation events were conducted from 28 October 2016 to 13 November 2016 by the CEGIS, and again on 21 October 2017 to present the findings of the environmental due diligence (**Table 7.1**). Two consultation events (i.e., early stage of EIA preparation and presentation of findings) were participated by the ADB Project safeguard staff and consultants.

548. The two formal consultation[71] events were done on 12-13 November 2016 to present Component 1 and another on 21 October 2017 to discuss the outcome of the EIA conducted for Component 1. Aside from the NWPGCL Project Team, ADB safeguard staff, and consultants, the formal consultations were attended by government representatives from Khulna City Corporation, teachers from the KNM Boys & Girls Grade School that will be relocated, students, School Management Committee, journalists, fisher folks, and interested individuals. The first formal consultations on 12-13 November 2016 were participated by 91 attendees while the second formal consultationon 21 October 2017 was joined by 64 attendees (**Annex 5**). Aside from the primary stakeholders who previously joined the consultations in November 2016, the second consultation was attended by the Mayor, Khulna City Corporation, Councilor of Ward No. 13, and other local government officials. Photo documentation during the formal consultations is presented in **Annex 6.** A handout in Bengali was given to participants (**Annex 7**).

Table 7.1: Location of consultations

Division	District	Upazila	Municipality/ Union	Meeting type	Meeting Place	Date
Khulna	Khulna	-	Ward No. 13, Khulna City Corporation	Workshop	IEB conference room, Khalishpur	12/11/2016
		-		FGD	IEB conference room, Khalishpur	12/11/2016
		-		FGD	IEB conference room, Khalishpur	13/11/2016
Khulna	Khulna	Dighalia	Senhati	FGD	Chandonimahal village	13/11/2016
Khulna	Khulna	Batiaghata	Jolma	Rapid Rural Appraisal	Puthimari Bazar	28/10/2016
Khulna	Khulna	Batiaghata	Jolma	Group Discussion	Tetultola village	28/10/2016
Khulna	Khulna	Khalishpur	Khalishpur	Workshop	IEB conference room, Khalishpur	21/10/2017

7.4 People's perception of Component 1

549. NWPGCL and CEGIS discussed Component 1 to participants, its potential environmental impacts, and mitigation measures. Local people within the project site have already learned about

[71] Formal consultation is referred to as a consultation event where most of the participants are invited either by letter or phone call, advertisement of the event on the local paper, and venue agreed among the local people.

Component 1 from designated staff of NWPGCL and their consultants who frequently visited the project site. Thus, they are aware of some of the potential impacts but showed positive attitude towards the implementation of Component 1. **Table 7.2** presents the perceptions of the local people on Component 1.

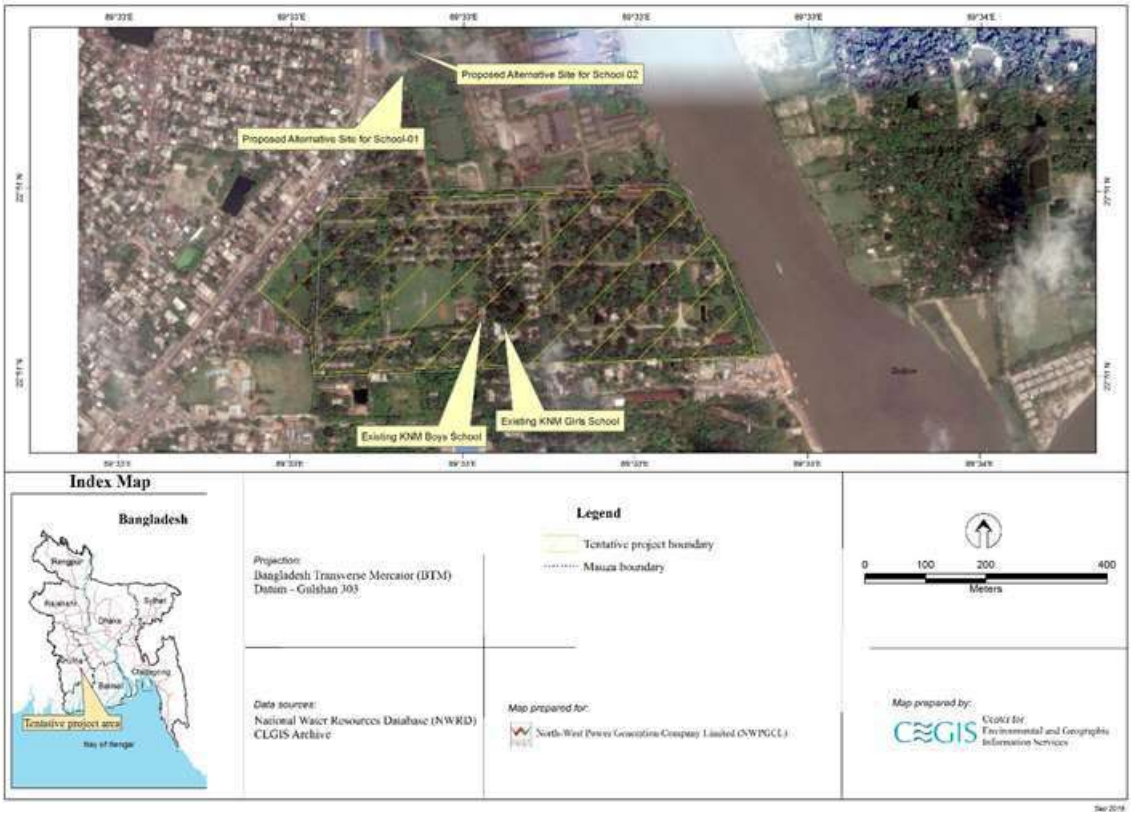
Table 7.2: Perceptions of local people to Component 1

Issues	Observations by the participants
Benefits from the Project	• Electricity will be generated which may have positive impacts on the local and national economy; • Reliable and stable supply of electricity; • Additional power generation capacity may result to setting up of new industrial area along with small and medium industry in the country • Project site is currently abandoned and not economically productive but proper use may motivate local entrepreneurs to start new industries in Khalishpur which may have positive impacts on land price and livelihood of the local people • Potential employment opportunities • Renovation of existing structures like the mosque and mass graveyard marker
Adverse impacts of the Project	• Regular activities of KNM boy's school and girl's school may be affected during the construction period • Potential loss of jobs among security personnel, caretakers, cleaners, and cooks involved with KNM maintenance • Some wildlife species (snake, frog, fox, insects) that found the abandoned KNM site as habitat may be affected • Livelihood of fishermen group may be affected indirectly as the Bhairab River is going to be used as transportation route for the power plant • Clearing of trees within the abandoned KNM site may adversely affect the natural environment • Demolition of abandoned structures at the current KNM site will cause generation of dust, noise, solid wastes and debris which may adversely affect students, teachers, and the local people

550. The existing boys' school and girls' school will be directly affected and, thus, will be relocated. The proposed 50 acres (or 20.2343 hectares) of land is still under the ownership of KNM and awaiting transfer to NWPGCL.

551. As a result of consultations, the school authority suggested three alternative relocation sites for the construction of new school building and campus but preferred the two relocation sites located in the KNM boundary: right side or left side of the main gate to the KNM property (**Figure 7.1**). The two preferred options are about 350 m to 400 m away from the current school campus.

Figure 7.1: Alternative relocation sites for the proposed school campus



552. **Table 7.3** presents the summary of consultations on 12-13 October 2016 while **Table 7.4** gives the summary of consultation on 21 October 2017.

Table 7.3 Summary of consultations, 12-13 November 2016

Issues	Concerns	Suggested measures
Socio-economic impact	• Existing two schools (one for boys and the other one for girls) will be relocated and it may adversely affect the regular study routine of the students and teachers • Staff who are currently involved in maintenance of KNM (night guard, caretaker, cleaner and cook) may lose their jobs • Around 100 fishermen households are residing across the project site on the opposite side of the Bhairab River. They are dependent on Bhairab River on navigation and may be indirectly affected by potential traffic along the	• New building for school should be handed over to the school authority prior to construction works • Existing school occupies 1.81 acre (or 0.732 ha). New school needs to be in the same amount of land. • New school campus should have facilities like playground, science laboratory, computer laboratory, library, canteen, sanitation facility, drinking water, waiting room for the guardians etc. • For the new school, the School Management Committee prefers the land within the Bangladesh Chemical Industries Corporation (BCIC) property

Issues	Concerns	Suggested measures
	river causing broken fishing nets during construction phase • Demolition of abandoned structures in the project site will generate wastes, dust, and noise • Potential increase in ambient noise level due to the power plant may disturb activities in the mosque, school, and residential areas	• Install noise barriers to keep the school away from potential increase in noise levels • NWPGCL to consider during recruitment those who may lose jobs from KNM due to the implementation of Component 1 • Location of power plant (machineries that generate noise) area should be kept far away from the settlements • Consider natural hazards like earthquake in the design of the new school • Provide prayer space/partition for the women in the mosque • Ensure that care and reverence are observed in the renovation/restoration of the mosque and the mass graveyard • Provide mitigation measures to fisherfolks who may be affected by potential traffic along the Bhairab River due to Component 1 • Consider engaging local people for activities such as land development, removal of the solid waste, and other non-technical works during pre-construction and construction stage • To reduce load shedding during irrigation period at the village level
Ecological impact	Site preparation will require clearing of trees that may adversely affect the natural environment and loss of habitat to some faunal species	• Save century-old trees (if any) and limit vegetation clearing to what is required • Rescue wild animals prior to construction works • Assign a wildlife expert to observe the condition and/or rehabilitation of animals based on Bangladesh wildlife Act that may be encountered during pre-construction and construction stage • Consider in the design avoiding trees. • Provision for afforestation within the project area

Table 7.4: Summary of consultations, 21 October 2017

Issues raised by participants	Response from NWPGCL and CEGIS
Modern technology should be adopted.	Latest available technology will be adopted for Component 1 to reduce air emission, noise level, and water extraction following the requirements of DoE and ADB. Some of these are: (i) low-NOx burner, (ii) stack height of 70 m for HSRG and 50 m for bypass, (iii) use of closed loop cooling water system, (iv)

Issues raised by participants	Response from NWPGCL and CEGIS
	wastewater treatment plant, and, (v) groundwater will not be used to meet water requirements.
Consider local experts' inputs (e.g. from Khulna University) on technical aspects of Component 1	NWPGCL and CEGIS to include inputs from relevant experts/teachers at the Khulna University during consultations or alternatively, Khulna University can access the documents to be posted in the website of ADB and NWPGCL
All mitigation measures identified must be implemented	Implementation of EMP will be monitored by NWPGCL from pre-construction to operation phase
To carefully review the EIA to ensure that people truly gain from the outcome of development	Project implementation will be monitored by NWPGCL from pre-construction to operation while ADB will monitor compliance of NWPGCL
To ensure health, safety and security at and around the project	• All safety measures required by GoB and ADB will be complied. • Workers will be trained on disaster and emergency preparedness including safety awareness. • First aid kits and the service of a trained physician will be provided as well as personal protective equipment to workers and staff who will need them
Relocation site for the boys and girls school needs to be finalized as early as possible	• Current condition of the schools is a safety risk for the students and relocation needs to be done as early as possible. • Selection of the relocation site will consider inputs from stakeholders like the School Management Committee, school authority, etc. including environmental and social considerations before submission of report to ADB and GoB • Two modern multi-storeyed schools' buildings will be constructed with better and modern school furniture • Two school buses (a bus per school) and laboratory with modern instruments, furniture will be provided • A solar panel will be installed as back-up during load-shedding of electricity (if it occurs) • A playground (bigger and better than the current one) will be included • The school will be ready before students move in • A clinic with ambulance service will be provided as well as safe drinking water system • EMP and monitoring plans will be implemented by NWPGCL and monitored for compliance by ADB
Mosque and graveyard of martyrs should be renovated and/or improved.	Relevant works for the renovation of mosque and graveyard of martyrs will be done with carefully and with reverence.
Livelihood of fishermen across the project site on the other side of Bhairab River may be at risk during the implementation of Component 1	NWPGCL and CEGIS conducted the study in the buffer zone considering 10 km radius from the project. No adverse impacts on river ecology were identified at Bhairab River and Atai River.
Rehabilitation programme should be introduced to affected fishermen	There is no need for a rehabilitation programme

Issues raised by participants	Response from NWPGCL and CEGIS
All the KNM security guards should be employed in the new power plant	• Newsprint mill has another factory with machinery and administrative office. The security guards affected will be employed by KNM authority in another place. • Should there be a need to employ security guards NWPGCL will consider them or other local people. • Recruitment of permanent staff at the power plant will follow the relevant Bangladesh civil service requirements.
Potential impacts on fish and biodiversity should be mitigated	IUCN is doing biodiversity assessment of Bhairab River, Atai River, and Rupsha River within the identified project area of influence focusing on the Ganger River dolphin. Their recommendations on management and monitoring will be considered for implementation by NWPGCL. The assessment is still ongoing.
Is there any experience of NWPGCL regarding this type of project in Bangladesh?	NWPGCL is an experienced and reputed company on combined cycle power plant technology. The existing 225 MW CCPP in Goalpara is owned and operated by NWPGCL.
Technical issues are not clearly understood. Is there any video document of combined cycle power plant using natural gas as fuel? If yes, please show us.	There are several video documentaries on natural gas combined cycle power plant in the internet. But due to lack of internet access in the location of consultations, we regret that we cannot show the video.
Is there any Government plan to provide electricity to all houses?	In Vision 2021, the Government aims to provide electricity to every home within 2021.

553. Consultations with stakeholders will continue during the implementation of Component 1. A communications strategy plan will be prepared with the technical support of a Consultant. This will ensure that stakeholders are engaged, as and when needed.

554. A project summary of Component 1 will be posted in the website of NWPGCL. In addition, a one-page flyer on project brief including details on grievance redress mechanism and contact person in case of complaints and/or concerns will be prepared in Bangla and will be made available at the field office of PMU in Khalispur, Khulna and at the NWPGCL office in Dhaka. More details on Component 1 will also be available from the EIA posted on the website of ADB.

8.0 GRIEVANCE REDRESS MECHANISM

555. Grievances, within the context of environmental assessment, are actual or perceived concerns about the implementation of Component 1. NWPGCL takes relevant concerns of their stakeholders seriously and ensures that they are considered as partners throughout the project cycle.

8.1 Current system at NWPGCL

556. NWPGCL manages grievance and/or complaints through the Grievance Redress System (GRS) which is required by the GoB and part of the mandatory Annual Performance Agreement (APA). This agreement will be signed and renewed annually between NWPGCL and GoB.

557. GRS requires the NWPGCL to designate a staff as Focal Point whose name and contact details are disclosed at the website of NWPGCL. Compliance to the GRS is a Performance Indicator in the APA. NWPGCL has designated its Focal Point as required by GRS and the details disclosed in its website.

558. The GRS consists of specified roles, rules, and procedures for resolving complaints, grievances, disputes, or conflicts systematically. The objective is to provide an effective and objective way of lodging and resolving complaints on public service delivery.

8.2 Grievance system required by SPS 2009

559. A grievance redress mechanism (GRM) will be set up once ADB funding for Component 1 becomes effective. Similar to GRS, the GRM aims to provide stakeholders with a clear and simple way of filing a complaint on the environmental performance of Component 1. According to SPS 2009, the GRM will address complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate and readily accessible to the affected persons at no costs and without retribution. Given these requirements, handling of potential complaints/grievance on the implementation of Component 1 will be as follows:

560. **Information disclosure**. NWPGCL will post signboards at the construction sites on the grievance mechanism including the details of the contact person who will take the grievance. Details of the grievance mechanism together with the project brief will be posted in the website of NWPGCL to capture a wider audience.

561. **Procedure.** The GRM will provide three-tier entry points in grievance redress.

First Level – Field officers: In case of grievances that are immediate and urgent on-site field officers (of the PMU) will provide the most easily accessible first level of contact. The officer will put the complaint in writing and record the date, nature and type of grievance. It is anticipated that field officers will be able to respond and resolve minor grievances, especially by working with on-site contractors etc. The field officer will respond (or resolve where possible) queries within two weeks. Contact phone numbers and names of the concerned PMU field officer will be posted at all construction sites at visible locations.

Second Level – PMU Grievance Committee: If no resolution or understanding is reached, the field officer files the grievance/complaint to the PMU grievance committee for it to be resolved within 15 days after filing. The PMU Grievance Committee will include:

(i) a Representative of NWPGCL (i.e. Project Director) - Convener; (ii) Social Safeguard Specialist – Member; and (iii) a representative of the affected people – Member.

A meeting can be called, if needed, to give the AP the chance to present the concern in person. During the meeting, the PMU committee will receive, clarify and simplify the issues involved and would try its best efforts to resolve the issues to be acceptable to both the AP and the PMU. If an agreement or resolution is reached, the resolution will be signed summarizing the points of agreements. If there was no such agreement, the matter is presented to the GRC.

Third Level –Grievance Redress Committee. The GRC will meet at short intervals subject to the number of grievances to resolve. The complainant may present their issue to the GRC in person and will be encouraged to bring along a friend, family member of third party for support. In case of complicated cases, the GRC members can request additional information or carry out field level verifications. Resolutions should be based on consensus among members, failing which the decision may be taken on majority vote. Any decision made by the GRC must be within the purview of RP policy framework and entitlements. The GRC will function throughout the life of the project loan and will not deal with any matters pending in the court of law.

562. **Composition.** NWPGCL will ensure the representation of women in the members of the GRCs which the following could be:

- Representative of NWPGCL, Convener;
- Representative of the Local Government Institution (City Corporation), Member;
- Local women member from City Corporation, Member;
- Representative of the affected people, Member;
- Representative of the DC, Member.

563. The APs, not satisfied from the decision of the GRC, will have their right to take the grievance to a court of law. The GRM will be continuously disseminated to people during project implementation. The Project grievance procedure does not impede access to the court at any time. This includes ADB Accountability Mechanism whereby people adversely affected by ADB-financed projects can express their grievances; seek solutions; and report alleged violations of ADB's operational policies and procedures, including safeguard policies.

564. **Responsibilities.** GRCs will be expected to: (i) resolve grievances filed in writing or by phone to any member of the PMU, (ii) convene at least once a month to review grievances lodged (if any), (iii) record the grievances and resolve the issues within 14 days or a maximum of 30 days from the date the grievance was filed, and (iv) report to the complainant(s) the status of grievance resolution and the decisions made.

9.0 ENVIRONMENTAL MANAGEMENT PLAN

565. The environmental management plan (EMP) covers measures that will be conducted in every phase of implementing Component 1 to ensure that adverse impacts are minimized and positive impacts enhanced. Aside from the mitigation measures, the EMP also includes the required monitoring and implementation arrangements with cost estimates.

566. The EMP includes several plans for implementing mitigation and enhancement measures including Emergency Response Plan (ERP), Occupational Health and Safety Plan (OHSP), and Environmental Code of Practices (ECPs).

9.1 Objectives of EMP

567. Broadly, the EMP aims to manage the potential adverse impacts associated with the implementation of Component 1. Specifically, the objectives include:

- To facilitate the implementation of mitigation measures identified to minimize the potential adverse impacts and to comply with the environmental requirements of GoB, ADB, and IFC-WB EHS General Guidelines 2007 (if needed);
- To maximize potential project benefits and reduce adverse impacts;
- To draw the roles and responsibilities for NWPGCL, the EPC Contractors, consultants, and other staff who will be involved in the implementation of Component 1; and,
- To incorporate stakeholders' engagement initiatives such as the Communication Action Plan.

9.2 Implementation Arrangements

568. NWPGCL has a total of six staff on environmental, chemical and safety managing EHS concerns related to their operations. According to the Annual Report 2015-2016 of NWPGCL, additional eight staff will be recruited to enhance the technical capacity on EHS.

569. For the Rupsha 800 MW CCPP, NWPGCL will set up a PMU who will be responsible for project management and safeguards compliance monitoring of the EPC contractor during the construction stage. Component 1 will be managed and supervised also by the PMU. NWPGCL will require the EPC Contractor to recruit an environmental staff (or a Consultant) who will be primarily responsible for ensuring that EMP is properly implemented during construction. This requirement for the EPC Contractor will be included in the Bidding documents. The Environmental staff (or consultant) of the EPC Contractor will coordinate and liaise with the PMU (NWPGCL) on compliance to ADB requirements, relevant government agencies and local authorities on clearances (as needed) and will prepare the environment section of the Project's Quarterly Progress Report (QPR) submitted by the EPC Contractor to the PMU. The environment section in the Project's QPR will be summarized by the PMU Environmental staff and submitted to ADB during construction phase as semi-annual environmental monitoring reports to ADB (see **Annex 8** for the format of environmental monitoring report). The semi-annual environmental monitoring reports are posted on ADB's website as required by SPS 2009 and PCP 2011. NWPGCL will submit the environmental monitoring reports starting from the date the loan becomes effective.

570. As soon as the detailed engineering design is completed, this draft EIA will be revised and or/updated to incorporate the changes (if any) and the new detailed information. The updated EIA

will be submitted to ADB prior to any construction works. The PMU Environmental staff together with NWPGCL Environmental staff will revise or update the EIA and submit to ADB for review. The revised and/or updated EIA of Component 1 will be re-posted on the ADB website to comply with the disclosure requirements of SPS 2009 and PCP 2011.

571. Before the start of any construction work, the PMU will inform the EPC Contractor on their responsibility to comply with the EMP and the requirements of DoE and ADB. The specific responsibilities of the EPC Contractor on the implementation and compliance to the EMP, environmental monitoring, and submission of environmental compliance status during the construction phase will be monitored by the PMU and the NWPGCL Corporate Environment staff (or Consultant).

572. During the operation phase, PMU will assign a staff (or Consultant) who will be responsible to handle the associated environmental issues and compliance to DoE and ADB's environmental requirements. Submission of environmental monitoring reports by NWPGCL to ADB during the operation phase will be annually. These environmental monitoring reports will be reviewed by ADB and will post them into their website as required by SPS 2009 and PCP 2011.

573. In the event of environmental impacts not identified in the EIA (unanticipated environmental impacts), or in case of non-compliance to any environmental covenant in the loan agreements, NWPGCL will prepare a corrective action plan (CAP) describing the process and the time-bound actions that will be undertaken to ensure compliance. The CAP will be submitted to ADB for review and disclosure to ADB's website.

9.3 Various Categories of Mitigation Measures

574. The EMP includes various categories of mitigation measures and plans: (i) general and non-site-specific measures in the form of ECPs;(ii) project-specific and to the extent possible, site-specific mitigation measures; and, (iii) Construction Environmental Action Plan (CEAP) with site-specific and construction-specific management plans to be prepared by the EPC contractor, which include pollution prevention, occupational health, safety and environment, and emergency response.

9.3.1 Inclusion of EMP in Contract Documents

575. In order to make the EPC Contractor fully aware of their responsibilities in ensuring compliance to EMP, technical specifications in the tender documents will include compliance requirements (addressing GoB, SPS2009 and IFC guidelines as applicable) and all mitigation measures identified for Component 1.In addition, there shall be provision in the clauses of the tender document that, in case of any unanticipated impacts identified during implementation of Component 1, the EIA will be revised and submitted to ADB for review, and re-posted to ADB website. The EPC Contractor will be responsible in complying with the EMP during pre-construction and construction phase.

9.3.2 Environmental Code of Practices

576. A set of ECPs has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9: Air Quality Management; ECP 10: Noise Management;

ECP 11: Protection of Flora; ECP 12: Protection of Fauna; ECP 13: Protection of Fisheries; ECP 14: Road Transport and Road Traffic Management; ECP 15: Construction Camp Management; ECP 16: Cultural and Religious Issues; ECP 17: Workers Health and Safety, ECP 18: Construction and Operation Phase Security; and ECP 19: Demolition work management. The Contractors will be contractually obligated to comply with these ECPs, presented in **Annex 9.**

577. The Contractor will prepare the CEAP to address pollution prevention, occupational health, safety and environment, and emergency response including the requirements of ECPs and EMP. These will be reviewed and approved by the environmental staff (or consultant) of PMU, NWPGCL before implementation of construction works.

9.4 Environmental Management Plans during Pre-Construction

9.4.1 Site Preparation

578. The site preparation would require cutting of trees and clearance of vegetation. The proposed project land was not used for storage or dumping of any kind of waste by the previous paper mill and the soil test results including ground water quality secondary data ensure no sign of soil contamination. The contractor shall have a detailed EHS related investigation before starting site preparation activities and in this regard, the contractor will prepare a specific site preparation plan on the basis of ECP 4, ECP 5, ECP 7, ECP 8, ECP 12, and ECP 13 including site preparation plan to ensure safeguarding of Occupation Health, Safety and Environment (OHSE). This plan must be submitted to Owner's Engineer (OE) for review and approval. A temporary scrub materials storage yard will be prepared and transportation route and system should be planned before starting of demolition work.

9.4.2 Demolition work management plan

579. The demolition works for the existing structures at the project site (151 structures) will be done through a sequential process. The abandoned buildings are all brick buildings and no hazardous materials noted. However, during demolition process, the specialized demolition contractor shall have to be engaged and they will follow OHSE procedures of international standards, GoB guidelines, (the ECP 20) and also proponent-approved demolition plan to protect workers and community health. An assessment on the presence of asbestos or asbestos-containing material will be done prior to any demolition works by a suitable qualified surveyor. A copy of the result of the assessment will be provide to ADB.

580. The demolition plan will include but not limited to:

- Protection of the location of the site on which the structure to be demolished and following pre-demolition measures are to be followed:
    - Underground essential services like drainage and sewerage system, gas line, water system, communication cables, liquid fuel lines or any process line like (lubrication, chemicals or acid) are to be cut off and removed as required.
    - Above ground essential services like electricity line, electrical pole to be removed.
    - Underground structures such as a basement, cellars, or storage tanks are to be taken acres as required.

- The overall height of the structure above ground level and the least distance from the structure to each site boundary are to be taken into consideration.
- The type of building (occupancy class), its structural support system and the principal materials of its construction.
- The proposed methods of demolition including the number and types of major itemsof plant.
- The proposed methods for handling and disposing of demolished materials and,in particular, of hazardous materials.
- The proposed methods of controlling and maintaining access and egress to workplace.
- The proposed sequence of carrying out the demolition works and an estimate of the time (in days) it is likely to be taken to complete all of each of the stages of the work.
- The proposed hoardings, scaffolding and fencing and of any overhead sidewalk protection.
- Any other plans, illustrations, written documents, or specialist reports including avoidance of loss of wild life and clearing of limited vegetation as may be necessary to support the proposed methods of work or protective structures.
- Traffic management arrangements, which includes managing vehicles and mobile plant hazards in relation to operation at the workplace and interaction with the public.
- Demolition process shall be conducted cautiously particularly near to the old mosque and graveyard area to avoid cracks on these structures due to excessive vibration. In addition, precaution shall also be taken with consultation of engineers before starting of the demolition activities to avoid vibration cracks including excessive noise and dust particles which will have impact on the people coming for prayer and visiting graveyard.
- The general condition of structures on adjoining properties, particularly where these are close to or on the boundaries of the demolition workplace to be taken care off.
- The effect demolition may have on people working in adjoining properties or seeking access to and egress from those properties, and,
- The emergency arrangements, which should include equipment for the rescue of injured persons.

9.4.3 Solid Waste/Garbage

581. A waste collection and disposal system will be adopted in managing solid waste/garbage generated during the construction phase. The aim is to reduce generation of solid waste. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc. will be collected depending on the type of materials and managed separately. Some temporary bins with different color indicating disposal of degradable and non-degradable wastes will be installed at the construction sites. Waste collected will be disposed of at a suitably designed and licensed designated place approved by GoB. Burning of waste at the construction sites and on-site disposal will not be allowed.

9.4.4 Stakeholder engagement plan

582. The stakeholders will be engaged, as appropriate, to create and foster good relationship and smooth implementation of Component 1.PMU, NWPGCL will identify the stakeholders who

are directly and indirectly impacted by relevant project activities. With the support of experts, PMU, NWPGCL will develop a stakeholder engagement plan/communication action plan prior to construction works. PMU, NWPGCL will ensure that relevant project information will be disclosed to stakeholders by posters, billboards, etc.

583. PMU, NWPGCL will establish a Grievance Redress Mechanism (GRM) to handle potential complaints/concerns related to Component 1. **Chapter 8** of this EIA provides guidance on GRM. Signboards about the GRM will be set-up at the construction sites and other community locations (school, local government office), with phone number/email for submitting grievances.

9.4.5 Relocation plan

584. Relocation of the Schools is a prime issue for successful implementation of this project. The schools will be constructed prior to any civil works for Component 1. NWPGCL will ensure that this process will be executed properly to avoid inconvenience and disruption to the students and the education system.

9.4.6 Drinking Water Supply and Sanitation Plan

585. A separate water supply and sanitation (with mobile STU) will be provided at the construction site. Safe drinking water will be provided by Khulna City Corporation water district. A Plan will be prepared by the EPC Contractor on basis of ECP 3. The Plan will be submitted to PMU, NWPGCL for review and approval before contractor mobilization.

9.4.7 Management of surface water for navigation and consumption

586. Conveying of machineries, equipment, and construction materials through waterway is cheaper and easier for Component 1 but will ensure proper navigational depth. The Bhairab River is classified by BIWTA as Class II for navigation.

588. A detailed plan will be prepared by the EPC Contractor referring to ECP 3 and also the given mitigation plans in this EIA, after discussion with PMU, NWPGCL, and relevant authorities. The Plan will be submitted to NWPGCL for approval.

9.4.8 Riverbank erosion management plan

587. Protection measures against erosion at the eastern boundary of project site along the Bhairab River shall be undertaken before any land development. A detailed plan will be prepared by EPC Contractor and submitted to PMU, NWPGCL for approval.

9.4.9 Flooding management plans

588. Component 1 is located at elevation +3.5 m and +2.3 m MSL towards the bank of the Bhairab River while the surrounding area has an elevation of approximately between EL+3.5m and EL+3.2m (MSL). Towards the bank of the Bhairab River is approximately between EL+3.5m and EL+2.3m (MSL). According to BWDB, the highest water level in Khulna is 3.86 m which occurred in 2005 based on yearly water level since 1946. Hydrological investigation on the Bhairab River by the Bangladesh Power Cell in May 2016 indicated a maximum flood level at 3.86 m PWD or 4.32 MSL with a return period of 100 years. To ensure protection from potential flooding due to extreme climatological condition, a flood management plan will be prepared by the EPC

Contractor referring to ECP3, the EMP, and consultation with relevant authorities. The plan will be submitted to PMU, NWPGCL.

9.4.10 Habitat management plan

589. The development of new green belts will help in the protection and conservation of visiting animals and will also provide habitat for roosting and nesting place of birds. The existing mosque and graveyard area are also covered with dense vegetation that created habitats for some animals.

590. **Annex 10** presents a faunal rescue procedure that can guide the EPC Contractor during site preparation to ensure that disruption to wildlife is minimized and rescue initiated, as needed. A habitat management plan will be prepared to provide guidance to NWPGCL in restoring some open spaces after construction works.

9.5 Environmental Management Plans during Construction

591. The EPC Contractor is expected to address the following:

9.5.1 Solid Waste/Garbage

592. Similar to the pre-construction phase, a waste collection and disposal system will be adopted in managing solid waste/garbage generated during the construction phase. The aim is to reduce generation of solid waste. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc. will be collected depending on the type of materials and managed separately. Some temporary bins with different color indicating disposal of degradable and non-degradable wastes will be installed at the construction sites. Waste collected will be disposed of at a suitably designed and licensed designated place approved by GoB. Burning of waste at the construction sites and on-site disposal will be strictly prohibited.

9.5.2 Construction waste management plan

593. The EPC Contractor will be required to prepare a construction waste management plan to ensure that waste generated during construction phase are collected, transported, and disposed of properly. Measures such as limiting site clearance activities, planned/scheduled stocking-up and delivery of materials for construction, covering of equipment; fencing around the construction site, and strictly enforcing good housekeeping at all times at the construction site will be implemented. A temporary garbage dumpsite at the construction site will be identified in consultation with the environmental staff of NWPGCL. The EPC Contractor will ensure that no garbage or waste will be dumped/discharged to the Bhairab River. Hazardous material from construction site including fuel and other combustible materials shall be stored at a designated place. Spillage, accidental release of chemicals will be controlled following the Material Safety Data Sheet (MSDS).

9.5.3 Fisheries Resources

594. Fisheries management is ongoing covering the river system within the project area. GoB enforces fishing ban in the river systems during breeding/spawning period to avoid overfishing. In addition to this, NWPGCL will ensure that fishing ban is observed and no worker will do fishing along the stretch of the Bhairab River close to the project site.

9.5.4 Pollution Prevention Plan

595. A pollution prevention plan will be required by PMU, NWPGCL to the EPC Contractor referring to ECP 1, ECP 2, ECP 11, and the IFC-WB EHS General Guidelines. The plan will be subject to approval of PMU, NWPGCL.

9.5.5 Waste Disposal and Effluent Management Plan

596. Waste Disposal and Effluent Management Plan is mandatory to manage the construction waste and effluent including waste and effluent from labor sheds. A detail plan will be prepared and implemented by the Contractor on the basis of ECP 1, ECP 4, and EHS Guidelines, as well as the mitigation plans given in this EIA. The Plan will be submitted to the PD for review and approval before contractor mobilization.

9.5.6 Traffic Management Plan

597. The project site is well connected for transportation of materials via Khalispur main roads and also river routes using Rupsha –Bhairab river system. Construction materials such as sylhet sand, bricks, cement, roads can be brought via river and roads as well. The land filling materials can be brought via river. As such, the number of truck loads and river vessels are not quantified at this stage. Therefore, it is suggested that, EPC shall develop a plan for transportation of materials during construction period and also quantify the possible number of vehicles and movement including loading unloading time. On the basis of that plan a traffic management plan will have to be developed and notify accordingly to the local residents for avoiding accidents. The detail plan will be prepared by the Contractor on the basis of ECP 15 and also the mitigation plans given in this EIA, after discussion with PMU and authorities responsible for roads and traffic. The Plan shall be submitted to the PD for their review and approval before contractor mobilization.

9.5.7 Labour recruitment plan

598. The labour recruitment policy should be formulated in such a way so that the local labours can get preference in employment in the project activities. If these labours are found to have no previous experience on such type of technical jobs, it is suggested that, the authority can recruit them for non-technical activities of the project or the authority can facilitate technical trainings for them.

9.5.8 Occupational and community safety risks

599. The transportation of the waste and other materials should be in safe manner considering the rule of road traffic. Make mandatory the use of safety gears (helmets, safety belts, masks, gloves and boot) by workers depending on nature of work Necessary planning and safety approach will be made for rescue during emergency Workers will be provided with first aid and health facilities at the site. There will be provision for group accidental insurance for the workers. Child labour is strictly prohibited in all the activities executed by the contractors. Occupational health and safety performance should be evaluated against internationally published exposure guidelines as permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA). Indicative Occupational Exposure Limit Values published by European Union Member States or the similar sources.

9.5.9 Good Handling and Operation of Construction Equipment

600. The equipment and machinery for construction activities should be handled and operated in a way that would ensure low noise, low emission of SO_x, NO_x, smoke, no oil leaks, no accidental event, etc. A detail plan of handling and operation of construction equipment will be prepared by each Contractor on the basis of ECP 2, 10 and 11. The Plan will be submitted to the PD for review and approval before contractor mobilization.

9.5.10 Fuel and Hazardous Substances Management Plan

601. The plan will be prepared by each Contractor on the basis of ECP 2 as well as the mitigation plans given in this EIA and in accordance with the standard operating procedures, relevant guidelines, and where applicable, MSDS. The Plan will include the procedures for handling oils and chemical spills. The Plan will be submitted to the PD for review and approval before contractor mobilization.

9.5.11 Communication Plan

602. A communication plan has been prepared and presented in **Table 9.1** while carrying out the communication plan modifications of process and planning may be done as per the Project's requirement.

Table 9.1 Communication Plan Adopted for the Project

Stakeholder	Information/Message	Communication Means	Timing/ Frequency	Responsibility
PAPs	Project awareness (general project information, etc.)	Consultations	Regular basis	Project Authority
	Employment opportunities	Government procedure: for new recruitment at AE position informed public by TV, radio, newspaper (English / Bangla); for others, NWPGCL internal system.	4 weeks before recruitment / job opening	PIU, NWPGCL
	Grievance redress to be continued throughout project implementation period	Consultations, Application, Register	Office time	Local Administration and Project Authority
General population (Local)	Job, opportunities, CSR	Poster, local daily newspaper, consultation	3 to 4 weeks before recruitment	PMU, NWPGCL
Fire Service	Incidents of disasters	Telephone, cell phone	Immediately when any incident is detected	PMU, NWPGCL
Police Station	Incidents of disasters and security issues	Telephone, cell phone	Immediately when any incident is detected	PMU, NWPGCL

Source: CEGIS, 2016.

9.5.12 Surface water availability management

603. Navigation is important to convey the construction materials and machineries / mechanical equipment at this stage. Water is required for piling, mortar mixing, sprinkling the ground, curing the concrete and other purposes including kitchen and washing during construction. A detail plan will be prepared by the Contractor on the basis of ECP 3 and also the mitigation plans given in this EIA, after discussion with PMU. The Plan will be submitted to the PD for their review and approval before installation.

9.5.13 Level of salinity management plan

604. Salinity intrusion is a common occurrence in the study area due to the tidal influence of the Bay of Bengal on the river systems. A detailed plan will be prepared by the EPC Contractor on the basis of ECP 3 and also the mitigation plans given in this EIA, after discussion with PMU. The Plan will be submitted to the PMU, NWPGCL for their review and approval.

9.5.14 Riverbank erosion management plan

605. Monitoring of riverbank protection works along the right bank of Bhairab River as well as project's eastern boundary at the preconstruction stage, should be done properly for its stability. A detail plan of monitoring will be prepared by the Contractor on the basis of ECP 6 and also the mitigation plans given in this EIA, including bank protection design, after discussion with PMU and authorities responsible for riverbank protection work. The Plan will be submitted to the PD for their review and approval before installation.

9.5.15 Flooding management plans

606. Similar to pre-construction stage, a detailed plan to manage potential flooding due to climate change will be prepared by the EPC Contractor referring to ECP 4 and also the mitigation plans given in this EIA, after discussion with PMU and authorities responsible for flood or water resources management. The Plan will be submitted to PMU, NWPGCL for review and approval.

9.5.16 Green belts development

607. A significant portion of the total project area will be covered with greenbelts. The tree plantation will be done considering maximum yearly average wind direction and tree height and carbon stock. The green belts will be developed following the guideline of the Department of Social Forestry. Along with following guidelines during green belt development will be considered.

- Limiting vegetation clearance and base stripping within project boundary.
- Local and indigenous species should be chosen for green belt development.
- In green belt plant composition should be made considering plant of different height and different canopy size to reduce sound pollution.
- Along the project area, local species e.g. Coconut (*Cocos nucifera*), Teak (*Tectona grandis*) , Mahogony (*Swietenia mahagoni*) , Mango (*Mangifera indica*), Jack Fruit (*Artocarpus heterophyllus*), etc. should be planted.
- Plantation should be made following the guideline of the Department of Forest.

9.6 EMP during Operation Phase

608. With reference to the possible significant environmental impacts during operation stage identified in **Chapter 5**, impact specific EMP has been prepared.

9.6.1 Sewerage Management Plan

609. Component 1 will have an STP as an integral part of the facility. The design will meet the requirements of ECR 1997, WHO, and IFC-WB EHS General Guidelines 2007. The treated water will be reused for gardening and other general purpose washing. The sludge from the STP shall be disposed of in accordance with ECR 1997.

9.6.2 Wastewater Management

610. Component 1 will also have an ETP to manage wastewater generated during the operation phase. An oil-water separator will be installed to handle oily waste from the workshops, machinery repair and vehicle area. Disposal of spent chemicals used to minimize biofouling in the cooling tower and other equipment will be in accordance with the MSDS of the chemicals. Process chemicals will be selected to ensure that they are environment-friendly and no special treatment will be required for their disposal. Chlorine dosing for ETP will refer to the MSDS, IFC-WB EHS General Guidelines 2007, the USEPA limits and FAO. Treated wastewater will be re-used for gardening or other general purpose washing. The treated effluent will comply with ECR 1997 and for the ETP with IFC EHS Guidelines on Thermal Power 2008.

9.6.3 Sludge from the wastewater treatment plant

611. The sludge from the wastewater treatment plant will be disposed of properly. Iron rich sludge from water pre-treatment and demineralization plant might be utilized in the industries which use iron as raw materials. The EPC contractor should explore the market of the iron sludge. Generally, there is a good demand of iron sludge in steel re-rolling mills. The sludge from oily water separation unit should be managed properly with due treatment and disposing in scientific pit. It should be disposed in accordance with the Hazardous Waste and Ship Waste Rules 2011.

9.6.4 Solid Waste Management

612. This project will develop a waste prevention strategy, which will significantly reduce the total amount of waste. The strategy will focus on recycling and the facility wise implementation of recycling plans, considering the following items (as per Financer/IFC Guidelines):

- Evaluation of waste production processes and identification of potentially recyclable materials.
- Identification and recycling of products that can be reintroduced into the operation of the plant.
- Investigation of external markets for recycling by other power plant operations located in the neighborhood or region of the facility (e.g. waste exchange).
- Establishing recycling objectives and formal tracking of waste generation and recycling rates.
- Providing training and incentives to employees in order to meet these objectives.

9.6.5 House Keeping

613. This project will implement a good house-keeping practice, such as the sorting and placing loose materials generated from different repairing activities in the established areas away from common workspace, cleaning up excessive waste debris and liquid spills regularly, locating electrical cords and ropes in common areas and marked corridors.

9.6.6 Occupational Health Safety and Environment

614. A detailed Occupational Health, Safety and Environment (OHSE) Plan has been prepared including the following:

- Occupational Hazard Identification and Control Plan
- Inspection and Auditing Plan
- Leadership and Administration Plan
- OHSE Communication Plan
- Required PPEs
- Site Security Plan
- OHSEProgram for the Contractors/Sub-Contractors
- Preventative Maintenance Plan
- Incident Investigation Mechanism

9.6.7 Fisheries Resources

615. Fisheries management plan has been developed with the aim of avoiding pollution causing activities and to protect fisheries of the Bhairab River. The EMP includes the following:

Measures for plant operation

- Should follow the EMP including regulatory guidelines for effluent treatment. Power plant will be operated on the basis of zero discharge, no discharge of effluent to the Bhairab River will be permitted.
- On-site wastewater should be treated to achieve maximum reuse and recycling.

Measures for water intake structure

- The water supply pipeline intake point from the feeder canal should be provided with sufficient screening to filter out larger aquatic organisms (e.g. fish, frogs, and toads) and foreign matter, preventing this material from being drawn into the pumps. The pums will be appropriately covered to reduce noise level within acceptable limit of Noise Pollution Control Rules (2006) and IFC standards which ever is stringent and appropriate.
- Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible.
- The water velocity in the intake channel should be below 0.5 Ft/s during normal conditions.
- Monitoring should continue to ensure that the deterrents are working effectively.
- Fish including dolphins Conservation Program, e. g. installation of barrier net and screens.
- Enforcement of fishing ban in the Bhairab river during breeding/nursing period.

9.6.8 Ecological Environment

616. All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal to the designated area and never release to the Bhairab River. Crews and other staffs of the cargo/ship should be well aware of the consequence of oil spills and all other discharges shall follow ECR 1997 of GoB and also IFC standards whichever is stringent and appropriate.

9.6.9 Community exposure to diseases

617. NWPGCL will evaluate the risks and impacts to the health and safety of the affected communities during operation phase. An emergency preparedness and response mechanism will be developed in consultation with the affected communities close to Component 1. A continuous ambient air quality monitoring station will be installed downwind of Component 1 to monitor ambient air quality. With this, there will be now two continuous ambient air quality monitoring station: one from DoE and one from NWPGCL.

9.6.10 Surface water availability management

618. Monitoring of navigability and consumption of water of Bhairab River in the study area is important for assessing water demand and supply in dry season. The planning and monitoring agency should be initiated at this stage. All other additional factors related to these issues should be included and taken under consideration for the fruitful operation. So, a detailed plan for monitoring will be prepared by the proponent on the basis of ECP 3 and also the mitigation plans given in this EIA. The Plan will be submitted to the PD and PMU.

9.6.11 Level of Salinity management plan

619. The bank protection of the project area shall be maintained throughout the project period. The salinity level increases during the dry season and to reduce salinity level to meet the plant requirement, the intake river water will be treated through the reverse osmosis (RO) plant. Treated water from the RO plant will be fed to the water system and the waste containing brine (68.5m^3/hr) will be further treated through the ETP prior to reuse for other purposes. Power plant will be operated on the basis of zero discharge, no discharge of effluent to the Bhairab River will be permitted.

9.6.12 Riverbank erosion management plan

620. The riverbank erosion protection works along the eastern side of Component 1 will be monitored for stability. A detailed plan of monitoring will be prepared by the EPC Contractor on the basis of ECP 6 and mitigation measures in this EIA. The Plan will be submitted for review and approval to the PMU, NWPGCL.

9.6.13 Flooding management plans

621. The HFL along the Bhairab River has been incorporated in the design of Component 1. However, given the uncertainty of climate change, a detailed drainage management plan will be prepared by the EPC Contractor referring to ECP 4 and the relevant mitigation measures in this EIA. The Plan will be submitted for review and approval to the PMU, NWPGCL.

9.6.14 Safe Work Practices and Procedures

622. Safe work practices and procedures will be incorporated in the OHSE plan. Together with the OHSE plan will be an OHSE management system (**Table 9.2**)

Table 9.2: OHSE Management Systems and Key Responsibilities Register

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors)* *(to follow)***
1. Policy and commitment		
Make a draft OHSE Policy for Project director for approval	□ Communicate policy. □ Provide leadership in line with policy commitments. □ Assess any changes to organization structures, activities, processes, etc. for OHSE implications.	□ Feedback ideas for changes to policy. □ Understand policy and follow intent. □ Follow OHSE processes.
Collate changes and publish.	□ Assist with important changes.	
2. Legal & other requirements		
Monitor legal requirements and produce a monthly report to communicate relevant changes to the business.	□ Implement actions required to ensure legal compliance. □ Communicate requirements, including any changes to work programs or practices, to staff.	□ Follow procedures, work instructions etc. as these should be in compliance with legal and other requirements. □ Report issues where procedures / work instructions may not be in compliance with legal requirements to Manager or OHSE representatives.
Develop corrective and preventative actions to ensure that relevant changes to legal requirements are incorporated into OHSE documentation.		
Update OHSE processes.	□ Assist with important changes.	
3. Hazard identification & risk management		
Coordinate strategic risk assessment process within lines of business.	□ Ensure risk assessments are carried out and registers are updated. □ Understand key risks and mitigation measures.	□ Understand key risks and mitigation measures relevant to their own areas. □ Report new risks and hazards. □ Participate in risk reviews. □ Report potential gaps in controls.
Facilitate Site Hazard Register development and maintenance.	□ Coordinate Site Hazard Register development and maintenance, including providing adequate resources.	
Provide OHSE technical advice on the development of project risk assessments and plans.	□ Ensure controls are in place to control identified risks.	
Provide technical advice on the development of operational risk assessments and plans.	□ Coordinate development and implementation of operational risk assessment and plans, including providing adequate resources.	
4. Planning & objectives		
Coordinate the development of strategic OHSE plans.	□ Engage and provide resources to enable strategic assessment and subsequent plans to be developed.	□ Be involved in the development and implementation of OHSE objectives, targets and programs.
Advise and propose OHSE objectives, targets and improvement activities.		

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors) (to follow)***
Facilitate the development of OHSE programs and advise on OHSE strategy.		
5. Accountability & Leadership		
Ensure that OHSE accountabilities, roles and responsibilities are clearly documented in OHSE documentation and communicated in OHSE training.	□ Ensure OHSE accountabilities and requirements are identified and documented in Work Plans and Position Descriptions. □ Lead and support OHSE system requirements. □ Provide adequate supervision and leadership to staff (especially new starters).	□ Ensure OHSE requirements are understood and met □ Participate in the continual improvement of the OHSE system.
6. Awareness, training & competency		
Coordinate OHSE training needs analysis for the development of a comprehensive training requirements register.	□ Conduct OHSE training needs assessment for the team. □ Ensure teams' training requirements are communicated to OHSE representatives for inclusion in the OHSE training program.	
Incorporate core OHSE training requirements in the training requirements register.		
Facilitate OHSE training program.	□ Understand training and competency requirements for personnel they are responsible for (including contractors).	□ Sign up to and attend training. □ Understand competency requirements and make sure they are met.
Coordinate and deliver some in house training (e.g. OHSE system training, OHSE inductions, OHSE risk management, etc.).	□ Ensure staffs (including contractors) are trained and competent to do the work assigned to them.	
Maintain records of training required, training attendance and competencies awarded (via HR).	□ Incorporate OHSE training requirements into data management system. □ Make people available to attend training. □ Ensure records of training and competency requirements, training attendance and competencies awarded are documented within their jurisdiction.	□ Provide evidence of prior learning, licenses or other relevant competencies required to do the assigned work. □ Provide feedback on training suitability and quality.
7. Communication, consultation & involvement		

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors) (to follow)***
Ensure that management and staff are consulted when changes are made to the OHSE system.	□ Ensure staffs are consulted when changes are made to assets and operations that might affect OHSE policies and procedures.	□ Participate in team meetings and communicate/raise OHSE concerns, issues, key learning and wins. □ Participate in OHSE policies / procedures review.
Provide monthly OHSE report with key learning.	□ Communicate OHSE issues at team meetings (e.g. monthly status and key learning).	□ Engage with and discuss monthly reports and key learning.
Compose and circulate OHSE alerts.	□ Respond to OHSE issues / concerns.	□
Compose and circulate program newsletters and updates.		□ Read OHSE communication items and attends communication sessions.
Communicate changes to OHSE policies and procedures to management.	□ Communicate relevant information on OHSE system changes to staff.	
Develop and maintain OHSE Essentials web portal.		
8. Document & record management		
Maintain OHSE documentation, including: Filing OHSE records such as assessments, plans and reports. Developing and distributing monthly report for project director. Developing and maintaining internet sites to enable ease of access to OHSE documents and information Reviewing and updating OHSE documentation. Maintaining OHSE documents and records in accordance with OHSE system requirements.	□ Ensure resources are available to manage documents and records. □ Ensure documents and records are adequately managed.	□ Manage documents and records as required.
Manage OHSE document change requests.	□ Ensure area-specific OHSE process requirements are appropriately documented.	□ Provide input into development of OHSE documents. □ Raise OHSE document change requests where gaps or issues are identified. □
9. Assets & operations		

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors) (to follow)***
Administer OHSE operational control processes.	□ Identify OHSE risks associated with assets and operations, ensuring they are recorded in OHSE risk registers. □ Ensure controls and processes are implemented to adequately manage OHSE risks.	□ Be involved in the development of OHSE risk management programs, plans and processes.
Facilitate strategic and operational risk management processes to enable the development and implementation of appropriate control measures.	□ Document all monitoring and measuring processes implemented in order to demonstrate that controls are effective.	□ Implement / follow OHSE risk control measures.
Provide professional advice to business units on OHSE management and improvement initiatives.		
10. Project management		
Provide advice and support to project managers in the development and implementation of project OHSE Management Plans.	Project Team Managers: □ Ensure that OHSE Risk Assessments are conducted for all projects. □ Understand their OHSE accountabilities.	Project Managers: □ Ensure that project OHSE management plans are developed and implemented.
Lead and participate in project-related OHSE initiatives.	□ Participate in, and inform staff of, project-related OHSE initiatives.	
Ensure other OHSE procedures support project management (e.g. Hazard ID and Risk Management, Audit, Management of Contractors & Suppliers)		
□ Management of contractors & suppliers		
Document process to ensure OHSE risks associated with contractors and suppliers comply with legal requirements (OHSE and Contracts & Procurement processes)	□ Ensure process for managing contractors and suppliers are in place and followed. □ Ensure relevant personnel are trained in contractor and supplier management, as required (e.g. project managers).	□ Follow OHSE processes around contractors and suppliers. □ Monitor contractor / supplier compliance with OHSE system requirements.
11. Emergency preparedness		
Facilitate strategic emergency assessment and planning processes. Guideline- Refer to Emergency Response Plan that attached in the EIA report	□ Identify potential OHSE emergencies.	□ Understand roles and responsibilities in Emergency Response Plan situations
Provide advice on assessing emergency risk and planning adequate responses.	□ Ensure adequate response plans are resourced, developed and maintained	□ Attend OHSE emergency training and participate in drills.

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors) (to follow)***
	□ Ensure adequate drills, training and response equipment are resourced, maintained and in place.	□ Be involved in debriefs and response plan improvements.
Facilitate the development of emergency response plans, when required.		
12. Monitoring & measuring		
Provide data to measure OHSE performance	□ Review performance data and agree on improvement programs	
Recommend programs based on review of OHSE performance	□ Ensure equipment used to monitor OHSE performance is maintained, calibrated etc. people are trained e.g., gas detectors.	□ Ensure relevant procedures are followed.
13. Incident management		
Provide technical advice on incident investigations and the development of corrective actions.	□ Ensure OHSE incidents are reported and investigated as per the procedure. □ Ensure root causes are identified and actions implemented to prevent recurrence.	□ Complete and submit incident reports for all health, safety or environmental incidents, hazards and near-misses. □ Participate in incident investigations as required.
Audit the Incident Management procedure. Analyze incident data to identify trends and communicate them to management.		
14. Audit		
Develop and facilitate annual internal OHSE audit programs	□ Consider audit requirements and nominate projects or processes to be audited.	
Conduct OHSE audits	□ Participate in audits. □ Make staff and resources available to auditors. □ Develop and implement actions from audits.	□ Participate in audits. □ Develop and implement actions from audits
Facilitate OHSE certification process (ISO 14001 and OHSAS 18001)		
15. Management review		
Facilitate OHSE management review processes.	□ Conduct OHSE management reviews. □ Develop actions and programs aimed at continual improvement of OHSE performance. □ Communicate and implement OHSE improvement programs.	□ Participate in OHSE management review process through employee representatives attending Executive Safety Team meetings. □ Participate in relevant improvement programs.

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer – NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors)* *(to follow)***
Provide data analysis and information for OHSE management review processes.		

623. EPC contractor will prepare site specific OHSE plan based on the general guidelines for OHSE plan and present to OE and PIU for approval. The plan should address all pertinent issues to create a work place that protects worker health and safety with due respect to the environment and promote an atmosphere to grow employee learning and opportunity in a way that is fulfilling, recognized and fairly rewarded during construction phase of the project. **Table 9.3** presents general expectations from the EPC contractor while implementing the OHSE plan.

Table 9.3: Expectations from the EPC Contactor

Commitment and Leadership	Management shall provide strong visible commitment, leadership and personal involvement in health, safety and the environment. Management shall make available the resources necessary to achieve NWPGCL's OHSE objectives.
Policies and Objectives	Develop and communicate policies demonstrating a commitment to OHSE that is consistent with, and at least equal to, other business aims. Supporting objectives shall be defined, deployed and maintained at all organizational levels.
Organization, Resources and Documentation	Define, document and communicate the roles, responsibilities and accountabilities to enable every individual to fulfill their role in improving OHSE performance.
Risk Evaluation and Management	Continually evaluate the OHSE risks to the workforce, customers and the environment. Continually evaluate processes and activities for specific hazards-assess potentials, record and control the subsequent risk to a tolerable level.
Planning	OHSE considerations shall be integral to all aspects of business planning or changes in the design, development, purchasing and delivery of our products and services.
Implementation, Recording and Monitoring	Determine and record whether those actions are effective. Activities shall be conducted in accordance with defined standards, and continuous improvement shall be promoted and monitored through active employee participation.
Audit and Review	Audits and reviews shall be conducted to verify the implementation and effectiveness of the OHSE Management System and its conformation to this specification.

9.7 EMP to Address Cumulative Impacts

9.7.1 Air Quality Management

624. Emission of CO, SO_2. NO_x, PM from the future upcoming industries would add additionally to the proposed project case scenarios of the ambient airsheds. Increasing amount of industries and vehicular activities would increase the ground level concentration of the criteria pollutants. Based on cumulative impact assessments though CALPUFF dispersion modelling predicted that concentration of PM_{10} and SO_2 will exceed the guideline of IFC Thermal Power Plants 2008 but within the IT value -1. The concentration of PM is relatively higher due to lots of reasons in the cities of Bangladesh. Road dust, area sources, households, pollens are the major sources of PM. The combustion of gaseous fuels such as natural gas does not produce significant particulate matter. But other industries like brick kilns or open firing of the solid wastes contribute for

increasing of PM. However, NWPGCL should take initiative at the policy level to reduce emissions from selected facility. DoE can take action to bring specific facility in compliance. In addition, a trade-off between heavy and low polluting industries should be established with the initiative of DoE. For ensuring a sustainable development and pollution free airshed, some policy intervention and strategic initiatives are very much required.

9.7.2 Noise Management

625. A comprehensive plan for noise reduction and attenuation is required to control ambient noise limit within the permissible level. Therefore, the contractor should develop an integrated plan on the basis of ECP 11. Develop a greenbelt around the power plant boundary to separate the project area from the surrounding areas.

626. In addition, NWPGCL needs to take initiatives to construct at least 3m high brick wall having capacity of noise attenuation at outer boundary of the RMS and other units to buffer noise propagating to nearest community.

9.8 Mitigation Plan

627. The mitigation plan presented in **Table 9.4** includes various actions, defines responsibilities for implementation as well as supervision of each action, and also indicates the timing of these actions. After this assessment stage, if there are any changes to the Project design or methods of construction and operation, the impacts and mitigation measures discussed may need to be revised. To address the changes, the environmental and social implications will require re-addressing.

Table 9.4: Mitigation Plan

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
PRE-CONSTRUCTION AND DEMOLITION PHASE				
Pre-construction requirements		• Baseline air, noise and water quality surveys during pre-construction per Table 9.6 to be undertaken at least one month prior to commencement of any works including demolition to provide a comparator for monitoring results • Detailed design to ensure structural engineering design of the power plants meets the applicable seismic design standards for its location Include for demolition and construction: • If potential archaeological remains are found immediately cease activities and consult archaeological department. • Bid documents will include a copy of the EIA/EMP and specify regulatory requirements, permits/standards/codes by which the demolition and EPC Contractors will be required to comply.	Demolition contractor EPC Contractor PMU	NWPGCL

		• Update EIA based on detailed design and submit to ADB for clearance prior to the commencement of any works. • Health impact assessment should be completed and included in the update of EIA based on detailed design. • Obtain national environmental clearances and other required permits before the commencement of any works. • Ensure compliance with all national regulations including per Table 2.1 of EIA. • Prior to I works, PMU will have an orientation briefing for EPC Contractor and their workers about the environmental requirements by the DoE and ADB that need to be complied with, their roles and responsibility for compliance, record keeping and reporting, awareness on socially transmitted disease like HIV/AIDS to avoid the potential occurrence of this diseases in the construction site etc. • The demolition contractor and EPC Contractor will be required to prepare a Demolition/Construction Environmental Action Plan including an emergency response plan covering the requirements of the environmental management plan (EMP) and the ECPs as well as the EHS Guidelines on Construction and Demolition for clearance by NWPGCL before the commencement of works. • The demolitation contractor and EPC Contractor will be required to undertake a H&S risk assessment to identify how risks can be minimised and prepare a Demolition/Construction Health and Safety Plan including an emergency response plan and covering the requirements of the environmental management plan (EMP) and the ECPs as well as the EHS Guidelines on Occupational and Community Health and Safety for clearance by NWPGCL before the commencement of works. • Detailed design will be based on dry low NOx burner with wet injection of 100m3/s for HSD use in order to achieve guaranteed 10ppm or less NOx emission at the conditions stated in IFC EHS Guidelines on Thermal Power, PM emissions for HSD will meet emission standards		

		of 30mg/m3 for DA (as per the IFC EHS Guidelines on Thermal Power). • Detailed design will include minimum 50 m high bypass stack and minimum 70 m high steam turbine stack. • Air quality assessment (modelling) will be rerun to confirm maximum GLC are a fraction of the short term (<10%) and annual (<1%) ECR, 2005 standard for NOx, in both the open and combined cycle mode. • Space will be retained to retrofit catalytic reduction if needed in future. • Power plant to be designed to ensure that all noise generating equipment is housed in sound proof building and that exhaust silencers, low-noise type of fans and cylindrical hood at the air exit of fans are incorporated to result in a noise level of no more than 70dBA at 1m. • Detailed design to specify design and location of permanent noise barrier to be installed on the site boundary during construction phase to protect all sensitive locations on the west and south, mosque area from noise levels that exceed national and IFC EHS Guidelines. • Noise assessment (modelling) of the detailed design will be undertaken and included in updated EIA to demonstrate that limits of 70dBA at the boundary and 55dBA day and 45dBA night at receptors can be met including during start up and shut down. • Intake to be designed to meet the requirements of the IFC EHS Guideilnes for Thermal Power including a velocity of <0.5ft/s, barrier nets and fine mesh screen to prevent entrapment/entrainment of fish and dolphin (if present). Install a steel gate (size of bars <20cm) to prevent dolphin entering the channel. Use of angled screens with louvers or inclined screen or strobe lights or air bubble curtain will also be considered for diverting or repulsing the aquatic organisms from the intake. • Detailed design will be subject to HAZOP assessment, measures to minimise fire/explosion risk as set out in the EIA will be adopted, and the power plant will be equipped with fire-fighting systems and alarms.		

Ambient air A1. Dust and gases generated from demolition works and transportation of the debris and dragging of cutting trees	The emitted dust (SPM, RPM) from the demolishing areas will disperse to the ambient environment. The respirable particulate matters may be inhaled by the human being causes respiratory problem. Moreover, the fugitive dust will fall over the leaves of the vegetation near to the project site.	• Fencing, hoarding the demolition site before beginning of demolition works. • Avoid the demolition works at the evening especially during winter • Watering of the possible sources of fugitive emission especially during winter. • Regular water spraying on the adjacent vegetation, roads and unpaved ground especially during winter.Dust impact and compliance monitoring should be done as per the EMoP at the sensitive location. • Provide appropriate PPE to protect workers against dust, including respiratory masks, aside from the use of PPE, orientation/awareness on their use will improve workers health. • Grievance redress mechanisms should be established and initiate free health checkup for the workers as well as the PAPs as CSR activities of the project.	Demolition Contractor	OE/ESHSU
Ambient noise B1. Noise level Noise will be generated during demolishing of the leftover buildings especially though manual process	Noise will be generated the use of hand tools such as jackhammers, sledge hammers and picks etc. Generation of impulse noise will harm to the people especially for the sick and sleeping one. Uneven noise will affect the behavioral of the nocturnal animals.	• Ear protection PPE will be provided to workers exposed to high noise levels and workers will be rotated to limit exposure based on the exposure levels set out in the EHS Guideilnes on Occupational Health and Safety. • The procedure of demolition will be conducted as per the demolition manual[72] prepared by the EPC • The machines/equipment's/vehicles should be turned off when not in use. • Specify that all sound-reducing devices and restrictions be properly maintained throughout the demolition period. • Limit the hours of demolition to between 7am and 6pm, Sunday through Thursday • Temporary or portable noise panels to contain noise from powered tools shall be used. • Use rubber-tired equipment rather than track equipment • Keep loading and staging areas on site within the perimeter protected by the recommended temporary noise barrier and away from the noise-sensitive sides off site.	Demolition Contractor	OE/EHSU

[72] The demolition plan will be prepared by a separate contractor as this project activity will not be funded by ADB/IsDB. The demolition contractor will be the one to prepare the demolition plan following the requirements of NWPGCL (based on national and local laws) and incorporated in the Bid documents.

		• Stop the demolition work during prayer time, weekend and night time (6pm-7am). • Noise impact and compliance monitoring should be done as per the EMoP at the sensitive location especially at the Mosque and proposed school areas. • Use of appropriate PPE, awareness, motivation works will improve the workers heath. • Properties within 50m of the site boundary or which and other identified properties at risk of vibration damaage will be subject to structural survey prior to commencement of demolition and other works (to provide a baseline in case of damage claim due to vibration). • For buildings identified at risk of vibration damage crack and vibration monitors will be installed and checked daily to check for any damage during blasting, piling or similar, if dany damage is identified it will be immediately repaired at the expense of the contractor. • Grievance redress mechanisms should be established and initiate free health checkup for the workers as well as the PAPs as CSR activities of the project.		
Socio- economic condition C1. Disturbance for school students and present dwellers	The students, teachers, guardians may face difficulties during the transition period They also may be affected due to the noise pollution, dust etc.	• In restoring the mosque and 3 storey guestt house ensure no asbestos or other hazardous materials are used in construction, seismic, fire and safety design as per national guidelines and good international practice set out in EHS Guidelines on Community H&S, and adequate sanitation and clean drinking water supplied, etc. • EPC Contractor to submit detailed restoration plan for clearance by NWPGCL and the Imam. • EPC Contractor to appoint suitably qualified archaeologist to oversee restoration of the mass graveyard,including completion of drawings and photographic before and after record. Before record to be submitted to NPWGCL for approval before any restoration can commence. • In finalizing new school site ensure it is not located within 500m of CCPP, no asbestos or other hazardous materials are used in construction, seismic, fire and safety design as per national	Contractor/EPC Contractor/NWPGCL	NWPGCL

		guidelines and good international practice set out in EHS Guidelines on Community H&S, and adequate sanitation and clean drinking water supplied, etc. • The project activities including all demolition and construction works should be initiated after the completion of new school building • Constructing noise barrier. The noise barrier is to be properly designed acoustic wall. (The school will be relocated and far from the power plant construction. Constructing noise barrier refers to enclosures generally installed during construction to contain dust and minimize noise, and safety risks.)		
C2. Employment Opportunity	Many local people may be occupied in the land preparation activities as clearing trees and bushes, demolishing the buildings, disposal of solid waste, relocation of school building, renovation of mosque and graveyard development and non- technical activities Temporary workers in the project area may become workless	• No worker under 18 years old will be recruited by the demolition or EPC Contractor for the duration of works. • Engagement of local people in the project activities or alternative occupation should be ensured. • Keeping provision for the rehabilitation of the workers those who are working in the project area temporarily.	Contractor/NWPGCL	NWPGCL
C3. Health safety	Noise of demolition activities may cause harms to the people of project area Accident for transportation of dispose materials Unsafe and unhygienic labour shades may create a very hazardous health problem Occupational health safety may be disturbed, and sexually transmitted diseases may arise in the locality due to the flow of outsiders	• Before demolition, suitably qualified surveyors will assess the site thoroughly to confirm no asbestos is present is any of the structures that will be demolished. • Before demolition, a contaminated land risk assessment followed by site investigations (with contaminant testing suite appropriate to former use as paper mill) will be undertaken to confirm no contaminated land is present. • If asbestos or comtaminated land identified develop appropriate remedial plan following international good practice guidance for approval by NWPGCL and ADB before any demolition or other works take place. • Removal and disposal of any asbestos in buildings should be performed only by specially trained personnel in accordance with agreed remedial plan.	Contractor	NWPGCL

		• A site demolition plan outlining procedures and guide for safe demolition following the requirements of the Bangladesh National Building Code, regulations of the Khulna City Corporation, Khulna Development Authority and the EHS Guidelines on Contstruction and Demolition will be prepared by the demolition contractor for approval by NWPGCL before any demolition works takes place • Buildings will be demolished by appropriate contractor in accordance with good international practice (EHS Guidelines on construction and demolition) as well as national requirement. • Location of labor camps to be approved by NWPGCL and ADB. Locate 500m from residential properties and at least 100m from waterbodies or groundwater wells. Adequate facilities should be provided for workers in accordance with national requirements and http://www.ebrd.com/downloads/about/sustainability/Workers_accomodation.pdf • Make mandatory the use of safety gears (helmets, safety belts, masks, gloves and boot) by workers depending on nature of work. • Necessary planning and safety approach will be made for rescue during emergency. • Use of dust controls (exhaust ventilation) to keep dust below • Workers will be provided with first aid and health facilities at the site. • There will be provision for group accidental insurance for the workers. • Child labour (including the employment of those under 18 years of age) is strictly prohibited in all the activities executed by the contractors. • There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services. • Waste management plan will be developed by the Contractor for NWPGCL approval before any works. Solid and hazardous wastes generated will be stored in accordance with national regulations and the EHS Guildelines on Waste Management and disposed of by suitably licensed		

		contractor (transfer notes to be retained) to suitably designed and licensed treatment or disposal waste facility following the relevant requirements of the DoE. Bruning of waste and on-site disposal are not permitted.		
Water bodies D1. Flooding	Regular flooding on the project land	• Provision of optimum land elevation of 5.5m considering HFL and freeboard. • Fill materials must only be sourced from demolition works or GoB approved providers of sand, no new sources should be opened for the project • Provision of additional protection works to avoid the loose soil being washed away due to runoff access and extreme flood. • Additional riverbank protection measures of more 500m upstream and downstream portion, except project eastern boundary. • Provision of adequate internal drainage system to drain out the storm water. • Groundwater will not be used for drinking water or power plant requirements. • Domestic water requirements will be supplied by the Khulna Water Supply and Sewerage Authority and be regularly tested to confirm it meets the national drinking water standards.	NWPGCL	EHSU officers
Biological Environment E1. Life lost and relocation of wildlife	During this clearing and demolition process, some of the common lizards, frogs may be affected.	• The existing structures should be demolished one after another cautiously after properly supervised by an ecologist (having plant and wildlife management experience) to avoid damage of any animal and also any old tree outside of the proposed layout plant of the power plant. In addition, appropriate building demolition including clearing of vegetation guidelines to be adopted for sustainable management of environmental quality of life and growth. Much time should be given for safe departure of the visiting animals during demolition activities following Wildlife Act (2012) and also IFC guidelines. • With vegetation clearing, excavation and earthmoving works, the EPC Contractor will be required to follow the "chance find" procedures including a fauna rescue and handling procedures.	Contractor (with their Expert as required)	NWPGCL (Environment Cell)

		• Detailed design of intake channel, jetty and river bank works and construction method statements setting out measures to minimise pollution and disturbance of dolphin, fisheries and navigation to be submitted by contractor for NWPGCL and ADB clearance prior to commencement of any works, detailed design to use case in-situ pile and minimize dredging reuirement, intake channel to meet requirements of EHS Guidelines for Thermal Power. Contractor to undertake assessment of underwater noise to demonstrate that with mitigation criterion considered as injury threshold (applicable to turtles and cetaceans) of peak sound pressure level (SPLpeak) of 224 decibel reference 1 micro pascal (dB re 1 µPa); sound exposure level (SEL) of 198 decibel reference 1 micro square pascal second (dB re 1 µPa2 s); and threshold for behavioural changes the SEL of 183 dB re 1 µPa2 s will not be exceeded. • EPC shall develop a plan for transportation of materials during construction period and quantify the possible size and number of vessels and movement including loading unloading time for clearance by NWPGCL and ADB prior to commencement of any works. Contractor to include assessment of underwater noise from boat traffic to demonstrate that with mitigation criterion considered as injury threshold (applicable to turtles and cetaceans) of peak sound pressure level (SPLpeak) of 224 decibel reference 1 micro pascal (dB re 1 µPa); sound exposure level (SEL) of 198 decibel reference 1 micro square pascal second (dB re 1 µPa2 s); and threshold for behavioural changes the SEL of 183 dB re 1 µPa2 s will not be exceeded.		
E2. Dust and sound pollution on vegetation and wildlife	During demolition of buildings, it is expected to create sound pollution and dust which may affect surroundings vegetation, sensitive areas and wildlife.	Control moisture content during construction by watering. Stabilize road surface with a suitable stabilizer. Create proper noise barrier and enclose for each building demolition to meet Noise pollution control Rules (2006) of GoB and also IFC guidelines as appropriate.	Contractor (with their Expert as required)	NWPGCL (Environment Cell)

E3. Chop down of terrestrial vegetation	Chop down of terrestrial vegetation has been planned (trees, herbs and shrubs) to initiate land development process which will reduce carbon sequestration of about 6880.480046 for 30 acres of land cover and will ultimately impact biological process and food chain as well	• The Mosque, graveyard and part of the Khulna paper mill area currently outside the proposed power plant layout plan may be conserved for vegetation resources and religious activities. In addition, a significant portion of the proposed power plant area is suggested to develop as green belt which will ultimately makeup loss of carbon dioxide sequestration due to clearing of existing vegetation at the proposed plant area and also to promote conservation of visiting animals of the project study area and also beyond that area. The cleared undergrowth plants can be converted to compost for application as a soil conditioner. • Loss of 1,777 trees will be compensated for by planting on at least 1:1 basis, if sufficient space is not available within the project site off-site planting will be undertaken	Contractor (with their Expert as required)	NWPGCL (Environment Cell)
E4. Habitat loss, life lost and relocation of mammals, birds and other wildlife	Removal of enormous terrestrial vegetation (trees, shrubs, herbs) may cause damage of habitat of some mammals, reptiles etc., which may create pressure on other species. The land development activities would impact to other micro wildlife, invertebrates also at the project area.	The existing Mosque, graveyard and part of the Khulna paper mill area is outside of the proposed project area which is covered with large number of plants and some visitor animals. Therefore, this area will also be used as resting place of local visiting animals. In addition, a significant portion of the proposed power plant area is suggested to be developed as green belt which will ultimately makeup loss of carbon dioxide sequestration due to clearing of existing vegetation at the proposed plant area and also promote conservation of visiting animals of the project study area and also beyond the study area. This new development of green belt will help in the conservation of large number of visiting animals and also roosting and nesting place of large number of birds as well throughout the seasons of the year. During the clearing of vegetation, the existing common wildlife should be allowed to go away under the supervision of an Ecologist through applying popper method (as per Wildlife act-2012, IFC guidelines and international best practices).	Contractor (with their Expert as required)	NWPGCL (Environment Cell)
E5. Riverine, dolphin habitat and benthic community	The existing Bhairab river habitat may be impacted due to discharge of oil spill and created under water noise during transportation of ship along the river for carrying of construction and	• All the vessels must follow the inland river transportation regulation for movement. For any discharging from the project site and vessels, GoB and IFC guidelines which ever is stringent to be followed. • An ecologist will be appointed by NWPGCL. During the clearing of vegetation, the existing common	Contractor (with their Expert as required)	NWPGCL (Environment Cell)

	demolished materials, machineries to the project site.	wildlife should be allowed to go away under the supervision of an Ecologist through applying popper method (as per Wildlife act-2012, IFC guidelines and international best practices). They will survey the project site prior to clearance and will have the authority to halt the removal of vegetion if species need to be rescued or nesting birds are present.		
CONSTRUCTION PHASE				
		• EHS Guidelines on Construction and Demolition and Occupational Health and Safety to be followed during construction.		
Ambient air F1. Dust and gases generated from construction works and transportation of the materials and equipment	The emitted dust (SPM, RPM) from the construction areas will disperse to the ambient environment. The respirable particulate matters may be inhaled by the human being causes respiratory problem. Moreover, the fugitive dust will fall over the leaves of the vegetation near to the project site.	• Fencing, hoarding the construction site before the construction works. • Avoid civil and road construction works at the evening especially during winter or watering to the possible sources of fugitive emission. • Regular water spraying on the adjacent vegetation, roads and unpaved ground especially during winter. • Use of canopy, bounding fence need to be protected. • Impact and compliance monitoring should be done as per the recommended guideline at the sensitive location. • Use of appropriate PPE, awareness, motivation works will improve the workers heath. • GRM should be established and initiate free health checkup for the workers as well as the PAPs as CSR activities of the project.	Contractor	OE/ESHSU
Ambient noise G1. Noise level	Noise will be generated from the moving and idling vehicles, welding operation, and heavy machineries.	• The machines/equipment/vehicles should be turned off when not in use. • Using of appropriate PPEs (Ear Plug for Noise) during construction work. • Temporary or portable noise panels to contain noise from powered tools shall be used. • Use rubber-tired equipment rather than track equipment • Keep loading and staging areas on site within the perimeter protected by the recommended temporary noise barrier and at least 50 m away from the noise-sensitive properties offsite. • Stop the construction work during prayer time and night time (6pm-7am).	Contractor	OE/EHSU

		• Blasting, pile driving and noisy works in proximity to the receptors on the southern boundary e.g. on the RMS station, buildings and works shops, water treatment chemical plants, etc. will not be permitted at the weekend. Noise mpact and compliance monitoring should be done as per the EMoP at the sensitive location especially at the Mosque and proposed school areas. • Noise level at the boundary of the construction site will be monitored to ensure compliance to the Noise Pollution Control Rules 2006 and IFC-WB EHS General Guidelines 2007 (70dBA at the site boundary). • Vibration level at the boundary will be monitored to ensure it is less than 0.12in/sec (approximately 95VdB) • Grievance redress mechanisms should be established and initiate free health checkup for the workers as well as the PAPs as CSR activities of the project. Grievance redress mechanisms should be established and initiate free health checkup for the workers as well as the PAPs as CSR activities of the project.		
Water bodies H1. Groundwater salinity	Workers and other professional will face difficulty to drink and use of groundwater. Level of salinity will increase due to low infiltration at ground water table.	• Provision of fresh water supply into the project area. • Provision of fresh ground and rain water reservoir. • Provision of storage of rain water enhancing groundwater infiltration. • Provision of generated rainwater runoff drainage facility from the project inside. • Installation of oil/water separators to treat surface run-off prior to discharge to the storm water system.	NWPGCL, &Contractor	EHSU officers
H2. Erosion-Accretion	Regular erosion at both bank of Bhairab River. High flood water may erode the east boundary of project during the construction. Loading and unloading of machineries and equipment's from waterway, may create additional damage of river bank. Damages due to anchoring, unloading	• Provision of plantation and another strong riverbank protection works. • Provision of monitoring for levee and other protection measures continued up to the operational designed period. • No storage of stockpiles of earth/spoil within 100m of the river bank • Protection of stockpiles by plastic sheeting to ensure that they are suitably secured against the wind; • Provision of channels, earth bunds or sand bag barriers to direct storm water to silt removal facilities;	NWPGCL, BWDB and Contractor	Planning and Design division and EHSU officers

	goods and materials and other natural disasters.	• Appropriate surface drainage will be designed and provided where necessary; • Drainage systems, erosion control and silt removal facilities will be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit will be removed regularly • Any temporarily diverted drainage will be reinstated to its original condition when the construction work has finished or when the temporary diversion is no longer required; • Oil interceptors will be provided in the drainage system where necessary and regularly emptied to prevent the release of oil and grease into the storm water drainage system after accidental spillages; and • Temporary and permanent drainage pipes and culverts will be provided to facilitate runoff discharge. These will be designed for the controlled release of storm flows.		
Biological Environment I1. Riverine, dolphin habitat and benthic community	Construction of jetty in order to anchor ship and cargos to the Bhairab River may temporarily disturb dolphins' movement and benthic community. The riverine water quality may be deteriorated due to disposal of waste water and oil spill from the ship during transportation of machinery, materials etc.	• Dolphin watchers will be employed on all construction boat transports, as well as adequate pollution prevention measures (including on board pollution prevention equipment, emergency response plan, and up to date service records) with reference to EHS Guideilnes on shipping adopted. Dolphin watchers will have the authority to direct vessels when dolphins are seen. Vessels that do not have up to date service records and adequate pollution prevention measures must not be used. • Boats used for material transport will be inspected and audited by NWPGCL. Each barge will be inspected at least once in every 6 months. If any non-compliance with respect to the GOB regulations is observed, the project must terminate the services of the boat transporter unless corrective action is immediately undertaken to address it. • Continuouse doliphin surveys by qualified NGO. • All the vessels must follow the standard of Inland river transport regulation. In addition, for	Contractor (with their Expert as required)	NWPGCL (Environment Cell)

		transportation of maintenance equipment from abroad, IMO, MARPOL shall be followed. • All kinds of discharges from the construction site shall meet regulatory requirements of GoB and IFC guidelines whichever is stringent and appropriate. • Any kinds of alien species must be quarantined before transshipments from abroad for carrying maintenance equipment for the power plant.No river works permitted during seasons like spawning and egg development periods, ideally undertaken during winter (dry) season when there are fewer dolphins present in the study area • It will be ensured that barges / workboats have slop tanks for collection of liquid / solid waste generated on board. Discharge of wastes into the river will be prohibited. • Spill control measures will be adopted while fuelling piling equipment, barges, workboats, etc. • Jetty construction activities should be confined within limited area of the jetty construction site and excavated soil will be utilized for filling of project site avoiding turbidity in the water. All the vessels must follow the Inland water transport regulations of GoB as applicable (details in Chapter-2). However, during transportation of machineries from abroad to the port, IMO and MARPOL will be followed. Construction discharges from the project site and from the vessels or construction equipment during construction period, GoB and IFC guidelines whichever is stringent will be followed. • A greenbelt will be retained of existing well-established vegetation, so the habitat for fauna remains. • Watching brief for presence of dolphin will be undertaken during river works, if any dolphins are sighted within about 500m of the works then the ecologist will have the authority to request works to cease until the dolphins have left the area • In order to reduce underwater noise levels, underwater air bubble curtains, or similar will be used to reduce noise levels to below those		

		that could adversely impact on dolphin during construction stages (the criterion considered as injury threshold (applicable to turtles and cetaceans) is peak sound pressure level (SPLpeak) of 224 decibel reference 1 micro pascal (dB re 1 µPa); sound exposure level (SEL) of 198 decibel reference 1 micro square pascal second (dB re 1 µPa2 s); and threshold for behavioural changes the SEL of 183 dB re 1 µPa2 s.) • A greenbelt of at least 3.5 m width consisting of two rows plantation with gradual increase of height of plant will be developed within the project site after construction phase. • Greenery will be planned, designed, and maintained as required by BPDB.		
Occupational Health and Safety J1. Health and safety hazard	Injuries leading to casualty, or death may be caused during transportation of machinery and equipment, from the ship to site, and their installation/erection, lifting heavy materials, working at heights, etc.	• Proper health and safety training on hazard identification and how to handle hazardous equipments must be provided to the workers before starting any construction activities. • The health and safety staff of contractor must ensure that the equipments and safety harness are working properly before the workers start their work. In identification of a faulty equipment, they must be promptly replaced. • An on-site medical team should be set up and emergency first-aid kit should be at hand in case of any accidental injuries (burns, cuts, broken bones etc.). • The workers should use the appropriate PPEs. • Ensure workers hygiene and health status. Conduct monthly health check up to monitor their health condition and provide appropriate treatment for any ailments. • Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce;	Contractor	EHSU
J2. Fire hazards from welding	Welding operations during laying of pipeline may cause fire accidents if proper care is not taken	• All arc welding and cutting operations shall be shielded by non-combustible or flameproof screens which will protect welders and other persons working in the vicinity from the direct rays of the arc. • In addition, the welders should use (i) hand shields to protect against flashes and radiant energy, (ii) see his skin is covered completely to prevent burns and other damage by ultraviolet rays, (iii) Welding	Contractor	OE/EHSU

		helmets shall be free of leaks and openings, and free of highly reflective surface, and (iv) welding trucks shall be equipped with approved fire extinguishers and first aid.		
Solid Waste Disposal K1. Storage space and visual effect	Poor aesthetic view due to the storage and disposal of old and used equipment and materials. Moreover, spillage and leakage from improper storage can result in contamination in soil.	• Rubbles generated from the construction site should be stored in appropriate bins/skips, well-covered in accordance with national regulations and the EHS Guildelines on Waste Management. • All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal in accordance with national regulations and the EHS Guildelines on Waste Management. • Segregate hazardous and nonhazardous 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 or areas away from direct sunlight, wind and rain. • Food waste, liquid and hazardous materials and waste must be stored in impermeable bunded area with 110% volume. • Use of spill or drip trays to contain spills and leaks, and use of spill control kits to clean small spills and leaks. • Burning of waste and on-site disposal are not permitted. • Rubbles and all solid and hazardous wastes generated will be disposed of by suitably licensed contractor (transfer notes to be retained) to suitably designed and licensed treatment or disposal waste facility following the relevant requirements of the DoE.	Contractor	Health and Safety Officer
Socio- economic condition L1. Disturbance for school students and present dwellers	They also may be affected due to the noise pollution, dust etc.	Constructing noise barrier, the noise barrier is to be properly designed acoustic wall.	Contractor/NWPGCL	NWPGCL
L2. Employment opportunity	The local people may be engaged in the land development and non- technical activities and it will create in migration in the project area	• Engagement of local people in the project activities or alternative occupation should be ensured. • There should have provision for the rehabilitation of the workers those who are working in the project area temporarily.	Contractor/NWPGCL	NWPGCL
L3. Human safety	During preparation and installation of the	Special attention should be provided for supplying safe drinking water, safe	Contractor/NWPGCL	NWPGCL

	power plant along with threats for human safety to the technical and non-technical labor	sanitation system for the labor sheds. Registered doctor and assistants should be employed during construction phase		
Fisheries Resources M1. Fish habitat condition and quantity	Bhairab River is rich in Hilsa, Deshi Pangus and Shrimp PL which would be affected due to disposal of waste water like ballast and bilge water from the ship/cargo carrying machinery and ancillaries having oil and grease contaminants. Open water fish habitat would also be affected due to the washing of various solid waste such as sand particles, food wastes, cans, and bottles etc. which are generated by the project workers.	• In river works and vessel movement should be limited during Hilsa (September - October) and Deshi Pangus (June - July) spawning period and peak shrimp PL (February – March) collection periods. • Ballast water and oil spillage must be controlled from the ships, vessels and construction site. • Specific waste management programs that emphasize on reduction, reuse and recycling of the waste will be implemented.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
M2. Fish species diversity and composition	Alien species may be introduced through cargo/ vessels. As a consequence, invasive species may cause negative impacts on pelagic and benthic communities.	• Foreign cargo/vessels must be checked for protecting the migration of invasive species. • The crew should be advocated to maintain a certain path and abstain from dumping solid and liquid wastes particularly during fish breeding season.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
M3. Fish production	With the consequence of aforesaid reasons, fisheries resources may cause decline in fish productivity of the river and its connectivity.	• Fish breeding and fish spawning seasons should be avoided for transporting construction materials and machinery as well as ancillaries through waterways. • Oil spillage from cargo/ vessels should be controlled efficiently.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
OPERATION PHASE				
Ambient Air N1. Maximum ground level concentration of air pollutants	Emission of exhaust gas from the stack may contribute elevated ground level concentration of CO, SO2, NOx, PM10, PM2.5 etc. at the downwind direction.	• This power plant will already adopt inbuilt pollution control measures like Dry Low-NO_x burner with guaranteed 10ppm NO_x emission, wet injection process of 100m^3/s for operation on HSD etc. Emission from the stacks must be limited to 10ppm NO_x and 30mg/Nm^3 PM due to degraded airshed at the conditions specified in the IFC 2008 standard for thermal power plant. • Stack monitoring will be conducted continuously of the criteria pollutants. Annual stack testing will also be done. Moreover, two CAMS will be operated and ambient	NWPGCL	EHSU

		passive monitoring will be continued at certain period of time at the potentially affected areas. • Compliance monitoring will be done to the regularly and check the monitoring instruments. • Power plant to operate on natural gas, HSD of <0.25% wt sulphur will only be used in case of emergency and for no more than 500 hours maximum per year (or about 21 days assuming continuous operation of 24 hours, or less than 2 days per month). • If natural gas supply is not available long term the power plant must be shut down. • During commissioning the power plant must not be operated using HSD.		
Noise level O1. Noise level inside the control room, turbine hall	Hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from rotator machineries at exceedance level.	• Install 3m high acoustic boundary walls and thick plantation to attenuate noise in the sensitive receptors. • Replace the sealing of doors and windows of the control room and office building for making noise proof the workspace. Control room needs to be insulated to meet 65dBA inside. • The machines/equipments/vehicles should be turned off when not in use. • The turbines, pumps, fans etc. should be covered with soundproof dampeners to limit the spread of noise. • Greenbelts should be developed around the power plant area to limit the spread of noise to the nearby community. • Workers should use appropriate PPEs (soundproof earpiece, earmuffs etc.) while working close to noise equipment.	Contractor	EHSU
Water bodies P1. Salinity	Every cooling tower will receive individually about 45% of water among the total water needed for whole operation. By this process, about 48% of this water gets evaporated from cooling tower and the rest 52% of it will be highly denser water (due to salinity) going blow down to the river after flowing through a monitoring basin. This	• Strong water quality monitoring section should be provided to make sure the parameters must be within standard limits before disposal. • Effluent from the ETP will meet ECR 1997 (Schedule 10) and Table 5 of IFC-EHS Guidelines for Thermal Power 2008. • Effluent from the STP will comply with Schedule 10 of ECR 1997 and Table 1.3.1 of IFC-EHS Guidelines 2007. • Power plant will be operated on the basis of zero discharge, no discharge of effluent to the Bhairab River will be permitted.	NWPGCL	Planning and Design division and EHSU officers

	process may impact the level of salinity of river water.	• Provision of reuse of disposal water from monitoring basin. • Sludge will be disposed of following the requirements and/or procedures of the Khulna Water Supply and Sewerage Authority, if disposed of to land WHO guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006) will be followed. • Installation of oil/water separators to treat surface run-off prior to discharge to the storm water system.		
P2. Flooding	Two major causes of flooding the project site, one may be urban flooding, causing due to extensive runoff access which couldn't be drained out quickly for the time being. And another cause of flood water may come from river be occurred due to uncertainty of extensive flood.	• Provision of community cleaning committee inside the project area • Provision of flood retention structures and plantation • Provision of access road surrounding the project periphery.	NWPGCL	Planning and Design division and EHSU officers
P3. Intake Channel Outlet	Accretion occurs at the eastern boundary by monsoon flood. Tidal activity carries and deposit clay at the intake point. Loading and unloading activities via ships/ Berge break the intake channel accidentally. Sliding the sand or other land development material over the developed slope to the toe of the slope.	• Provision of bank protection works at the eastern boundary. • Provision of flowing tidal wave at the intake point required to avoid sedimentation at bottom of the intake channel. • Position of jetty have to be located to a place where intake channel remains safe from crushing by the Ship / Berge.	NWPGCL	Planning and Design division and EHSU officers
Risks and emergency Q1. Corrosion of gas pipes	Corrosion on the internal wall of a natural gas pipeline can occur when the pipe wall is exposed to water and contaminants in the gas, such as O_2, CO_2, or chlorides.	• Pipe will be coated using 3-layer polyethylene (3 LPE). • Buried pipes and fittings shall be protected against corrosion by means of external coating and wrapping. • Holiday detector shall be used to detect any holiday and shall be repaired. • Cathodic protection test points shall be installed and connected to temporary cathodic protection facilities in accordance with the specification as the final operation of lowering or tieing-in is in progress. • Conduct inspection after all installation before back-filling.	Contractor	OE/EHSU

Q2. Gas compressor fouling	Polymer deposits on compressor internals, which increases frictional losses and alters flow pattern and lead to loss of compressor efficiency, pressure drop increase in after coolers, potential for unbalancing, rotor, and seal damage.	A cleaning regime in Bangladesh would be a combination of online cleaning and semi-annual offline washing.	Contractor	OE/ESHSU
Q3. Gas pipeline leak	Poor tying-in may cause leak of significant amount of gas from the pipe	Separate welded joint sections of the pipeline shall be tied into a continuous system in such a manner that no stress will be induced into the pipe as a consequence of the tieing-in operation.	Contractor	OE/ESHSU
Socio- economic condition S1. Diversity of occupation	Different occupational facilities may be created after the implementation of this project in the study area	Let the local people be engaged in the project related activities as well as in the other industrial activities	Contractor/NWPGCL	NWPGCL
S2. Human safety	Accidental issues may occur during the operation period. It may create a problem in housing facility, treatment facility, sanitation and drinking water facility issues	• Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods. • Solid and hazardous wastes generated will be stored in accordance with national regulations and the EHS Guildelines on Waste Management and disposed of by suitably licensed contractor (transfer notes to be retained) to suitably designed and licensed treatment or disposal waste facility following the relevant requirements of the DoE. • Segregate hazardous and nonhazardous 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 or areas away from direct sunlight, wind and rain • Burning of waste and on-site disposal are not permitted • Food waste, liquid and hazardous materials and waste must be stored in impermeable bunded area with 110% volume • Use of spill or drip trays to contain spills and leaks, and use of spill control kits to clean small spills and leaks	Contractor/NWPGCL	NWPGCL

		• Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce.		
S3. Employment opportunity	Fishermen community may be affected due to water traffic and net broken	• A contingency budget for breaking fishermen's nets should be captured in the safeguards documentation. They may be taken under different training program for livelihood restoration of the fishermen • NWPGCL official will must be engaged in the Grievance Redress Mechanism.	Contractor/NWPGCL	NWPGCL
Fisheries Resources T1. Fish habitat condition and quantity	Abstraction of river water at the rate of 2010m3/hr for operating power plant may cause crisis for river water availability during dry season which alter the capture fish habitat condition.	• Temporary water reservoir can be built for water storage rather than direct abstraction from river. • Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
T2. Fish species diversity and composition	Water intake from the Bhairab River would entrap fish, crustaceans and other aquatic organisms particularly the sluggish species. Predator-prey relationship might be affected due to spread of invasive species through ballast water. Integrated impact to be caused for withdrawal of water 2010 m3/hour may alter the fish diversity due to salinity intrusion	• Water intake velocity will not be more than 0.5ft/s at the screen of the intake channel. • Intake point of the feed water pipeline should be provided with sufficient screen i.e. fish deterrence machine to filter out aquatic organisms like fish, frogs, and toads. • To use bio-indicator for monitoring the health of the aquatic ecosystem.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
T3. Fish production	With the consequence of aforesaid reasons, estimated net loss to fish production would be 240 Mt per year from the study area.	• Continuous monitoring of intake water velocity should be ensured and necessary measures are to be taken if intake water velocity exceeds 0.5 ft/s in the dry season and specially breeding season. • Develop monitoring system to maintain biodiversity of Bhairab River ecosystems.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office
T4. Fisheries Based Livelihoods	Associated livelihood would be affected due to the reduction of catch per unit area and effort and would	• Alternate livelihoods might be developed through proper trainings and incentives by the project proponent. • installation of barrier net and screens.	Contractor in collaboration with District Fisheries Office and local fishers.	NWPGCL and District Fisheries Office

	narrow down the fishing area.	• Beel management program and community based fisheries management might be introduced by local Jele community at the Bashuakhali beel and others government Khas land.		
Ecological Environment U1. Impact on terrestrial vegetation	The emission of SOx, NOx and SPM including noise pollution may have significant impact on vegetation and other sensitive receptors around the project and study area.	Al measures for limiting the emission of SO_x, NO_x and SPM will be within the GoB standards and IFC guidelines whichever is appropriate and stringent. With such measures, in effect the emissions would exert less impact on vegetation of the study area. On the other hand, development of a significant portion of greenbelt in and around the project area will improve the vegetation coverage and enhance the capacity of carbon sinking.	Contractor (with their Expert as required)	NWPGCL (Environment Cell)
U2. Riverine, dolphin habitat and benthic community	Transportation of power plant equipment, other materials including fuel during operation period along the river ways, may degrade the riverine water and habitat quality of aquatic species due to movement, creation of underwater noise, and discharges of waste and oil spill from all these river transports. Water extraction from Bhairab River particularly during dry season for cooling and make-up process may affect aquatic ecosystem, aquatic species including dolphin and their prey. Some of the species may be trapped in the extraction pipe and get killed.	• Dolphin watchers will be employed on all maintenance and HSD boat transports, as well as adequate pollution prevention measures (including on board pollution prevention equipment, emergency response plan, and up to date service records) with reference to EHS Guideilnes on shipping adopted. Dolphin watchers will have the authority to direct vessels when dolphins are seen. Vessels that do not have up to date service records and adequate pollution prevention measures must not be used. • Continuous dolphin surveys by qualified NGO. • The plant will extract maximum 0.12% against total discharges of the Bhirab river in which is low amount and will not have impaction the aquatic species. Any excess of the suggested amount of water extraction to be discouraged. • All the vessels must follow the standard of IMO, MARPOL during transportation of materials up to the port of delivery of foreign imported machinery and equipment. • In addition to that, in case of any discharges from the vessels, shall also follow ECA 1995, ECR 1997 of GoB and all applicable IFC guidelines and standards which ever is stringent and applicable.	Contractor (with their Expert as required)	NWPGCL (Environment Cell)

Source: CEGIS, 2016

9.9 Emergency Response and Disaster Management Plan

628. An Emergency Response Plan (ERP) is prepared. Each Contractor after assessing potential emergencies that could be encountered during construction phase should prepare site specific ERPs (guidance can be taken from the ERP proposed in this EIA) and include in their CEAP. The CEAP will be submitted to the OE for review and approval before contractor mobilization.

629. The ERP proposed for NWPGCL identified possible emergency events during construction and operational phase. The emergencies could be immediate medical evacuation due to personnel injury, traffic accidents (road), leakage of hazardous chemicals, terrorist events/threats and gas leakage/explosion, kidnap and/or extortion, bomb threat, pandemic, significant business loss, pollution incident, fire and explosion, gas leak and structure collapse.

630. The ERP outlines the framework of Emergency Response Strategy which will be followed by the contractor's, operation and maintenance staffs of NWPGCL during decommissioning, construction, and erection and operation and maintenance phases.

631. As a general rule the initial response is guided by three priorities which are as follows:

1. People
2. Property
3. Environment

632. ERPs will identify who does what and when, in the event of an emergency situation. Responsibilities for the Officials who are in charge and their coordination for emergency actions shall be identified under the specific "Roles and Responsibilities". The anticipated Nature of Emergency & Hazardous Situations may be categorized as follows:

I. Emergency
- ❖ Fire
- ❖ Explosion
- ❖ Medical Emergency
- ❖ Kidnap/ Extortion
- ❖ Civil Unrest
- ❖ Bomb Threat
- ❖ Pandemic
- ❖ Spillage of toxic chemical, and electrocution

II. Natural Disasters
- ❖ Flood
- ❖ Earthquake
- ❖ Tornado/ Cyclone/ Hurricanes

III. External Factors
- ❖ Food poisoning/ water poisoning
- ❖ Sabotage and
- ❖ War

9.10 Budget for EMP

633. The cost of implementing the EMP including monitoring is about $2 million. Details of EMP and associated costs are given in **Table 9.5**.

Table 9.5: Tentative cost of EMP

Items	Unit	Quantity	Unit Rate ($)	Amount ($)
EPC Contractor (Investment Cost)				
Continuous Stack Emission Monitoring System	No	2[73]	30,000	60,000.00
Water ETP	Included in Project Cost			-
Continuous Micro-Climate Station	No	1	15,000	15,000
Passive/Continuous long term Ambient Air Quality Monitoring Station	No	2	20,000	40,000.00
Noise Attenuation Measures	LS	LS	6,000	6,000.00
Environmental Laboratory	No	1	200,000	200,000.00
Provision of fencing the Dyke/Levee avoiding navigation reduction of Bhairab River.	per meter	1,400 meters	40	56,000
Storm water pumping station and pump house (during construction period)	LS	1	-	4000
Environmental Management Plan				
Plantation Program				5,000.00
Emergency Response related Equipment				200,000.00
Community Health, Safety and Security	LS			10,000
EHS Staffs of Contractor	Medical professional Man month	1000	100	1,00000
Contractor's HIV/AIDS Management	LS			10,000
Awareness and training for the local people (e.g. fisherman, labour, farmer, etc.)	Quarterly meeting for 3 years' time frame			22,500
Institutional Arrangements				
EHS Consultant of Owner's Engineer				**800,000.00**
EHS Staffs of EHSU Circle (long term)				200,000.00
Capacity Building and Training				100,000.00
Environmental Monitoring Plan (Demolition, pre-construction and construction)				**80,150**
Environmental Monitoring Plan (Operation)				**78,950**
Independent Monitor for five (5) years period including one (1) year of operation				**150,000.00**

[73] Only two stacks (for combined cycle) will be monitored as this project is a combined cycle power plant. As mentioned earlier the simple cycle will be used only at the initial stage of the project when the installation of the HRSG is not complete yet. The effective stack height will be more than 500 m. When operating on combined cycle, the bypass stack will be capped/closed. It will not be practical and economically viable to install CEMS on a stack that will be seldom used as this approach will just simply increase the generation cost.

Items	Unit	Quantity	Unit Rate ($)	Amount ($)
			Grand Total	**2,137,600.00**

LS = lump sum.

9.11 Monitoring Plan

634. A three-tier monitoring program has been proposed comprising of compliance monitoring, impact monitoring, and external or independent monitoring in certain duration as one of the key elements of the EIA study. The main purpose of this monitoring program is to ensure that the various tasks those detailed out in the environmental management plan, particularly the mitigation measures which are to be implemented efficiently and effectively, and also to evaluate project's impacts on the key environment and social parameters.

9.11.1 Compliance Monitoring

635. Compliance monitoring is a very important tool/aspect of environmental management to safeguard the environment. The compliance monitoring plan is presented in **Table 9.6** and **Table 9.7**. The monitoring activities will be supervised by the respective Environmental Management Official from the Environmental Cell of the NWPGCL. The compliance monitoring program will be conducted by an independent third party.

636. For monitoring of physic-chemical parameters, locations near the baseline sampling points and potentially affected locations are suggested in this section below. Actual monitoring time and location will be decided by the OE and NWPGCL. The Contractor will be responsible for carrying out or contracting an approved third party for monitoring all the parameters as required with frequency is shown in the following table. This monitoring will be carried out by its own cost during the construction phase. The measurement values are to be compared with the IFC's EHS General Guidelines, where relevant standards are specified, or the national standards (ECR 1997 and amended in 2005).

9.11.2 Impacts monitoring

Impacts Monitoring during Construction

637. The purpose of the impact monitoring is to ensure that the contractor implements the mitigation measures given in the EMP efficiently, effectively and timely. This monitoring will generally be carried out by the OE with the help of checklists prepared on the basis of the impact monitoring Plan.

9.11.3 Independent/External Monitoring

638. The NWPGCL should engage an independent organization for monitoring the implementation of EMP. The main purpose of the Independent monitoring is to verify the borrower's monitoring reports and ensure that all key entities including EHSU, OE and contractors are effectively and adequately fulfilling their designated role for EMP implementation. All the EMP requirements are being implemented efficiently, effectively and timely.

Table 9.6: Environmental Compliance Monitoring Plan during Demolition and Construction

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented By	
						Monitoring	Supervision
Environmental Monitoring during Pre-construction and Construction Phase							
Ambient Air Quality	SPM, PM_{10} and $PM_{2.5}$	Mosque, School, Residential areas, Labour work places and S, W, N, E corner of the project	Monthly	24 hr Continuously during demolition and construction works	SPM- 50 µg/Nm3 $PM_{2.5}$- 16.25 µg/Nm3 PM_{10} -37.5 µg/Nm3	EPC/ Third Party	OE/ NWPGCL
Ambient Noise Day time (6:00 – 21:00) and Night time (21:00 – 6:00), Leq values in dBA	Leq, L10 and L90 during the demolition and construction works at	Mosque, School, Residential areas, Labour work places and S, W, N, E corner of the project	Daily	Sampling greater than 15 minutes	Mosque and School – 50 dBA (day) 40 dBA (Night) Residential areas - 55 dBA (day) 45 dBA (Night) Remaining areas 70 dBA (day) 70 dBA (Night)	EPC/Third Party	OE/NWPGCL
Water quality	PH, BOD, COD, Total N, Total P, Oil and Grease, TSS, Total Coliform	Surface water – 100m u/s, middle and 100 m d/s of Bhairab river from the eastern boundary, pond inside KNM, Tube well water from the residential area of KNM	Quarterly for river bank works monitoring will commence two weeks prior and be undertaken weekly until two weeks post completion of works	Composite sampling	Maintaining the baseline quality of river water and prohibite any kind of discharge from the project area	EPC/Third Party	OE/NWPGCL
Water Resources	Building residuals, Bank erosion, flood, drainage system	Dumping places, project eastern boundary, drainage outlet	Quarterly	Observation, Water level data and KII	Zero solid waste dumping, flood and erosion protection and drainage clearance	EPC/Third Party	OE/NWPGCL
Biological Environment	Mammals, Aves, Reptiles, Amphibians rescued,	Project area	During buildings demolition and vegetation	Direct Observation/ Transects	To reduce the mortality and safe migration of	EPC (with their Expert as required)	NWPGCL (Environment Cell)

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented By	
						Monitoring	Supervision
	relocation and rehabilitation		clearing period		the wild animals, Increase in-situ conservation		
	Plantation and Plant health (Plant Growth, Canopy Coverage, Disease, etc.)	Protected area and Green belt area within the project site	Six monthly	Plot Survey, Plant health Survey	Conserve the existing plant health, facilitate for green belt development	Contractor (with their Expert as required)	NWPGCL (Environment Cell)
	Dolphin Occurrence and Habitat status	Two confluence sites (Bhairab-Atai and Bhairab-Madhumati) and River route from Rupsha bridge to Madhumati Bhairba confluence	Quarterly	Direct Counting, line Transect Survey, Water Quality, water availability	Conserve suitable habitat and abundance of dolphin species	Contractor (with their Dolphin Expert as required)	NWPGCL (Environment Cell/Experts)
	Underwater noise	River adjacent project site	Daily during river works and boat movements	Underwater noise survey	No exceedance of underwater noise levels that could have adverse impact on dolphins, the criterion considered as injury threshold (applicable to turtles and cetaceans) is peak sound pressure level (SPLpeak) of 224 decibel reference 1 micro pascal (dB re 1 µPa); sound exposure level (SEL) of 198 decibel reference 1 micro square pascal second (dB re 1 µPa2 s); and threshold for behavioural changes the SEL of 183	Contractor	NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented By	
						Monitoring	Supervision
					dB re 1 µPa2 s.		
Fish Diversity and Habitat	Capture Fisheries Diversity, Richness, Productivity, etc.	Bhairab River within around 2 - km u/s and d/s away from the Project site	Quarterly	Fish Catch Assessment Survey, Fishing Survey and Fishers' interview	Conserve suitable habitat for spawning of capture fisheries	EPC Contractor (with their Expert as required)	DoF and NWPGCL
Fishing Livelihoods	Number of fisher, amount of capture fishes	Fishermen of the villages of Chandanimohal	Quarterly	KII, FGD	To ensure the sustainable fishing practices by the fisher	EPC Contractor (with their Expert as required)	DoF and NWPGCL
Worker Health and Sanitation	Availability of Potable Water, Drinking water quality, Availability of Hygienic Toilet	Power Plant work place, labor camps	Quarterly	Inspection and interview of labor, project personnel	To ensure the Performance standard (PS 2) of IFC and reduce the grievance from labor	EPC Contractor	OE, NWPGCL
Working condition, laws, Safety and Security	Relationship, Compliance law, Protecting equipment, Training	Workplaces, Labor camps and adjacent communities	Quarterly	Inspection and interview of labor, Project personnel followed by a checklist	To reduce the grievance, safe and sound working environment as per PS 2	EPC Contractor/ OHAS auditor	OE, NWPGCL
Generation of Non-Hazardous Solid Waste (Domestic waste, Office Waste,)	Collection system, Proper disposal, waste sprawling	Demolition and dumping site, labour camp, construction yard, another Designated Site etc.	Quarterly	Visual Inspection, waste classification	Reduce, reuse and recycle of waste,	EPC Contractor	NWPGCL
Community Safety and Security	Accidents, diseases, emergency preparedness, security	School, Residential areas of KNP, adjacent communities	Quarterly	KII to the students, school committee, residence and communities, Disclosure	To reduce any disturbance of the community and minimize the risk of the community as per PS 4	EPC Contractor/ OHAS auditor	OE, NWPGCL
Agricultural Production	Crop Production Loss, Diseases	Three locations: in the study area within 0.5-2km from the project site	Six monthly following cropping patterns	Soil sampling, Agricultural Survey, KII and FGD	To reduce the soil contamination due to dry or wet deposition of SO_x, NO_x or PM and induced impacts	EPC Contractor	OE, NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented By	
						Monitoring	Supervision
Drinking water	National drinking water standards	Potable water source	Quarterly	Sampling of potable water sources at power plant	National drinking water standards	EPC Contractor	NWPGCL
Health and safety	Near miss, no lost time, lost time and fatal incidents	Power plant	Continuous	Records of health and safety indicidents and workplace related disease occurrences	Zero lost time incidents	EPC Contractor	NWPGCL
Status of Dolphin community	Habitat, Abundance	Two confluence sites (Bhairab-Atai-Rupsa and Bhairab-Madhumati)) and River route from Rupsa bridge to Madhumati Bhairba confluence.	Wet and Dry seasons (twice per season during works)	Dolphin Survey following methods used to establish baseline, KII with the fisher	To ensure the sustainable habitat for the dolphin community as per baseline (no negative change in population)	EHSU (Dolphin Expert as required)	NWPGCL (Environment Cell/Experts)

Table 9.7: Environmental Compliance Monitoring Plan during Operation

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented by	
						Monitoring	Supervision
Environmental Monitoring During Operation							
Fuel Use	HSD Use and Sulphur Content	Power plant	Continous	Records of HSD consumption and analysis of HSD sulphur content	<500hours maximum a year HSD use <0.25%wt Sulphur HSD	EHSU/KP	Independent Monitor/NWPGCL
Stack Emission	NO_x, SO_x, CO PM_{10}, $PM_{2.5}$	Stacks both by pass and HRSG stacks (all four stacks)	Continuous	Continuous	10ppm NOx 30mg/Nm^3 PM	EHSU /KP	Independent Monitor/ NWPGCL
Stack Emission	NO_x, SO_x, CO PM_{10}, $PM_{2.5}$	Stacks both by pass and HRSG stacks (all four stacks)	Annual	Annual stack emission test	10ppm NO_x 30mg/Nm^3 PM	EHSU /KP	Independent Monitor/ NWPGCL
Ambient Air Quality	NO_x, SO_x, SPM, PM_{10}, $PM_{2.5}$, CO, O_3	Two CAMS monitor in the location of the maximum deposition to the 2.5km (CAMS9) and 800m north east of project site	Continuous	1 hour,24 hours, annual etc.	Guideline values of IFC2007 and ECR2005 (no deterioration in baseline)	EHSU/ KP	Independent Monitor/ NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented by	
						Monitoring	Supervision
Ambient Air Quality	NOx	31 ambient air quality receptors identified in EIA	Monthly Average (weekly passive sampling) for 3 years	Passive NOx sampling	Guideline values of IFC2007 and ECR2005 (no deterioration in baseline)	EHSU/ KP	Independent Monitor/ NWPGCL
Ambient Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) LAeq, L10, L90	• Outside the project boundary: ➢ South-west corner communities ➢ Southern boundary residential areas ➢ Proposed School of KNP • Indoor Noise: ➢ Administrative building ➢ Health care unit ➢ Residential buildings ➢ Mosque premises	Monthly	Three Sample during day time and one sample during night, 15 min sampling each time.	IFC 2007 for Industrial areas and ECR 2006 for the remaining area	EHSU/ KP	Independent Monitor/ NWPGCL
Leak detection	Gas release, Pressure change, Physical damage	RMS and pipeline corridor	Every shift of every day	Visual Observation for stressed vegetation and with a “sniffer”	Ensure safe handling and reduction the risk	EHSU	Independent Monitor/ NWPGCL, PGCL
Storm Water	Drainage System, Congestion, local flooding	Inside the power plant area, Drainage outlet	Weekly during monsoon season	Observation, KII	Eliminate any possibilities of drainage congestion in the project area	EHSU	Independent Monitor/ NWPGCL
Ambient Water Quality	pH, EC, TDS, Salinity, TSS, Residual Cl, Fe, As, Hg, Pb, NO_3, PO_4, SO_4, BOD, COD, Coliform	Surface Water – 100 u/s, outfall point and 100 d/s from the discharge point in Bhairab river,	Spring and Summer (for 5years)	Composite Sampling	Maintaining the baseline water quality	EHSU	Independent Monitor/ NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented by	
						Monitoring	Supervision
		Ground water – wells within the project boundary					
Generation of Non-Hazardous Solid Waste (Domestic waste, Office Waste,)	Collection system, Odor, waste sprawling	Designated Sites	Monthly	Visual Inspection, waste classification	Safe solid waste disposal, Pollution prevention and introduce 3R technologies	EHSU	NWPGCL
Generation of Hazardous Waste like	Quantity, Types, Toxicity	Waste Disposal Point, Waste Generation Sources like sludge from ETP, STP, WTP; chemical waste from reverse osmosis Plant, Laboratories, Medical Center etc.	Monthly	Visual Inspection, waste classification	Safe hazardous waste disposal, Pollution prevention as per PS3	EHSU	NWPGCL
Workers Health and Sanitation	General Health Condition, accident, fatalities, injuries Complain, fitness, etc.	Workers involved in the Plant operation and maintenance	Quarterly	Health Check-up, Grievance register	Congenial work environment, Good health and sanitation facilities as per PS2	EHSU	NWPGCL
	Available quantity and quality of potable water	Work place, residence	Monthly	Sampling, Checking			
	Hospital, Hygienic Toilet, Gym	Workplace, Residence, common places	Monthly	Observation, KII			
Exposure to Electro-magnetic Field	EMF	Outside the safety fence of Substation, Power evacuation bay, other EHV area	Quarterly	Measurement by EMF Meter Inspection of workers' roster shifting hours etc.	Reduce the risk of exposing electromagnetic field by individual / Community	EHSU	NWPGCL
Occupational Noise	LAeq, noise exposure	Inside Plant Area (Turbine hall, RMS, etc.) Control room Administrative building, residential buildings, health unit	Quarterly	Continuous sampling for 4 hr during day and 2 hr during night (as USEPA) by using: ANSI Type II Noise Meter Inspection of record of shifting hour, workers' roster	To complying with occupational H&S noise standards in the EHS guideline on occupational H&S	EHSU	NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented by	
						Monitoring	Supervision
Community Health, Safety and Security	Status of Communicable Diseases, Status of Vector Borne Diseases	Plant Residence, Nearby communities	Yearly	Inspection of Disease Profile/Records in Health unit, nearby Hospital	To avoid or minimize risks and impacts to community health, safety, and security to the vulnerable group as per PS4	EHSU	NWPGCL
	Emergency Preparedness	N/A		Visual Inspection and Record Checking			
	Community Relation Program/ Community Awareness Program, Training	N/A		KII, Public consultation, Community Register check.			
Impact of Intake	Fauna entrapped or entrained by intake	Intake	Daily/ Quarterly	Recording of number and species of fauna entrapped or entrained/ Fish Catch Assessment Survey, Fishing Survey and Fishers' interview	No entrapment or entrainment of dolphin, no impact on fish population (compared to baseline)	EHSU	NWPGCL
Status of Dolphin community	Habitat, Abundance	Two confluence sites (Bhairab-Atai-Rupsa and Bhairab-Madhumati)) and River route from Rupsa bridge to Madhumati Bhairba confluence.	Wet and Dry seasons for at least 3 years	Dolphin Survey following methods used to establish baseline, KII with the fisher	To ensure the sustainable habitat for the dolphin community as per baseline (no negative change in population)	EHSU (Dolphin Expert as required)	NWPGCL (Environment Cell/Experts)
Fish Diversity and Composition	Capture Fisheries: Diversity, Richness, Productivity, etc.	Bhairab River within around 1 km us/ and d/s away from the Project site	Six Months	Fishing Survey and Fishers' interview		IM	NWPGCL
Vegetation (Plant) heath	Plant Growth, Canopy Coverage, Disease, etc.	One at the proposed greenbelt area within the plant boundary and one at the mosque area and one at social forest of Chandanimahal	Yearly	3 plots (15m x 15m) in the study area		IM (with their Expert as required)	NWPGCL (Environment Cell
Land use and Land Cover change	Land cover and Land use	5km radius area of the Plant	Once in	Stakeholder Consultation and Satellite Image (2km		IM	KP/NWPGCL

Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Target Standard	Implemented by	
						Monitoring	Supervision
			three years	buffer area of KPS) Analysis			
Agricultural Production	Crop Production Loss	Three locations: in the study area within 0.5-2 km from the project site	Yearly	Farmers' Interview, Secondary Data from DAE		IM	KP/NWPGCL
Monitoring of the CSR activities	Dependent on the specific type of programs	N/A	Yearly	Stakeholder Consultation		IM	NWPGCL
Greenhouse gas	CO_2 emissions	Power plant	Yearly	Calculation of CO_2 emissions based on fuel consumption		IM	NWPGCL
Drinking water	National drinking water standards	Potable water source	Quarterly	Sampling of potable water sources at power plant	National drinking water standards	IM	NWPGCL
Health and safety	Near miss, no lost time, lost time and fatal incidents	Power plant	Continuous	Records of health and safety indicidents and workplace related disease occurences	Zero lost time incidents	EPC Contractor	NWPGCL

IM = Independent/External Monitoring; NWPGCL = North-west Power Generation Company Limited; OE = Own Engineer.

These monitoring parameters will be revised after monitoring the effluent water quality from the discharge channel. Some parameters might become redundant if the effluent water does not contain in the effluents

Table 9.8: Impact Auditing Plan

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
During Construction					
Hydrocarbon and chemical storage	Construction area	Visual Inspection of storage facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Damage to local roads	Approach Roads to the construction sites	Visual inspection to ensure local roads are not damaged	Monthly	EPC Contractor	OE/ Independent Monitor
Traffic Safety	Approach Roads	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	EPC Contractor	OE/ Independent Monitor
Air Quality (dust, - smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (e.g., spraying of waters) are in place.	Daily	EPC Contractor	OE/ Independent Monitor
	Batch mixing Plant	Visual inspection to ensure batch plant is located >500 m from residential areas	Monthly	EPC Contractor	OE/ Independent Monitor
	Material storage sites	Visual inspection to ensure proper maintenance i.e. covering, dust suppression etc. as per ECP	Monthly	EPC Contractor	OE/ Independent Monitor
Noise	Construction sites	Physical inspection to ensure good standard equipment are in use		Noise	Construction sites
	Construction sites	Visual inspection to ensure ear plugs/earmuffs are in use by the construction workers	Daily	EPC Contractor	OE/ Independent Monitor
		Ensure work restriction between 20:00-06:00	Daily	EPC Contractor	OE/ Independent Monitor
Plantation	Designated sites	Visual inspection to observe growth of saplings as per provided green belt design (subjected to the initiation of plantation)	Monthly	EPC Contractor	OE/ Independent Monitor

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Ganges River Dolphin	Rupsha Bridge to Bhairab-Madhumati Confluence	Boat Transect (Shayer et al. (2015) method	Quarterly	EPC Contractor	OE/ Independent Monitor
Waste Management	Construction area	Visual inspection that solid waste is disposed at designated site and are managed in efficient way	Weekly	EPC Contractor	OE/ Independent Monitor
Hazardous Waste Handling	Hazardous Material Storage Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage of hazardous waste and hazardous materials	Fort-nightly	EPC Contractor	OE/ Independent Monitor
Drinking water and sanitation	Labor shed, offices	Ensure the construction workers are provided with potable water and sanitation facilities in the site	Fort-nightly	EPC Contractor	OE/ Independent Monitor
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	EPC Contractor	OE/ Independent Monitor
Safety of workers Monitoring and reporting accidents	At work sites	Visual inspection of usage of Personal Protective equipment, Safety Sign, Safety Documentation, safety training, etc.	Daily	EPC Contractor	OE/ Independent Monitor
Emergency Response Facilities	At project sites	Inspection of Emergency Preparedness and Response mechanism and facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Grievance Mechanism	At project sites	Inspection of the complaint register	Monthly	EPC Contractor	OE/ Independent Monitor
During Operation and Maintenance					
Monitoring of Environmental Quality (Ambient Air, Noise, Water, effluent, Soil, etc.)	At project sites	Inspection and Record checking of Monitoring activities carried out by EHSU circle of	Quarterly	Independent Monitor/ PIU	NWPGCL

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Environmental Laboratory	KP	Inspection of laboratory Condition, accreditation and certification (from GoB) status	Six-monthly	PIU	Independent Monitor, NWPGCL
Meteorological Condition	KP	Checking and compiling climatic data collected and recorded by micro weather station installed in KP	Quarterly	Independent Monitor	NWPGCL
Ambient Noise Level	Residential area, Administrative area and nearby community	Noise nuisance/ disturbance perceived by power plant personnel and nearby community to be surveyed by interview and FGD	Yearly during stakeholder consultation	Independent Monitor	NWPGCL
Fisheries	Effluent discharge points	Interviewing local fishermen	Yearly during stakeholder consultation	IM	NWPGCL and DoF
Plant Health	Green belt area and influence zone	Visual inspection	Yearly	Independent Monitor	NWPGCL
Land use and land cover	5km radius area the Power Plant	Stakeholder Consultation and Satellite Image (2km buffer area of KP) Analysis	Yearly	Independent Monitor	NWPGCL
Hazardous Waste and Hazardous Material Handling	Hazardous Material Storage Area and Use Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage hazardous waste and hazardous materials	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
GRM	At project site	Inspection of the complaint register/grievance form and interviewing local people	Six-monthly	EHSU Circle	Independent Monitor, NWPGCL
ERP	Project site	Inspection of Emergency Preparedness and Response mechanism	Quarterly	EHSU Circle	Independent Monitor, NWPGCL

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Health and Safety Preparedness	Project site	Inspection of training list, safety meetings records, means of awareness growing	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
Community Relation	Nearby Community	Inspection of community relation maintaining procedures, relation building activities, FGD with community	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
CSR Program (if any)	Nearby Community	Inspection of record completed and planned CSR programs and activities	Six-monthly	Independent Monitor	NWPGCL

9.11.4 Implementation of Environmental Monitoring Plan

Responsible Agency

639. The Chief Engineer, Rupsha 800MW CCPP is the responsible authority for administering and implementing the Project and the Project Director will implement environmental monitoring program during construction and the Plant Manager (Superintending Engineer) will implement monitoring plan during operation stage. During construction stage, the Environmental Compliance Monitoring will be conducted by the Contractor(s) supervised by OE and Environmental Impact Monitoring will be carried out by OE with the support of the Contractor(s). In addition, an independent Monitor will also be retained by PIU during three years of construction and one years of post-construction (operation stage). The EHSU Circle will implement the monitoring program during operation stage.

Action during Emergent Operation

640. The Plant can have an Emergent operation if there is a major failure of control system, plant component, grid failure, etc. Normally the modern DCS is good enough to handle all such emergencies. Otherwise, the plant operator/shift in-charge can change the plant control to manual mode and adjust the process variables and finally change the plant back to auto mode. The proposed project will have DCS with modern sensors and a proper interface with the existing old sensors/system.

641. The plant will be operated ensuring all pollution control devices are in order. In case of any event of malfunction of a pollution control device, immediate action of resolving the problem will be taken. If any emergent situation arises during operation, the shift in-charge will be immediately notified to take corrective measures and action.

9.11.5 Performance Indicators

642. For evaluating the performance of the environmental management and monitoring plan, performance indicators are identified to, for efficient and timely implementation of measures/actions proposed in EMP. The indicators are defined both for construction and

operation phases. OE will be responsible for compiling the information on these indicators and report to NWPGCL.

643. To measure the overall environmental performance of the project, an additional list of performance indicators is provided below:

- Number of inspections carried out by OE per month
- Number of non-compliances observed by OE or EHSU.
- Continuous period of non-compliance
- Number of grievances received.
- Number of grievances resolved.
- Number of construction and occupational related accidents.
- Timely reporting of documents (as defined in EMP and monitoring plan)
- Availability of environmental and H&S specialists in EHSU.
- Availability of environmental and H&S specialists in OE.
- Availability of environmental specialists and H&S with contractors.
- Number of trainings imparted to stakeholders/other capacity building initiatives

9.11.6 Reporting and Feedback Mechanism

644. The monitoring activities will require proper documentation. In case of Independent monitor, the monitoring results and relevant document should be properly reported to the project implementation authority. The project authority would submit the report to the DoE and ADB.

645. During construction stage, the environmental specialist of OE will be engaged in monthly discussion meeting with the project implementation unit and the Contractor(s) for giving necessary feedback. The project implementation unit may arrange a discussion meeting after six months with the financer regarding environmental compliance.

646. During the operation phase, the EHSU Circle will carry out the monitoring activities and keep all the records and results of monitoring with proper documentation and will produce quarterly reports on Environmental Monitoring. Besides, the third party Independent Monitor would prepare and submit environmental compliance monitoring report annually to the power plant authority. All the reports should be submitted to DoE which is a condition of renewing the ECC from DoE and to the financer for post-completion monitoring and evaluation of the Project.

647. During operation, the EHSU Circle will give necessary feedback instantly to the person in concern. The EHSU Circle will arrange a monthly meeting to disclose the results of environmental monitoring to the personnel.

9.11.7 Budgets for Monitoring

648. Summary costs of monitoring including investments costs are presented in **Table 9.9** and **Table 9.10**.

Table 9.9: Environmental Compliance Monitoring Cost

No.	Activities	Estimated Cost (USD)/Year
During demolition, pre-construction and Construction (borne by EPC Contractor)		
1	Environmental quality (air, water, noise, soil) monitoring	40,000
2	Occupational health, safety, and sanitation	6,500
3	Ecological Monitoring	
	3a. Supervision of clearing as per layout plan avoidance of wildlife loss	7,500
	3b. Species composition and population of dolphin	12,500
	3c. Plantation program (as required)	3,000
4	Land and agricultural resources monitoring	650
5	Fisheries Fish habitat Fish diversity and composition Fish migration Fish Farm Fish production	6,500
6	Consultation and awareness building	1,000
	Subtotal	**77,650**
During 1 year of operation (to be included in O/M cost)		
1	Environmental quality (air, water, effluent, noise, soil) monitoring	45,000
2	Waste Generation and Management	4,500
3	Ecological Monitoring	
	3a. Plant health	6,500
	3b. Disturbance to wild life/dolphin	6,500
4	Land and agricultural resources monitoring	650
5	Fisheries Fish habitat Fish diversity and composition Fish migration Fish Farm Fish production	6,500
6	Effluent monitoring	3,500
7	Occupational Health, Safety and Security	6,500
8	Community Health Safety and Security	3,800
9	Monitoring beyond compliance	2,000
10	Consultation and awareness building	500
	Subtotal	**85,950**

Table 9.10: Cost of Independent Auditor

No.	Activities	Estimated Cost (USD)
1	Independent Monitor for a five (5) years period including one (1) year of operation (only fees and cost)	150,000

10.0 HAZARD AND RISK ASSESSMENT

10.1 Introduction

649. Hazard is considered those that can cause harm or has the potential to cause harm; whereas, risk is the likelihood of hazard being occurred and its severity. Thus, a risk assessment is conducted, to carefully examine the potential hazards, how they occur and the measures to prevent such hazards. Mismanagement of one particular hazard can have consequences that simultaneously impact to a varying degree on several risk types.

10.2 Hazard assessment process

650. In the EIA stage, potential hazards are identified and discussed in detail along with risk assessment. An inclusive safety management plan is also developed accordingly. The steps followed in this preliminary hazard and risk assessment are mentioned below:

i. Identification of Hazards
ii. Cause Analysis
iii. Consequence Analysis
iv. Assessment of Likelihood
v. Identification of Existing Safeguards
vi. Risk Ranking, Recommended Actions and Safety Measures

10.3 Identification of hazards and Cause Analysis

651. Potential hazards are identified based on the different stages of the project phases, various location and project activities. Cause analysis is also conducted for potential hazards for each of the project activities.

10.3.1 Potential Hazard and Risk during Construction and Erection

652. The potential hazards and risk during construction, and erection are listed in **Table 10.1**.

Table 10.1: Potential hazard and risk during construction and erection

Location of hazard	Potential Hazardous Activities	Potential hazard	Cause Analysis	Consequences
Construction and Erection				
Machinery and equipment	Mobilizing machines, equipment and vehicles for site clearance activities	• Trips and falls • Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	• Health injury • Disability • Life loss
Construction site	• Construction of building, steel structure and its foundation, stacking of HRSG	• Accidents (burns, electric shocks etc.) • Injuries from falls and slips • Injuries from falling of heavy objects/machineries	• Fatigue or prior sickness • Electric failure • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area	• Physical injury • Disability • Life loss

Location of hazard	Potential Hazardous Activities	Potential hazard	Cause Analysis	Consequences
	components, cutting, welding, painting works, drilling work, etc. • Use of machineries and equipment for dismantling of structures	• Inhalation of dust • Cuts and bruises	to prevent entry of outside people) • Not abiding to health and safety rules (e.g. not wearing appropriate PPEs during work, being careless at handling heavy equipments etc.) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night (for those working overtime)	
	• Work at heights • Lifting of machineries and equipment from tall heights	• Accidents • Injuries from falls and slips (e.g. broken bones, fractures, traumas, etc.) • Fatalities	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not abiding to health and safety rules (e.g. not wearing appropriate PPEs and safety harness during work, being careless at handling heavy equipments, not wearing safety harness when working at heights etc.) • Not maintaining enough lighting during the night	• Health injury • Disability • Life loss
	Vehicle and vessel movement	• Noise generation • Accident (e.g. vessel capsize) • Emission from vehicles • Spread of dust and minute particles due to vehicle movement.	▪ Running engine, hydraulic horns, sirens etc. ▪ Mechanical failure • Old engine or engine parts/lack of maintenance	• Injuries • Health problems (e.g. respiratory, hearing and/or cardiac problems) • Fatalities • Disabilities
	Handling of hazardous chemical	• Accidental release of chemicals and noxious fumes • Acute/chronic toxicity from exposures to chemicals • Fire/explosion	▪ Lack of safety protocols ▪ Carelessness (e.g. smoking near chemical storage area) ▪ No proper bounding of chemical storage area • Improper chemical storage (e.g. faulty/leaky containers, improper containers, improper sealing of containers etc.)	• Health injuries (burns, anxiety, depression etc.) • Disabilities • Fatalities • Loss of properties

Location of hazard	Potential Hazardous Activities	Potential hazard	Cause Analysis	Consequences
	Possible fire and Explosion hazard from machineries, equipments, oxyacetylene cylinders (used for welding purposes), generators and vehicles	• Explosion caused due to poor maintenance of oxyacetylene cylinders or due to using faulty cylinders • Fire caused by mechanical/electrical failure of generators • Fire caused by mechanical/electrical failure of vehicle oil tanks	▪ Lack of proper maintenance of machineries, equipments and vehicles	• Health injuries • Disabilities • Fatalities
	Working in a confined space (Gas pipelines, HRSG etc.)	• Suffocation • Falling of debris • Release of toxic fumes	▪ Lack of protective measures ▪ Faulty/Damaged pipelines ▪ Negligence towards work	• Health injuries • Fatalities
	Occupational Hazard	• Cuts, bruises and burns • Falls, slips and trips • Health injuries • Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Improper hygiene ▪ Prior sickness or illness • Heavy workload	• Health injuries (burns, anxiety, depression etc.) • Disabilities • Fatalities
Chemical Storage Area	Storage of chemicals	• Release of toxic fumes • Fire/explosion • Falls and slips	▪ Lack of proper ventilation in chemical storage area ▪ Storing flammable and volatile chemicals in the same area. ▪ Faulty electric connections ▪ No bounding around chemical storage areas ▪ Not ensuring proper labelling/MSDS ▪ Lack of training of chemical handlers/workers	• Health injuries • Suffocation/asphyxiation • Fatalities
Plant Jetty site	• Loading and unloading of machineries, equipment and fuel oil	▪ Slip, trip and falls • Health injuries (from falling of heavy objects or debris)	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Heavy workload	• Health injuries • Disabilities • Fatalities

10.3.2 Potential Hazard and Risk during Operation

653. The potential hazards and risk during operation are listed in **Table 10.2**.

Table 10.2: Potential hazard and risk operation

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
Gas pipelines	Transmission of gas to project site	• Toxic Vapor Cloud Formation • Vapor Cloud Explosion • Jet Fire • Limited Space Explosion • Over Pressure Explosion	▪ Mechanical failure ▪ Faulty connections/weld failure ▪ Cracks/shear stress on pipeline • Improper coating on pipelines • Corrosion • Sabotage	• Health injury • Fire/explosion • Possible poisoning • Suffocation • Damage to structure
Gas Metering and Regulatory Station	• Regulation of gas pressure and its quantity • Intake of gas from metering station to the plant	• Gas leakage to the atmosphere • Flash fire/jet fire/explosion (if in contact with an ignition source)	▪ Mechanical failure ▪ Faulty connections/weld failure ▪ Cracks/shear stress on pipeline • Improper coating on pipelines • Failure of maintenance activities creating ingress of air into natural gas piping and vessels and subsequent start-up without adequate purging. • Corrosion ▪ Sabotage	• Property damage • Environmental damage • Health injuries (e.g. burns) • Fatalities
Steam turbine, turbines, HRSG, generator and its ancillary components	Electricity generation	• Mechanical hazard • Leakage of natural gas • Fire hazard/explosion (if in contact with an ignition source) • Electrical hazard • Noise generation	▪ Mechanical failure (due to failure of rotating machineries or failure in gas or steam pipelines) ▪ Lack of sound buffers ▪ Electric short circuit ▪ Engineering design fault	• Health injury (from projectiles, fires, electrical shock etc.) • Fatalities • Property damage • Environmental damage
• Cable gallery • Power transformer • Switchyard	Transmitting electricity from generator to unit transformer	• Fire due to resulting arc flash/arc blast • Other electric hazard due to	▪ Short circuit in control room and switch gears ▪ Faulty cables and wires ▪ No safe connection to earth	• Health injury from electric shock, fires etc. • Fatality from electrocution, fires etc.

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
• 230KV Switchyard control room	• High voltage (230KV) power transmission • Open air power transmission • Controlling and monitoring the power transmitting system	unprotected cables • Slips and trips from unorganized/loose cables lying in the floor	▪ Using cables with different voltage and current ratings • Unorganized cables	• Electric burns
• Boiler and pressure parts • Compressed air system and pipeline • Live steam line	• Steam generation • Operate pressure valve, switch and control system • Flows live high pressure steam from boiler to turbine	• Fire (near burner) • Release of high pressurized steam • Explosion	▪ Failure of the water pumps ▪ Mechanical failure of safety switch and valves ▪ Busting of furnace and pressurized pipes ▪ Presence of contaminant in fuel • Accidental leakage, lack of heat sink for combustion process and nonfunctional safety and bypass valve.	• Incomplete combustion • Equipment damage • Health injury • Loss of life • Environmental degradation
Water treatment and waste water treatment plant	Produce clarified, dematerialized water for steam generation and treat effluent water	Chemical hazard	▪ Spillage/accidental release • Mishandling and misuse	• Possible health injury due chronic or acute toxicity • Disability • Loss of life • Degradation of air, water and/or soil quality
Intake channel	Water intake for plant operation	Mechanical Hazard	▪ Accident due to ship anchorage ▪ Negligence of ship master. ▪ Poor signal	• Disruption of intake channel for the powerplant. • Interruption of reverse osmosis plant.
Chemical storage	Use for water treatment in different phases of dematerialized water, cooling water and potable water.	Toxic accidental release due to multifunction of equipment & callousness of operator.	▪ Chemical spillage ▪ Chemical fires • Mishandling and misuse	• Health injury (chronic or acute toxicity) • Disability • Loss of life • Degradation of air, water and soil quality
Air circulating system	Generating air flow both in and out of boiler	Non-functional air circulating system	• Mechanical failure	• Equipment damage and risk to human health and surrounding environment

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
Plant site	Daily plant activities	• Cuts, bruises and burns • Falls, slips and trips • Health injuries • Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Prior sickness or illness ▪ Heavy workload • Unsafe working environment.	• Health injury • Electric shock • Sickness • Anxiety and depression

10.4 Consequence Analysis

10.4.1 Leakage from Gas Pipe Line

654. Natural gas is a flammable chemical which is enlisted as explosive under the '***Explosive Act 1884'*** of Bangladesh. The natural gas used for the proposed plant consists of mostly Methane (96% by volume) and ethane, propane, butane and other alkanes. Though methane is highly flammable gas, its explosion limit is low (5% - 15%). Leakage of gas from pipeline and other associated events may cause series of hazards. It describes and assesses the unplanned events that could potentially cause risks to public safety and harm to the environment. In the following sections, potential hazards and consequences are discussed.

655. Gas transportation and pipeline construction plan is shown in **Figure 10.2.** Gas will be supplied from Regulating and Metering Station (RMS) situated at south-west corner of the proposed site. Leakage from these Gas supply facilities may lead to series of hazards that may ultimately results in damage of the property and loss of human life. **Table 10.3** has listed down all identified major potential hazards and hazard sourcing points related to natural gas during plant operation. Sequential Hazard Event from a Gas Leakage is shown in **Figure 10.1.**

Figure 10.1: Sequential Hazard Event from a Gas Leakage

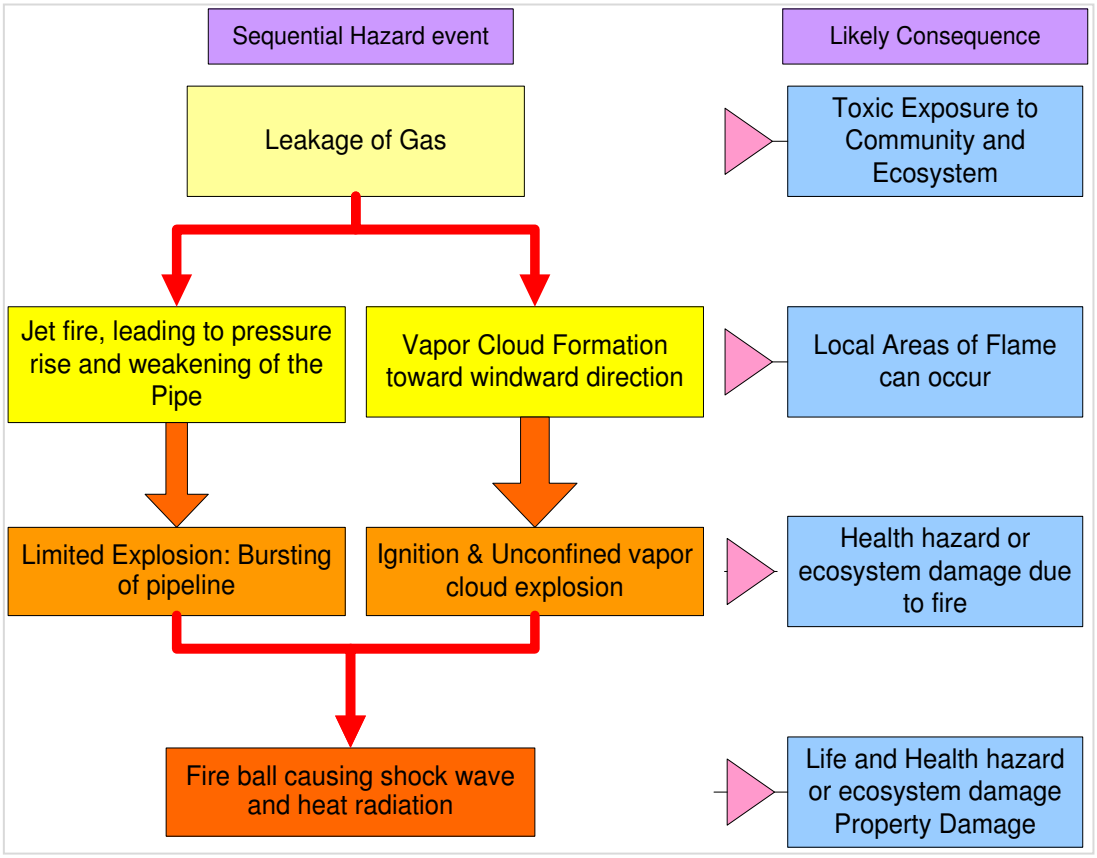
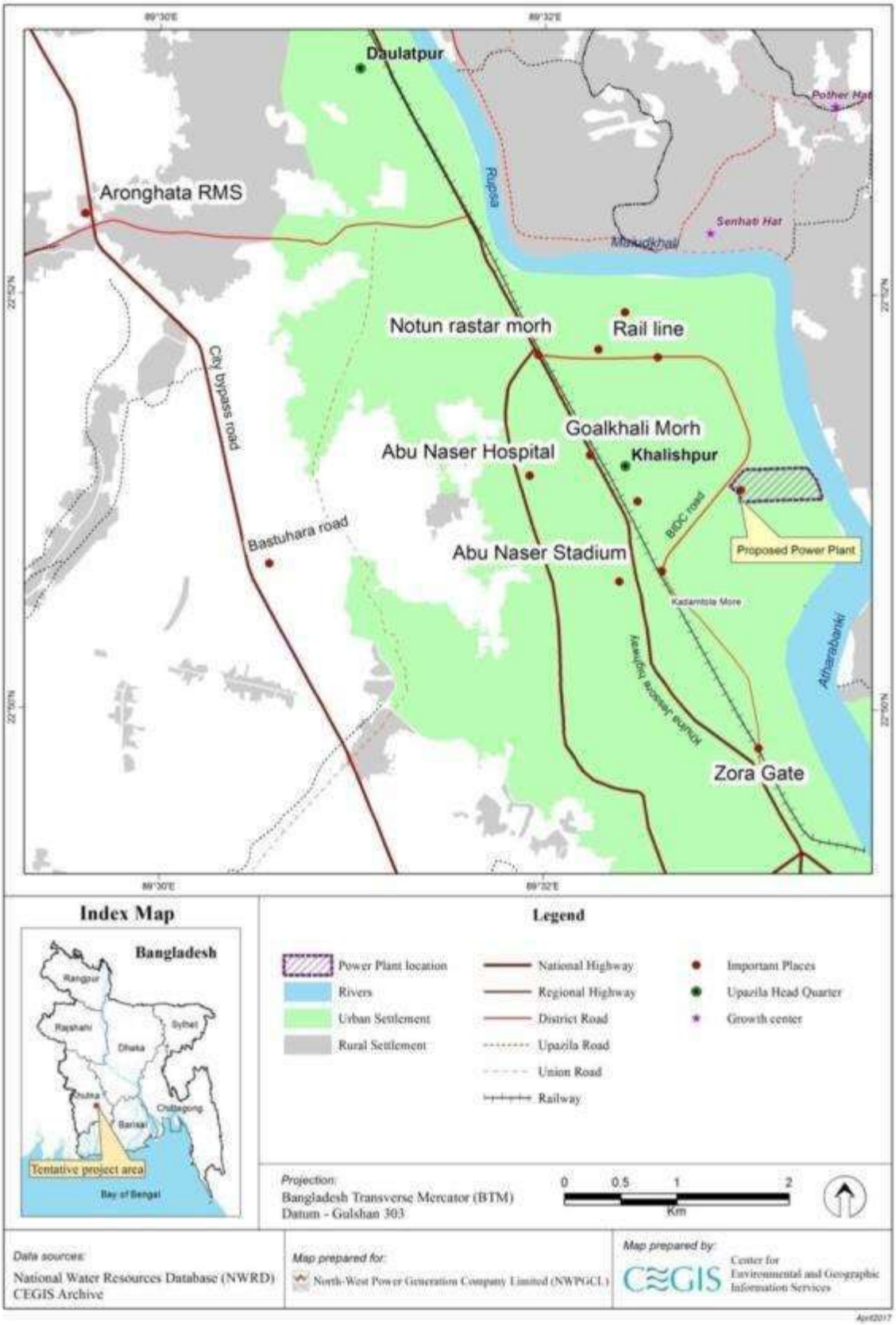


Figure 10.2: Proposed gas distribution pipeline construction plan



Risks associated with gas pipeline

656. Some major reasons which may be attributed to the Risks associated with the transmission of natural gas through gas pipeline are:

- Material Failure (faulty design or manufacture; faulty installation, welding or construction of facilities)
- Corrosion-internal or external pipe;
- Excavation damage (dig-ins)
- Human Error-Natural Forces (i.e. ground movement); and
- Others

Table 10.3: Potential hazard points and possible consequences

Hazard Points	Possible Hazards	Consequences
Regulatory and Metering Station	Gas Leak leads to: • Toxic Vapor Cloud Formation • Vapor Cloud Explosion • Jet Fire • Limited Space Explosion • Over Pressure Explosion	• Fire • Poisoning • Suffocation • Damage to Structure • Health Loss
20" Gas Pipeline, valves		

657. Leakage from pipeline or RMS may lead to sequential hazards. The gas pipeline may experience leakage due to any fracture or failure of the pipeline. ALOHA (Areal Locations of Hazardous Atmospheres) software has been used to simulate the consequences of gas leakage or pipeline failure. ALOHA is a modelling tool to estimate threat zones associated with hazardous chemical releases, including toxic gas clouds, fires, and explosions. The simulation considers that it is possible to close off the gas supply connection through valve installed at RMS. ALOHA has been applied to simulate the following sequential hazards-

- Thermal radiation from jet fire
- Toxic Area of Vapor Cloud Formation
- Flammable Area of Vapor Cloud Formation
- Blast Area of Vapor Cloud Formation

658. The basic assumptions include climatic condition, site condition and release conditions. One of the key assumptions is wind direction, which has been considered as flow from 'South East' on the basis of the analysis of the wind rose diagrams provided in **Chapter 4**. The wind rose indicates that most of the time in a year wind flows from South-East to the North-West direction. Average Wind speed has been considered as 1.4 m/s. Most of the time in a year wind speed remains 1-2.5 m/s at 5 m height. The pipeline area is surrounded by main plant structure and vegetation that may obstruct free flow of wind in the proposed area. Both ends of the gas pipe between plant and RMS is regulated by valves.

Simulation of Toxic Area of Vapor Cloud Formation

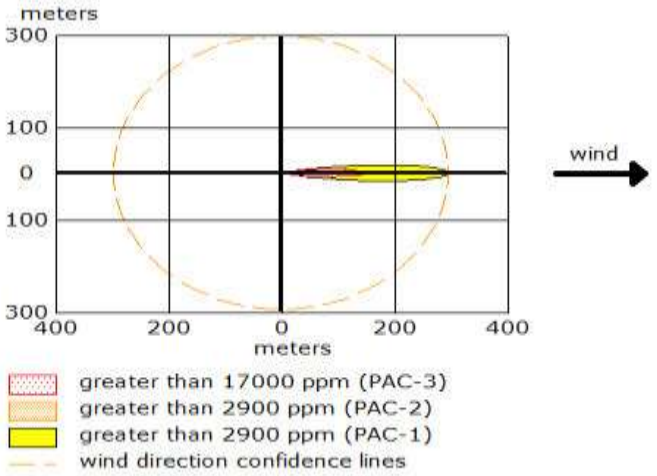
659. ALOHA estimates that toxicity may spread up to 298 m from the source point. Death threatening toxicity may spread up to147 m towards windward. **Figure 10.3** presents the threat zone area of toxic vapour cloud formation. In addition, **Table 10.4** presents a brief summary of the toxicity.

Table 10.4: Threat Zone of Vapor Cloud Formation

Items	Red Threat Zone (meter)	Orange Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	PAC 3: Concentration <17000 PPM More than one-hour exposure to this concentration threats adverse health effect or death	PAC 2: concentration < 2900 PPM, More than one-hour exposure to this concentration threats irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape	PAC 1: concentration <2900 PPM, exposure to this concentration threats discomfort, irritation, or certain asymptomatic, non-sensory effects
Toxic Area	147 m	298 m	298 m

Note: PAC: Protective Action Criteria

Figure 10.3: Threat zone of toxic vapor cloud from gas pipeline failure



Note: Assumptions: Wind Direction from SE, Temperature: 28^0C, Wind Speed 1.4m/s

Simulation of Flammable Area of Vapor Cloud Formation

660. The vapour cloud formed from a leakage of a gas pipeline has flammability. ALOHA has been applied to estimate the possible flammable area of the vapour cloud. The explosion limit of methane is low, only 5% (LEL) - 15% (UEL). The local area of flame can occur even though the concentration is below the lowest explosion limit (LEL). ALOHA considers 60% of the LEL to cause a flame.

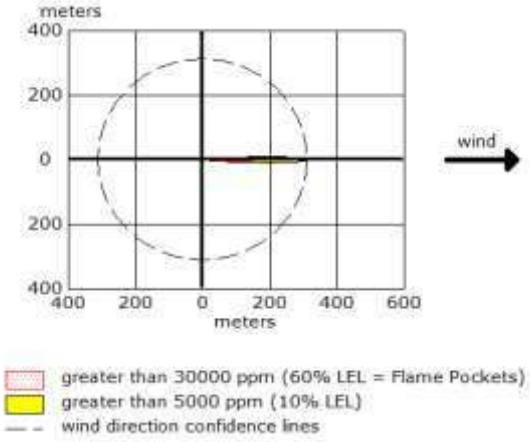
661. 60% of the LEL level i.e., 30,000 ppm concentration has been considered as high threat zone (red) of occurring flame and 10% of LEL i.e., 5,000 ppm is considered low threat zone (yellow) of occurring flame. The model estimated the high threat zone might spread up to 313 m. The details of the simulation results are shown in **Figure 10.4** and **Table 10.5**.

Table 10.5: Threat Zone of Vapor Cloud Formation (Flammable)

Items	Red Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	LOC: > 30,000 PPM Which is 60% of the Lowest Explosion Limit (LEL) of Methane.	LOC: > 5000 PPM Which is 10% of the Lowest Explosion Limit (LEL) of Methane.
Flammable area of vapor cloud formation	155 m	313 m

LOC = Level of Concern.

Figure 10.4: Threat zone of flammable vapor cloud resulted from leakage



Simulation of Blast Area of Vapor Cloud Formation

662. ALOHA defines three levels of concern for classifying threat zones on the basis of overpressure formed by the shock wave created from blast.

- High Threat Zone, 8 psi pressure which is destructive for buildings
- Moderate Threat Zone, 3.5 psi pressure serious injury
- Low Threat Zone, 1.0 psi pressure that is enough to shatter window glass

663. The model predicts that, the possible blast of the Blast area will not be strong enough to create any pressure above 1 psi to shatter even a window glass.

10.4.1.1 Simulation of Jet Fire

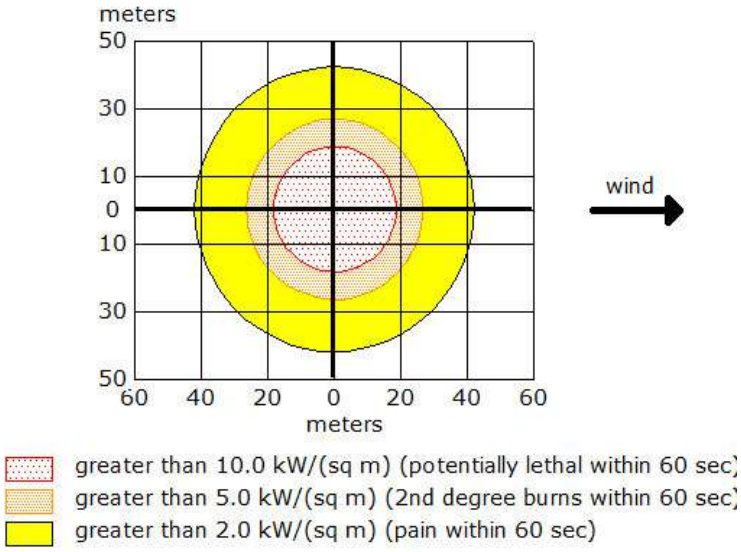
664. Methane gas leakage from a pipeline may cause a jet fire if it ignites with fire; come close proximity to thermal radiation, heat and toxic by-products. ALOHA software has been applied for estimating the threat zone of thermal radiation of the possible jet fire. **Figure 10.5** shows the predicted areas of different threat zone and **Table10.6** gives a narrative summary of the prediction.

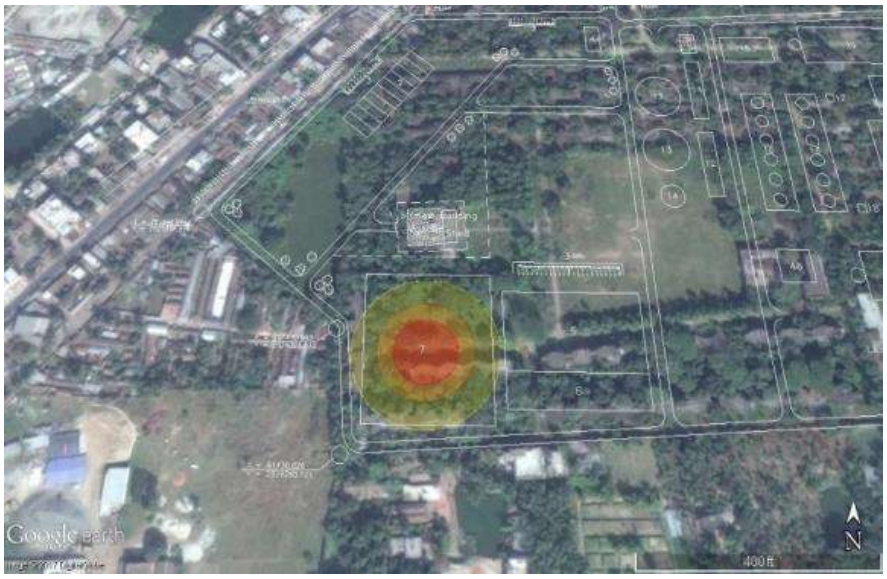
Table 10.6: Threat Zone of Thermal Heat Radiation of a Jet Fire from Gas Leak

Items	Red Threat Zone (meter)	Orange Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	LOC: 10 kw/m^2 Potentially lethal within 60 sec exposure	LOC: 5 /m^2 2nd degree burn within 60 sec exposure	LOC: 2 kw/m^2 Pain within 60 sec exposure
Heat radiation from jet fire	19 m	27 m	43 m

LOC = Level of Concern.

Figure 10.5: Threat Zone of Thermal Heat Radiation of a Jet Fire from a Gas Leak





Note: Assumptions: Wind Direction SE, Temperature: 28^0C, Wind Speed 1.4 m/s.

665. High threat zone (red) of occurring flame may exceed to 19 m and the LOC (Level of Concern) will be of 10 KW/m^2whichmay be potentially lethal within 60 second exposure and the moderate threat zone i.e. LOC of 5 Kw/m^2 is considered moderate threat zone (orange) of occurring flame. In addition, the model estimated the low threat zone might spread up to 43 m.

666. The simulation of the threat zone shows that, the low risk zone (yellow threat zone of the area of flammable vapour cloud will not reach to HSD storage tank (in case of a gas leak when the wind direction is SE and wind speed is 1.4 m/s). But some accidental explosion may be considered for the HSD tank.

Simulation of Thermal radiation of Pool Fire Formation

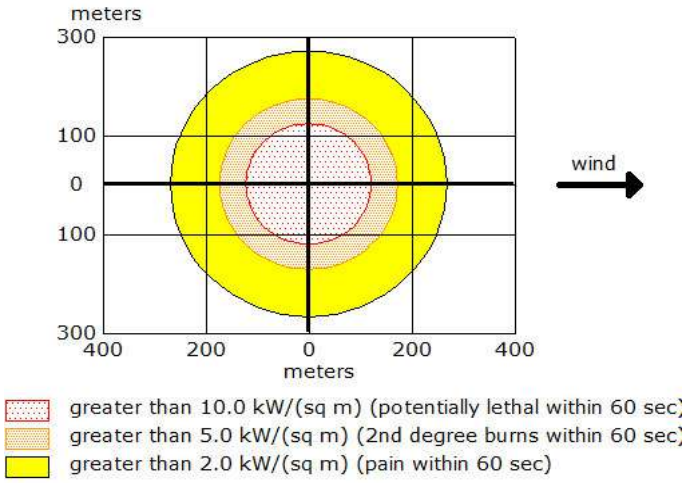
667. ALOHA has also been applied to estimate the possible thermal radiation zone caused by pool fire which may be created through the HSD tank failure. The explosion limit of N-Hexane is low, only 1.2 (LEL) –7.4(UEL). The radiation my spread up to 269 m. The details of the simulation results are shown in **Figure 10.6** and **Table 10.7**.

Table 10.7: Threat Zone of Vapor Cloud Formation (Flammable)

Items	Red Threat Zone (meter)	Orange threat zone	Yellow Threat Zone (meter)
Definition	LOC: 10 kw/m^2 Potentially lethal within 60 sec exposure	LOC: 5 kw/m^2 2nd degree burns within 60 sec)	LOC: 2 kw/m^2 Pain within 60 sec exposure
Thermal radiation from pool fire	122 m	173 m	269 m

LOC =Level of Concern

Figure 10.6: Threat Zone of Vapor Cloud Formation (Flammable)



10.5 Preventive Measures

668. Accidental incidents like the failure of pressure vessels, piping, coated materials of the storage tanks and structural components may be occurred by the excessive heat generation or failure in the internal pressure load or by any other extraneous events. Hence, the associated hazards need to be taken into consideration in order to minimize the loss of life and properties. The model generated threat zone of vapor cloud and flammable cloud are directed to N-W from the RMS station which would be vacant ground as per layout. Moreover, the zone of jet fire will be within the project boundary. Only the threating zone of pool fire of the HSD Tank will encompass adjacent installations where a number of preventive measures like safe containment/bund wall will be provided. Specific strategies also need to be adopted in order to fight against these hazards. Though it is suggested to abolish hazards that might be controlled /mitigated through following systems. Such as

- Emergency shutdown of the fuel supply system
- Automatic fire fighting system development
- Control of spills from the HSD Tank
- Failure of Fire and gas systems
- Readiness of the active and passive fire protection
- Evacuation escape and rescue system development

669. Within the safety management system, a HS & E plan will have a fire and related hazard prevention plan, which in turn will include a plan for blast and fire strategy for piping. The strategies may be comprised of:

- Identification of the critical piping at the RMS area
- Readiness of the Fire Safety units of the Rupsha Power Plant
- Selection of specific pipe design materials and procedure to protect fires and explosions

- Selection of non-combustible piping supports for conveying pipe inside the power plant.

670. **Jet Fires from the RMS.** In order to prevent the jet fire from the RMS of Rupsha Power Plant, the products of the RMS and surrounded area should be cementitious. Whole gas pipeline will be rated with jacket system. Moreover, the pipes will be rated with flanged removal components and valve removal components. If possible, the firewall of the south west side of the RMS would be proofed with Blast rated firewall design, fabrication and the area will be rated with deluge system.

671. **Pool Fires from the Tank.** Reactive, flammable, and explosive materials should be managed in order to avoid the uncontrolled reactions or events resulting from fire or explosion.

- Use of flame arresting devices on vents from flammable storage containers
- Provision of grounding and lightning protection for tank, transfer stations, and other equipment that handles flammable materials
- Selection of materials of construction compatible with HSD stored for all parts of storage and delivery systems, and avoiding reuse of tanks for different products without checking material compatibility
- Prohibition of all sources of ignition from areas near flammable storage tanks prevent fire, explosion, spill, and other emergency situations from affecting facility operations

672. Secondary containment or the bund may be characterized by the critical aspect to control accidental releases of HSD during storage and transfer. The design and construction of the secondary containment should be in a manner so that it may hold released materials effectively until they can be detected and safely recovered. Appropriate structures should be consisting of berms, dikes, or walls and will be made of impervious, chemically resistant material. Design should also consider means to prevent contact between incompatible materials in the event of a release.

673. However, there are many environmental and safety advantages of underground storage of hazardous materials, including reduced risk of fire or explosion, and lower vapor losses into the atmosphere, leaks of hazardous materials can go undetected for long periods of time with potential for soil and groundwater contamination.

10.6 Assessment of Likelihood

10.6.1 Hazard Magnitude & Frequency Analysis

674. The potential impacts of the project have been scaled and prioritized based on the magnitude of those potential impacts and the likelihood of them occurring (frequency). The magnitude of the said impacts are classified and illustrated in **Table 10.8**.

Table 10.8: Hazard Magnitude Scale

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Duration of potential impact	Temporary with no detectable potential impact	Limited to construction period	Medium Term (1 to 2 years)	Long term (more than 2 years)	Permanent Damage
Spatial extent of the potential impact	Specific location within project component or site boundaries with no detectable potential impact	Within project boundary	Beyond immediate project components, site boundaries or local area	Widespread far beyond project boundaries with some community and wildlife habitat coverage	Beyond project boundaries extending to widespread communities and wildlife habitat
Reversibility of potential impacts	Baseline remains almost constant	Baseline returns naturally or with limited intervention and within a few months	Potential impact requires a year or so for recovering with some interventions to return to baseline	Potential impact is long-term, requiring considerable intervention to return to baseline	Potential impact is effectively permanent, with little to no chance of returning to baseline
Compliance to Legal Standards before Mitigation Measures	Complies with all minimum requirements only some improvement opportunities to strengthen good practices	Meets minimum national standard limits or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Complies partially with limits given in national standards but breaches international lender guidelines	Completely breaches national standards and or international guidelines/ obligations
Extent of health injuries	Minor pain, scratch, discomfort requiring no medical attention	Health injuries can be cured with first aid and/or some medical attention	Health injury requires hospitalization; may require long term recuperation; may lead to long term absence from work	Health injury may lead to permanent disability; few fatalities of workers and or community people	Fatalities of workers more than five (5) and or community people more than two (2)
Impact on wildlife	Minimal disturbance within compliance	Disturbing habitat of wildlife causing discomfort	Disturbing habitat of wildlife causing decrease of preys and forcing them to relocate	Impact leading to deaths of any endangered species and decrease of their food source	Impact may lead to deaths of two (2) or more endangered marine mammals and-or five (5) of other endangered species

675. Criteria for determining the frequency of the potential hazard being occurred are outlined in **Table 10.9**.

Table 10.9: Criteria for Determining Frequency of the Potential Hazard

Frequency Scale Determination	Definition
1(Rare)	Rare chance of occurrence, if not at all
2(Low)	Very minimal chance of occurring
3(Medium)	May occur considering if the conditions are abnormal or exceptional
4(High)	Occurs more frequently without prior warnings
5(Almost Certain)	Occurs under typical conditions

10.7 Risk Matrix Development

676. Following the magnitude and frequency scales, a risk matrix can be developed after analyzing the potential hazards for the Project. The table below (**Table 10.10**) shows the risk matrix for the potential hazards and how frequently they may occur. In **Table 10.11**, the risk evaluation based on the type of activities and potential hazards are shown.

Table 10.10: Risk Matrix of Potential Hazards/Impacts

	Hazard Magnitude (M) →				
Frequency (F) of Hazards ↓	**1 (Insignificant)**	**2 (Minor)**	**3 (Moderate)**	**4 (Major)**	**5 (Severe)**
1(Rare)	1	2	3	4	5
2(Low)	2	4	6	8	10
3(Medium)	3	6	9	12	15
4(High)	4	8	12	16	20
5(Almost Certain)	5	10	15	20	25

Color Legend:

Red (15-25)	≡ Top Priority	: Action with follow-up Verification & Validation by Authority needed before allowing work
Orange (10-14)	≡ High Priority	: Action needed under follow-up Supervision before allowing work
Yellow (5-9)	≡ Medium Priority	: Need maintaining with routine monitoring & reporting
Green (1-4)	≡ Low Priority	: Only for awareness; no Intervention Action needed to start work

677. The risk for the potential hazard/impact is evaluated based on the combination of the hazard consequence and their frequency (NHS, 2008). In order to calculate the potential risk, the frequency of impact is multiplied with consequences. E.g. Level 1 of frequency of a hazard (Rare) is multiplied with Level 1 of hazard consequence (insignificant) to give a total score of 1 (1X1=1) and so on. In that regards, a score between 1 to 4 is considered low priority; a score between 5 to 9 is considered medium priority and; a score between 10 to 14 is considered high priority and; a score between 15 to 25 is considered top priority

10.8 Identification of Existing Safeguards

678. Since this is a new power plant, no existing safeguards are present. Suggested safety measures are shown in **Table 10.11**.

Table 10.11: Risk Management Plan

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Construction and Erection Phase										
Machinery and equipment	Mobilizing in machines, equipments and vehicles for site clearance activities	• Trips and falls ▪ Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training ▪ Not abiding to general health and safety and traffic rules	3	3	**9**	• Arranging toolbox meeting before going out for work • Regular inspection and maintenance of equipments • A thorough lorry driver selection process via interviews, checking whether they have the proper licenses and from past experiences • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road after the selection process is complete • Limiting movement of vehicles after sunset and before sunrise • Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs.	2	1	**2**
Construction site	• Construction of building, steel structure and its foundation, stacking of HRSG components, cutting, welding, painting	• Accidents (burns, electric shocks etc.) • Injuries from falls and slips • Injuries from falling of heavy objects/machineries • Inhalation of dust ▪ Cuts and bruises	• Fatigue or prior sickness • Electric failure • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people)	3	2	**6**	• Arranging toolbox meeting before going out for work (during each construction activities.). Provide each worker with a safety checklist and safety permit (based on their work) before starting work. • Regular inspection and maintenance of equipments, machineries and especially, safety harness. Maintain a registry for any faulty equipment found; inform site contractors and have them replace those immediately. No work should be done until the faulty machineries are replaced and tested.	2	2	**4**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
	works, drilling work, etc. ▪ Use of machineries and equipments for dismantling of structures		• Not abiding to health and safety rules (e.g. not wearing appropriate PPEs during work, being careless at handling heavy equipments etc.) • Not maintaining a designated place for backfilling storage ▪ Not maintaining enough lighting during the night (for those working overtime)				• Regular health and safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. • Enclosing the area with yellow barricade tape and restricting outside access to local people during the whole construction process. • Spraying water on dust to minimize its spread via wind; put stockpile at a designated place and cover them with GI sheet; put up GI sheet fencing around the construction site. • Equipments, machineries and electric wires should be checked for current and voltage ratings. When using an extension cable, its wire rating should match with the equipment wire rating. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken ▪ Maintenance of an accident registry book			
	▪ Work at heights ▪ Lifting of machineries and equipment from tall heights	• Accidents • Injuries from falls and slips (e.g. broken bones, fractures, traumas, etc.) ▪ Fatalities	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not abiding to health and safety rules (e.g. not	4	3	**12**	▪ Regular inspection and maintenance of equipments, machineries and especially, safety harness. Maintain a registry for any faulty equipment found; inform site contractors and have those replaced immediately. No work should be done until the faulty machineries are replaced and tested. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken ▪ Maintenance of an accident registry book. ▪ Not allowing workers working in dimly lit areas. Appropriate warning signs must be placed in hazard	3	2	**6**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			wearing appropriate PPEs and safety harness during work, being careless at handling heavy equipments, not wearing safety harness when working at heights etc.) ▪ Not maintaining enough lighting during the night				prone working areas with the hazard signs being fluorescent and perfectly readable from 3-4 meter distance. ▪ Restricting workers from working without appropriate safety measurements in place during night times (e.g. wearing appropriate PPEs and safety harness etc.). ▪ Maintaining a registry on who is working night shifts and where. ▪ Overtime hours should be restricted to no more than two hours per day as per Bangladesh Labour Rules, 2015			
	Vehicle and vessel movement	▪ Noise generation ▪ Accident (e.g. vessel capsize) ▪ Emission from vehicles ▪ Spread of dust and minute particles due to vehicle movement.	▪ Running engine, hydraulic horns, sirens etc. ▪ Mechanical failure ▪ Old engine or engine parts/lack of maintenance	3	3	**9**	• Regular inspection and maintenance of equipments, machineries and vehicles. • Training of traffic rules, including maintaining vehicle speed limit for different categories of roads. • Spraying water on dust at plant site to minimize its spread via wind or vehicle movement. • Regulate the use of hydraulic horns during construction. Set a limit on the amount of noise generated as stipulated in schedule III of ECR, 1997. • Switch off engines/generators/equipments when not in use. ▪ Monthly health checkup of workers for any illness. Provide treatment accordingly	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
	Handling of hazardous chemical	• Accidental release of chemicals and noxious fumes • Acute/chronic toxicity from exposures to chemicals ▪ Fire/explosion	▪ Lack of safety protocols ▪ Carelessness (e.g. smoking near chemical storage area) ▪ No proper bounding of chemical storage area ▪ Improper chemical storage (e.g. faulty/leaky containers, improper containers, improper sealing of containers etc.)	4	3	**12**	▪ Putting up “fire hazard” and “chemical hazard” warning sign near chemical storage areas. Set up awareness programs and training on how to handle/store chemicals ▪ Check containers for leaks, faults and cracks. Change them immediately if found. ▪ Labeling chemical storage containers for easy recognition. Put up MSDS in chemical containers along with appropriate warning labels (e.g. corrosive, toxic, flammable etc.) ▪ Storing different types of chemical separately. All flammable or corrosive chemicals should be stored separately and should have proper bounding ▪ A fire extinguisher/ fire hydrant should be installed nearby in case of any fire breakout. Emergency contact details for fire fighters and ambulance service should also be placed there. ▪ In case of a spillage, keep flammable substance away from the spillage area and inform on site EPC contractor immediately. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken.	3	2	**6**
	Possible fire and Explosion hazard from machineries, equipments, oxyacetylene cylinders (used for welding	• Explosion caused due to poor maintenance of oxyacetylene cylinders or due to using faulty cylinders	Lack of proper maintenance of machineries, equipments and vehicles	4	3	**12**	• Regular inspection and maintenance of equipment, machineries, vehicles and acetylene cylinders. ▪ Check for leaks or faults in acetylene cylinders before. Make sure proper labeling signs are marked on the cylinders ▪ Training on how to use/handle acetylene welding machines. Ensure proper usage of PPEs (gloves,	3	2	**6**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
	purposes), generators and vehicles	• Fire caused by mechanical/electrical failure of generators • Fire caused by mechanical/electrical failure of vehicle oil tanks					safety mask etc.) before commencement of welding works. ▪ Ensure firefighting equipments such as fire extinguishers are at hands reach in case of a minor fire breakout. In case of severe fire break out, raise alarm and notify appropriate authorities and nearby firefighting departments.			
	Working in a confined space (natural gas pipelines, HRSG etc.)	• Suffocation • Falling of debris	▪ Lack of protective measures ▪ Faulty/Damaged pipelines ▪ Negligence towards work	4	3	**12**	• Ensure cathodic protection on pipelines as per standard procedure to prevent rusting • Ensure proper connection of pipelines • Inspect pipelines for cracks and faults. Make prompt repairs if found. • Ensure regular communications with outside when entering underground. • Use proper safety precautions (e.g. PPEs, oxygen masks etc.) when working at confined spaces	3	2	**6**
	Occupational Hazard	▪ Cuts, bruises and burns ▪ Falls, slips and trips ▪ Health injuries ▪ Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipments ▪ Improper hygiene ▪ Prior sickness or illness ▪ Heavy workload	3	3	**9**	▪ Regular inspection and maintenance of equipment, machineries and vehicles. ▪ Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. ▪ Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road. ▪ Maintenance of hygiene at construction site and providing appropriate training to workers in hygiene maintenance	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							▪ Supplying workers with safe drinking water ▪ Monthly health checkup of workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital. ▪ Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour Rules, 2015[74]. ▪ Employment of child labour (children below the age of 18), pregnant women and elder citizens in hard labour and dangerous activities must be prohibited. ▪ All other facilities (toilet, canteen, overtime hours, leaves etc.) should be followed as stipulated in Labour Rules, 2015.			
Chemical Storage Area	Storage of chemicals	• Release of toxic fumes • Fire/explosion • Falls and slips	▪ Lack of proper ventilation in chemical storage area ▪ Storing flammable and volatile chemicals in the same area. ▪ Faulty electric connections	3	3	**9**	▪ Safe storage of chemicals should be ensured with adequate ventilation ▪ Flammable chemicals should be stored separately and away from any ignition source ▪ No smoking inside the chemical storage area ▪ Storage should be done in an organized way. No empty boxes or containers should be kept haphazardly in the floor ▪ A record should be kept on the type of chemicals being stored along their expiry date and date of manufacture. Maintain MSDS.	3	2	**6**

[74] Bangladesh Labour Rules (2015). *Ministry of Labour and Employment*. Retrieved from http://www.dpp.gov.bd/upload_file/gazettes/14079_83432.pdf.

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			▪ No bounding around chemical storage areas ▪ Not ensuring proper labelling/MSDS ▪ Lack of training of chemical handlers/workers				▪ The storage area should be fitted with adequate fire alarms, automatic fire defusing hydrants and fire extinguishers in case of a fire breakout ▪ Regular inspection of storage area for any abnormalities ▪ Training workers on how to handle and store certain chemicals			
Plant Jetty site	Loading and unloading of machineries, equipment and fuel oil	▪ Slip, trip and falls ▪ Health injuries (from falling of heavy objects or debris)	▪ Lack of awareness on health and safety aspects ▪ Negligence of safety precautions whilst working	3	2	**6**	• Arranging toolbox meeting before going out for work (during each construction activities.). Provide each worker with a safety checklist and safety permit (based on their work) before starting work. ▪ Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all construction workers, including the proper use of PPEs during work.	2	2	**4**
Operation Phase										
Gas pipeline	Transmission of gas to project site	• Toxic Vapor Cloud Formation • Vapor Cloud Explosion • Jet Fire • Limited Space Explosion • Over Pressure Explosion	▪ Mechanical failure ▪ Faulty connections/weld failure ▪ Cracks/shear stress on pipeline • Improper coating on pipelines • Corrosion • Sabotage	3	3	**9**	• Ensure the proper cathodic protection on pipelines as per standard procedure to prevent rusting • Ensure proper connection of pipelines ▪ Inspect pipelines for cracks and faults. Make prompt repairs if found. ▪ Cutting off gas supply if leakage is found. ▪ Informing nearby communities in case of gas leakage. Ensure proper evacuation measures if needed.	3	2	**6**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Gas Metering and Regulatory Station	• Regulation of gas pressure and its quantity ▪ Intake of gas from metering station to the plant	• Toxic gas leakage • Fire/Explosion	▪ Mechanical failure ▪ Faulty connections ▪ Cracks/shear stress on pipeline ▪ Improper coating/cathodic protection on pipelines	4	3	**12**	• Ensure proper connection of pipelines ▪ Inspect pipelines for cracks and faults. Make prompt repairs if found. ▪ Ensure gas pressure is regulated as required. ▪ Wear ear-muffs when entering RMS area.	3	3	**9**
Steam turbine, turbines, HRSG, generator and its ancillary components	Electricity generation	• Mechanical hazard • Fire hazard/explosion • Electrical hazard ▪ Noise generation	▪ Mechanical failure ▪ Lack of sound buffers	4	3	**12**	▪ Installing machines with computerized control and monitoring system for detecting any faults in the machines ▪ Installing machines with environment friendly and safe design (e.g. with noise buffers, energy efficiency, manual override, automated kill switch etc.) ▪ Test running the machines and its safety systems before going into final operation. Do a monthly inspection and maintenance. ▪ Install automated fire alarms and fire hydrant system in turbine and generator room.	3	2	**6**
• Cable gallery • Power transformer • Switchyard ▪ 230 KV Switchyard control room	• Transmitting electricity from generator to unit transformer • High voltage (230 KV)	• Fire due to resulting arc flash/arc blast • Other electric hazard due to unprotected cables ▪ Slips and trips from unorganized/loose	▪ Short circuit in control room and switch gears ▪ Short circuit in control room and switch gears ▪ Faulty cables and wires	3	3	**9**	▪ Monitoring. Installation of fire defense and fighting systems. ▪ Checking the insulation of the wire, along with the wire's voltage and electric ratings. Change wires if ratings do not match with the power supply or if the insulation is damaged ▪ Proper earthlings should be made to avoid electric shocks.	2	2	**4**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
	power transmission • Open air power transmission ▪ Controlling and monitoring the power transmitting system	cables lying in the floor	▪ No safe connection to earth ▪ Using cables with different voltage and current ratings ▪ Unorganized cables				▪ Open wires should be passed through a plastic pipe to avoid exposing them with outside contact. ▪ Switch off power before doing any electrical work. Inform supervisor and respected machine operator before starting any electrical work. Inform them again after the electrical works are done. ▪ All power transformers and transmission should be fitted with lightning arrester to protect from lightning strikes. ▪ Switchyards should be fitted with circuit breaker in case of short circuit or during an unusual surge of electrical current. ▪ When working with exposed live wire/machines, the maintenance worker should maintain distance of 6 meters from the live exposed part[75]. ▪ Maintain a safe distance from the rights-of-way (RoW). Don't raise any construction under the RoW. ▪ Any cranes or vehicles passing through a high voltage overhead transmission line should have a minimum 1 meter distance from the overhead transmission line. ▪ Place "electrical hazard" or "high voltage" signs on all switchboards and power transformers. ▪ Restrict access to power transmission area, switchyards and control to power plant officials and maintenance workers only.			

[75] http://electrical-engineering-portal.com/electrical-safety-standards-for-lvmvhv-part-2#16

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
• Boiler and pressure parts • Compressed air system and pipeline ▪ Live steam line	• Steam generation • Operate pressure valve, switch and control system ▪ Flows live high pressure steam from boiler to turbine	• Fire (near burner) • Release of high pressurized steam ▪ Explosion	▪ Failure of the water pumps ▪ Mechanical failure of safety switch and valves ▪ Busting of furnace and pressurized pipes ▪ Presence of contaminant in fuel ▪ Accidental leakage, lack of heat sink for combustion process and non-functional safety and bypass valve.	4	3	**12**	▪ Control system to monitor and regulate temperature, intake air and furnace system. ▪ Monitoring fuel quality & safety system. Provision of firefighting and safety ▪ Check pipelines for leaks and cracks. Conduct quarterly inspection of pipelines ▪ Inspection and maintenance of safety valve, pipelines and steam line ▪ Restrict entry except authorized personnel ▪ Install control system to monitor required pressure at different points. ▪ Installation of fire defense and fighting systems.	3	2	**6**
Water treatment and waste water treatment plant	Produce clarified, dematerialized water for steam generation and treat effluent water	Chemical hazard	▪ Spillage/accidental release ▪ Mishandling and misuse	3	3	**9**	▪ Safe use of chemical. Using appropriate MSDS to aware people of chemical properties, storage and handling procedures. ▪ Limited entry except authorized personnel ▪ Training and use of appropriate PPE ▪ Make spill kits available in case of accident. ▪ Install safety shower, eye wash and first aid facilities	2	2	**4**
Intake channel	Water intake for plant operation	Mechanical Hazard	▪ Accident due to ship anchorage ▪ Negligence of ship master. ▪ Poor signal	3	2	**6**	▪ Proper signaling system to be installed on the plant jetty site. ▪ Ship master shall communicate with the plant jetty site before anchorage.	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							▪ Intake channel shall be routinely maintained and repaired if required. ▪ Plant jetty site shall have adequate security system (CCTV, Security guards etc) in place.			
Chemical storage	Use for water treatment in different phases of dematerialized water, cooling water and potable water.	Toxic accidental release due to multifunction of equipment & callousness of operator.	▪ Chemical spillage ▪ Chemical fires ▪ Mishandling and misuse	3	3	**9**	▪ Putting up “chemical hazard” warning sign in the entry of chemical storage areas. Set up awareness programs on how to handle/store chemicals ▪ Check containers for leaks, faults and cracks. Change them immediately if found. ▪ Labeling chemical storage containers for easy recognition. Put up MSDS in chemical containers along with appropriate warning labels (e.g. corrosive, toxic, flammable etc.) ▪ Storing different types of chemical separately. All flammable or corrosive chemicals should be stored separately and should have proper bounding ▪ A fire extinguisher/ fire hydrant should be installed nearby in case of any fire breakout. Emergency contact details for fire fighters and ambulance service should also be placed there. ▪ In case of a spillage, keep flammable substance away from the spillage area and inform on site EPC contractor immediately. ▪ Recording of any unusual activities and issuance of fines or suspensions if any rules are broken.	2	1	**2**
Air circulating system	Generating air flow both in and out of boiler	▪ Non-functional air circulating system	Mechanical failure	3	3	**9**	▪ Regular maintenance and monitoring control system ▪ Inspecting the functioning of FD, ID fans and vacuum systems.	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Plant site	Daily plant activities	• Cuts, bruises and burns • Falls, slips and trips • Health injuries ▪ Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipments ▪ Prior sickness or illness ▪ Heavy workload ▪ Unsafe working environment.	3	3	**9**	▪ Regular inspection and maintenance of equipments, machineries and vehicles. ▪ Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all officers and plant workers, including the proper use of PPEs during work ▪ Monthly health check-up of officers and workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital ▪ Keeping all safety & precaution measure in order such as, maintaining first aid & well equipped primary health center on plant site.	2	2	**4**

10.9 Occupational Health and Safety Plan

679. Occupational health and safety (OHS) in Bangladesh is still in developmental stage. Here, the term “OHS” mainly refers to the needs of workers of industries or some manufacturing processes but does not completely cover all occupations of the country. Although the government has some kind of occupational health care services for the workers and labours, the responsibility for ensuring health and safety at work is generally placed on the employer. However, it is also the responsibility of the workers/employees to follow the health and safety guidelines set out by the employer diligently to ensure no harm befalls them. Every workplace is different, so it is important to develop an OHS program that addresses the specific needs of the operation. This OHS Program Template serves as a starting point to help employers develop an OHS program for all the personnel involved in the pre-construction, construction and operation of the Rupsha 800 MW CCPP project.

680. The proposed construction will be implemented by an EPC contractor supervised by a NWPGCL appointed OE. The EPC contractor is to be involved in erection of new equipment including civil works and expected to sub-contract the civil, mechanical, electrical, instrumentation and control components to local Bangladeshi contractors. Prior to the construction, the EPC contractor will develop an OHSE Plan that will address OHSE aspects associated with each phases of the project.

681. During the operational phase, NWPGCL will develop, rollout and implement a formal OHSE management system for the operation of the power plant. The EPC contractor will need to ensure that their OHSE plan also complies with stipulated laws and regulations.

682. The OHSE activities should not be strictly limited to the aforementioned plan. The plan, once developed, needs to be reviewed and updated as seen fit to identify the strengths and weaknesses of the program. In some cases, reliance on basic common sense could be the difference between averting a major disaster or death.

10.9.1 OHS Policies in Bangladesh

683. Bangladesh does not have its own specific OHS policy. There are a number of laws and regulations that are have some provisions related to occupational health and safety. Some of these laws have provisions on occupational hygiene, occupational diseases, industrial accidents, protection of women and young persons in dangerous occupations and also cover conditions of work, working hours, welfare facilities, holidays, leave, etc. However, most of the laws lack in standard values and are rather general in nature. The laws and regulations that falls into OHS aspects include:

- The Fatal Accidents Act,1855
- The Explosives Act, 1884
- The Explosive Substances Act, 1908
- The Poisons Act, 1919
- The Dangerous Cargoes Act,1953
- The Fire Prevention and Protection Act, 2003
- The Labour Act, 2006
- The RailwayAct,1890
- The Motor Vehicles Ordinance, 1983
- The Highways Act, 1925

- The Building Construction Act, 1952
- National Energy Policy
- Any other Act/Rules applicable to particular situation/activity/operation

684. However, NWPGCL must also have their own health and safety policy in spite following the above rules and regulations.

10.9.2 Who is accountable?

685. All OHS activities related to pre-construction, construction and operation will be governed by the EHS Manager, who will be tasked with delineating OHS responsibilities to his subordinates. He will also be the responsible person in ensuring that OHS processes are being incorporated to his staff members. He will also provide appropriate OHS training to other officers, plant foreman, supervisors and workers.

10.9.3 OHS Training

686. The on-site EHS Manager in conjunction with the (AM/DM health and safety manager, AM/DM environment and relevant stakeholders/organization heads) will be responsible for the development of the OHS training plan. The (EHS Manager) will be responsible for ensuring that the appropriate employees receive training required under the plan. The company's human resources representative will be responsible for ensuring that all employees receive introductory training on the EHS Management System.

10.9.4 Training Procedure

Task-Specific Training

- A training program will need to be developed to ensure that employees are capable of accomplishing the tasks required to meet OHSE objectives and targets. The program will identify training topics, who should receive the training, when training should be given, and the training method. The program will also distinguish between training conducted to comply with OHS regulations and other training.
- A training needs assessment for the employees needs to be made. The EHS Manager will review past training and the nature of the employee's work. Based on this review, specific training requirements for each employee or type of employee will need to be documented.
- The EHS Manager shall document the OHSE Training Program.
- The training plan shall be implemented by the EHS Manager. Upon completion of training by employees, the EHS Manager shall make the (Superintendent Engineer and Chief Engineer) aware of the training completed.
- The EHS Manager) shall document the training completed form and Training Log.
- Specific documentation pertaining to training received shall need to be maintained by the operational work areas for a minimum of two years, or as required by regulation.
- Training effectiveness will need to be evaluated to ensure that the OHS Management System is being implemented effectively when changes are made to significant risks, objectives, targets or operational controls. Improvements to the training plan will need to be made accordingly.

General EMS Training

- All employees shall receive introductory training to make them aware of the OHS Management System.
- The human resources representative shall be responsible for coordinating the effort to assure that all new and existing employees have received suitable training.

10.10 Emergency Response Plan

687. ERPs are developed to address a range of plausible hazard scenarios that are unplanned and emphasize the tasks required to respond to a physical event. The ERP for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a predetermined sequence if it is to deal major and minor accidents effectively and efficiently. The primary objective of the plan is.

- Providing clear lines of authority and communication during incident and crisis events
- Providing means by which trained people and resources are available to those managing the incident or crisis event
- Keeping the workplace safe and to achieve minimal incidents for health hazard; as well as keeping the impacts on the environment, materials, machineries and equipment from these unplanned events to a minimum.

688. This ERP is intended to provide information, strategies and procedures relating to all aspects of emergency management which comprise of:

- Prevention of emergencies;
- Preparation for emergencies;
- Response to an emergency and;
- Recovery following an emergency
- Documenting and Reporting

689. Emergency response management plan, which includes preventive measures taken for the possible scenarios and natural disasters, are shown in **Appendix 13.**

10.10.1 Emergency Prevention

690. Project risks are prevented through implementation of risk mitigation measures to address events such as gas main leak/explosion, traffic accidents, structural failure and other minor structural issues (e.g. pavement). The potential risks and measures to reduce each type of risk are given in the **Table 10.12** below:

Table 10.12: Risk and Mitigation Measures

Risk	Preventative Mitigation Measure
Flooding	• Regular checking and maintenance of River Training Works.
Earthquake	• National building code should be followed strictly and the buildings should have capacity to withhold the impacts of minimum 8.00 magnitude earthquake • Auto gas supply stopping system during strong earthquake should be incorporated in the design
Cyclone	• Cyclone warning should be followed regularly and management measures

Risk	Preventative Mitigation Measure
	should be followed according to standard guidelines. (detailed would be provided in final report)
Traffic Accidents (Road & Rail)	• Traffic Control devices (road signs and markings, speed signs, stop signs, speed bumps and safety barriers) • Infrastructure maintenance and improvements (including upgrades of road surfaces, rail lines, rail crossings, bridges and drainage) • Closing of bridge during extreme wind.
Spill/leak of Hazardous Materials in Land and Water	• Fire Department personnel in the ERC will possess sufficient Hazmat training and have access to an appropriate number of Hazmat suits.
Terrorist Events/Threats	• Regular contact and updates from National intelligence agencies regarding threats. • Random security checks at the bridge ends during threats. • Bangladesh Army and Police personnel will be appropriately resourced and trained to quickly respond to terrorist emergency events.
Gas Leak/ Explosion	• Regular inspection and preventative maintenance of Gas main according to the *Operation and Maintenance Manual.* • Regular checking of Gas main pressure and pressure valves.

10.10.2 Emergency Preparedness

691. Preparedness includes emergencies from fire related disasters and the necessary steps required to prepare for such emergencies. For this, it is required to design, manufacture, deliver to the site, install, test and commission the fire-fighting and fire detection equipment to protect the steam & gas turbine, generating units and all associated equipment. The following **Table 10.13** includes the list of preparedness measures to be included.

Table 10.13: List of Preparedness Measures

No	Area of Requirement	Preparedness Actions
1	Design Requirement	• Design should take into account basic operating policy • All automatic systems must have a manual initiation facility • All fire protection installations should comply with the requirements of the codes of practice of the National Fire Protection Association, Boston, Massachusetts, U.S.A., as appropriate for the respective systems, to the approval of the Engineer.
2	CO_2 Gas Fire Protection System	• An automatic Carbon Dioxide (CO_2) gas fire protection system should be provided in all machinery enclosures of gas turbine generating units except in the unit local control package. • The Protection System should consist of a fire detector and an automated fire extinguishing mechanism once fire/smoke is detected. • Facilities for alternative manual actuation of the fire protection system should also be provided such that, when the manual mode has been selected the protection sequence will not proceed beyond the alarm stage without manual action by an operator.

No	Area of Requirement	Preparedness Actions
		• High risk areas should be marked as “fire protection zones” and should have a separate fire protection system independent of others. • The protection system should be checked on a monthly basis to test their functionality. Any defect should be reported to the manger and should be replaced immediately.
3	Hydrant System	• Water hydrants should be provided in the plant in such places that are susceptible to fire, such as, gas & steam turbine generating units, HRSG, Gas station, Gas Booster, Chemical Plant electrical building, Outdoor transformers etc. • Firefighting water pool/ storage tank should have a capacity of minimum 4 hours of supply in case of worst case scenario. • Regular inspection of the hydrant system should be made to see if they are functioning properly or not. Any defect should be reported to the manger and should be replaced immediately.
4	Piping	• The fire-fighting water mains should consist of buried piping of at least 150 mm diameter. • The underground pipe-work should be provided with an approved protective coating unless the pipe is manufactured from an approved non-corrosive material.
5	Portable Equipment	• Portable equipment such as, CO_2 extinguishers and dry chemical extinguishers of various weights and sizes should be provided at various locations of the plant • Regular inspection of portable extinguishers should be made and noted. Expired extinguishers should be replaced immediately.

692. A professional training needs to be given to the designated fire team. The training would include the following **Table 10.14**.

Table 10.14: Types of Trainings and Training Actions

No.	Type of Training	Training Actions
1	Actions to be taken in the event of a fire	Use fire exit and educating workers and staffs of the nearest emergency evacuation zone. Proper evacuation procedure in the event of a fire. Training on locating emergency equipments and use of portable fire extinguishers to extinguish fires. Training on whim to contact in case of an emergency.
2	Handling of flammable liquids	Training on the safe handling and storage of volatile/flammable chemicals/oils. Training on waste classification system and use of various color-coded bins for various waste disposals. Training on the use of PPEs.
3	Emergency Drills	Regular monthly training on mock fire drills.

No.	Type of Training	Training Actions
		Regular monthly workshop on emergency response and preparedness plan.
4	First-aid and medical assistance	Training on first-aid treatment for broken bones/fractures, burns, cuts/wounds, unconsciousness, breathlessness.

693. In case of an emergency fire breakout, the EHS Manager should be notified immediately who will delineate the information and responsibilities to other staff members. An emergency contact list should be prepared by the EPC contractor consisting of Manager's/ AM's contact details, Hospitals, Police, Ambulance services and other relevant contact details.

694. In order to reduce the risks associated with accidents, internal and external threats, and natural disaster a safety training program is essential for workers in plant operation. There should be regular training programs on safety for the workers to increase their awareness and also to reduce the risks. Provision of yearly professional training for health and safety, would enhance the effectiveness of safety. Safety training should be planned for the local people living around the project area so that they can be aware about the risk possessed by the Power Plant and can take appropriate preparedness (**Table 10.15**).

Table 10.15: Training schedule that may be adopted for safety

Target trainee	Training schedule
Worker	Two trainings per year
Professional	Two trainings per year
Local people	Two trainings per year
Drivers	Four trainings per year
Safety professional	Three trainings per year

695. In addition, there must be a discussion and awareness session for increasing awareness on safety in each and every kind of meeting. Tool box meeting and job safety analysis should be regularly practiced by the employee. Further details on the type of trainings to be provided will be discussed in the separate Emergency Response report.

696. The EPC contractor will formulate a plan for evacuation in the event of an emergency. He/she will make a layout plan, showing all the possible emergency fire exits and the location of the evacuation zone. An emergency contact list should also be prepared by the EPC contractor consisting of EHS Manager's contact details, Hospitals, Police, Ambulance services and other relevant contact details.

10.10.3 Emergency Response

697. Emergency events are broken down to three level tiers; Tier 1, 2 and 3. Tier 1 having the lowest threat level and Tier 3 having the highest threat level

698. In the case of an emergency event, the Incident Response Team (IRT) at plant site would be mobilized with the Emergency Response Group (ERG) (Chaired by the Chief Engineer of NWPGCL) coordinating and overseeing arrangements to ensure that the IRT meets its emergency management obligations. In the case of Tier 1 emergencies, the cases are escalated primarily to site specific IRTs only. Tier 2 involves ERG providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and for providing operational response to any emergency situation which may occur in the affected (such as, fire,

explosion, coal spillage and various social crisis). The Incident Management Team (IMT) (also located at NWPGCL) is activated in the case of Tier 3 incidents and responsible to define and control strategy for those incidents. The following table (**Table 10.16**) shows the emergency response escalation protocol for different levels of emergencies.

Table 10.16: Emergency Response Escalation Protocol

Impact/ Consequence	Health & Safety	Natural Environment	Reputation Government Community Media	Financial $	Civil Unrest Hartals		Definition	Country Threat Level	Escalation				Site specific IRT Members
Tier 1	Minor injury – First Aid treatment.	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols.	Minimal impact to reputation.	Financial loss <$50,000	Situation generally stable with some protests / Hartals against government		Incidents that are containable by the Operations' Site Incident Response Team (IRT)	**Insignificant Low**	Operation Sites	Plant Manager	**IRT**	ERG Leader	Plant Manager other **IRT** members **ERG - as required**
Tier 2	Moderate injury- Medical Treatment, Lost Time injury	Impact on fauna, flora and/or habitat but no negative effects on ecosystem, may require immediate regulator notification.	Moderate to small impact on business reputation.	Financial loss >$50,000	Security unrest appears to escalate to regular outburst - but **authorities appear to be capable of maintaining control**		Incidents that require Dhaka based ERG, governmental and regulatory support	**Medium High**	**ERG**	ERG Leader	Chief Engineer NWPGCL **activates Dhaka ERG**	**Inform Member-Generation**	ERG Leader – Chief Engineer other ERG members **ERG - activated for EHS / Security issues**
Tier 3	Injury requiring ISOS activation. Permanent disabling injury and or long term off work and fatality.	Long term impact of regional significance on sensitive environmental features, likely to result in regulatory intervention/action	Significant impact on business reputation/ or international media exposure.	Financial loss greater than $100,000.	Confirmed direct threat to foreign business interest or against expatriates **Situation certain to escalate further beyond Government control**		Incidents when there are multiple injuries or fatalities requiring IMT support and also international support, regulatory and public relations assistance.	**High Extreme**	**IMT**	IMT Leader **activates IMT**	Director Technical	**Managing Director-NWPGCL IMT**	**IMT** other **IMT** members **IMT - activated**

The Incident Response Team

699. The Incident Response Team (IRT), based at plant location, is trained and responsible for dealing with all envisaged incidents and emergency situations which may occur at the location. Where additional support in the way of resources and advice may be required by the IRT at a remote location this will be requested through and provided by the Emergency Response Group (ERG) of Dhaka Office. On all occasions when an IRT is mobilized due to an incident or emergency situation, the ERG Manager must be notified immediately.

700. The IRT will be headed by the Plant EHS Manager and will also include DM/AM of both HS and Environment as well as Logistics department within the plant.

The Emergency Response Group

701. The Emergency Response Group (ERG) is based in the NWPGCL Head Office in Dhaka and will be chaired by the (Chief Engineer). He will also nominate an Emergency Response Coordinator to coordinate with representatives from various agencies and also senior staff from HR, Finance, HSE, Logistic, Security, IT, and public affairs department within NWPGCL. ERG will be responsible for providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and will provide operational response to any emergency situation that may occur. The function of the ERG is to coordinate and oversee arrangements to ensure that the IRT meets its emergency management obligations. ERG should develop a plan, in consultation with the appointed EHS Manager where it should describe how to handle both the "technical" crises e.g. fire, explosion, oil spill, and "social" crises e.g. illness, injury, kidnap, civil unrest. On all occasions that the ERG is mobilized due to an incident or emergency situation the Managing Director must be notified immediately.

The Incident Management Team

702. The Incident Management Team (IMT) is the corporate body located in the NWPGCL headquarters in Dhaka, with the responsibility to define and control strategy for major incidents. A strategic response is defined as a situation arising from a single or multiple incidents or emergencies that escalate to a point beyond which significant damage to the Company's business could result, including commercial and reputation damage, significant financial loss, shareholders' loss of confidence and damages resulting from litigation. When a potential strategic situation appears the IMT will be mobilized to manage issues pertaining to the reputation and the continued commercial wellbeing of the Company. The IMT may however also be called upon to address some of the tactical roles that would normally be the responsibility of the ERG, for example, if the Dhaka Office were out of action or in the event of an evacuation from a country, which may equally limit the ERG's capability.

703. The IMT is chaired by the Managing Director of NWPGCL and includes high level representation from the Ministry of Power, Energy and Mineral Resources, Army, Police Department, Fire Department, District Commissioner's Office and the Disaster Management Bureau (DMB) of the Bangladesh Government.

10.10.4 Emergency Recovery

704. After the emergency situation had passed, the ERG would assess and categorize the damage and would provide for compensations for the injured; provide provisions for temporary services; reinstate normal environmental and working standards; initiating investigation process

for the cause of disaster; evaluating response procedure and providing a recommendation to mitigate future emergencies.

10.10.5 Documenting and Reporting

705. Implementation status of the safety plans should be monitored and documented regularly. Monthly monitoring report should be prepared based on regular inspection and should be submitted to the Superintending Engineer of the Power Plant. Any kind of incidents or even near misses should be documented and reported to the Superintending Engineer.

10.10.6 Emergency Evacuation Plan

706. The EPC contractor will formulate a plan for evacuation in the event of an emergency. He/she will make a layout plan, showing all the possible emergency fire exits and the location of the evacuation zone. An emergency contact list should also be prepared by the EPC contractor consisting of EHS Manager's contact details, Hospitals, Police, Ambulance services and other relevant contact details.

11.0 CONCLUSION AND RECOMMENDATION

707. To address the increasing deand for electricty and to ensure a stable and reliable power supply, the NWPGCL has taken the initiative to enhance the power generation capacity of Bangladesh through the implementation of Rupsha 800 MW CCPP in Kalishpur, Khulna. The Rupsha 800 MW CCPP is designed as a dual-fired CCPP with natural gas as the main fuel and high speed diesel as back-up fuel to be used only during emergency events estimated to be not more than 500 hours per year.

708. Project components are interrelated such that (i) Component 1 will be development and operation of the Rupsha 800 MW gas-fired CCPP, (ii) Component 2 will supply the natural gas to Rupsha 800 MW CCPP from the existing Khulna City Gate Station owned by the SGCL through a new 10 km, 24" distribution pipeline and a new 2 km, 20" distribution pipeline (branched off) to serve the existing Khulna 225 MW CCPP owned by NWPGCL, (iii) Component 3 will be the 29.3 km, 230 kV double circuit overhead transmission line to transfer the generated power to the national grid, and (iv) capacity building of NWPGCL.

709. The project site was previously used by GoB for the KNM, but in 2002 the operations were terminated and the structures were abandoned. Pre-construction stage will involve demolition of the abandoned structures. The demolition will not be funded by ADB. Two schools (boys and girls school) will be relocated, a mass grave marker to commemorate the death of the 1971 liberation forces (Muti Bahini) and a mosque will be renovated and refurbished.

710. The project is "red category" based on ECA 1995 and ECR 1997 of DoE requiring both site clearance and environmental clearance. In November 2017, the DoE has exempted NWPGCL from submitting the initial environmental examination in securing the site clearance. According to SPS 2009, the project is category A requiring an EIA.

711. Following the requirements of DoE and ADB, an EIA was prepared. Air quality modeling through CALPUFF was carried out to predict the ground level concentration of air quality pollutants from burning 125 MMCFD of natural gas through a stack height of 70 m and a guaranteed NO_2 emission of 10 ppmv. For HSD as secondary fuel, a maximum sulfur content of 0.25%wt will be required. Ambient noise level was simulated using SoundPlan Essential 3.0 software while ALOHA was used to simulate the consequences of gas leakage or pipeline failure. A biodiversity assessment was conducted by IUCN Bangladesh from May 2017 to January 2018 due to the presence of the endangered species, Ganges River dolphins, in Bhairab River where the cooling water for the closed-loop cooling tower system will be taken. About 30 km river stretch along the key rivers within the project site: Bhairab River, Atai River, and Rupsha River were covered by the assessment. Results of the assessment of the IUCN Bangladesh showed that there is no critical habitat for the Ganges River dolphin within the immediate vicinity of the project site as defined by SPS 2009 and the IFC Performance Standard 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources (January 2012).

712. Component 1 is estimated to emit about 1.69 M tons of GHG during 92% operation through natural gas and 8% operation through HSD considering a 70% PLF. In case of operating Component 1 with HSD only, about 1.86 M tons of GHG will be emitted annually. CO_2 emissions reduction will be at least 0.17 M tons annually from providing natural gas to the existing 225 MW Combined Cycle Power Plant also operated by NWPGCL. This will be case of fuel switching from HSD to natural gas for 225 MW Khulna Combined Cycle. Thus, the net contribution to GHG will be 1.52 M tons of GHG.

713. A total of six consultation events were conducted from 28 October 2016 to 13 November 2016 and again on 21 October 2017 to present the findings of the EIA to key stakeholders. A GRM will be set up by PMU consistent with the requirements of GoB and ADB. A project brief in English and in Bangla with details on the GRM will be made available at the NWPGCL office in Khulna and in Dhaka. Consultations will continue in varying degrees throughout the project's life cycle. With the assistance from experts, NWPGCL will finalize the communication action plan for the project.

714. This draft EIA will be disclosed at the ADB website in accordance with SPS 2009 and PCP 2011. Prior to construction works all the relevant permits required for Component 2 will be obtained by NWPGCL.

715. While there are associated impacts in implementing Component 1, they can be readily mitigated through design, employing best available technology (e.g. Emissions reduction), good engineering construction methods, effective stakeholder engagement (as and when needed), diligent monitoring of EMP implementation, and compliance to relevant regulations on power plant operations, and environmental, health, and safety.

716. Except for the biodiversity assessment carried out by IUCN Bangladesh in connection with this EIA, there have been no surveys and studies on the Ganges River dolphins along the Bhairab River, Atai River, and Rupsha River. These rivers drain to the Bay of Bengal and are tidal influenced. It is recommended that additional surveys be done within this area to confidently determine the abundance and dispersal of these endangered species.

Environmental Impact Assessment

Document stage: Draft
Project Number: 50161-003
May 2018

Bangladesh: Rupsha 800-Megawatt Combined Cycle Power Plant Project

Volume 2
(Component 2 – Gas Supply to the Power Plant)

Prepared by North-West Power Generation Company Limited for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 14 February 2018)

Currency unit	–	taka (Tk)
Tk1.00	=	$0.0120548
$1.00	=	Tk82.96

ABBREVIATIONS

ADB	–	Asian Development Bank
CITES	–	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DoE	–	Department of Environment
EA	–	executing agency
ECA	–	Environment Conservation Act
ECC	–	Environmental Clearance Certificate
ECR	–	Environment Conservation Rules
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EMoP	–	Environmental Monitoring Plan
IEE	–	initial environmental examination
MoEF	–	Ministry of Environment and Forests
PMU	–	project management unit
RoW	–	right-of-way
SPS	–	Safeguard Policy Statement

WEIGHTS AND MEASURES

^{o}C	–	degree Celsius
dB(A)	–	A-weighted decibel
ha	–	hectare
lac	–	100,000
ppm	–	parts per million
$\mu g/m^3$	–	microgram per cubic meter
m^2	–	square meter

GLOSSARY

Bangla	–	official language of Bangladesh
hydrostatic testing	–	process of filling a pipeline with water, or a mixture of water and ethylene glycol or methanol to test the structural integrity of the pipeline under pressure
khal	–	Bangla word for a small channel or canal
thana	–	sub-district level of government administration, comprising several unions under the district
union	–	smallest unit of local self-government comprising several villages

NOTE

In this report, "$" refers to United States dollars.

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EXECUTIVE SUMMARY

Introduction

North-West Power Generation Company Limited (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB) has taken the initiative to enhance the power generation capacity of Bangladesh to address the growing demand for electricity. This initiative will involve the construction of a new Rupsha 800 MW Combined Cycle Power Plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP will be designed to use natural gas as the main fuel and high speed diesel (HSD) as back-up fuel (about 500 hours maximum annually). The Government of Bangladesh (GoB) has applied for financing of this new power plant from the Asian Development Bank (ADB). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

Project Description

Key interrelated project components include: (i) the development and operation of the Rupsha 800 MW gas-fired CCPP (Component 1); (ii) the construction of a gas distribution pipeline and related network infrastructure ensuring reliable supply of fuel to the CCPP (Component 2); (iii) the construction of a power transmission interconnection facility to transfer the generated power to the national grid at the existing substation in Khulna (Component 3); and (iv) capacity strengthening of NWPGCL (Component 4).

Component 2 will provide the infrastructure to supply natural gas to Rupsha 800 MW CCPP. Sundarban Gas Company Limited (SGCL) will deliver gas from the existing Khulna City Gate Station (CGS) in Arongghata to the Rupsha 800 MW CCPP in Khalishpur. A new 24-inch underground gas pipeline of about 10 km long will be installed from the Khulna CGS to the Rupsha 800 MW CCPP. A gas receiving and metering station (RMS) will be located at the Rupsha800 MW CCPP. In addition, a new 20-inch underground distribution gas pipeline of about 2 km long will be branched off from the line from Khulna CGS to Rupsha 800 MW CCPP, to serve NWPGCL's existing Khulna 225 MW CCPP.

Under the Bangladesh Oil, Gas and Mineral Corporation (Petrobangla), SGCL was established in 2009 by the GoB to manage the operations of the gas distribution networks within five districts: (i) Kustia, (ii) Jhenedah, (iii) Jessore, (iv) Khulna, and (v) Bagehat including other 21 district towns of Khulna, Barisal and Dhaka Divisions. Petrobangla, the national gas utility and the single-buyer for the gas industry, will procure liquefied natural gas (LNG) from international sources and deliver regasified LNG to Khulna city gas station (CGS). The regional gas distribution company, SGCL will deliver gas from the existing Khulna CGS in Arongghata to the Rupsha power plant in Khalishpur

The associated gas distribution pipeline network of the Khulna CGS of SGCL is included as Part C of the ongoing Loan 2622/2633-BAN: Natural Access Improvement Project (formerly Clean Fuel Development Project) funded by ADB with a total amount of $537 million approved on 26 March 2010. Part C (Access Improvement in South Western Region) involved the construction of about 845 kilometer (km), 2 inch to 20 inch distribution pipelines in south western region comprising of the districts of Kushtia, Jhenidah, Jessore, Khulna and Bagerhat (including Mongla). As such, it was subject to ADB's environmental requirements. Also included in the loan is capacity building for SGCL.

NWPGCL will create a Project Management Unit (PMU) to manage the day-to-day implementation of the project and will have about 80 staff. NWPGCL will get the necessary technical support from SGCL for Component 2 and Power Grid Corporation of Bangladesh (PGCB) for Component 3. The project will have a high-level Project Steering Committee (PSC) consisting of members from various government departments, NWPGCL, PGCB and SGCL and act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB.

Environmental Requirements

National requirements. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997. Under these regulations, except for Component 4, all the three components of the Project are "Red" category requiring an environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (ToR) of the EIA for Component 2 was approved by the Department of Environment (DoE) on 3 November 2016 (see **Annex 1**). The approved NWPGCL has obtained exemptions for submitting an IEE required in obtaining the SCC for all the project components as follows:

(1) Component 1 – 5 November 2017; DoE/Clearance/5584/2016/564
(2) Component 2 – 5 November 2017; DoE/Clearance/5668/2016/563
(3) Component 3 – 5 November 2017; DoE/Clearance/5669/2016/549

In August 2016, NWPGCL contracted the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, to prepare the EIAs for the three components.

ADB and IsDB requirements. The project is subject to the environmental requirements of both ADB and IsDB since NWPGCL is seeking their financial supports. The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility. Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

Under SPS 2009, projects are screened and categorized based on their potential environmental impacts. Following this screening procedure, the project is category A on environment which requires the preparation of an environmental impact assessment (EIA).[1] This EIA (Volume 2) covers the Component 2 of the project.

NWPGCL will be the executing agency of the project. On 17 October 2015, NWPGCL approved its Environmental, Health & Safety and Social Policy. NWPGCL is also certified in ISO 9001, ISO 14001. BS OSHAS 18001 valid until October 2019.

[1] Asian Development Bank Safeguard Policy Statement (SPS 2009),https://www.adb.org/documents/safeguard-policy-statement. (Accessed 23 November 2017)

Description of the Existing Environment

The description of the environment for Component 2 was based on the areas that will be traversed by the gas distribution pipeline route. Component 2 will cross five road crossings, three railway crossings and two river crossings along Mayur River in Khulna City.

Average yearly rainfall in the study area is 1,813 mm and is within seismic Zone which is considered as seismically quiet zone. The maximum temperature varies from 25.3ºC to 34.9ºC while the minimum temperature varies within the range of 12.2ºC and 26.3ºC.

The project area is mainly urban roads, modified semi-urban landscape where biological features are limited. Thus, floral and wildlife diversity is much less. However, there are planted vegetation along the Basthuhara roads and Khulna-Mongla highway to Arongghata. Most of the trees are newly planted and immature. The unused areas along the road were covered by common scattered planted tree, herbs and shrubs species. Common cultivated plants along the roadside are Rain Tree (*Samaneasaman*), Mehogani (*Swieteniamahagoni*), Sugar Date Palm (*Phoenix sylvestris*), Banana (*Musa*sp.), Egyptian thorn (*Vachellianilotica*), Horse radish tree (*Moringaoleifera*), Indian jujube (*Zizyphusmauritiana*), North Indian Rosewood (*Dalbergiasisssoo*). No threatened plant species has been found along the gas pipeline route. Fauna that have seen along the roadside is Golden Jackal, Grater bandicoot rat and Small Indian mongoose. Birds species seen in roadside trees are Black Drongo, Common Myna, Asian Pied Starling, Spotted Dove, Red-vented Bulbul, House Sparrow, Brahminy Kite, Long tailed shrike, House crow, Oriental Magpie Robin, etc. Garden lizard, toadand Indian cricket frog are commonly found along the road. No IUCN listed and rare fauna species are found within the project area.

Component 2 will mainly pass through non-agricultural land. Within the project area, only one acre land is cultivated for crop production and single Boro crop is produced during the dry season. The proposed pipeline route will cross one goldagher near the borrow pit at Toiyab Nagar KDA link road. Mayur River and a canal are not presently potential for fish habitat as the water quality has deteriorated due to discharge of wastewater from Khulna City.

The average household size is 4.1 and the male-female ratio is 109. Within the project area, the highest number of population (about 27 %) belongs to age group of 30 to 49 years while the lowest number (about 3%) belongs to 60 to 64 years age group. Literacy rate is 59% and employment rate is about 39.2%. About 35.1% of the population is engaged in household work while 25.1% are unemployed. Household income per month ranges from BDT 7,000 to BDT29,000.

Anticipated Impacts and Mitigation Measures

The pipeline route will cause five road crossings, three railway crossings and two river crossings along Mayur River. Construction works along these crossing may have potential environmental impacts. Horizontal directional drilling (HDD) will be used in installing the pipeline in these crossings to minimize environmental impacts and disturbance to local people. Other potential environmental impacts during construction include increased level of noise and dusts, generation of waste from construction works, and clearing of 370 trees. Appropriate compensation will be given to privately-owned trees and budget estimates included in the Resettlement Plan for Component 2.

Prior to any civil works, the PMU will have an orientation briefing to the Engineering, Procurement, and Construction (EPC) Contractor and their workers about the environmental requirements by the DoE and ADB that need to be complied with, their roles and responsibility for compliance, record keeping and reporting, awareness on socially transmitted disease like HIV/AIDS to avoid the potential occurrence of this diseases in the construction site. The EPC Contractor will be required to prepare a Construction Management Plan (CMP) outlining their actions and measures to manage potential environmental impacts during construction phase. The CMP will be reviewed and approved by the PMU. As excavation works will be involved, a "chance find" procedures will guide workers in the event a physical cultural resource is affected.

The main sources of noise generation will include trenching, laying of pipe, grading, stringing, coating, etc. Movement of construction vehicles and material transport will also contribute to noise generation. Ambient air quality may be affected by dust generated from excavation, vehicular emissions, transport of construction materials, and other construction works like boring of road and railway. Noise generating activities during construction will be limited to daytime hours and will be stopped during school hours, madrasa and prayer time at mosques. Workers exposed to high ambient noise will be provided with ear muffs.

Construction activities such as excavation, laying and welding of pipes, mobilization of vehicles may pose occupational and community safety risks. A contingency fund will be made available by Component 2 to cover assistance in case of accidents involving workers and local people. To minimize occupational risks, the EPC Contractor will be required by PMU to provide workers with personal protective equipment (PPE), sanitary facilities, wash areas, and safe drinking water. The field construction camps will be provided with first aid kit, garbage bins, fire-fighting equipment and good housekeeping will be enforced at all times. Clear and visible safety and danger signs will be posted by the EPC Contractor at and around the field camps that may be enclosed (as needed) to contain dust levels and ambient noise level.PMU will regularly monitor compliance of the EPC Contractor.

To avoid traffic congestions which may inconvenience local residents particularly in areas that will be crossed by the gas pipeline, appropriate traffic signs will be posted and temporary pedestrian crossing will be installed to accommodate children, women, elderly, and persons with disability.

While areas that may be affected are mainly non-agricultural, about one acre agricultural land will lose about 1.8 tons of high yield variety (HYV) Boro rice production during construction phase. Production period of Boro rice is November to May. To avoid the loss, construction works in this agricultural area will avoid November to May. Also, trenching will affect *gher* along the Toiyab Nagar KDA road to Khulna City link road. It is estimated that the impact will be about 0.5 acre and a production loss estimated to be 147 kg of total impacted gher area.

Before commercial operation, Component 2 will be subjected to hydrostatic testing to check for leaks and strength. The hydrostatic testing plan, which will include disposal of used water, will be approved by PMU. Workers that will be involved in hydrostatic testing will be provided with appropriate safety gear and equipment. Used water will be checked for quality prior to discharge to ensure compliance with Schedule 10 of ECR 1997. Residents relatively near to the pipeline route will be informed of the schedule for hydrostatic testing.

Operation of Component 2 may pose occupational and public safety risks. A hazard risk assessment was conducted and an emergency preparedness plan is included. Part of continuing consultation will be a regular awareness campaign on disaster and emergency

preparedness. A communications strategy program will be done by NWPGCL with technical guidance from a communications expert.

Clear and visible warning signs/markers following appropriate safety standards will be installed along the pipeline route to avoid accidental digging or exposure aboveground of the pipeline. The operation of the pipeline system will be monitored 24 hrs daily through the Supervisory Control and Data Acquisition (SCADA) which is equipped with an automatic shut off of gas flow in the event of pressure differential or leak.

NWPGCL staff who will be involved in the operation of Component 2 will have the necessary experience and skills. At the same time, regular training on safety, disaster and emergency preparedness, and monitoring will be conducted to staff managing Component 2.

Analysis of Alternatives

A "no project" option means that the area along the proposed alignment of Component 2 will remain the same as the current condition. However, the supply of natural gas for the Rupsha 800 MW CCPP will not be provided and NWPGCL will be compelled to use high speed diesel (HSD) as the primary fuel when a better and more environment-friendly fuel can be used.

"With project" evaluated three options and the selected pipeline route will result to less number of structures to be affected.

Information Disclosure, Consultation and Participation

A total of six consultation events were conducted from 12-14 June 2017 participated by 31 persons. These consultations were key informant interviews (KII) and informal interviews done in Arongghata, Ward No 9, and Ward No. 12 in the district of Khulna.

The people within the project area of Component 2 are aware of the project from other consultants who frequently visited the sites. They understood the potential project impacts and showed positive attitude and support towards the project. The RoW along the pipeline route is owned by the Government. Consultations will continue and a program for consultation will be finalized by NWPGCL with support from the communication expert to ensure that stakeholders are consulted, as and when needed.

A project summary with details on grievance redress mechanism (GRM), and contact person in case of complaints will be prepared in both Bangla and English and will be made available at the field office of PMU in Khaliaspur, Khulna and at the NWPGCL office in Dhaka. More details on Component 2 will also be available from the EIA posted in the website of ADB.

Grievance Redress Mechanism

NWPGCL currently manages grievance and/or complaints through the Grievance Redress System (GRS) which is required by the GoB and part of the mandatory Annual Performance Agreement (APA). This agreement will be signed and renewed annually between NWPGCL and GoB.

To meet the requirements of SPS 2009, a GRM will be set up once ADB funding for Component 2 becomes effective. The GRM will provide three-tier entry points in grievance redress. Two grievance redress committees (GRCs) will be formed: (i) local grievance redress committee

(LGRC); and (ii) project grievance redress committee (PGRC). Grievances considered minor can be resolved onsite at the LGRC level within 7 days from receipt of complaint. Other complaints not resolved at the LGRC level will be forwarded to PGRC which will take two weeks (or 14 days) to resolve. Meetings of the LGRC will be held onsite (PMU office) and members may do site visits to check or verify the issue. Complainants will be informed of the status of resolution. The third tier entry point for grievance redress will be the appropriate rule of court.

Environmental Management Plan

The Corporate environmental staff of NWPGCL and the PMU will monitor the EPC Contractor on its compliance to the EMP. Environmental monitoring plans (EMoP) have been prepared. A total of Lac Tk 36 has been budgeted for the implementation of EMP and additional Lac Tk7.3 for monitoring. Environmental monitoring reports will be submitted by PMU to ADB semi-annually and these reports will be posted in the ADB website as required by SPS 2009 and PCP 2011.

Conclusion and Recommendation

The pipeline route in Component 2 was chosen with the least environmental impacts which can be mitigated by best available technology, compliance to design standards and specifications, applicable requirements of GoB and ADB. The EIA for Component 2 was prepared following the requirements of the DoE and ADB. An EMP and EMoP were included in the EIA with cost estimates.

The pipeline route will cause five road crossings, three railway crossings and two river crossings along Mayur River. HDD will be used in installing the pipeline in these crossings to minimize environmental impacts and disturbance to local people. Other potential environmental impacts during construction include increased level of noise and dusts, generation of waste from construction works, clearing of 370 trees, disturbance to local traffic at road and railway crossings, occupational and public safety risks. These temporary and of short duration impacts can be easily mitigated. Mitigation measures for these impacts are included in the EMP and the parameters for monitoring have been identified in the EMoP. Component 2 will be designed, constructed, supervised by technical consultants, and operated by experienced engineers, technical staff, and natural gas consultants.

This draft EIA will be disclosed in the ADB website in accordance with SPS 2009 and PCP 2011. Prior to construction works, all the relevant permits required for Component 2 will be obtained by NWPGCL.

1.0 INTRODUCTION

1. The Power System Master Plan 2016 recommends for diversification in the use of fuel for power generation such as domestic and imported coal and natural gas, oil, nuclear power, and renewable energy.[2] Consistent with this, the North-West Power Generation Company Limited (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB) has taken the initiative to enhance the power generation capacity of Bangladesh to address the growing demand for electricity. This initiative will involve the construction of a new Rupsha 800 MW Combined Cycle Power Plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP will be designed to use natural gas as the main fuel and HSD as back-up fuel (about 500 hours maximum annually). The Government of Bangladesh (GoB) has applied for financing of this new power plant from the Asian Development Bank (ADB). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

2. The objectives of this initiative include the following:

- To contribute in meeting the demand for electricity and to increase reliability of supply by minimizing load-shedding;
- To support in achieving the vision of GoB, "Power to All by 2021;"
- To reduce the increasing gap between demand and supply of electricity throughout the country;
- To accelerate economic development by providing adequate and reliable power generation;
- To enhance the stability and reliability of the national grid system, and to reduce the systems loss by local generation; and
- To develop human resource through technology transfer.

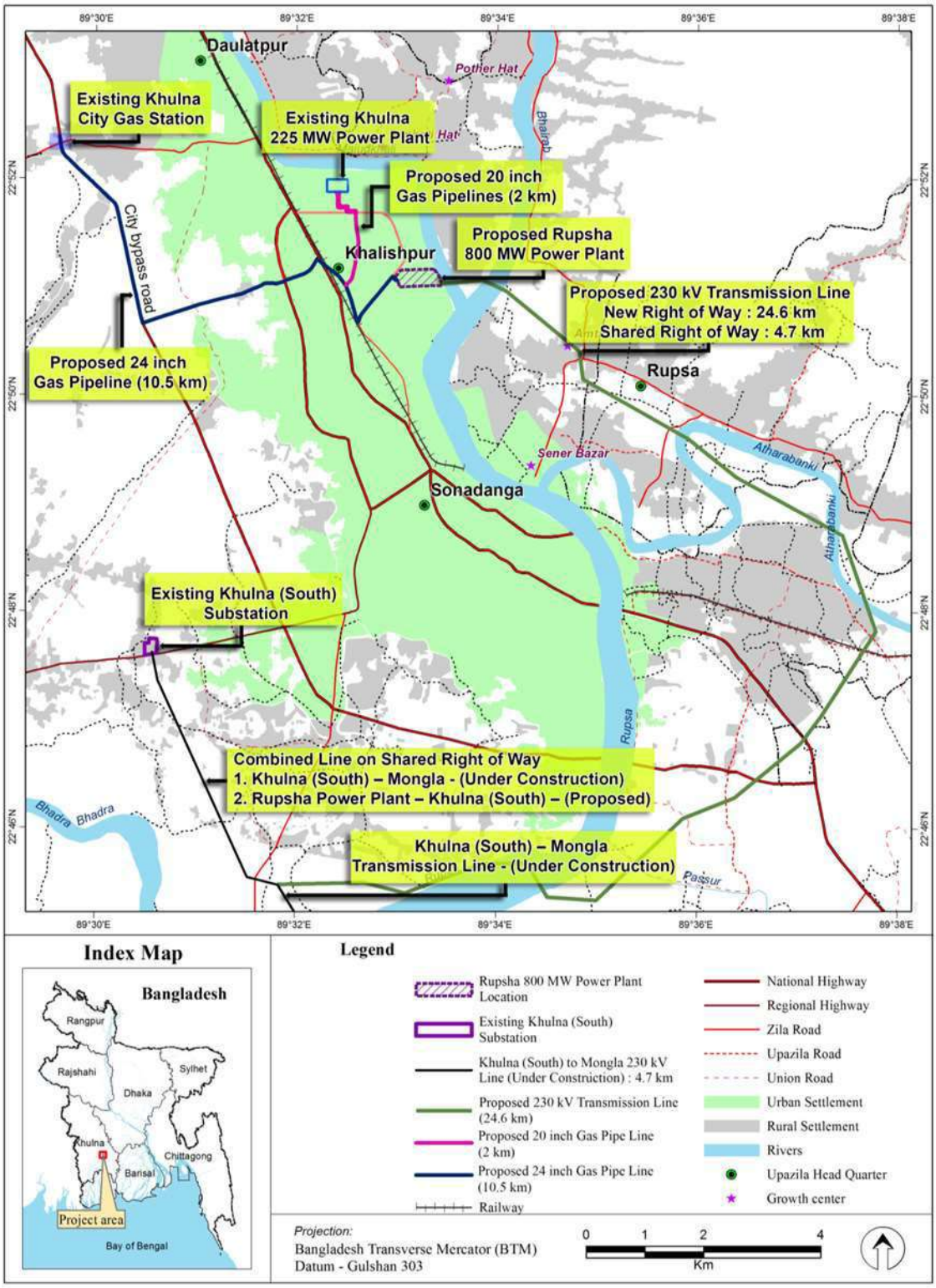
3. Overall, the goal is to improve the economic growth of Bangladesh by providing a reliable and stable power supply with this initiative.

1.1 Overview of the Project

4. The project targets strengthening energy security in Bangladesh. The country faces serious electricity shortages in the short- to medium-term and needs to secure cost-effective, new and diversified energy sources. Key interrelated project components include: (i) the development and operation of the Rupsha 800 MW gas-fired CCPP; (ii) the construction of a gas distribution pipeline and related network infrastructure ensuring reliable supply of fuel to the CCPP; (iii) the construction of a power transmission interconnection facility to transfer the generated power to the national grid at the existing substation in Khulna; and (iv) capacity strengthening of NWPGCL. The project will establish the first ever power plant to use gas from the Bangladesh gas transmission network, where its gas supply would be attributed to LNG imported into Bangladesh. **Figure 1.1** shows the project.

[2] Ministry of Power, Energy and Mineral Resources, and Bangladesh Power Development Board. People's Republic of Bangladesh Power & Energy Sector Master Plan. http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised.pdf. (Accessed 18 August 2017)

Figure 1.1: Location map



Component 1: Rupsha 800 MW CCPP

5. Rupsha 800 MW CCPP will be built in the (now abandoned) Khulna newsprint factory premises. The power plant will use combined cycle gas turbine technology, comprising two identical generating units, each nominally rated at 400 MW. Each combined cycle unit will consist of one gas turbine and one heat recovery steam generator (HRSG), forming a one-on-one configuration. At full capacity of 800 MW, the Rupsha power plant is capable of meeting 5% of the forecast peak demand of Bangladesh in year 2022. The cooling system will be closed-loop forced-draught cooling tower system that will require 2,010 m^3/hour of water to be taken from the Bhairab River.

Component 2: Gas Supply to the Power Plant

6. Petrobangla, the national gas utility and the single-buyer for the gas industry, will procure liquefied natural gas (LNG) from international sources and deliver regasified LNG to Khulna city gas station (CGS). The regional gas distribution company, Sundarban Gas Company Limited (SGCL) will deliver gas from the existing Khulna CGS in Arongghata to the Rupsha power plant in Khalishpur. A new 24-inch (0.6 m) underground gas pipeline about 10 km long will be installed from Khulna CGS to the Rupsha 800 MW power plant. The gas receiving and metering station (RMS) will be located at the Rupsha power plant. In addition, a new 20-inch (0.5 m) underground gas pipeline 2 km long will be branched off from the line from Khulna CGS to Rupsha power plant, to serve NWPGCL's existing Khulna 225 MW power plant. Owing to non-availability of gas, this 225 MW power plant is presently operating on diesel.

Component 3: Power Transmission Interconnection

7. Electricity generated in the Rupsha power plant will be stepped-up to the transmission voltage of 230 kilovolt (kV). A new 29 km transmission line will be built from Rupsha 800 MW CCPP to the existing Khulna South substation. The conductor to be used is twin-ACCC Hamburg[3], and the line will have two circuits, each capable of transferring 1400 MW. The new transmission line will require three main river crossings and three minor river crossings, and would traverse for 29 km, mostly through rice fields. Upon reaching the existing Khulna South substation, the line will be terminated at two new line bays and termination equipment to be installed under the project. Thereafter, electricity produced at Rupsha power plant will flow into the 230 kV transmission network to serve the electricity demand in Khulna and elsewhere in the country.

Component 4: Capacity Strengthening of NWPGCL

8. Strengthening institutional capacity has the following three major subcomponents: (i) improving project implementation, management, and construction supervision capabilities; (ii) establishing enterprise resource planning (ERP) system in NWPGCL; and (iii) enhancing operation and maintenance practices through procurement and installation of modern and high technology universal power plant operations training simulator. Project management and construction supervision support will be provided for the development of Rupsha power plant. ERP system support includes both hardware and software for introducing computerized management system for NWPGCL. The ERP system will substantially improve business process and NWPGCL's efficiency and transparency by computerizing the Financial

[3] Aluminium Conductor Composite Core (ACCC) Hamburg has a current carrying capability of 1440 ampere at 120^0C.

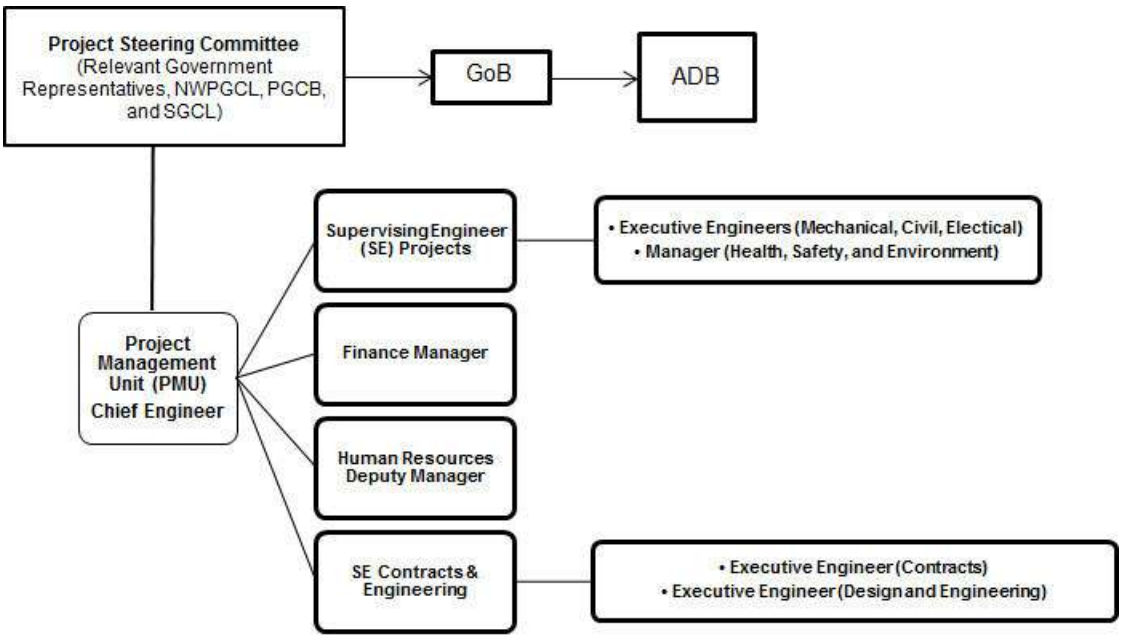
Accounting, Budgeting & Costing, Human Resource Management, Procurement Inventory, Planning and Monitoring, Operations & Maintenance and Project Management and Accounting.

1.2 Project Implementation Arrangements

9. Implementation supervision for the Rupsha 800 MW CCPP, power transmission, and gas distribution facilities will be carried out by the NWPGCL with assistance from a team of international and national implementation consultants. From time to time, assistance will be provided by the Power Grid Company of Bangladesh (PGCB) for Component 3, and the SGCL for Component 2 to ensure that coordination is achieved and implementation progresses smoothly. During construction, further assistance will be provided by SGCL and PGCB for approval of detailed design and drawings submitted by the contractors of Component 2 and Component 3, respectively. This arrangement has worked well for the Bheramara 360 MW CCPP project financed by the Japan International Cooperation Agency (JICA), which is very similar to the Rupsha 800 MW CCPP.

10. NWPGCL is currently setting up the project management unit (PMU) and so far, has assigned limited staff to it. The organogram (see **Figure 1.2**) prepared for the PMU shows the unit will have a compliment of 80 staff. It will be headed by a Chief Engineer, and will have 4 divisions, headed by: (i) Supervising Engineer (SE) Projects; (ii) Manager Finance; (iii) Deputy Manager Human Resources and (iv) SE Contracts & Engineering. SE Projects will have reporting to him, three Executive Engineers, (Mechanical, Civil, and Electrical) and Manager Health, Safety and Environment (HSE) while the SE Contracts& Engineering will have reporting to him Executive Engineer Contracts and Executive Engineer Design and Engineering. In addition, the project will have a high-level Project Steering Committee (PSC) consisting of members from various government departments, NWPGCL, PGCB and SGCL and act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB.

Figure 1.2: Project Implementation Arrangements



1.3 The Need for Environmental Assessment

11. The project is subject to the environmental requirements of GoB, ADB, and IsDB since the NWPGCL is seeking the financial support of ADB and IsDB.

1.3.1 National Requirements

12. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997. Under these regulations, all the three components of the Project are "Red" category requiring and environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (TOR) of the EIA needs the approval of the Department of Environment (DoE). The DoE is the authority that regulates and enforces environmental management regulations to ensure that development projects are implemented sustainably, and to conserve and manage the environment in Bangladesh.

13. The ToR of the EIA for Component 2 was approved by the DoE on 3 November 2016. NWPGCL has obtained exemptions for submitting an IEE in obtaining the SCC for all the project components as follows:

(1) Component 1 – 5 November 2017; DoE/Clearance/5584/2016/564
(2) Component 2 – 5 November 2017; DoE/Clearance/5668/2016/563
(3) Component 3 – 5 November 2017; DoE/Clearance/5669/2016/549

14. Without the EIA approved by DoE, NWPGCL cannot open line of credit in favor of importable machineries and cannot start any physical activities for the project. In 2016, NWPGCL has engaged the Center for Environmental and Geographic Information Services (CEGIS) to prepare the EIAs of all the project components required by the DoE.

1.3.2 Environmental requirements of ADB and IsDB

15. The Safeguard Policy Statement 2009 (SPS 2009) of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[4] Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

16. Under SPS 2009, projects that require funding from ADB will be subject to screening and categorization based on their potential environmental impacts. The project has four components: (i) Component 1 - Rupsha 800 MW CCPP, Component 2 – Gas Supply to the Power Plant, Component 3 – Power Transmission Interconnection, and Component 4 – Capacity Strengthening of NWPGCL. Component 4 is not expected to have adverse

[4] IsDB.Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nation's Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

environmental impacts. The project is category A on environment according to ADB's SPS 2009 which requires the preparation of an EIA.[5]

17. The EIA required by ADB was based on the findings of CEGIS and additional research for available secondary data to meet SPS 2009. Aside from the EIA, NWPGCL will provide ADB a copy of the ECC issued by the DoE for all the project components.

1.4 Structure of the Report

18. Following the requirements of SPS 2009, the environmental assessment for the project is presented as follows:

1) Volume 1 – EIA of Component 1;
2) Volume 2 – EIA of Component 2; and
3) Volume 3 – EIA of Component 3.

19. The EIAs of all the project components are based generally on the EIA format given in Annex to Appendix 1 of SPS 2009, pp41-43. This EIA covers Component 2 – Gas Supply to the Power Plant.

[5] Asian Development Bank Safeguard Policy Statement (SPS 2009),https://www.adb.org/documents/safeguard-policy-statement.

2.0 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 National environmental agency

20. The Ministry of Environment and Forests (MoEF) is the agency responsible for planning, promoting, coordinating and overseeing the implementation of programs and plans regarding environment and forestry. The MoEF deals with all national environmental matters and is responsible for the prevention and control of pollution, forestation and regeneration of degraded areas and protection of the environment, and in the framework of legislations. MoEF also undertakes surveys, impact assessment, pollution control, research, and collection and dissemination of environmental information, as well as environmental awareness among all sectors in Bangladesh.

21. Under the MoEF is the Department of Environment (DoE), which performs regulatory functions. DoE was created in 1989 as the primary government agency responsible for enforcing environmental management regulations to ensure sustainable development and to conserve and manage the environment. The DoE ensures the consistent application of environmental rules and regulations, and provides guidance, training and promotional campaign on improving environmental awareness.

2.2 National environmental regulations

22. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and Environment Conservation Rules (ECR) 1997. ECA 1995 provides the requirements on environmental protection, improvement of environmental standards, and control and abatement of environmental pollution. Through the ECA 1995, the DoE is mandated to undertake any activity needed to conserve and enhance the quality of environment and to control, prevent and mitigate pollution.

23. ECR 1997 provides for the declaration of ecologically-critical areas, categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.; (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for the IEE and the EIA based on categories of industrial and other development interventions. ECA 1995 and ECR 1997 outline the regulatory mechanism to protect the environment in Bangladesh. Aside from ECA 1995 and ECR 1997, **Table 2.1** presents a summary of relevant environmental regulations.

Table 2.1: Relevant national environmental regulations

Regulation	Brief Description	Remarks
Environment Court Act 2000 (amended in 2002 and 2010)	This Act is under the Judiciary and MoEF to ensure the resolution of disputes on environmental and social damages resulting from any development activities. This Act also allows for the completion of environment-related legal proceedings effectively.	NWPGCL will ensure that all potential environmental complaints will be dealt with effectively at the project level through the Project Management Unit (PMU). SPS 2009 requires setting up of a grievance redress mechanism for projects known to cause potential environmental impacts.

Regulation	Brief Description	Remarks
Bangladesh Water Act 2013	Makes provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources	Component 2 will have two crossings at Mayur River. NWPGCL will ensure that relevant provisions will be complied.
Vehicle Act 1927, the Motor Vehicles Ordinance 1983	These are under the Bangladesh Road Transport Authority (BRTA) which regulates vehicular emissions and noise including road safety.	This regulation will be complied with by vehicles that may be used during construction and operation of Component 2.
Factories Act 1965 and Bangladesh Labour 2006, Bangladesh Labor Act 2013	Regulations that aim to protect the interests and rights of the workers and to ensure their safety.	Workers recruited under Component 2 will be provided with personal protective equipment (if needed) and will comply with these regulations. No worker under 18 years old will be recruited.
The Forest Act 1927 (amended in 1982 and 1989)	This Act under the MoEF aims to protect the forest resources.	Component 2 will not traverse protected forest area or other forest type.
Telegraph Act 1885	Under the Ministry of Posts and Telecommunications, this provides power to the Telegraph Authority to alter position of gas or water pipes or drain (Sect. 14, a and b).	The route for Component 2 was selected considering this Act.
Electricity Act 1910	Relates to the supply and use of electrical energy, allows any person to secure a license to supply energy and to put down or place electrical supply lines for the transmission of energy. Sect 19(1) of the Act provides that the licensee, in the exercise of any of the powers conferred by or under this Act, will cause as little damage, detriment and inconvenience as may be, and will make full compensation for any damage, detriment or inconvenience caused by him or by any one employed by him.	Component 2 referred to the applicable provisions in this Act.
Gas Safety Rules 1991 (amended 2003)	Provides guidelines on the materials, design and construction of gas transmission and pipeline industry. This Safety Rules were based on the American National Standard Codes for Gas Transmission and Piping System.	NWPGCL and SGCL will comply with these safety rules.
Bangladesh Gas Act 2010	Regulates the transmission, distribution, marketing, supply and storage of natural gas and liquid hydrocarbon	NWPGCL and SGCL will comply with this Act.
Gas Distribution Rules (Industry) 2014	Provides guidance on gas distribution to industrial clients	NWPGCL and SGCL will comply with the relevant provisions of this rules.
The Antiquities Act 1968 (amended 1976)	Regulation on the preservation and protection of antiquities.	NWPGCL will have a “chance find” procedures.
Natural Water Bodies Protection Act 2000	According to this Act, the character of water bodies i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans	Any part of Component 2 that will cross rivers, ponds, canals, and drainage channels will refer to this Act and will secure the required

Regulation	Brief Description	Remarks
	formulated under the laws establishing the municipalities in division and district towns shall not be changed without approval of concerned ministry. This Act is under the Rajdhani Unnayan Kartipakkha/Town Development Authority/Municipalities.	approval and clearances.
Wildlife (Protection and Safety) Act 2012	Provides for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Under this Act, hunting, trapping, killing of wildlife are strictly prohibited.	Component 2 will not affect areas of habitats known to host wildlife. Route is along urban areas.
The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	Provides for the requirements for the protection and conservation of fish. This Act defines fish as "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, molluscs, echinoderms and frogs at all stages in their life history."	Component 2 will cross Mayur River twice and will ensure that no protected fish species under this Act will be destroyed or affected.

Source: ADB Consultant, November 2017

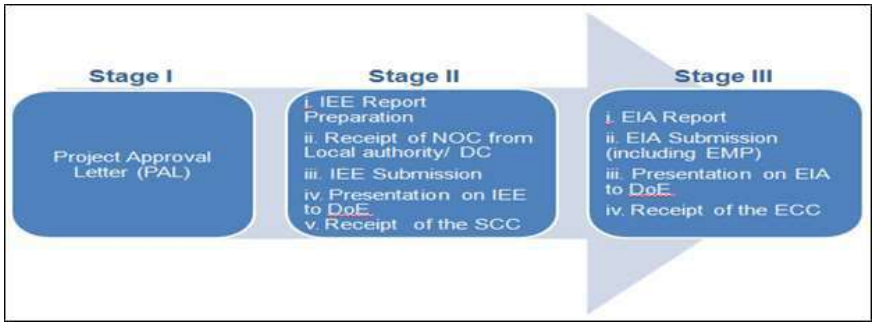
2.3 Overview of the environmental approval process

24. Section 12 of ECA 1995 provides that no industrial unit or project can be established or undertaken without securing an environmental clearance certificate (ECC) from the DoE. Following the requirements of ECR 1997, the DOE has classified various development interventions according to the potential adverse environmental impacts for the purpose of issuing the ECC. This classification includes: (i) green, (ii) orange-A, (iii) orange-B, and (iv) red. Green category refers to industries or projects considered to be relatively pollution-free, thus, no environmental study will be required while the Red category refers to industries/projects which may cause significant adverse environmental impacts and therefore, require an EIA.

25. For projects and industrial units classified as Orange-A, Orange-B, and Red (those that may have potential adverse environmental impacts), securing the ECC involves two steps: (i) issuance of site clearance certificate (SCC), and then (ii) the ECC.

26. SCC will be issued by the DoE upon approval of the IEE, receipt of the No Objection Certificate (NOC), which a "proof of authorization" to initiate a project, and the ToR of the EIA while the ECC will be issued upon the approval of the EIA. The project proponent cannot open line of credit in favor of importable machineries and cannot start any physical activities for the project without the EIA approved by the DoE. **Figure 2.1** shows the process of obtaining the ECC for Red category project.

Figure 2.1: Process of obtaining ECC



2.3.1 National environmental requirements for Component 2

27. According to ECR 1997, Component 2 is Red category requiring an SCC and an ECC. The NOC from the local government, Aviation Authority, and the Department of Forest have been obtained. On 5 November 2017, NWPGCL has obtained exemption from the DoE for submitting an IEE and approval of the ToR of the EIA (DoE/Clearance/5668/2016/563).

2.4 Relevant International Environmental Agreements

28. **Table 2.2** lists the applicable international environmental agreements where Bangladesh is a signatory which can provide guidance during the implementation of Component 2.

Table 2.2: Relevant international environmental agreements

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972)	Defines and provides for the conservation of world`s heritage by listing the natural and cultural sites whose value should be preserved.	3 November 1983	23 November 1972	Component 2 will have “chance find” procedures
Convention on Biological Diversity (1992)	A framework for biodiversity and requires signatories to develop national strategies (National Biodiversity Strategy and Action Plan) for the conservation and sustainable use of biological diversity.	3 May 1994	29 December 1993	Any replacement of cleared vegetation resulting from Component 2 will be consistent with the objectives and priorities of the current Action Plan.

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington 1973) – also known as CITES	Addresses the exploitation patterns and overharvesting that threaten species of flora and fauna. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.	20 November 1981	1 July 1975	Component 2 will ensure that it will not cause any harvesting and exploitation of wild flora and fauna during implementation.
Vienna Convention for the Protection of the Ozone Layer	A framework for efforts to protect the globe's ozone layer by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.	2 August 1990	22 March 1985	Component 2 will not use chemicals that can affect the ozone layer like methyl chloroform, a solvent generally used for industrial processes.
Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer)	Designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.	2 August 1990	1 January 1989	Component 2 will not use chemicals that can cause harm to the ozone layer.
Kyoto Protocol (1997)	Commits its Parties to set internationally-binding emission reduction targets.	22 October 2001	16 February 2005	Component 2 will ensure zero or minimal fugitive natural gas emissions.

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
	This agreement is linked to the United Nations Framework Convention on Climate Change (UNFCCC).			
UNFCCC (1992)	This framework came into force on 21 March 1994 and aims to achieve stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system.	15 April 1994		Component 2 will ensure zero or minimal fugitive natural gas emissions.
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	Aims to reduce the amount of waste produced by signatories and regulate the international traffic in hazardous wastes.	1 April 1993	5 May 1992	Component 2 will ensure that disposal of chemicals used (if and when needed) will follow the instructions in the material data safety sheet.

Source: ADB Consultant, November 2017

2.5 Environmental requirements of ADB and IsDB

29. SPS 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[6] Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

2.5.1 ADB

30. SPS 2009 consists of three key safeguard areas, (i) environment, (ii) involuntary resettlement, and (iii) indigenous peoples; aims to avoid adverse project impacts to both the environment and the affected people; minimize, mitigate and/or compensate for adverse project impacts; and help Borrowers to strengthen their safeguard systems and to develop their capacity in managing the environmental and social risks.

[6] IsDB.Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nation as Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

31. During the project identification stage, ADB uses a categorization system to indicate the significance of potential environmental impacts and is determined by the category of its most environmentally-sensitive component, including direct, indirect, cumulative, and induced impacts within the project's area of influence. The project categorization system and the assessment required is described in **Table 2.3**.

Table 2.3: SPS 2009 environmental categorization

Category	Definition	Assessment Requirement
A	Likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the sites or facilities subject to physical works.	Environmental impact assessment (EIA)
B	Likely to have adverse environmental impacts that are less adverse than those of Category A. Impacts are site-specific, few if any of them irreversible, and in most cases mitigation measures can be designed more readily than Category A.	Initial Environmental Examination (IEE)
C	Likely to have minimal or no adverse environmental impacts.	No environmental assessment is required but the environmental implications of the project will be reviewed.
FI	Project involves investment of ADB funds to or through a financial intermediary (FI).	FIs will be required to establish an environmental and social management commensurate with the nature and risks of the FI's likely future portfolio to be maintained as part of the FI's overall management system.

Source: ADB. Safeguard Policy Statement 2009, p. 19. http://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf.

2.5.1.1 Environmental requirements of ADB for Component 2

32. Based on SPS 2009, Component 2 is category A given that it is an auxiliary part of the Rupsha 800 MW CCPP. The EIA of Component 2 is referred to in the overall project environmental assessment as Volume 2. This draft EIA was based on the findings of CEGIS and additional research for available secondary data to meet SPS 2009. Aside from this draft EIA, the NWPGCL will provide ADB with a copy of the ECC issued by the DoE for Component 2.

2.5.1.2 Disclosure requirements

33. Aside from SPS 2009, the Public Communications Policy (PCP) 2011 provides for the requirements of disclosure for project information of projects and grants funded by ADB. Consistent with SPS 2009, PCP 2011 requires the disclosure of documents submitted by the borrower and/or client:

(i) a draft EIA report for category A project, at least 120 days before Board consideration;

(ii) a draft EARF, where applicable, before appraisal;[7]
(iii) the final EIA or IEE, upon receipt by ADB;
(iv) a new or updated EIA or IEE, and a corrective action plan, if any, prepared during project implementation, upon receipt by ADB; and,
(v) the environmental monitoring reports, upon receipt by ADB.

34. To meet the disclosure requirements of ADB, the EIA of Component 2 will be disclosed to ADB website at least 120 days prior to Board consideration of the project by ADB Management.

2.5.2 IsDB

35. On 8 December 1974, the IsDB was created as an international financial institution in accordance with the Articles of Agreement signed and ratified by all member countries done in the City of Jeddah, Kingdom of Saudi Arabia.[8] Consisting of 57 member countries in Africa, Asia, Europe, and Latin America, IsDB aims to foster the economic development and social progress in its member countries, and Muslim communities in non-member countries. Among others, IsDB is already a key player in the clean energy sector, with investments of around $1 billion between 2010 and 2012.[9] Since inception, IsDB has funded about $2.75 billion in renewable energy projects and has allocated 6% of its operation to climate change mitigating projects.[10]

36. During the projects' appraisal/negotiations stage in the IsDB's project cycle, activities cover the review and assessment of the following major aspects of a project: technical, institutional, economic, financial, social, and environmental impact.

37. IsDB is ADB's third-largest multilateral partner for project cofinancing since December 2015 and has signed a framework cofinancing agreement in September 2008 and was extended until 2017.[11]

2.6 Comparison of environmental safeguard principles between ADB and Bangladesh

38. **Table 2.4** presents a summary comparing the environmental safeguard principles of ADB and the Government of Bangladesh (GoB).

Table 2.4: Comparison of environmental safeguard principles

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
1	Use of screening process to determine the	Uses sector-specific rapid environmental assessment	• ECA 1995 and ECR 1997 set screening criteria to classify	No major gaps

[7] If no further mission for appraisal is required, the document will be posted before the management review meeting or the first staff review meeting for sovereign projects, or before the final investment committee meeting for non-sovereign projects, as applicable (ADB procedures).
[8] Islamic Development Bank, About IsDB. http://www.isdb.org/irj/portal/anonymous?NavigationTarget=navurl://24de0d5f10da906da85e96ac356b7af0
[9] UN Environment. UNEP and Islamic Development Bank Sign Agreement on Environmental Conservation. 20 January 2016. http://web.unep.org/newscentre/unep-and-islamic-development-bank-sign-agreement-environmental-conservation. (Accessed 6 December 2017)
[10] IsDB. What do Islamic Bank Care About the Environment: Role of Islamic Development Bank in Financing Sustainable Development. 6 March 2017.
[11] Asian Development Bank-Islamic Development Bank Partnership and Cofinancing Guide. 2016

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
	appropriate environmental assessment	checklist for screening and assigns categories based on potential impacts: • A - EIA required (irreversible, diverse or unprecedented adverse environmental impacts) • B - IEE required • C - no environmental assessment required but a review of environmental implications • FI - ESMS required	industries/projects based on potential environmental impacts as follows: Green (pollution-free), Orange-A, Orange-B and Red (cause significant environmental impacts). The screening criteria is based on project or industry type and do not consider the scale and location. The category determines the level of environmental assessment.	
2	Conduct an environmental assessment	• EIA and IEE - Identify potential impacts on physical, biological, physical cultural resources, and socioeconomic aspects in the context of project's area of influence (i.e., primary project site and facilities, and associated facilities) • ESMS for FIs	*Industry/project category* *Green* - no environmental assessment required *Orange A* - no IEE or EIA required but must provide process flow, lay-out showing effluent treatment plant, etc. *Orange B* - IEE required *Red* - both IEE and EIA are required	No major gaps
3	Examine alternatives	• Analyze alternatives to the project's location, design, and technology • Document rationale for selecting the particular project location, design, and technology • Consider "no project" alternative	• Regulations (i.e., ECA 1995 and ECR 1997) do not require specifically the identification and analysis of alternatives	Not required by law but the ToR for EIA to be approved by the DoE now includes a discussion on analysis of alternatives.
4	Prepare an environmental management plan (EMP)	• EMP to include monitoring, budget and implementation arrangements	• EMP and procedures for monitoring included in the IEE and EIA (i.e., Orange-A, Orange-B, and Red category projects)	No major gaps
5	Carry out meaningful consultation	• Starts early and continues during implementation • Undertaken in an atmosphere free of intimidation • Gender inclusive and responsive • Tailored to the needs of vulnerable groups • Allows for the incorporation of all relevant views of stakeholders • Establish a grievance redress mechanism	• Public consultation and participation are not mandatory based on ECA 1995 and ECR 1997 • Grievance redress mechanism is not mentioned in ECA 1995 and ECR 1997 • EIA format required by DoE includes stakeholders' consultation	Approval of the ToR of EIA by DoE now includes consultation with stakeholders.
6	Timely disclosure of draft environmental assessment (including	• Draft EIA report posted on ADB website at least 120 days prior to Board consideration	• No requirement for public disclosure of environmental reports but DoE posts the	Still no requirement for public disclosure of environmental

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
	the EMP)	• Draft EA/EARF prior to appraisal • Final or updated EIA/IEE upon receipt • Environmental monitoring report submitted by borrowers upon receipt	Minutes of the Meeting on the application for environmental clearance certificate to its website, http://www.doe-bd.org/minutes.php	assessment
7	Implement EMP and monitor effectiveness	• Prepare monitoring reports on the progress of EMP • Retain qualified and experienced external experts or NGOs to verify monitoring information for Category A projects • Prepare and implement corrective action plan if non-compliance is identified • Requires submission of quarterly, semi-annual, and annual reports to ADB for review	• ECC is subject to annual renewal based on compliance of the conditions set by DoE	No major gaps
8	Avoid areas of critical habitats (use of precautionary approach to the use, development and management of renewable natural resources)	Provides guidance on critical habitats	• ECA 1995 and ECR 1997 identifies ecologically-critical areas and the rules to protect them	No major gaps
9	Use pollution prevention and control technologies and practices consistent with international good practices	• Refers to World Bank's Environmental Health and Safety (EHS) General Guidelines 2007 (or any update) • If national regulations differ, more stringent will be followed • If less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification	• Effluent standards, ambient and emission standards included in ECA 1995 and ECR 1997 • Ambient noise levels included in Noise Pollution Control Rules 2006	No major gaps
10	Provide workers with safe and healthy working conditions	• Refers to WB EHS General Guidelines 2007 (or any update)	• Occupational health and safety standards included in the Factories Act 1965, the Bangladesh Labour Law 2006, and the Bangladesh Labor Act 2013.	No major gaps
11	Conserve physical cultural resources (PCR) and avoid destroying or damaging them	• Use of field-based surveys and experts in the assessment • Consult affected communities on PCR findings • Use chance find procedures for guidance	• Preservation and protection of cultural resources are within the Antiquities Act 1968.	No major gaps

3.0 DESCRIPTION OF THE PROJECT

3.1 Background

39. Component 2 of the Project will consist of the natural gas pipeline distribution from the existing Khulna Citygas Station (CGS) in Arongghata until the proposed 800 MW Rupsha Combined Cycle Power Plant in Khalispur. The Khulna CGS is operated and owned by the Sundarbans Gas Company Limited (SGCL).

40. Under the Bangladesh Oil, Gas and Mineral Corporation (Petrobangla), SGCL was established in 2009 by the GoB to manage the operations of the gas distribution networks within five districts: (i) Kustia, (ii) Jhenedah, (iii) Jessore, (iv) Khulna, and (v) Bagehat including other 21 district towns of Khulna, Barisal and Dhaka Divisions. **Figure 3.1** shows the franchise area of SGCL in the south western part of Bangladesh.

41. Petrobangla, the national gas utility and the single-buyer for the gas industry, will procure liquefied natural gas (LNG) from international sources and deliver regasified LNG to Khulna city gas station (CGS). The regional gas distribution company, SGCL will deliver gas from the existing Khulna CGS in Arongghata to the Rupsha power plant in Khalishpur. A new 24-inch (0.6 m) underground gas pipeline about 10 km long will be installed from Khulna CGS to the Rupsha 800 MW power plant. The gas receiving and metering station (RMS) will be located at the Rupsha power plant. In addition, a new 20-inch (0.5 m) underground gas pipeline 2 km long will be branched off from the line from Khulna CGS to Rupsha power plant, to serve NWPGCL's existing Khulna 225 MW CCPP.[12] Owing to non-availability of gas, this 225 MW power plant is presently operating on diesel. **Figure 3.2** shows the location of Component 2.

The existing associated gas distribution pipeline network of the Khulna CGS of SGCL is included as Part C of the ongoing Loan 2622/2633-BAN: Natural Access Improvement Project (formerly Clean Fuel Development Project) funded by ADB with a total amount of $537 million approved on 26 March 2010. Part C (Access Improvement in South Western Region) involved the construction of about 845 kilometer (km), 2 inch to 20 inch distribution pipelines in south western region comprising of the districts of Kushtia, Jhenidah, Jessore, Khulna and Bagerhat (including Mongla). As such, it was subject to ADB's environmental requirements. Also included in the loan is capacity building for SGCL.

As of 2016, SGCL has about 3,076 domestic connections including commercial and industrial clients with two power plants.[13] Safety features of SGCL operations include odorizer unit in distribution/district regulating station (DRS) to prevent accident from gas leakage along the distribution lines, a security map in all its establishments describing emergency routes and procedures, an emergency cell and security committee to handle disaster and emergency situation effectively, closed circuit camera to monitor activities in real time and metal halide explosion-proof emergency lighting installed in DRS, RMS and all other important areas of operation for better surveillance, and fire-fighting systems. These devices support the regular and manual ocular inspection of SGCL operations by designated technical staff.

42. Supply of natural gas will come from the regasified-LNG (R-LNG) and from domestic sources as follows:

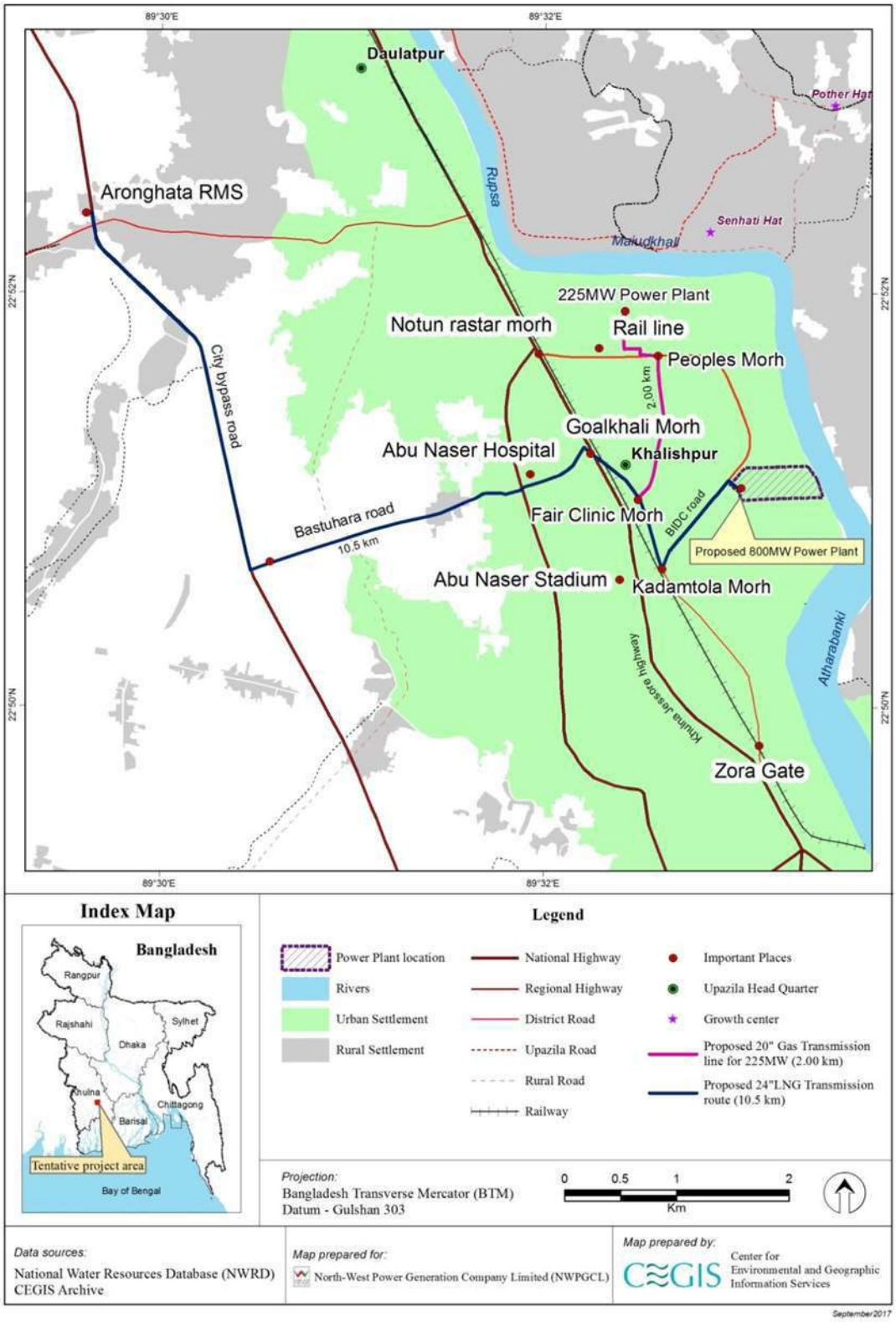
[12] ADB. Loan 2966-BAN: Power System Expansion and Efficiency Improvement Investment Program – Tranche 1. December 2012.
[13] Sundarban Gas Company Limited. Annual Report 2015-2016. http://sgcl.org.bd/annual-report/.

- FSRU Moheskhali - 500 MMSCFD of R-LNG will be made available by April 2018 developed by Excelerate Energy, USA-Bangladesh
- Summit LNG Terminal Company Limited – 500 MMSCFD R-LNG will be made available by October 2018
- GoB and RasGas (Qatar) has signed a deal in September 2017 for a 15-year LNG sales and purchase agreement to supply 1.8 million (M) tons LNG/year for 5 years and 2.5 M tons/year for the next 10 years
- According to Petrobangla, there will be additional supply (domestic) of 2,750 MMSCFD
- By 2021, Bangladesh Petroleum Exploration and Production Company Limited (BAPEX) will have 55 exploration wells and 31 development wells

These sources will provide adequate supply of natural gas.

Figure 3.1 Franchise Area of SGCL

Figure 3.2: Location Map



3.2 Features of Component 2

1. The gas distribution pipeline from Khulna CGS to Rupsha 800 MW CCPP will be about 10 km-long and will result to a total of three road crossings, two railway crossings, and two river crossing at different points in Mayur River. The gas distribution pipeline of Component 2 will have two parts:

3.2.1 Gas distribution pipeline route from Khulna CGS to Rupsha 800 MW CCPP

1. The gas distribution pipeline from Khulna CGS to Rupsha 800 MW CCPP will be about 10 km-long and will result to a total of three road crossings, two railway crossings, and two river crossing at different points in Mayur River.

3.2.2 Gas distribution pipeline route branched off from Khulna CGS to Rupsha 800 MW CCPP

2. The distribution gas pipeline route branched off from the Khulna CGS to Rupsha 800 MW CCPP will be about 2 km which will result to two road crossings, and one railway crossing.

3. The crossings of the gas distribution pipeline route on the road, railway and Mayur River are shown in **Figure 3.3**, **Figure 3.4** and **Figure 3.5**. **Table 3.1** gives the summary of the crossings while **Figure 3.6** shows the location of the crossings.

4. Aside from the gas distribution pipelines, there wil be a pig launcher at Khulna CGS, another pig launcher at the branched off point of the 20-inch diameter gas distibution pipeline to the existing Khulna 225 MW CCPP, and a pig receiver at the Khulna 225 MW CCPP, and an RMS at Rupsha 800 MW CCPP.

Figure 3.3: Some road crossings along the gas pipeline route

Figure 3.4: Railway crossing at Goalkhali Bus Stand

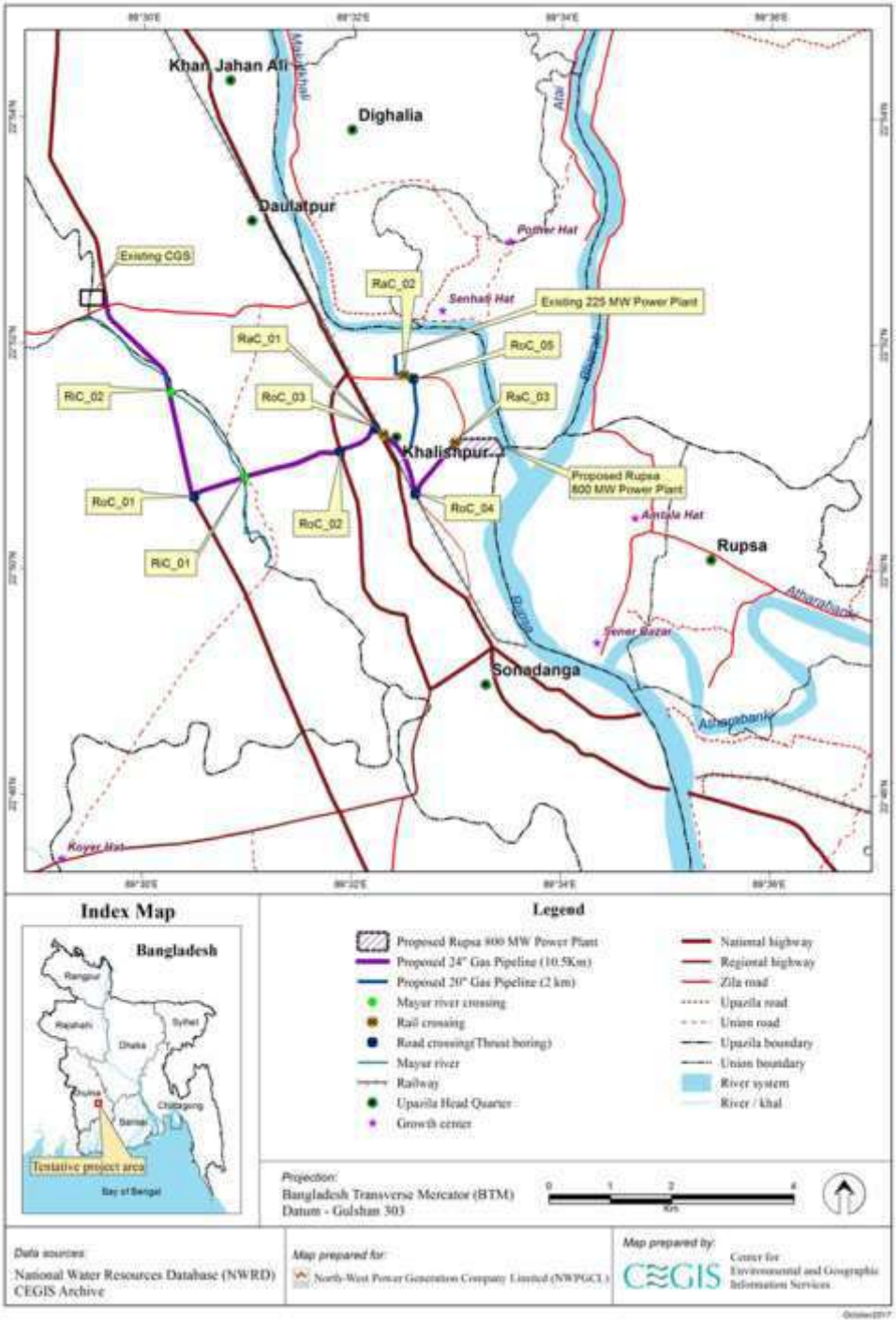
Figure 3.5: Crossing along Mayur River

Table 3.1: Summary of gas distribution line crossings

Crossing	Pipeline Route	Reference in Figure 3.4	GPS Coordinates
Road	Khulna CGS –Rupsha 800 MW CCPP	RoC_01	N 22° 51' 42",E 89° 30' 04"
	Khulna CGS –Rupsha 800 MW CCPP	RoC_02	N 22° 51' 06", E 89° 31' 43"
	Khulna CGS – Khulna 225 MW CCPP	RoC_03	N 22° 51' 18", E 89° 32' 03"
	Khulna CGS – Rupsha 800 MW CCPP	RoC_04	N 22° 50' 43", E 89° 32' 27"
	Khulna CGS – Khulna 225 MW CCPP	RoC_05	N 22° 51' 45", E 89° 32' 26"
Mayur River	Khulna CGS – Rupsha 800 MW CCPP	RiC_01	N 22° 51' 42", E 89° 30' 04"
	Khulna CGS – Rupsha 800 MW CCPP	RiC_02	N 22° 50' 51", E 89° 30' 47"
Rail	Khulna CGS – Khulna 225 MW CCPP	RaC-1	N 22° 51' 12", E 89° 32' 11"
	Khulna CGS – Khulna 225 MW CCPP	RaC-2	N 22° 51' 46", E 89° 32' 20"
	Khulna CGS – Rupsha 800 MW CCPP	RaC-3	N 22° 51' 08", E 89° 32' 49"

Source: CEGIS Field visit, June 2017. Note: RaC - Rail Crossing, RiC - River Crossing, RoC - Road Crossing

Figure 3.6: Location of crossings



3.3 Project activities

5. Main activities include the following: (i) pipeline route survey, (ii) detailed drawing and design, (iii) procurement of materials, (iv) temporary storage and stockyard, (v) equipment and vehicle mobilization, (vi) pipeline construction, and (vii) pipeline testing and commissioning.

3.3.1 Pre-Construction Phase

6. The distribution gas pipeline route branched off from the Khulna CGS to Rupsha 800 MW CCPP will be about 2 km which will result to two road crossings, and one railway crossing. A summary of pre-construction activities in implementing Component 2 is given below.

Activities	Description
Pipeline route survey	Survey takes into consideration major factors such as access to the pipeline from the main road, river crossing, railroad and major road crossings. Other factors include presence of ecologically-sensitive areas and settlements. Component 2 will have a total of 5 road crossings, 2 river crossings and 3 railway crossings. The pipeline route will follow the existing road easements.
Detailed drawing and design	Pipeline construction must conform to Bangladesh Mineral Gas Safety Rules of 1991 (as amended in 2003) and other industry standards such as ASME B31.8 (Gas Transmission and Distribution Piping Systems) and relevant ASTM standards.
Procurement of materials	Required office furniture, machinery, accessories, pipeline materials, and other equipment will be purchased following the procurement guidelines of GoB and ADB.
Establish temporary storage and stockyard for materials and equipment	A space will be set up to keep the pipes, machinery, equipment and other support materials to facilitate construction activities.
Mobilization of equipment and vehicles	Vehicles, equipment and machinery will be inspected and assessed on their current condition to ensure that they are working properly before the start of construction phase. Periodic inspection will be undertaken to the construction vehicles, machinery, and equipment such as grader, dozer, side booms, trenching machine, excavators, welding machines, water pumps, dump trucks, crane, horizontal directional drilling (HDD) machine, tools, etc.

3.3.2 Construction Phase

7. At this stage, activities include site preparation, staking of the RoW, excavation, trenching, pipeline stringing, welding, back-filling, testing and commissioning, and clean-up. These major activities will be scheduled efficiently to ensure the completion of the total pipeline construction within the dry working season.

8. The Engineering, Procurement and Construction (EPC) Contractor will be selected following the guidelines and procedures of ADB and GoB. The Project Management Unit (PMU) will monitor the performance of the EPC Contractor and will supervise the overall implementation of Component 2. The labour force that will be recruited will consist of technical, skilled and unskilled workers and staff. NWPGCL will require the EPC Contractor to give priority to local hiring.

9. **Main working camp.** This will be the construction office of the EPC Contractor which includes office accommodation, utilities, waste and sanitary facilities. Wastes that will be

generated from construction activities will be collected and disposed of in designated areas approved by the district administration of Khulna. PMU, NWPGCL will monitor the management of the EPC Contractor.

10. **Workers construction camps.** This will be field camps for workers working close to the road easement along the gas pipeline route and will be shifted depending on the expected completion of the work required. The field camps will be provided with sanitary facilities, water for general purpose washing, safe drinking water, electricity, first aid, etc. Given the scale of Component 2, (about 12 km-long gas distribution pipeline) and the location of the alignment (urban area), there may be less than 50 workers who will be staying in the field camps.

11. **Pipeline route and working areas.** The width of the pipeline trench for Component 2 is approximately 2m and depth of about 1.5 m from the top of the pipe along the route will be requisitioned as right-of-way (RoW) for construction of the pipeline. In general, the EPC Contractor shall clear and grub the RoW by removal of crop and vegetation. Trees will be avoided whenever possible. Debris shall be removed to the extreme edge of the RoW and disposed of properly so that these are not mixed with trench backfill material.

12. **Grading.** Where required, grading will be undertaken to have a reasonably level workspace during construction. Grading will be carried out also in areas where the pipeline route cuts across steep slopes to keep a gentler slope for pipe bending limitations.

13. **Pipe diameter factor.** Component 2 will use 24" diameter for the 10 km-long pipeline and 20" diameter for the 2 km-long pipeline. The larger the diameter of pipe, the greater width of RoW will be required. Large diameter pipe will require very accurate bends. The amounts of tough bends are usually kept to a minimum. Increasing the use of bends will increase the use of specialized heavy equipment like bending machine and crane/side boom.

14. **Trench depth factor.** The amount of soil excavated from the ditch to meet construction specifications is the main factor in determining the width of RoW with respect to ditch depth. Ditch depth will vary depending on the diameter and operating pressure of the pipeline and applicable codes and regulations.

15. **Stringing.** Stringing will be done through specialized trailers and equipment that haul and lift the pipe off the trailers and then place carefully onto the RoW that has been cleared and proper grading completed to ensure that the pipe or its coating are not damaged. GTCL will require the EPC Contractor to ensure that the pipe is strung properly at designated locations. Pipes shall be raised on sandbags.

16. **Coating of pipeline**. The pipeline will be protected from corrosion through barrier coating and cathodic protection system. The outer side will be coated to prevent moisture from coming into direct contact with steel that may cause corrosion. The 3-layer polyethylene (3LPE) coating is considered to be excellent in corrosion protection.

17. **River, railway, and road crossing.** Component 2 will involve two crossings of Mayur River at different points, a total of five road crossings, and three railway crossings (see **Table 3.1** and **Figure 3.4**). For crossings at Mayur River, HDD will be used and horizontal boring technique for road and railway crossings. These procedures help to minimize the environmental impact, disturbance and interference in traffic arteries. **Figure 3.7** shows the process of HDD. While drilling fluid components are generally not hazardous materials, excavation spoils may affect the quality of Mayur River (e.g., color, turbidity). HDD contractor will be required to

dispose of excess drilling fluid properly following Schedule 10, ECR 1997 and also to properly reinstate and protect the river banks from potential erosion.

Figure 3.7: HDD process

Sources: https://www.slideshare.net/davidtole1/perforacion-direccional-y-horizontal; http://www.njspotlight.com/stories/15/05/31/natural-gas-pipelines-remain-great-divide-for-advocates-opponents/

18. **Trenching.** The pipeline will have casing or cover whenever it crosses a highway, rail track, or water body. The minimum depth of cover shall be measured from the top of the pipe to the surface of the working grade. Crown materials along the surface of the ground level will not be considered as a part of the depth of cover. The depth will vary depending on the site condition and specifications by the design codes of practices. The trench shall be carefully cut so that the pipe is evenly bedded throughout its length with sufficient joint holes and trial holes made, where necessary. Trenching uses heavy equipment to give enough space for the pipeline to be moved over and lowered into place, and to protect from excavation damage.

Figure 3.8: Laying of Pipeline

Source: http://www.energydigital.com/utilities/gas-pipeline-project-through-bread-basket-france

19. **Lowering-in.** Prior to this, the trench is checked to make sure it is clean from any debris and other foreign material, and dewatered, if needed. Lowering-in will follow the applicable regulation and standards such as Bangladesh Natural Gas Safety Rules 1991,

ASTM, ASME, etc., and will commence right after the trench has been excavated. Lowering-in of pipeline will be undertaken and supervised by skilled operators and experienced engineers. The trench is then backfilled using the excavated material.

20. **Tying-in.** Separate welded joint sections of the pipeline shall be tied into a continuous system in such a manner that no stress will be introduced into the pipe as a consequence of the tying-in operation and duly certified for integrity upon Non-destructive Testing.

21. **Cathodic protection.** Cathodic protection test points shall be installed and connected to temporary cathodic protection facilities in accordance with the specification at the time of final operation of lowering or tying-in. The installation shall require inspection before backfilling is placed.

22. **Backfilling.** Before any backfilling is performed, the pipeline will be evenly bedded upon the bottom of the trench throughout its length and will be correctly positioned. Compaction of back filling material shall be performed by an approved method to prevent any subsequent subsidence.

23. **Re-instatement and clean-up.** As soon as the pipeline has been laid and backfilled, the road easement, RoW and work areas will be cleaned up to ensure that they are returned to their original condition (before the project) as much as possible.

24. **Placing route markers**. Reinforced concrete route markers will be placed on both sides of roads, rail, and river crossings with a specified maximum separation distance between markers. Specifications of other route markers along the pipe line will be also placed.

25. **Installing aerial marker**. There will be aerial markers at every horizontal bend and at intervals along the pipeline route based on design specifications and standards.

26. **Hydrostatic testing and dewatering**. Before commissioning of Component 2, it will be subjected to hydrostatic testing and dewatering (if needed). The entire length will be filled with water to carry out pressure test which will identify leaks and will ensure that it has adequate safety margin beyond the operating pressure. Wastewater from hydrostatic testing will be tested prior to discharge to ensure compliance with Schedule 10 (Rule 13) of ECR 1997. Hydrostatic testing Contractor will be required by NWPGCL to ensure proper discharge of wastewater.

27. **Commissioning.** After hydrostatic testing and dewatering, the pipeline will be cleaned and dried using mechanical tools (or pigs) moved through the pipeline with the aid of pressurized dry air. The pipeline will be dried to minimize internal corrosion. Once pipeline clean-up is complete, re-instatement/clean-up of RoW is done, installation of RoW markers and aerial markers are finished in accordance to design, standards, and procedures; and acceptable to the Quality Assurance Department, then NWPGCL will start the operation of the system with technical support from SGCL.

28. **Metering stations and other permanent above-ground facilities.** Small area of land will be required permanently to accommodate the metering stations, valves/stations, scraper facilities and to provide adequate pipeline clearance at the two river crossings in Mayur River. Construction activities for metering stations are similar to those employed for process plants, i.e., site preparation (grading, drainage construction, fencing, etc.) and plant construction/installation.

3.3.3 Operation and Maintenance Phase

29. After commissioning of the pipeline, it is ready to transport gas at a regulated pressure from Khulna CGS to the Rupsha 800 MW CCPP in Khalishpur and the existing Khulna 225 MW CCPP in Goalpara. The operation and maintenance of Component 2 will commence on the day it will be commissioned.

30. The Supervisory Control and Data Acquisition (SCADA) will monitor the gas distribution operations to ensure that there will be no pressure drop along the pipeline. The pipeline will operate at 300 psi with gas throughput of about 125 million cubic feet per day (MMCFD). Emergency maintenance engineers will be trained and will be immediately available to repair line breaks, leak clamping, replacement of section of pipes and other necessary repairs along the pipeline route.

31. Designated NWPGCL staff will walk regularly along the route and will log down any noticeable changes on the RoW. The pipeline will be protected by impressed current cathodic protection system. The potential difference at the pipeline test poles will be monitored to ensure that cathodic protection is working all the time. Operation and maintenance activities will include:

- Removing and replacement of the length of the pipeline section, valves, meters, regulators, etc., on occasion for the purpose of inspection, repair, and maintenance.
- Regular overall repair and maintenance including workshops and vehicles.
- Pigging of pipe for cleaning purposes. This occurs on required basis. However, the waste disposal facilities should be maintained.
- Operation and maintenance of metering station at the Khulna CGS, the Khulna 225 MW CCPP, and the Rupsha 800 MW CCPP.
- Condensate will be generated at metering stations, which requires proper handling and storage. However, minimal condensate will be generated at different sources as SGCL generally transports drier and cleaner natural gas.

3.3.4 Waste and disposal activities

32. NWPGCL, with technical support from SGCL, will adopt reduce, reuse, and recycle as strategy to minimize the generation of wastes during operation including maintenance of good housekeeping.

33. **Solid wastes.** These will include cleared vegetation, domestic wastes, scrap materials, welding torches, etc. Solid waste will be separated, identified, stored and disposed in designated areas. Plastic containers will be either returned to the suppliers or recycled.

34. **Chemicals.** All chemicals used during the operation of Component 2 will be listed, stored, and disposed of according to the material safety data sheet and the requirements for safe disposal procedures of GoB and ADB.

35. **Sewage water.** Black water will be discharged through toilets with septic tank facilities and will follow Schedule 9 of ECR 1997.

36. **Diesel/oil.** Oily wastes from machine workshops, equipment, repair of vehicles, etc., will be passed through an oil-water separator prior to disposal at designated sites.

37. **Gaseous emissions.** Vehicular emissions and dust from opened areas along the pipeline route will be generated during construction and installation of the pipeline system. During operation, vehicular emissions will be generated during inspection and maintenance along the pipeline route.

4.0 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

4.1 Component 2 – Project's Area of Influence

38. The project area is the physical location of Component 2 (10 km of 24-in diameter gas line connecting from Khulna CGS, Arongghata to Rupsha 800 MW CCPP and also an off-take line of 2 km, 20-in diameter from the 10 km line at the point of Fair clinic morh/Modern morh to the existing Khulna 225 MW CCPP) and,receiving and metering station (RMS) of the project. The focus of the study will be limited to the area where the impacts of the activity will be directly felt. A 120m buffer along both sides (i.e. 60m+60m=120m) of the gasdistribution pipeline has been considered for environmental analysis as area of influence and for the baseline study area.

4.2 Physical Environment

39. Physical environment includes natural environment i.e. air, noise, water, topography, built environment i.e. houses, roads, transport systems, buildings, infrastructure and the social and economic characteristics of the societies and communities in which we live. The baseline conditions of physical environment of the study area in terms of metereology, geology, water resources and transportation are given in the following sections.

4.2.1 Seismicity

40. Bangladesh is one of the seismically active regions of the world, experiencing numerous earthquakes over thepast 200 years. As per the updated seismic design provisions of Bangladesh National Building Code 1993, the study area falls under ZoneI, which is considered as seismically quiet zone, with basic seismic zone coefficient of 0.075. **Figure 4.1** shows the earthquake zone map.

4.2.2 Meteorology

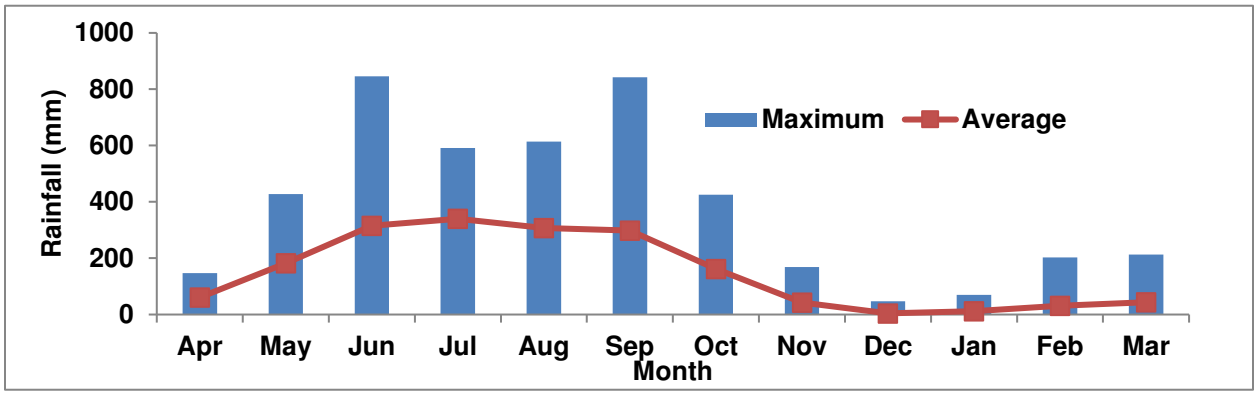
41. The data of all meteorological components were collected from Khulna BMD stationas it is the only station nearest to the study area.

Rainfall

42. Rainfall data of 1984-2013 was analyzed to understand the baseline condition of the study area. Maximum rainfall was observed at 846mm. Heavy rainfall occurred between May to October.About 80-83% of the annual average rainfall occurred during this period. The average yearly rainfall is 1,813 mm.The monthly maximum and average rainfall of the area for the above period are shown in **Figure 4.2**.

Figure 4.1: Seismic Zonation Map of Bangladesh

Figure 4.2: Monthly Rainfall of Khulna BMD Station (1984-2013)

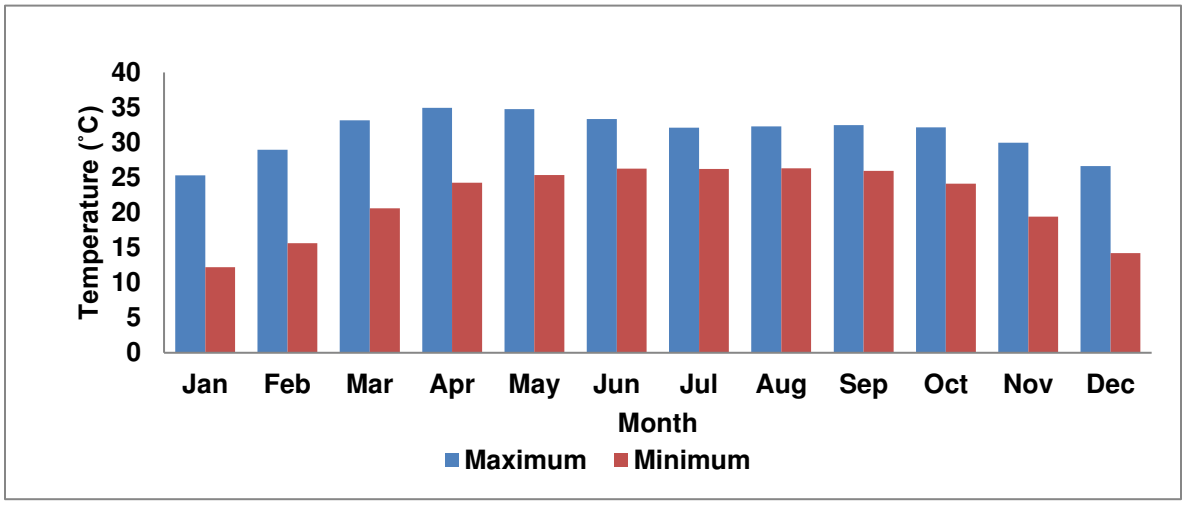


Source: BMD, Khulna

Temperature

43. The analysis of 30 years data during 1984-2013 shows that the maximum temperature in the project area varies from 25.3ºC to 34.9ºC while the minimum temperature varies within the range of 12.2ºC and 26.3ºC. The temperature rises during February to June and falls during December to February. The average of monthly maximum and minimum temperatures during this period is shown in **Figure 4.3**.

Figure 4.3: Monthly Temperature of Khulna BMD Station (1984-2013)

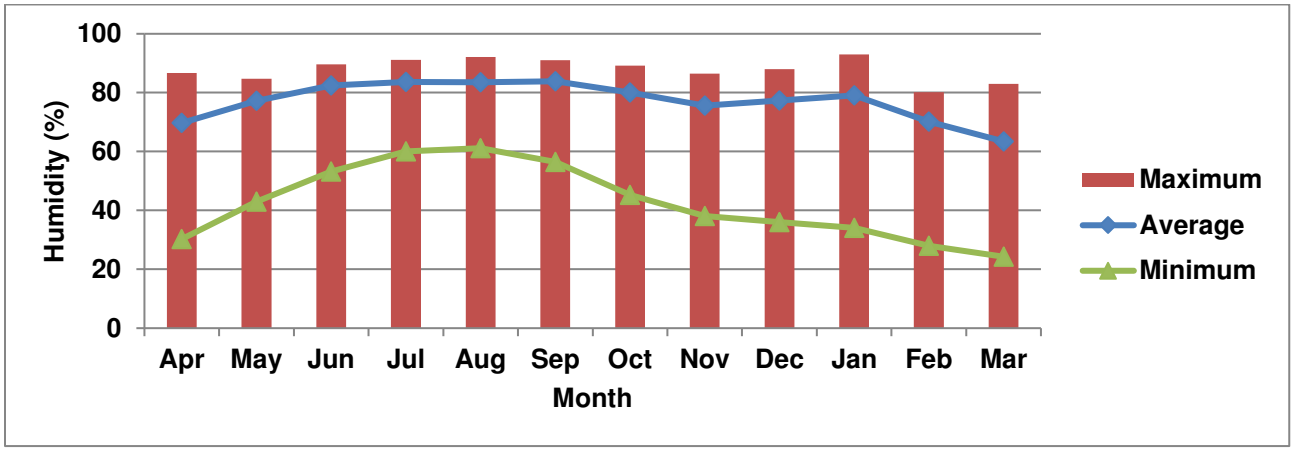


Source: BMD, Khulna

Humidity

44. The relative humidity data has been collected from 1984 to 2013. It shows that the monthly maximum relative humidity is 93% which occurs in January while the monthly minimum humidity is 25% observed in March. The monthly, maximum, minimum and average relative humidity is presented in **Figure 4.4**.

Figure 4.4: Monthly Humidity of Khulna BMD Station (1984-2013)

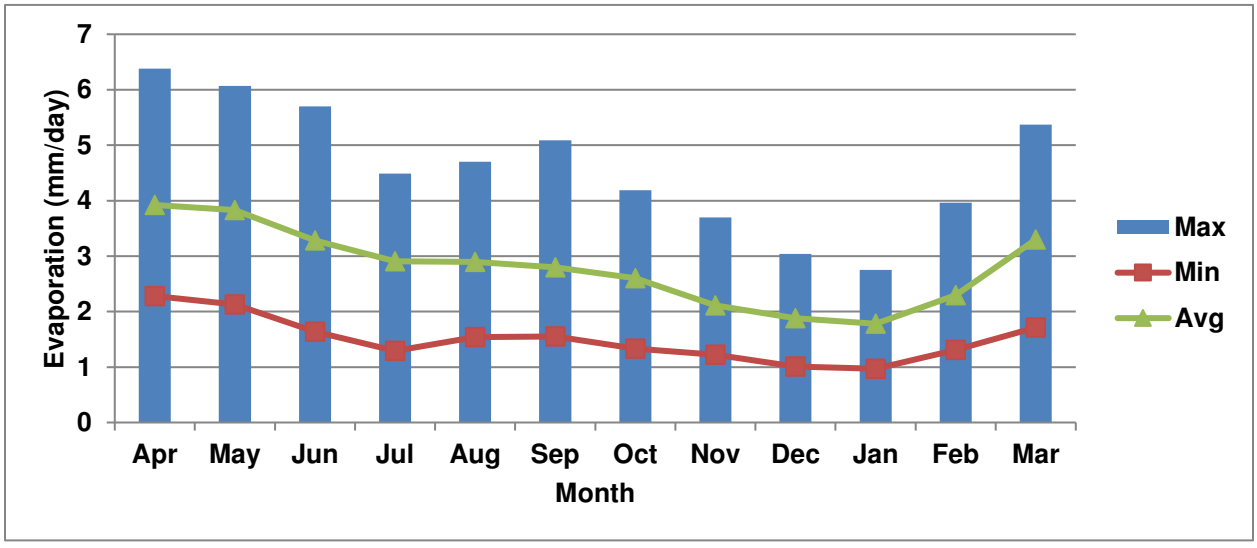


Source: BMD, Khulna

Evaporation

45. Available historical data on evaporation for the last 20 years 1992 to 2011 was collected and analyzed. It is observed that the monthly average evaporation rate varies from 1.78 to 3.92 mm/day. The monthly maximum, average and minimum evaporation rate is shown in **Figure 4.5**.

Figure 4.5: Monthly Evaporation of Khulna BMD Station (1992-2011)

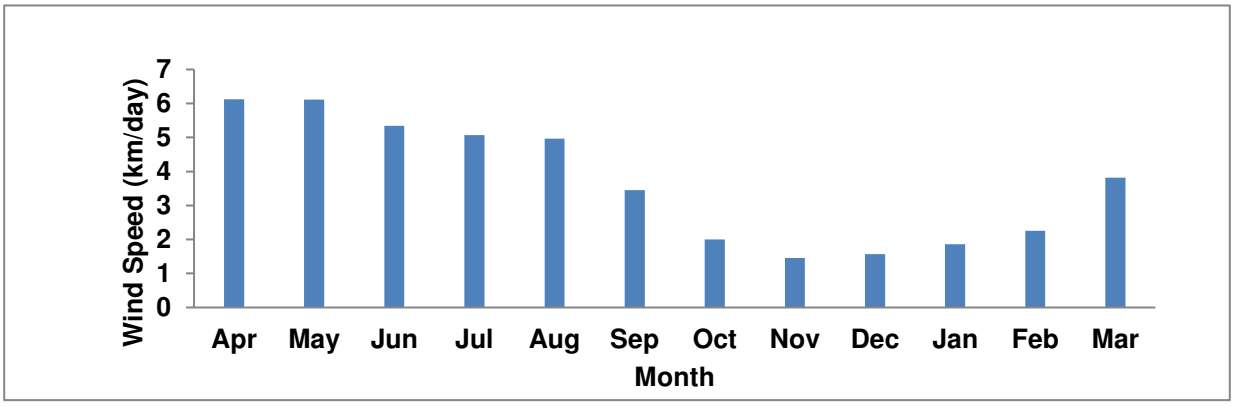


Source: BMD, Khulna

Windspeed

46. Wind speed data of last 30 years (1984 to 2013) was collected and analyzed. It shows that the monthly average windspeed varies from 1.5 to 6.1 km/day and the monthly maximum wind speed varies from 57 to 170 km/day. The average wind speed is shown in **Figure 4.6.**

Figure 4.6: Monthly Wind Speed of Khulna BMD Station (1984-2013)

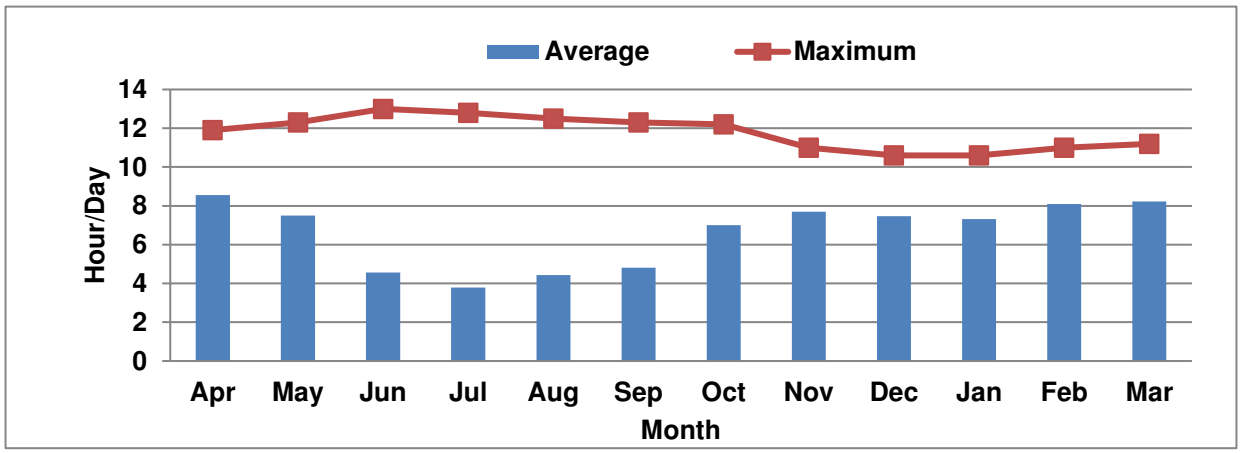


Source: BMD, Khulna

Sunshine Hour

47. The data of sunshine hours for the last 30 years (1984-2013) has been collected, analyzed and plotted (see **Figure 4.7**). The mean monthly values of sunshine hours vary from 4 to 9 hour/day while the maximum sunshine hour of 13 hr/day occurs in June.

Figure 4.7: Monthly Sunshine Hour of Khulna BMD Station (1984-2013)



Source: BMD, Khulna

Road and railway

48. The crossing roads are Bypass road, Bastuhara road, Refugee colony road, Goalkhali link road, BL College road, BIDC road, Aronghata mor, Outer Bypass and Khulna Jessore Highway (see **Figure 4.8**). The present road conditions are quite good except at some locations.Railway crossing will be beside the Golkhali Busstand.

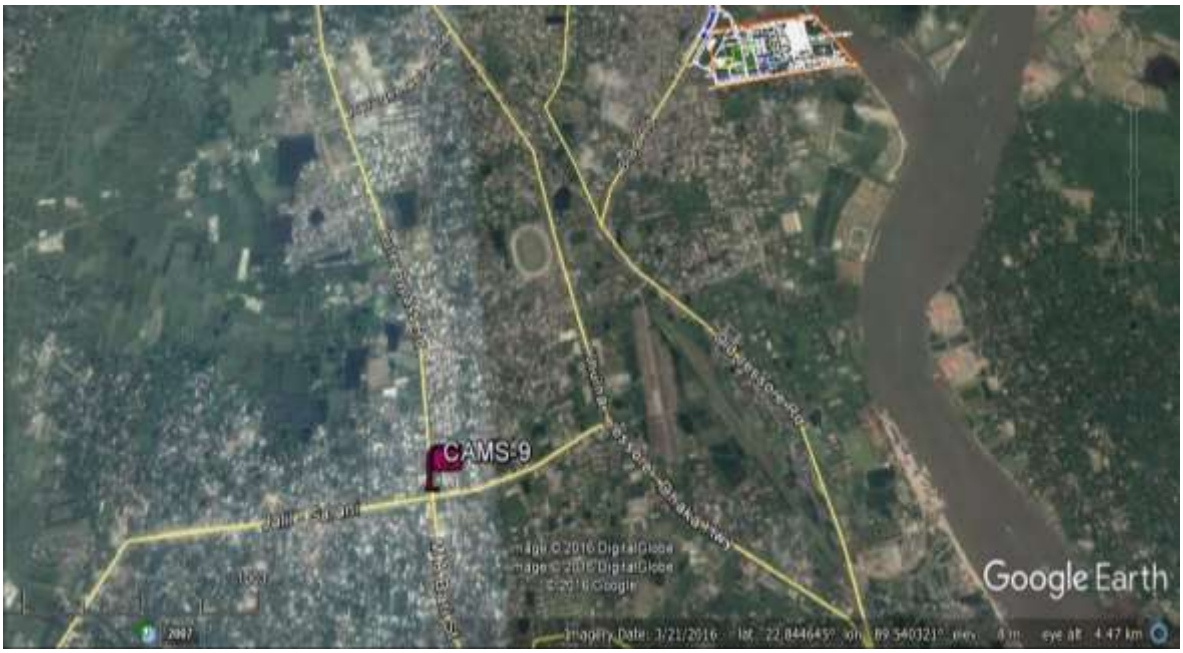
Figure 4.8: Road network

4.2.3 Ambient Air Quality and Noise Level

Ambient Air Quality

49. The quality of air is mainly characterized by the presence of criteria pollutants. Major criteria pollutants are particulate matter (PM_{10} and $PM_{2.5}$), NO_2, CO, SO_2 and Ozone (O_3). The DoE has set national ambient air quality standards for these pollutants in ECR 2005. These standards aim to protect against adverse human health impacts. One CAMS-9 (latitude 22.83 N, longitude 89.53 E) has been established in Khulna City to monitor the criteria pollutants. It is located in the Department of Social Forestry Office Campus at Baira, which is very much near to gas distribution line (**Figure 4.9**). Because of the topography of the city (flat) and good natural ventilation of the CAMS site representative air pollution levels of the city would be measured at this site. The location is relatively unaffected by nearby air pollution sources.

Figure 4.9: CAMS station in Khulna City



50. The sampler was placed on the flat roof of the CAMS housing. The roof height was 5 m above the ground and the intake nozzle of the sampler was located 1.8 m above the roof.Ambient air quality of Khulna city has been monitored for last four years. The results of 2013-2015 are shown in **Table 4.1** where the national air quality standard are also presented for comprehensive understanding and ready reference.

Table 4.1: Ambient air quality results at Khulna CAMS station

Criteria Pollutants	Standard Concentration (ECR 2005)		Result of 2013	Result of 2014	Result of 2015
	Period	µg /m^3	µg /m^3	µg /m^3	µg /m^3
Carbon Monoxide (CO)	8 Hr	10000µg /m^3	1790	1020	550
	1 Hr	40000 µg/m^3	1590	860	460
Sulphur Dioxide (SO_2)	24 Hr	365µg/m^3	16.7	12.1	31.4
Nitrogen Dioxide (NO_x)	24 Hr	-	27.07	DNA	122.76
Particulate Matter (PM_{10})	24 Hr	150 µg/m^3	132	219	93.5
Particulate Matter ($PM_{2.5}$)	24 Hr	65 µg/m^3	76.0	102	83.6

51. Initial assessment of the data shows that yearly average of 24-Hr PM concentration levels in both fractions ($PM_{2.5}$ and PM_{10}) in the Boyra CAMS monitoring sites (near to the gas distribution line) were high and $PM_{2.5}$exceeded the Bangladesh National Ambient Air Quality Standards.

Ambient Noise Level

52. The study area will cross the national and regional roads and highways. Noise is generated in this area due to movement of vehicles like bus, micro, auto, van, motorbike, cycle which ply over the road all day long.

Figure 4.10: Noise Level Measuring Location (Navy School, Khulna)

Figure 4.11: Noise Level Measuring Location (City Polytechnic Institute, Khulna)

53. Noise Pollution Control Rules 2006 gives the limits based location sensitivity. Based on this rules, the study area falls under the commercial area. The noise level measured and the locaiton of noise level monitoring are shown in **Table 4.2** and **Figure 4.12**.

Table 4.2: Noise level at several locations

No.	Date and Time	Location	Coordinates	Day Time Monitoring Result	Noise Pollution Control Rules 2006 (Day)
				Leq (dBA)	Leq (dBA)
NL_01	12/06/17 1:20 pm	Bangladesh Navy School & College, Khulna	N 22° 51' 07" E 89° 31' 46"	69.5	70
NL_02	12/06/17 3:15 pm	Khulna City Polytecnic, BIDC	N 22° 50' 52" E 89° 32' 33"	68.5	70
NL_03	12/06/17 2:15 pm	Abu Naser Hospital, Khulna	N 22° 51' 08" E 89° 31' 48"	63	70

Source: Field visit, CEGIS, June 2017

54. Limited noise level measurements show that it is within the limits set by the Noise Pollution Control Rules 2006.

4.2.4 Water Resources

Flooding

55. Component 2 will follow the present regional and zonal road including Khulna bypass highway. These roads are free from river flooding.But during heavy moonsoon, roads get inundated due to poor drainage system.

Mayur River

56. Component 2 will cross the Mayur River at Bastuhara Bypass road. Mayur River is animportant river situated in the western side of Khulna City. The length and width of the Mayur River is 11.5 km and 52 m wide. Water quality is poor due to wastewater and solid waste generated from the Sonadanga Kancha Bazar. The river originates from Rayer Mahal and falls in Rupsha Riverat Labonchora. It is almost a dead river. This river receives all types of municipal wastes through sewages outfall, which contains various organic and inorganic nutrient and other pollutants. Recently Khulna City Corporation has planned to develop a Linear Park on the bank of the river starting from Gollamari Bridge to RayerMahal surrounding Khulna University Campus on the east.

Figure 4.12 Mayur River crossing location

Surface water quality

57. Water sampling was conducted at Mayur River in November 2016 (dry season). **Figure 4.13** shows the sampling stations. A total of 21 different parameters were investigated. The parameters includetemperature, turbidity, TSS, TDS, electricalconductivity (EC), pH, dissolved oxygen (DO), hardness, BOD, COD, boron, nitrate, sodium, calcium, chloride, ammonia, coliform (Faecal), lead, sulphate, salinity. The results are shown in **Table 4.3**.

Figure 4.13: Water quality and noise sampling map

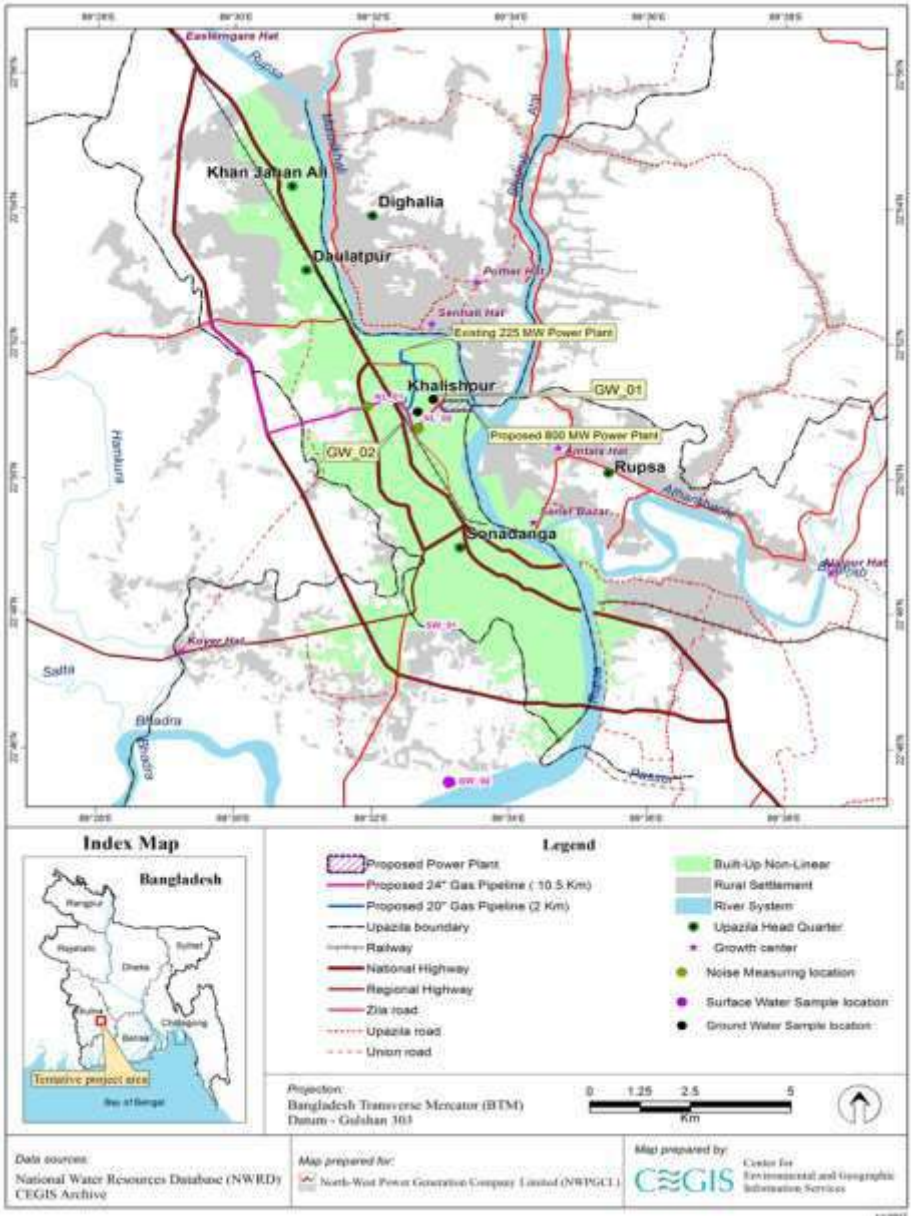


Table 4.3: Results of water quality, Mayur River

Name of Sample Locations and ID no	Lat (WGS 84)	Long (WGS84)	Parameter						
			Ammonia (mg/l)	Arsenic (mg/l)	BOD (mg/l)	Boron (mg/l)	Calcium (mg/l)	COD (mg/l)	Chloride (mg/l)
Buro Moulavir Darga (**WL_01**)	22°47' 48.00" N	89°32'35.52"E	0.78	0.002	4	0.21	165	16	242
10 Gate (**WL_02**)	22°45' 29.60" N	89°33'4.90 "E	0.61	0.001	1	<LOQ	138	4	194
ECR 1997 (assumed that river water usable for fisheries)	-	-	-	-	6	-	-	-	-
Name of Sample Locations and ID no	**Lat (WGS 84)**	**Long (WGS84)**	**Parameter**						
			Lead (mg/l)	**Nitrate (mg/l)**	**pH**	**Salinity (%)**	**Sodium (mg/l)**	**Sulphate (mg/l)**	**Temperature (°C)**
Buro Moulavir Darga (**WL_01**)	22°47' 48.00" N	89°32'35.52"E	0.01	0.39	7.2	0.66	178	3	24.9
10 Gate (**WL_02**)	22°45' 29.60" N	89°33'4.90 "E	0.004	3.11	7.1	0.46	129	15	24.7
ECR 1997 (assumed that river water usable for fisheries)					6.5-8.5				20-30
Name of Sample Locations and ID no	**Lat (WGS 84)**	**Long (WGS84)**	**Parameter**						
			Coliform (Faecal) N/100ml	**DO (mg/l)**	**EC (µS/cm)**	**Hardness (mg/l)**	**TDS (mg/l)**	**TSS (mg/l)**	**Turbidity (NTU)**
Buro Moulavir Darga (**WL_01**)	22°47' 48.00" N	89°32'35.52"E	182	6.21	1320	475	655	25	2.9
10 Gate (**WL_02**)	22°45' 29.60" N	89°33'4.90 "E	240	6.3	930	425	460	20	16.3
ECR 1997 (Schedule 3) (assumed that river water usable for fisheries)				5/higher					

Source: CEGIS field survey. November2016

Groundwater

58. The Khulna Division, situated in Southwestern part of Bangladesh, lies on the Late Holocene Recent alluvium of the Ganges deltaic plain in the north and Ganges estuarine plain in the south. Lithologically, the area is composed of coarse to very fine sand, silt, silty clay and clay in various proportions up to a depth of 300m. The length of the pipeline would be about 10 km from the Khulna CGS and the RMS at the Rupsha 800 MW CCPP. The diameter of the pipeline will be 24 inches. The width of the trench will be about two meters. The pipeline will be laid in a trench to be excavated at a depth of about 1.5 m below ground surface. The groundwater table in the project area is about 40-60 ft below the surface. Thus, the trench for pipe laying is unlikely to interfere with groundwater and soil stability. **Table 4.4 and 4.5** presents the results of groundwater quality while **Figure 4.13** shows the sampling stations.

Table 4.4: Results of in-situ groundwater testing

Sample Source	Location of Sampling	pH	BOD_5 at 20°C	EC (mS/cm)	TDS ppm	Salinity (ppt)	Temperature (°C)	Time
GW-01	Deep tube well of 400 ft depth	4.51	0.2	1260	630	2	27	16:45 pm
GW-02	Deep tube well of 500 ft depth	7.75	0.5	1570	780	2	26	12:30 pm
ECR 1997 (Schedule 3) (drinking water standards)		6.5-8.5	0.2		1000		20-30	

Source: CEGIS field study, 2016

Table 4.5: Results of groundwater chemical analysis

No.	Water Quality Parameters	Unit	Ground Water-01	Ground Water-02	Analysis Method	LOQ	ECR 1997 (mg/L) (drinking water standards)
1	Arsenic	Mg/L	0.001	0.001	AAS	0.001	0.05
2	Calcium	Mg/L	49.3	48.3	AAS	0.17	75
3	COD	Mg/L	4	4	CRM	-	4
4	Chloride	Mg/L	210	348	Titrimetric	-	150-600
5	Silica	Mg/L	33	42	UVS		-
6	Hardness	Mg/L	350	405	Titrimetic	-	200-500 (as $CaCO_3$)
7	Iron	Mg/L	4.38	6.52	AAS	0.05	0.3-1.0
8	Lead	Mg/L	0.013	0.022	AAS	0.001	0.05
9	Nitrogen	Mg/L	1.6	1.1	UVS	0.10	1.0
10	Phosphate	Mg/L	1	0.50	UVS	0.98	6.0
11	Sulphate	Mg/L	3	2	UVS	1.0	400

Source: DHPE, 2016

4.2.5 Land Resources

59. The RoW/road easement of the proposed gas distribution line has fallen under the Gopalganj-Khulna Beels (AEZ: 14) and High Ganges River Floodplain (AEZ: 11) based on FAO/UNDP, 1988 and is shown in **Figure 4.14**. The land type is medium high to medium low land and soil texture are clay and muck (pit soil). **Figure 4.15** shows the landuse of the study area.

Figure 4.14: Agro-ecological zones of the study area

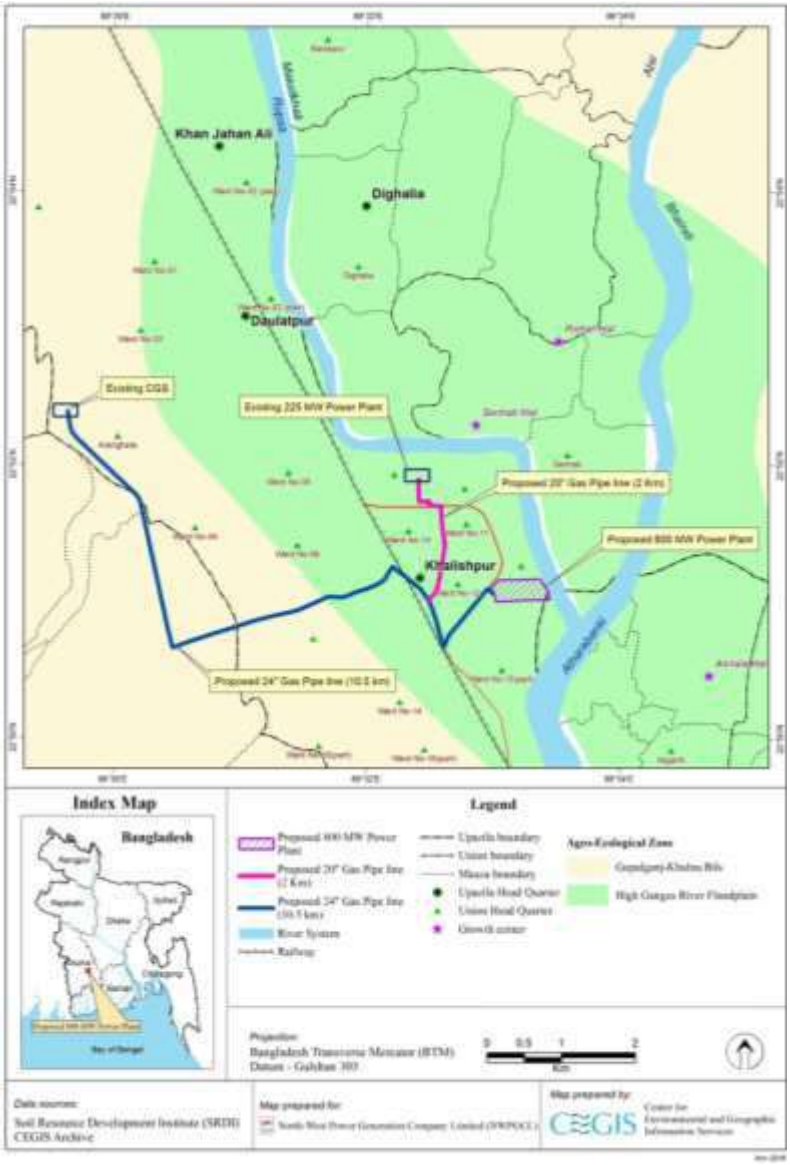
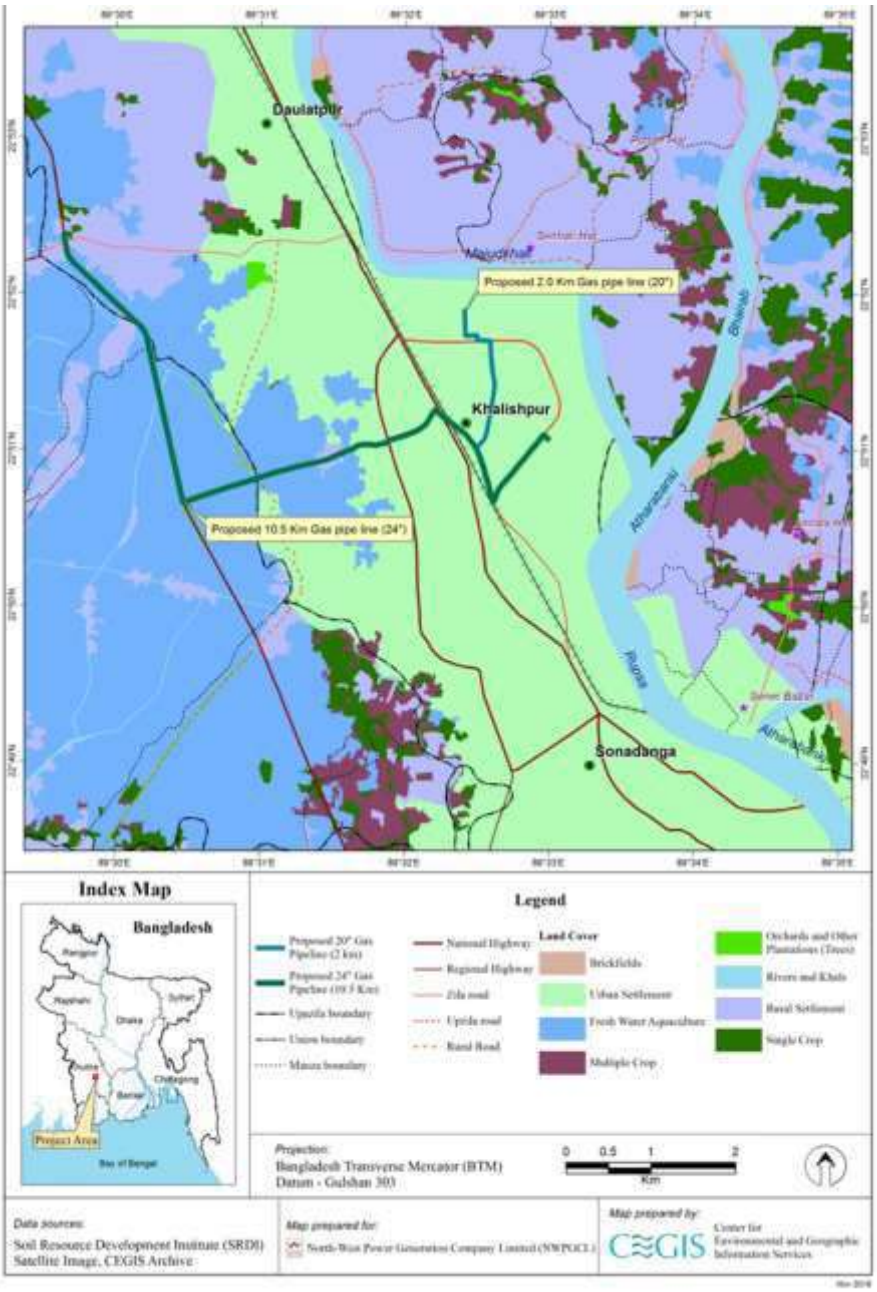


Figure 4.15: Land use map of the study area



Soil Salinity

60. CEGIS field team collected three soil samples from RoW of the project area (Depth: 0-15cm). These soil samples were analyzed by Soil Resources Development Institute (SRDI), Dhaka.

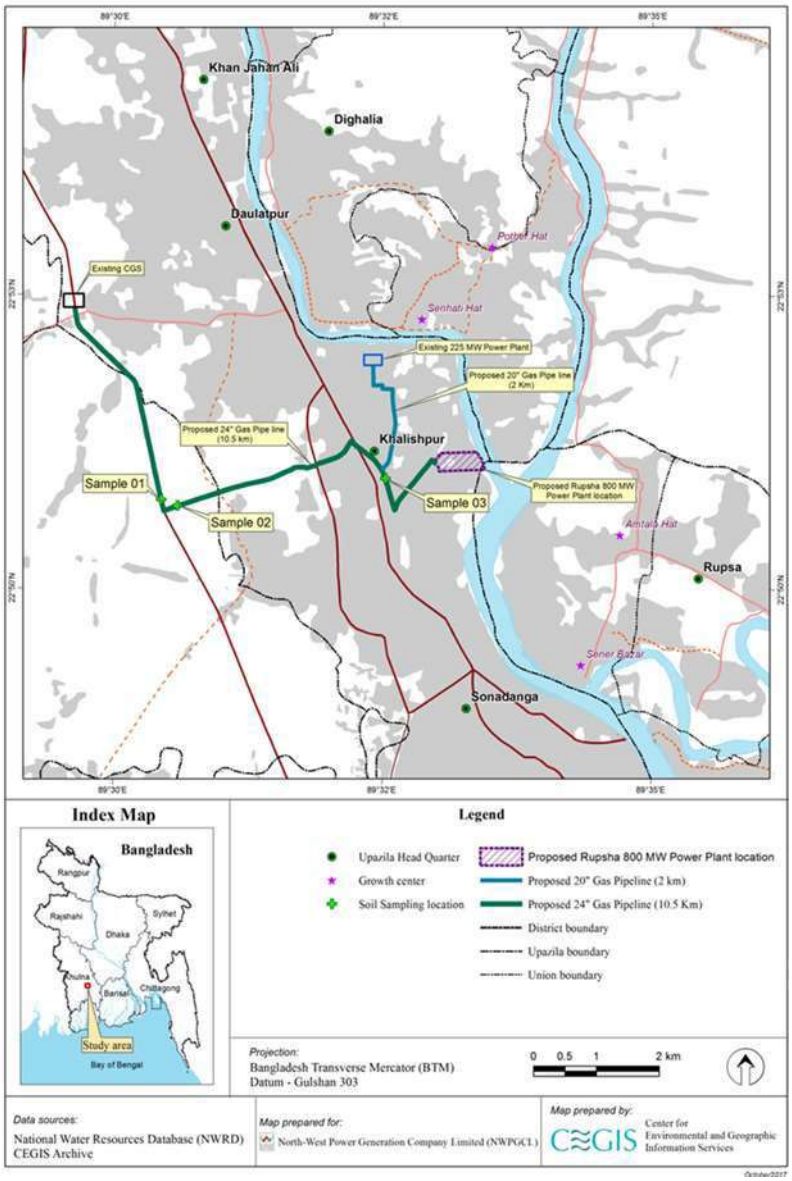
61. From the analyzed data, it is found that soil salinity of the Khalishpur, Khulna area is under S_1 soil salinity class (Non-saline).

62. The salinity status of Arongghata and Toiyabnagar was very slightly Saline with some slightly Saline (S_2). It might be due to the impact of poldarization of the area. Polders protect saline water from regular inundation of tidal effect during dry seasons, when water salinity is very high. Details soil analysis data in respect to salinity is presented in **Table 4.6**.

Table 4.6: Soil salinity results

Sample ID	Sampling Location	GPS	Analyzed data result (ds/m)	Standard
Sample 01	Arongghata, Khulna (Road side slop)	N 22º50´48´´ E 89º30´17´´	5.65	S_2(4.1-8.0)- Very slightly Saline with some slightly Saline
Sample 02	Toiyab Nagar, Khulna (Rice field)	N 22º50´45´´ E 89º30´26´´	5.45	S_2(4.1-8.0)- Very slightly Saline with some slightly Saline
Sample 03	Khalishpur, Khulna (Road side vegetables cultivated area)	N 22º50´59´´ E 89º32´22´´	1.35	S_1 (Non Saline)

Figure 4.16: Map of soil sampling



Soil quality

63. Three soil samples were collected from the project study area during field visit of the study team from 13-14 June 2017 (see **Figure 4.16**). All these samples were analyzed at Soil Resources Development Institute (SRD) to assess the quality of the soil. It has been found that the pH of the soil is slightly alkaline. This condition is good for supporting plant growth. The micro nutrient concentration of the soil is sufficient, but macro nutrient was very low to optimum. Organic matter content was sufficient in rice field. It has been observed that trace element (Pb and Cd) concentration in soil samples was found to be higher than the average amount in soil (10µg/g for Pb and 0.06µg/g for Cd). It might be due to the vehicular movement of nearby roads and over application of fertilizer in crop fields. Detail soil analysis result is presented in **Table 4.7**.

Table 4.7: Results of soil analysis

Sample ID	Sampling Location	pH	OM (%)	Total N (%)	K (meq/100 g soil)	P (µg/g)	S (µg/g)	Fe (µg/g)	Cd (µg/g)	Pb (µg/g)
Sample 01	Arongghata, Khulna	8.0	0.94	0.047	0.22	0.31	224.15	121.66	0.0045	13.28
Sample 02	Toiyab Nagar, Khulna	7.5	5.58	0.280	0.36	0.53	131.81	11.68	0.1125	20.32
Sample 03	Khalishpur, Khulna	7.8	1.28	0.064	0.21	1.12	36.96	315.22	0.108	18.29

Land use

64. The gross study area is 337 acres, of which 336 acres (99.7%) are non-cultivated land including settlement, waterbodies and the rest 1 acre (0.3%) is cultivated land. Detailed land use of RoW of gas transmission pipe line is presented in **Table 4.8**.

Table 4.8: Land use of RoW

Land Use	Area (Acre)	Percentage (%)
Urban Settlement	165	49.1
Rural Settlement	24	7.1
Fresh Water Aquaculture (gher)	136	40.4
Orchards and Other Plantations (Trees)	8	2.4
Rivers and Khals	3	0.7
Agriculture land	1	0.3
Total	**337**	**100.0**

Source: CEGIS estimation from field information, June 2017 and Rapid Eye Image, 2012

4.2.6 Agriculture Resources

65. The RoW area is mainly non-agricultural land with a total area of about on acre of cultivated land. This land is cultivated for crop production and single Boro crop is produced during dry season. This crop is transplanted in December and harvested by early May. About 1.8 tons of HYV Boro rice is produced in the study area.

4.2.7 Fisheries Resources

66. During field visit it was observed that the gher owners encroached the borrow pit at Khulna City Bypass Road and merged with their respective ghers to cover more areas (see **Figure 4.17)**. The pipeline will also cross Mayur River (near the Khulna city) and a natural canal which are not presently potential for fish habitat due to discharge of waste water from Khulna City causing poor quality of water **(**see **Figure 4.18)**. The natural canal has also become a narrow channel due to siltation and encroachment for gher owners.

67. Two types of fish habitat e.g. (i) gher for culture fisheries and (ii) river and khal for open water fisheries were found in the study area. No floodplain and cultured pond was found within RoW of the proposed line.

68. The estimated total fish habitat in the study area is 139 acres, out of which culture fisheries (only gher) is 137.5 acres and capture fisheries (river and canal) is only 2 acres (**Table 4.9**). Golda with white fish gher is dominant which comprise 99% of total fish habitat and rest is capture fish habitat. Among the gher area only one acre of land is used for rice cum golda culture.

Figure 4.17: Borrow pit with gher near the Toiyab Nagar KDA linked road

Figure 4.18: Mayur River in the study area

Table 4.9: Fish habitat status and production across the RoW

No.	Fishery Category	Habitat Type	Area (acres)	Productivity (Kg/acre/year	Total Production (kg)
1	Capture	River and canal	2	30 (all types of fishes)	60
	Sub-Total		**2**	**-**	**60**
2	Culture	Gherand pond	137	300 (golda with white fish)	41,100
	Sub-Total		**139**		**41,100**
	Grand Total				**41,160**

Sources: Field Survey, June 2017 and FRSS, 2016

69. Average fish production rate in river and khal is 30 kg/acre/year and gher is 300/kg/acre/year.The estimated total fish production of the study area is about 41,160 kg or 41.16 metric ton (MT). Most of the fish production (about 99.9%) comes from culture fisheries and very small amount from the capture fisheries. The reason for low production of capture fisheries is due to degradation of the river and canalhabitats for discharges of waste water of Khulna city and siltation asreportedby the local fishers and villagers.

70. The study area throughout the RoW of pipeline is poor in open water fish biodiversity. Local people reported that overall 10-15 fish species are found only in wet season in canal and Mayur River. Among these species, chingri (*Penaeus spp*), puti (*Puntius spp*), taki (*Channa punctatus*), shol (*Channa striatus*), tengra (*Mystus spp*), baim(*Mastacembelus pancalus*) and baila (*Glossogobiud giuris*) are commonly found in the canal and river but their abundance is very low **(Figure 4.19)**. Gher owners mostly concentrate in culture of golda (prawn) farming

which starts from May to September and continue until November depending on the availability of water in the gher. The Golda farmers follow improved extensive to semi-intensive systems along with freshwater fish which include Rui (*Labeo rohita*), Catla (*Catla catla*), Mirgel (*Cirrhinusscirrhosus*), puti (*Puntius gonionotus*), etc. Sometimes farmers also start rice cultivation in the ghers and fresh water fish culture along with rice **(Figure 4.20)**.

None of fish species that are found within the study area of the proposed gas pipeline is in the IUCN Red list and is shown in **Table 4.10**.

Table 4.10: Fish species in the study area

Sl	Scientific Name	Local Name	Conservation status Bangladesh	IUCN conservation status
1	*Machrobrachiumrosenbergii*	Prawn	NL	NL
2	*Peneous monodon*	Bagda	NL	NL
3	*Puntius sophore*	Punti	LC	LC
	Channa punctatus	Taki	LC	LC
4	*Channagachua*	Cheng	LC	LC
5	*Channastriatus*	Shol	LC	LC
6	*Mystustengra*	Tengra	LC	LC
7	*Mastacembeluspancalus*	Stiped Spiny Eel	LC	LC
8	*Glossogobiudgiuris*	Baila	LC	LC
9	*Labeorohita*	Rui	LC	LC
10	*Catlacatla*	Catla	LC	NE
11	*Cirrhinusscirrhosus*	*Mrigel*	NT	VU

LC = Least Concern; NE = Not Evaluated; NL = Not Listed in IUCN red list book; NT = Near Threatened; VU = Vulnerable.

Figure 4.19: Gher Fisheries (Golda)

Figure 4.20: Mixed catch of fish species

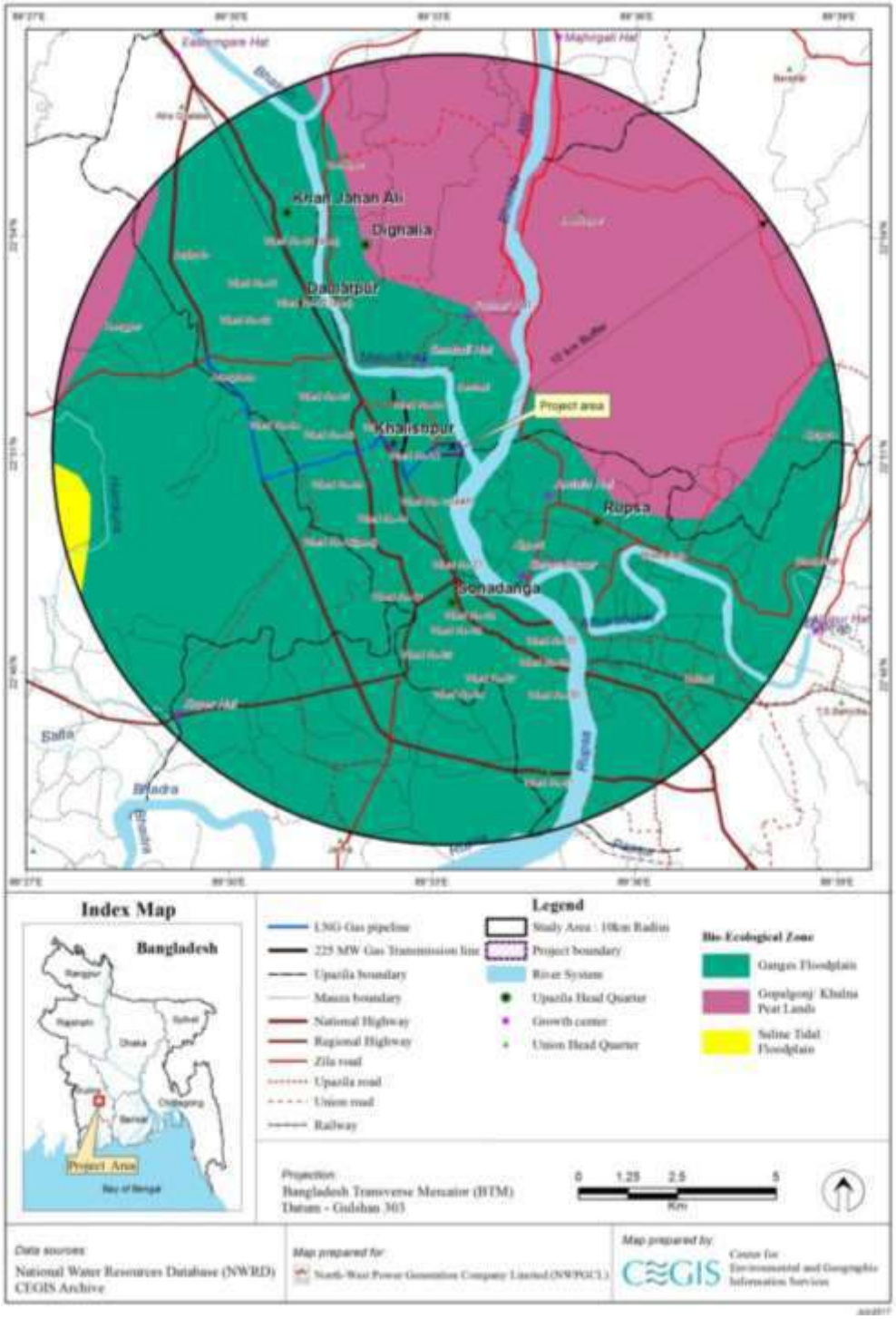
4.2.8 Biological Resources

Habitat characteristics of study area

Bio-Ecological Zone

71. IUCN has divided Bangladesh into 25 Bio-ecological Zones (Nishat et. al., 2002) with respect to physiographic units and biological diversity. Each of the bio-ecological zones represents overall ecological situation of an area of the country. The study area falls under the bio-ecological zones Ganges Floodplain (**Figure 4.21**). The area covered by bio-ecological zones is 337 acres or 100%.

Figure 4.21: Bio-ecological zone in Component 2



4.2.9 Ecosystem in the Study Area

Terrestrial Ecosystem

Roadside flora

72. Common cultivated plants along the road side are Rain Tree (*Samanea saman*), Mehogani (*Swietenia mahagoni*), Sugar Date Palm (*Phoenix sylvestris*), Banana (*Musa sp*), Egyptian thorn (*Vachellia nilotica*), Horse radish tree (*Moringa oleifera*), Indian jujube (*Zizyphus mauritiana*),Royal Poincian (*Delonix regia*), Spanish Cherry (*Mimusops elengi)*, Coconut (*Cocos nucifera*), North Indian Rosewood (*Dalbergia sissoo*) (**Table 4.11**). The road sides are also covered with semi-spontaneous shrub and herb vegetation (**Figure 4.22**). The major shrub and herb species havebeen seen during the field visits are Glory bower (Bhant), Croton (Ban Tulshi), Bitter vine (Asma lata), Senna plant (Kolkasunda), minnie-root (patpati), ivy wood rose (halud kalmi), flannel weed (sida), dodder (swarnolata), crown flower (akando), Durba grasses hairy fig (dumur) and orange berry (daton). No threatened plant species has been found along the proposed alignment.

Figure 4.22: Roadside vegetation along the proposed alignment

Table 4.11: List of tree species diversity in study area

Scientific Name	Local Name	IUCN Global Status	IUCN National Status
Acacia auriculiformis	Akasmoni	Least Concern	Not Assessed
Albizialebbeck	Sirish	Not Assessed	Not Assessed
Albiziaprocera	SadaKoroi	Not Assessed	Not Assessed
Albiziarichardiana	Chambul	Not Assessed	Not Assessed
Areca catechu	Supari	Not Assessed	Not Assessed
Artocarpusheterophyllus	Kanthal	Not Assessed	Not Assessed
Azadirachtaindica	Neem	Not Assessed	Not Assessed
Boassusflabellifer	Tal	Not Assessed	Not Assessed
Cassia fistula	Sonalu	Not Assessed	Not Assessed
Cocos nucifera	Narikel	Not Assessed	Not Assessed
Corymbiacitriodora	Eucalyptus	Not Assessed	Not Assessed
Dalbergiasissoo	Sisoo	Not Assessed	Not Assessed
Delonixregia	Krisnachura	Least Concern	Not Assessed
Erythrinaindica	Mandar	Not Assessed	Not Assessed
Eucalyptus sp	Eucalyptus	Not Assessed	Not Assessed
Gmelinaarborea	Gamari	Not Assessed	Not Assessed
Lenneacoromandelica	Jiga	Not Assessed	Not Assessed
Leucaenaleucocephala	Ipil	Not Assessed	Not Assessed
Mangiferaindica	Aam	Not Assessed	Not Assessed
Mimusopselengi	Bakul	Not Assessed	Not Assessed
Musa paradisiaca	Kola	Not Assessed	Not Assessed
Phoenix sylvestris	Khejur	Not Assessed	Not Assessed
Plumeriarubra	Khatgolap	Not Assessed	Not Assessed
Psitiumguajava	Peyara	Not Assessed	Not Assessed
Rubusargutus	Kalo Jam	Not Assessed	Not Assessed
Samaneasaman	Raintree	Not Assessed	Not Assessed
Samaneasaman	Raintree	Not Assessed	Not Assessed
Swieteniamahagoni	Mahogoni	Not Assessed	Not Assessed
Tamarindusindica	Tetul	Not Assessed	Not Assessed
Tectonagrandis	Segun	Not Assessed	Not Assessed
Trewianudiflora	Pitali	Not Assessed	Not Assessed
Ziziphusmauritiana	Kul	Not Assessed	Not Assessed

Roadside fauna

73. Fauna seen along the road side is Golden Jackal, Grater bandicoot rat and Small Indian mongoose. Birds species seen by the roadside trees are Black Drongo, Common Myna, Asian Pied Starling, Spotted Dove, Red-vented Bulbul, House Sparrow, Brahminy Kite, Long tailed shrike, House crow, Oriental Magpie Robin, etc. Common garden lizard, common Toad, and

Cricket frog are found along the roadside areas. No IUCN listed and rare fauna specieshas been found in the project area.

Wetland Ecosystem

Wetland flora

74. The proposed alignment is close to a few wetlands (**Figure 4.23**) along the Basthuhara and Khulna to Mongla highway. Plant species seen during the field visits are Water lily, Water hyacinth, *Polygonum barbatum, Trewia nudiflora, Barringronia acutangula, Crataeva nurvala, Polygonum lanatum,Sagittaria sagittifolia, Commelina benghalensis,* and*Rumex dentate,* etc. Water lettuce (*Pistia strateotes*) is found in most of the ditches as well as ponds mixed with hyacinth.

Figure 4.23: Wetlands along in the project area

Wetland Fauna

75. Water birds are an important component of most wetland ecosystems, but no notable water bird was seen during the field survey. Wetland bird species seen and heard are Lesser Whistling Duck, Little cormorant, Indian pond heron, Bronzed winged Jacana, Common Kingfisher, White breasted Water Hen, etc. Bullfrogs (*Hoplobactruchus tigerinus*), Skipper Frog (*Euphlyctis cyanophylctis*) were seen in water bodies. No threatened fauna species has been found in the study area.

4.3 Socio-economic Condition

4.3.1 Introduction

76. The socio-economic condition in the study area[14] is presented in this section. Primary data was collected using Rapid Rural Appraisal (RRA), Key Informant Interview (KII), observation and informal consultations. Alongside, relevant secondary information including

[14] Study area refers to the area that may be affected directly or indirectly by the project intervention. And project area means where proposed intervention will be implemented.

demographic profile, occupation and livelihood, standard of living, standard of education were compiled from the community series of the Population and Housing Census 2011 published by the Bangladesh Bureau of Statistics (BBS) in 2012.

4.3.2 Demographic Profile

77. **Area and Location.** Administratively the study area is under Khulna City Corporation except a portion of Gutudia union under Dumuria Upazila. Most of the wards (smallest administrative unit of City Corporation) are under Khalishpur Thana. Most of the study area covers Wards no. 7, 8, 9, 10, 12, 13 and 15 under Khalishpur Thana.

78. **Population.** The 3,771 households in the study area has a total population of 15,442 of which 8,114 (53%) is male and 7,324 (47%) is female. The female population is less in number than male population (**Table 4.12**). The male-female ratio is 115 which means there are 115 males per 100 females. This figure is higher than the national figure of 100.3 (BBS, 2012).

Table 4.12: Demographic data of the study area

Households	Population			Sex ratio
	Total	Male	Female	
3,771	15,442	8,114	7,324	115
	100 (%)	53 (%)	47 (%)	

Source: Population Census 2011, BBS, 2012

79. **Household size.** The average household size is 4.1 while the national average is 4.4 (BBS, 2012).

80. **Age structure.** The highest number of population (about 28 %) belongs to age group of 30 to 49 years while the lowest number (about 2%) belongs to 60 to 64 years age group. Age groups of 0-14 years is defined as children (28%), 15-24 years as early working age (21%), 25-59 years as prime working age (45%), above 60 and over as elderly people (6%). This classification is important as the size of young population (under age 15) would need more investment in education and health, while size of older populations (ages 65 and over) would need for more investment in the health sector. The workforce in the study area is 68% (people between the age 15 to 64 considered as working force according to ILO standard)

81. **Population migration.** Migration is common phenomena found in the study area. Permanent migration is negligible in both type of migration (In/Out migration). However, seasonal labor migration is also noticed. During the rainy season, they remain without work where the migrate temporarily to the other districts for livelihood. They mainly go to Dhaka, Sylhet and Mymensingh where they work as laborer, rickshaw puller, small scale businessman, etc.

Table 4.13: Migration status in the study area

	Labor Migration-Out		Labor Migration-In	
Type of Migration	Place of destination	% of total population	Place of origin	% of total population

Seasonal labour migration	Dhaka, Chittagong,	8%	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	15%
Permanent household migration	Dhaka, Chittagong,	2%	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	1%

Source: CEGIS fieldwork, 2016

4.3.3 Settlement and Housing

82. **Housing Condition.** Overall housing condition is moderate. The BBS (2011) data shows that on average 35% households are pucca, 27% households are kutcha, and 37% are semi pucca whereas the Jhupri house (1%) is very negligible.

4.3.4 Economy and Employment

126. **Employment status.** About 40.7% is employed in different sectors. About 33.5% of people are engaged in household work while about 25.3% of total population is not working.

127. **Occupational pattern.** Main occupation of total population is service (59%) in which 43% is male and 16% is female; about 17% people are engaged in agriculture while 24% of total population are engaged in industrial work.

83. **Labor availability and wage rate.** The wage rate varies between 400tk. to 500 tk/day (Table 4.14). A few migrant laborers stay in the study area almost all year round and return to their homes at the end of the year with all their income. Women participation in agricultural sector is negligible.

Table 4.14: Labor availability and wage rate in the study area

Type		Male			Female		
		Labor Availability	Average Wage tk/day		Labor Availability	Average Wage tk/day	
			Max.	Min.		Max.	Min.
Farming	Skilled	High	400	300	Nil	-	-
	Non-Skilled	High	350	300	Low	300	250
Non-Farming	Skilled	Medium	500	400	Low	400	300
	Non-Skilled	High	350	300	Medium	250	200

Source: CEGIS fieldwork, 2016

4.3.5 Utilities

84. **Drinking water facility.** According to the BBS 2012**,** collection of drinking water from tube well is predominant (92.6%) throughout the study area. About 7.2% households are dependent on tap water whereas only 0.2% household depends on other sources (pond, river and canal)

85. **Sanitation facility.** Until now, data show that about 15% of total population are using non-sanitary toilet. About 85% households have sanitary toilet facilities of which 43% are water-sealed and 42% are non-water-sealed. About 1% people are not using sanitary facility.

86. **Electricity.** About 93%of the households in the study area use electricity.

4.3.6 Community health and safety

87. **Community health.** Local people in the study area reported that the most prevalent diseases in the study area are diarrhea, typhoid, pneumonia, jaundice, skin diseases, etc. Children are mostly affected by water-borne diseases. Instant health facility is inadequate in nearby areas except the City corporation area. Hyper tension/high blood pressure is also increasing among the people. Disability is also found in the study area. Total disability is about 1.5%.

88. **Health services.** There is a 250-bed capacity health complex at Boyra. Patients from different districts go to Boyra for better medical treatment. There are number of private clinics in Khulna city where people can get better medical treatment.

89. **Availability of health services and facilities.** About 48% of patients go to trained physician as people have easy access to the trained physician in Khulna city. About 25% people in the study area go to paramedic doctor and about 22% patients go to quack doctors. Local people are nowadays much more aware about their health. They have eagerness to receive health treatment from trained physicians but all of them are not able to do that due to inadequate financial capability and availability of health facility.

90. **Literacy rate.** Literacy rate in the area is 71% where male accounts for 74% and female 68%

91. **Vulnerability to natural disaster.** Khulna is situated in the natural disaster-prone area. Local people opined that waterlogging, salinity intrusion, cyclone, surge, river erosion are the main natural disasters in the study area. These occur almost every year in this area.

92. **Safety nets.** Major social safety nets and poverty reduction programs in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social security among the targeted poor households and vulnerable communities. A number of local, national and international NGOs are working in the study area. The main activities of these NGOs are operating microcredit programs among the rural poor and landless women/men.

5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

93. Important Environmental Components (IECs) that are likely to be impacted by Component 2 have been selected based on the rationale presented against each IEC and these are discussed in the following sections.

5.1.1 Selection of IECs and their Rationale

Table 5.1: IEC on physical environment

IECs	Rationale for selection
Noise Level	The noise level in the study area at present is a little higher (just below the limits) compared to the limits given in ECR 1997 and Noise Pollution Control Rules 2006. It is presumed that the noise level during the construction phase will increase further due to the use of construction equipment, vehicle movement, construction works and other activities during construction phase. Thus, may cause inconvenience to local residents adjacent to the pipeline route. Thus, noise is considered an IEC.
Air Quality	During construction phase, the potential for air quality being affected is limited to vehicular emissions and dust during earth-moving works. During operation, pipeline leaks and fugitive gas emissions may occur which can cause fire or explosion depending on the concentration of natural gas in air and may pose safety risks.
Traffic Congestion	The pipeline will be laid at one side of the road which is within 2.5m from the toe of the road. There are some places, where the homestead is just adjacent to the RoW. The earth excavated for laying pipe if dumped beside the road due to homestead on the other side may reduce the width of the road. This may hamper vehicular movement and mobility of local residents.
Drainage	The natural drainage system might be disrupted during the installation of gas distribution line, dumping of earthen materials adjacent to the RoW of trench.

Table 5.2: IEC on land and agricultural resources

IECs	Rationale for selection
Soil quality	During construction, soil along the pipeline route will be disturbed due to excavation for trenching, pipe-laying, and backfilling. These activities may affect soil quality.

Table 5.3: IECs on fisheries resources

IECs	Rationale for selection
Fish Habitat	The pipeline route will mainly pass through along the road, gher, and across a canal and the small Mayur River. Construction works may cause temporary loss of fish habitat. These activities may also deteriorate water quality of gher, canal and Mayur River. Thus, fish habitat has been considered an IEC.
Fish Production	Temporary loss of fish habitat due to construction activities may affect fish production.

Table 5.4: IECs on ecological resources

IECs	Rational for selection
Terrestrial vegetation	Implementation of Component 2 may cause damage and clearing of vegetation particularly along the roadside. Vegetation clearing may affect habitat quality

Table 5.5: IECs on socioeconomic components

IECs	Rationale
Traffic and mobility	Component 2 will affect five road crossings and three railway crossings. During construction phase all these roads will be disrupted temporarily which may affect traffic and mobility of people.
Temporary loss for small-scale business	No land acquisition is required but some temporary structures have been identified on the RoW. These structures sell goods like food, vegetables, etc.
Employment opportunities	Temporary employment opportunities may be created. During construction, employment opportunities for both skilled and unskilled labor may increase. Aside from creation of employment opportunities, there will be opportunities also for small-scale business to sell food to the workers or rental housing to workers.
Accident risks	Movement of construction vehicles, machineries and heavy equipment like excavators may pose safety risks to workers and the public.

5.2 Impact Assessment

94. Assessment of potential impacts were based on activities that will be involved in the implementation of Component 2, the existing environment, environmental sampling, and consultations.

5.2.1 Impact Screening

95. As part of the process, a screening matrix was used focusing on the potential environmental impacts during the design, construction and operation phases. The matrix examined the interaction of project activities with various important components of the environment. The potential impacts thus predicted were characterized as follows:

- Highly negative (adverse) impact;
- Moderately negative impact;
- Insignificant impact;
- Highly positive (beneficial) impact;
- Moderately positive impact

96. The environmental screening matrix is provided in **Table 5.6.** The negative impacts predicted in this manner are the ‘unmitigated’ impacts before any measures been taken. Appropriate mitigation measures have been recommended as part of this EIA, thus reducing the possibility and severity of the potentialadverse impacts. The potential adverse impacts identified through this process are discussed in all the subsequent sections. The impact matrix is given in **Table 5.8.**

Table 5.6: Environmental Screening Matrix

Project Phase and Activities		Physical & Water Resources				Land & Agriculture	Fisheries		Ecology	Social and Socioeconomic			
		Noise Level	Air Quality	Traffic Congestion	Drainage	Soil quality	Fish habitat	Fish production	Terrestrial vegetation	Traffic and mobility	Temporary loss of small-scale business	Employment opportunities	Accident risks
Pre-construction phase													
Route Survey		-	-	-	-	-	-	-	-	-	-	-	-
Finalize alignment		-	-	-	-	-	-	-	-	-	-	-	-
Land acquisition and requisition		-	-	-	-	-	-	-	-	-	√	√	-
Site Clearance		-	-	-	-	-	-	-	-	-	-	-	-
Display Bilboard		-	-	-	-	-	-	-	-	-	-	-	-
Construction phase													
Equipment and Vehicle Movement		√	√	√	-	-	-	-	√	√	√	√	-
Removal of vegetation		-	-	-	-	-	-	-	√	-	-	√	-
Excavation		-	-	√	√	-	√	√	√	√	√	√	-
Stringing		-	-	-	-	√	-	-	-	-	-	√	-
Welding of Pipes		√	-	-	-	-	-	-	-	-	-	√	-
Coating and wrapping		-	-	-	-	-	-	-	-	√		√	
Laying of Pipes	a. Besides Roadway	-	-	-		-	-	-	-				
	b. Road, Rail and River Crossing	-	-	√	√		√	-	-	√	-	√	√
Backfilling		-	-	-	-	√	√	-	-	-	-	-	-
Cleaning		-	-	-	-	√	√	-	-	-	-	-	-
Pressure Testing		-	-	-	-	-	-	-	-	-	-	-	
Commissioning		-	-	-	-	-	-	-	-	-	-	-	
Operation phase													
Regulating and Metering Station Operation		√	√	-	-	-	-	-	-				√
Key: (√) – having impact; (-) – no significant impact													

5.2.2 Impacts during pre-construction phase

97. Site development involves the following activities:

- Route survey and finalizing the alignment
- Land acquisition and requisition
- Obtaining site clearance from DoE
- Display of billboards to provide information about the project

5.2.2.1 Socio-economic Condition

Impacts

98. There is no need for land acquisition and requisition as the land affected by Component 2 is owned by GoB. During the field visits, 48 structures are along the pipeline route that will require relocation before the start of construction.

Mitigation

99. Affected persons will be given assistance for relocation of the temporary structures. Affected persons will be given at least one month before construction. Compensation and assistance will follow the requirements of GoB and ADB.

Residual Impacts

100. Level of impact significance will be moderate given the mitigation above.

5.2.3 Impacts during construction phase

101. Component 2 will involve the following tasks during construction phase:

- Equipment and vehicle movement
- Removal of vegetation (Plants, Trees)
- Trench excavation
- Stringing and welding of pipes, coating, and wrapping
- Laying of Pipes
- Backfilling
- Cleaning
- Pressure Testing
- Commissioning

102. Given that excavation will be involved within the 12 km of gas pipeline, **Annex 3** presents the procedures to be followed in the event of a “chance find” physical cultural resources during construction phase.

5.2.3.1 Ambient Noise Level

Impacts

103. The main sources of noise generation are trenching, laying of pipe, grading, stringing, coating, vehicle movement, etc. HDD along Mayur River and the five road crossings, and three rail crossings will also contribute to the increase in ambient noise level. This impact may cause inconvenience and annoyance to residents living close to the

pipeline route. The significance of this impact is considered moderate based on magnitude and receptor sensitivity.

Mitigation

104. Noise-generating construction activities will be limited to daytime only and will be stopped during the school hours (if close to a school), madrasa, prayer time at mosque. Equipment that generate high noise will be enclosed. Ear protection devices (muffs) will be provided to workers assigned to noise generating equipment, machineries, and activities. Orientation, labor training and awareness building programs will be undertaken at the construction sites. Unnecessary use of equipment and device that generate noise like whistle, bells, megaphone, etc., will be avoided. RMS and valves will be fenced and trees will be planted as safe distance to provide buffer.

Residual Impact

105. With mitigation, the level of significance of the impact is considered to be low.

5.2.3.2 Ambient Air Quality

Impact

106. Dust generation from excavated soil, vehicle movement, trenching works, boring of road and railway might impact ambient air quality. The significance of this impact is considered moderate based on magnitude and sensitivity.

Mitigation

107. Trucks/vehicles that deliver dust-generating materials to the construction site will be covered. Protective enclosures will be installed during welding operations and laying of pipe following the Bangladesh Natural Gas Safety Rules 1991. Water will be sprayed regularly in opened areas where dust is generated. Opened land areas and excavated soil dump will be covered during off working hours. Solid wastes generated by workers will be collected daily and transferred to designated bins provided by the EPC Contractor. Excavated earth will be backfilled and excess soil will be avoided.

Residual Impact

108. Once the potential increase in dust level is mitigated, the level of impact will be low.

5.2.3.3 Potential increase in vehicular traffic

Impact

109. Mobilization of equipment and machinery, construction material and manpower to the project area will result in additional traffic on roads. Also, construction works and site preparation may cause traffic congestion. Daily activities of local residents may be affected due to equipment and machinery movement. Mostly it will create problem in the roads and rail crossing points.

Mitigation

- Construction Management Plan, which will include traffic management, will be prepared by the EPC Contractor and approved by PMU.
- Mobilization activities will avoid peak hours during the day
- HDD will be used at crossings to minimize disturbance to local people

- Staff will be assigned to enforce traffic regulations and facilitate movement and avoid accidents.
- Clear and visible traffic signs will be posted to help in people and vehicle movement.
- Temporary pedestrian crossings will be provided (as needed) accommodating children, women, elderly, and persons with disability.
- Awareness program will be conducted to ensure the safety of local people.

Residual Impacts

110. With mitigation, the significance of the impact will be low.

5.2.3.4 Drainage System

Impact

- There will be a total of five road crossings along the pipeline route. Drainage may be obstructed during construction if the trench excavated soil is dumped beside the RoW or road easement and back-filling is not conducted properly.
- The significance of this potential unmitigated impact is considered low based on magnitude and receptor sensitivity.

Mitigation

- To the extent possible, installation of the gas distribution pipeline will be undertaken during the dry season.
- Backfilling of the trenches after pipe laying will be conducted right after and properly following the industry standards.
- Installation at river crossings along Mayur River will be done through HDD process to minimize environmental impacts. Re-vegetation or stabilization of the river banks will be done as soon as it is appropriate to do so.

Residual Impact

111. With the mitigation above, the level of significance of the impact will be negligible.

5.2.3.5 Soil quality deterioration

Impact

- During the installation of Component 2, soil in the RoW and road easement will be dug at a depth of about 1.5 m and a width of 2 m. After the pipe-laying, the trench will be backfilled with the same amount of soil excavated. During excavation, the topsoil and sub-soil may be disturbed and likely displaced. Waste generated may degrade the surrounding soils.
- Level of significance of this impact based on magnitude and receptor sensitivity is considered moderate.

Mitigation

- Excavated soil will be properly stacked for backfilling and covered during off-work hours.
- Loosened soil will be compacted to minimize wind erosion and dust generation.

- Waste generated will be properly collected and disposed of to minimize potential contamination of soil quality.

Residual Impacts

112. Implementing the mitigation measures, the level of impact significance will be very low.

5.2.3.6 Fish Habitat

Impact

113. Construction activities may potentially affect the *gher*along Toiyab Nagar KDA road to Khulna City link road. It was noted from the field visit that there are about 15 *ghers* (both *golda* and gold with white fish *gher*) that may be potentially affected temporarily. The estimated *gher* area that may be affected will be about 0.5 acre. Two locations along the Mayur River will be crossed by the pipeline route. Construction activities along these river points may affect the fish habitat on short duration and temporary. The surface water quality in Mayur River is not suitable for fish production due to water pollution for discharged wastewater from Khulna City. Trenching and backfilling in two river crossings may further affect the quality of Mayur River particularly turbidity and color. HDD will be used at two river crossings to minimize potential environmental impacts. Level of significance is considered low based on magnitude and receptor sensitivity.

Mitigation

114. Temporary bamboo fencing between the trench and *gher* area will be done to avoid disturbance of fish culture. Construction activities will be scheduled during the dry season (i.e., November to April) whenever possible as Golda is not cultured during this period.

Compensation

115. *Gher* owner will be compensated for any damage that will be incurred during construction.

Residual Impacts

116. With proper compensation, the level of significance of this impact will be negligible.

5.2.3.7 Fish production

Impact

- The construction of the 10km gas pipeline from Khulna CGS in Arongghata to Rupsha 800 MW CCPP in Khalispur may potentially cause reduction of fish production temporarily. The estimated loss from gher fisheries production is about 147 kg of total impacted *gher* area.
- The significance of this potential impact before mitigation is considered low based on magnitude and receptor sensitivity.

Mitigation

117. Construction of temporary bamboo fencing between trench and *gher* area to avoid disturbance of fish culture within the *gher.*

Compensation

118. Gher owner will be compensated and cost estimates are included in the Resettlement Plan.

Residual Impacts

119. Given that the impact is temporary, with proper compensation, the significance of the impact will be negligible.

5.2.3.8 Loss of terrestrial vegetation

Impacts

120. The pipeline route is generally following the existing road easement. Roadside lands are fallow and covered by seasonal undergrowth vegetation and planted tree species. Site preparation for workers' shed and material stockyad may cause damage to roadside vegetation. A total of 326 trees will be cut along the 10 km pipeline and 44 trees for the 2 km off-take pipeline (see **Table 5.7**).

Table 5.7: Details on trees affected

Name of trees	Type	Size of tree				Total
		Big	Medium	Small	Sapling	
10 km alignment						
Khejur	Fruit	5	2	12		**19**
Tal	Fruit			12		**12**
Mehgoni	Timber		8	43		**51**
Akashmoni	Timber			17	120	**137**
Babla	Timber			37		**37**
Bot	Timber		1			**1**
Raintree	Timber	1	6	1		**8**
Mahogoni	Timber	20	9	32		**61**
2km off-take gas line alignment						
Ata	Fruit			1		**1**
Bakul	Ornamental			2		**2**
Eucalyptus	Timber		1			**1**
Khatgolap	Ornamental		1			**1**
Krisnachura	Ornamental			4	2	**6**
Kul	Fruit			2		**2**
Mahogoni	Timber		6	5		**11**
Narikel	Fruit		2	1		**3**
Neem	Medicinal		1			**1**
Raintree	Timber		8	2		**10**
Sajna	Fruit		4			**4**
Sisoo	Timber			2		**2**
Total		**26**	**49**	**173**	**122**	**370**

Source: Census & IOL survey, CEGIS, 2017

121. Significance of this impact is considered moderate based on magnitude and receptor sensitivity.

Mitigation:

- Inform and coordinate with proper authorities like Department of Forest (DoF)about the need to cut about 370 trees due to the implementation of Component 2.
- Proper compensation to tree owners especially fruit trees will be provided.
- Tree plantation in areas identified by DoF or other relevant government agencies will be undertaken to offset the cut of trees.
- Choose areas that are not productive when selecting sites for labour shed and materials stockyard to minimize impacts on vegetation.
- Should fuel wood be needed by workers, this will be purchased in the local market. Unauthorized cutting of roadside trees for fuel will be prohibited.

Residual Impacts

122. With mitigation above, the level of significance of the impact will be low.

5.2.3.9 Employment opportunities

Impact

123. Temporary employment opportunities will be created with the implementation of Component 2 during construction phase. There is adequate availability of local labour. Aside from employment opportunities, they may be potential for small-scale business opportunities by selling food to construction workers and rental housing.

Enhancement

- Provide employment for local community wherever possible.
- Local skilled labor will be given preference and local unskilled labor will be given priority for construction works
- EPC Contractor to target at least 30% local labor recruitment

5.3.4 Impacts during operation phase

5.3.4.1 Ambient air quality may be affected during maintenance

Impact

124. During maintenance and cleaning of the pipeline system, pigging will be undertaken. During pigging, some residual natural gas may be emitted. Also, as the pipeline system ages, fugitive natural gas emissions may occur. This occurrence will be temporary as continuous fugitive emissions would be safety risks. The significance of this potential unmitigated impact is considered moderate based on magnitude and receptor sensitivity.

Mitigation

- Pigging will be done by skilled workers and experienced staff to ensure that the procedure is done properly and safely.
- SCADA will monitor the operation of the gas distribution line 24 hours every day. An automatic valve shut off is included in the safety design. An odorant (normally “mercaptan” also used in liquefied petroleum gas) will be used to detect leaks.

- Distance between the valve stations will strictly follow the requirements of the Bangladesh Natural Gas Safety Rules 1991 and other international standards.

Residual Impacts

125. With proper safety measures, the significance level of the impact will be low.

5.3.4.2 Ambient noise level may increase during maintenance

Impact

- Valve stations and RMS may generate noise due to gas pressure. Local residents sensitive to ambient noise level may find the noise generated annoying and inconvenient. During pigging operation, ambient noise level may increase but this will be temporary and short duration.
- The significance of this potential unmitigated impact is considered as moderate based on magnitude and receptor sensitivity.

Mitigation

- Outer boundary of appropriate height will be installed in the valve station and RMS to contain the noise generated.
- Re-vegetation will be undertaken around the outer boundary to act as sound barrier.

Residual Impacts:

126. With mitigation, the level of significance will be low.

5.3.4.3 Occupational and public safety risks

Impact

127. Presence of the gas distribution pipeline system following the existing road easement may pose occupational and public safety risks. Identified risks are fire and explosion due to gas leaks along the pipeline.

Mitigation

- Pipeline will be designed and constructed following the Bangladesh Natural Gas Safety Rules 1991, ASTM, ASME and other international standards
- SCADA will monitor the pipeline operations 24 hours every day to detect any leaks. The pipeline system will be designed to have automatically valve shut off in case of leak.
- Clear and visible signs and danger warnings will be provided along the pipeline route.
- Appropriate and standard markers for gas distribution system will be installed.
- Contingency fund will be provided to address accidental issues.
- Periodic orientation on safety living near gas distribution pipeline system and emergency preparedness will be conducted by NWPGCL to neighboring residents.
- NWPGCL will have the necessary equipment, transport, and procedures in the unfortunate event of fire or explosion. Staff involved in the operation of the pipeline will have regular training.

Residual Impacts

128. With the above mitigation measures, residual impact will be moderate to low.

5.4 Hazard Identification and Risk Assessment

5.4.1 Introduction

129. Hazard is considered as those that can cause harm or has the potential to cause harm; whereas, risk is the likelihood of hazard being occurred and its severity. Thus a risk assessment is conducted, to carefully examine the potential hazards, how they occur and the measures to prevent such hazards. Mismanagement of one particular hazard can have consequences that simultaneously impact to a varying degree on several risk types.

130. A detailed assessment has been carried out as required by ECA 1995 and ECR 1997 of the DoE. This assessment identifies the potential hazards associated with natural gas distribution pipeline as in Component 2 so that these hazards can be avoided by incorporating safety plans in both planning and design process.

5.4.2 Hazard assessment process

131. The steps followed in this hazard and risk assessment are as follows:

- Identification of Hazards
- Cause Analysis
- Assessment of Frequency and Likelihood
- Risk Ranking, Recommended Actions and Safety Measures

The potential hazard points were identified to determine the causes and consequences (see **Table 5.8**).

Table 5.8 Potential hazard points identified for Component 2

Hazard classification	Hazard points
Mechanical	Clearing of standing installations in RoW, operation of laying equipment, welding equipment, etc.
	Valve and other pipeline components
	Construction sites
Fire and explosion	Gas pipeline (Stringing)
	Welding area
	Valve stations
	Pump stations
Methane gas leakage	Gas pipeline
	Valve stations
	Delivery stations
Failure mode hazard	Valve stations
	Gas pipeline
	Injection station/delivery station
	Final delivery station
Radiation Hazard	X-ray machine
Vehicular hazards	Motor vehicle and lorries, movement of vehicles

5.4.3 Identification of Hazards and Cause Analysis

132. Potential hazards are identified based on the different stages of the project phases, various location and project activities. Cause analysis is also conducted for potential hazards for each of the project activities. The potential hazards and risk during construction and operation stages are listed in**Table 5.9.**

Table 5.9: Hazard and Risk Assessment of Component 2

Location of hazard	Project Activities	Potential hazard	Cause Analysis	Consequences
Construction and Erection Stage				
Machineries, line pipe and other pipeline laying equipment.	• Bringing in machines and equipment for site clearance activities • Mobilizing line pipes, valves and other construction materials along the right of way	• Trips and falls • Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	• Health injury • Disability • Life loss
Construction site	Land excavation	• Inhalation of dust • Sickness • Accident (e.g. falling of machineries, equipment and debris) • Cuts and bruises • Trips and falls	• Fatigue or prior sickness • Drinking from unsafe water (e.g. ponds, arsenic prone tube wells etc.) • Mechanical failure (e.g. equipment failure etc.) • Lack of safety training • Not abiding to general health and safety rules	• Physical injury • Disability • Life loss
	Backfilling of the trench	• Accidents • Injuries from falls and slips • Inhalation of dust • Cuts and bruises	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night	• Health injury • Broken bones/Disability
	Occupational hazard	• Cuts, bruises and burns • Falls, slips and trips • Confined space hazard • Health injuries • Sickness and illness • Electrocution	• Lack of safety awareness • Carelessness in maintaining safety protocols • Use of faulty machineries and equipment • Improper hygiene • Not wearing appropriate PPEs • Prior sickness or illness • Heavy workload	• Health injuries (burns, anxiety, depression etc.) • Disabilities • Fatalities
Gas pipelines (Stringing)	Welding of pipelines	• Burn damage • Spread of fire • Electrocution	• Lack of safety training whilst handling the equipment • Carelessness in handling welding	• Injuries • Fire burns • Disability

Location of hazard	Project Activities	Potential hazard	Cause Analysis	Consequences
			machines • Negligent towards the use of safety equipment (e.g. safety mask, gloves etc.) • Selection of unskilled worker for welding works • Not abiding to general health and safety rules	
	• X-ray scanning of pipelines	• Exposure to radiation	• Lack of safety training whilst handling the equipment • Carelessness in handling the X-ray machine • Negligent towards the use of proper safety equipment • Not abiding to general health and safety rules	• Long term exposure leading to cancer, skin diseases and birth defects (in case of pregnant workers)
	• Cleaning of pipelines with pressurized water	• Injuries from pressurized water • Exposure to dirt and other muddy water	• Lack of communication • Carelessness in dealing with pressurized water	• Health injury • Broken bones/Disability
	• Marking of the pipeline route after the pipes are put in its place	• Falls and trips • Personal security (e.g. hijack, theft, kidnapping etc.)	• Traversing through a remote area alone • Traversing through a remote area at night alone	• Possible fatal Injuries • Loss of belongings • Mental trauma • Possible death
Motor vehicle and lorries	• Transportation of machineries • construction activities	• Noise generation • Accident	• Noise generated from running engine, hydraulic horns and construction activities • Mechanical failure of machines/ lorries/other equipment	• Health injury (e.g. hearing loss, accidents etc.) • Disability • Fatality
Gas pipelines and safety valves	• Installation of gas pipelines (laying) and safety valves	• Injury from falling pipes and debris	• Faulty safety harness of lorries, cranes and pulleys • Mechanical failures • Lack of proper safety training • Not abiding to HSE rules	• Disability • Life loss
Operation Stage				
• Gas pipelines • Valve station • Pump station	• Gas leakage • Thermal hazard • Environmental hazard • Mechanical hazard	• Asphyxiation • Explosion • Fire ball	• Faulty pipes • Faulty connections • Corrosion • Induced stress • Sabotage	• Life loss • Damage to nearby buildings, houses and properties • Damage to the environment and

Location of hazard	Project Activities	Potential hazard	Cause Analysis	Consequences
				ecosystem
	• Occupational activities • Repair and Maintenance	• Occupational exposure to gas leaks and explosions • Confined space hazard • Electrocution	• Lack of Health and Safety Training • Not abiding to HSE rules • Not wearing appropriate PPEs • Faulty pipes • Faulty safety harness and masks • Faulty connections • Corrosion • Induced stress • Sabotage	• Physical injury • Loss of consciousness • Life loss • Damage to nearby buildings, houses and properties • Damage to the environment and ecosystem

5.4.4 Assessment of Frequency and Likelihood

Hazard Consequence & Frequency Scales

133. The potential impacts of the project have been scaled and prioritized based on the magnitude of those potential impacts (consequence) and the likelihood of them occurring (frequency). The consequence of the said impacts are classified and illustrated in **Table 5.10**.

Table 5.10: Hazard Consequence Scale

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Duration of potential impact	Temporary with no detectable potential impact	Limited to construction period	Medium Term (1 to 2 years)	Long term (more than 2 years)	Permanent Damage
Spatial extent of the potential impact	Specific location within project component or site boundaries with no detectable potential impact	Within project boundary	Beyond immediate project components, site boundaries or local area	Widespread far beyond project boundaries with some community and wildlife habitat coverage	Beyond project boundaries extending to widespread communities and wildlife habitat
Reversibility of potential impacts	Baseline remains almost constant	Baseline returns naturally or with limited intervention and within a few months	Potential impact requires a year or so for recovering with some interventions to return to baseline	Potential impact is long-term, requiring considerable intervention to return to baseline	Potential impact is effectively permanent, with little to no chance of returning to baseline
Compliance to Legal Standards before Mitigation Measures	Complies with all minimum requirements only some improvement opportunities to strengthen good practices	Meets minimum national standard limits or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Complies partially with limits given in national standards but breaches international lender guidelines	Completely breaches national standards and or international guidelines/ obligations
Extent of health injuries	Minor pain, scratch, discomfort requiring no medical attention	Health injuries can be cured with first aid and/or some medical attention	Health injury requires hospitalization; may require long term recuperation; may lead to long term absence from work	Health injury may lead to permanent disability; few fatalities of workers and or community people	Fatalities of workers more than 5 and or community people more than 2
Impact on wildlife	Minimal disturbance within	Disturbing habitat of wildlife	Disturbing habitat of wildlife causing	Impact leading to deaths of any	Impact may lead to deaths of 2 or more

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
	compliance	causing discomfort	decrease of preys and forcing them to relocate	endangered species and decrease of their food source	endangered marine mammals and-or 5 of other endangered species

134. The criteria for determining the frequency of the potential hazardbeing occurred are outlined in **Table 5.11**.

Table 5.11: Criteria for determining frequency of the potential hazard

Frequency Scale Determination	Definition
1 (Rare)	Rare chance of occurrence, if not at all
2 (Low)	Very minimal chance of occurring
3 (Medium)	May occur considering if the conditions are abnormal or exceptional
4 (High)	Occurs more frequently and without any prior warnings
5 (Almost Certain)	Occurs under typical conditions

5.4.5 Developing Risk Matrix

135. Following the consequence and frequencyscales, a risk matrix can be developed after analyzing the potential hazards for the Project. The table below (**Table 5.12**) shows the risk matrix for the potential hazards and how frequently they may occur. In **Table5.13**, the risk evaluation based on the type of activities and potential hazards are shown.

Table 5.12: Risk matrix of potential hazards/impacts

Frequency (F) of Hazards ↓	Hazard Consequence (C) →				
	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Severe)
1 (Rare)	1	2	3	4	5
2 (Low)	2	4	6	8	10
3 (Medium)	3	6	9	12	15
4 (High)	4	8	12	16	20
5 (Almost Certain)	5	10	15	20	25

Color Legend:

Red (10-25)	≡ Top Priority	: Action with follow-up Verification & Validation by Authority needed before allowing work
Orange (10-14)	≡ High Priority	: Action needed under follow-up Supervision before allowing work
Yellow (5-9)	≡ Medium Priority	: Need maintaining with routine monitoring & reporting
Green (1-4)	≡ Low Priority	: Only for awareness; no Intervention Action needed to start work

136. The risk for the potential hazard/impact is evaluated based on the combination of the hazard consequence and their frequency (NHS, 2008). In order to calculate the potential risk, the frequency of impact is multiplied with consequences. E.g. Level 1 of frequency of an hazard (Rare) is multiplied with Level 1 of hazard consequence (insignificant) to give a total score of 1 (1X1=1) and so on. In that regards, a score between 1 to 4 is considered low priority; a score between 5 to 9 is considered mediumpriority and; a score between 10 to 14 is considered high priority and; a score between 15 to 25 is considered top priority.

5.4.6 Risk Ranking, Recommended Actions and Safety Measures

137. Based on the hazard consequence and frequency scales in **Table 5.10** and **Table 5.11** potential risk of a particular hazard/impact is estimated and given a score. The score is given in terms of the presence and absence of safeguards. The final evaluation of the potential risks is determined based on combined score of hazard consequence and its frequency. The following table (**Table 5.13**) shows the risk evaluation (risk ranking) of the project activities and its subsequent hazards (both before and after implementing safety measures).

Table 5.13: Risk evaluation for construction and operation of Component 2

Hazard points	Project Activities	Potential hazard	Cause Analysis	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Construction Stage										
Machineries, line pipe and other pipeline laying equipment.	• Bringing in machines and equipment for site clearance activities • Mobilizing line pipes, valves and other construction materials along the right of way	• Trips and falls • Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	3	2	**6**	• Arranging toolbox meeting before going out for work • Regular inspection and maintenance of equipment • A thorough lorry driver selection process via interviews, checking whether they have the proper licenses and from past experiences • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road after the selection process is complete • Limiting movement of vehicles after sunset and before sunrise • Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs.	2	1	2
Construction site	Land excavation	• Inhalation of dust • Sickness • Accident (e.g. falling of machineries, equipment and debris) • Cuts and bruises • Trips and falls	• Fatigue or prior sickness • Drinking from unsafe water (e.g. ponds, arsenic prone tube wells etc.) • Mechanical failure (e.g. equipment failure etc.) • Lack of safety training • Not abiding to general health and safety rules	3	2	**6**	• Arranging toolbox meeting before going out for work (during each construction activities.). Provide each worker with a safety checklist and safety permit (based on their work) before starting work. • Regular inspection and maintenance of equipment, machineries and especially, safety harness. Maintain a registry for any faulty equipment found; inform site contractors and have them replace those immediately. • No work should be done until the faulty machineries are replaced and tested. • Regular health and safety training and fire-fighting drills to all construction workers, including the proper use of PPEs during work. • Enclosing the area with yellow barricade tape and restricting outside access to local people during the whole construction process. • Spraying water on dust to minimize its spread via wind; put stockpile at a designated place and cover them with GI sheet; put up GI sheet fencing around the construction site. • Maintenance of hygiene at construction site and providing appropriate training to workers in hygiene maintenance • Supplying workers with safe drinking water • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken • Maintenance of an accident registry book	2	2	4
	Backfilling of the trench	• Accidents • Injuries from falls and slips • Inhalation of dust • Cuts and bruises	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated	3	3	**9**	• Putting up appropriate florescent warning signs at construction site. • Enclosing the area with yellow barricade tape and restricting outside access to local people during the whole construction process • Maintenance of a designated area for storing the backfilling	2	2	**4**

Hazard points	Project Activities	Potential hazard	Cause Analysis	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			place for backfilling storage • Not maintaining enough lighting during the night				materials • Ensuring proper lighting during night time • Regular health and safety training to all construction workers, including the proper use of PPEs. • Maintenance of an accident registry book			
	Occupational hazard	• Cuts, bruises and burns • Falls, slips and trips • Confined spaces hazard • Health injuries • Sickness and illness • Electrocution	• Lack of safety awareness • Carelessness in maintaining safety protocols • Use of faulty machineries and equipment • Not wearing appropriate PPEs • Improper hygiene • Prior sickness or illness • Heavy workload	3	3	**9**	• Regular inspection and maintenance of equipments, machineries and vehicles. • Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road. • Maintenance of hygiene at construction site and providing appropriate training to workers in hygiene maintenance • Supplying workers with safe drinking water • Monthly health checkup of workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital. • Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour Rules, 201515. • Employment of child labour (children below the age of 18), pregnant women and elder citizens in hard labour and dangerous activities must be prohibited. • All other facilities (toilet, canteen, overtime hours, leaves etc.) should be followed as stipulated in Labour Rules, 2015 • Equipment, machineries and electric wires should be checked for current and voltage ratings. When using an extension cable, its wire rating should match with the equipment wire rating. • Ensure the proper cathodic protection on pipelines as per standard procedure to prevent rusting • Ensure proper connection of pipelines • Inspect pipelines for cracks and faults. Make prompt repairs if found. • Ensure regular communications with outside when entering underground. • Use proper safety precautions (e.g. PPEs, oxygen masks etc.) when working at confined spaces	2	2	**4**
Gas pipelines (Stringing)	Welding of pipelines	• Burn damage • Spread of fire • Electrocution	• Lack of safety training whilst handling the equipment • Carelessness in handling welding machines	3	3	**9**	• Careful selection of workers who have prior welding experience • Inspection of welding machines and PPEs before starting work; change any faulty machines or PPEs if found. • Equipment, machineries and electric wires should be checked	2	2	**4**

[15] Bangladesh Labour Rules (2015). *Ministry of Labour and Employment*. Retrieved from http://www.dpp.gov.bd/upload_file/gazettes/14079_83432.pdf.

Hazard points	Project Activities	Potential hazard	Cause Analysis	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			• Negligent towards the use of safety equipment (e.g. safety mask, gloves etc.) • Selection of unskilled worker for welding works • Not abiding to general health and safety rules				for current and voltage ratings. When using an extension cable, its wire rating should match with the equipment wire rating. • Proper earthing with machineries should be made. • Maintenance of an accident registry book			
	X-ray scanning of pipelines	Exposure to radiation	• Lack of safety training whilst handling the equipment • Carelessness in handling the X-ray machine • Negligent towards the use of proper safety equipment • Not abiding to general health and safety rules	3	2	**6**	• Prevent intruders from work site to protect them against welding radiation • Protect integrity testers from exposure to X-ray.	2	2	**4**
	Cleaning of pipelines with pressurized water	• Injuries from pressurized water • Exposure to dirt and other muddy water	• Lack of communication • Carelessness in dealing with pressurized water	3	3	**9**	• Maintaining communication as to when to release water flow and when to stop water flow. • Making sure the effluents are released as far away from locality as possible and at a designated site. • Keeping an eye on the pressure gauge when releasing water; maintain pressure as required • Report any structural damage to the pipelines immediately; stop water flow as soon as any structural damage is notified to prevent accidents • Maintain a record of any incidents	2	2	**4**
	Marking of the pipeline route after the pipes are put in its place	• Falls and trips • Personal security (e.g. hijack, theft, kidnapping etc.)	Traversing through a remote area alone	3	3	**9**	• Walking in numbers when traversing through a remote area; seeking the support from local security personnel to accompany them • Travelling during daytime only. • Keeping the phone numbers of the local police office and ambulance at speed dial	2	2	**4**
Motor vehicle and lorries	• Transportation of machineries • construction activities	• Noise generation • Accident	• Noise generated from running engine, hydraulic horns and construction activities • Mechanical failure of machines/ lorries/other equipment	3	2	**6**	• Regular checking, servicing and maintenance of vehicle • Periodic health checkup of lorry drivers and construction workers • Maintaining traffic safety rules • Maintain safe vehicle speed limit at the construction site. Proper traffic guidelines and regulations as per The Motor Vehicle Rules, 1984, should be ensured • Switching off vehicles and machineries when not in use • Using earmuffs to protect against loud noises (e.g. from hydraulic horns); if possible limit the usage of hydraulic horns during construction	2	2	**4**
Gas pipelines and safety valves	Installation of gas pipelines (laying) and safety valves	Injury from falling pipes and debris	• Faulty safety harness of lorries, cranes and pulleys • Mechanical failures	4	2	**8**	• Arranging tool box meeting before going out for work • Regular checking, servicing and maintenance of lorries, cranes and pulleys and their safety harness	2	2	**4**

Hazard points	Project Activities	Potential hazard	Cause Analysis	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			• Lack of proper safety training • Not abiding to HSE rules				• Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs • Putting up appropriate safety signs at construction site • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken • Maintenance of an accident registry book.			
Operation Phase										
• Gas pipelines • Valve station • Pump station	• Gas leakage • Thermal hazard • Environmental hazard • Mechanical hazard	• Asphyxiation • Explosion • Fire ball	• Faulty pipes • Faulty connections • Corrosion • Induced stress • Sabotage	4	3	**12**	• Arranging toolbox meeting before going out for work • Inspection of the pipelines for leakage, corrosion etc. before installation • Making sure the connections are made properly at each junction • Covering the pipes with coatings/cathodic protection for corrosion protection • Proper pipeline weighting to reduce buoyancy • Periodic Inspection of pipelines for corrosion and leakage • Setup of an automated monitoring system to monitor any changes to gas pressure at junctions/Metering stations • Set up awareness programs to aware communities the dangers and hazards associated with gas transmission pipelines and motivating them to take an active part in prevention of any sabotage activities. • Setup an on-site emergency response team to mobilize immediately to an emergency situation. This is to ensure minimum casualties.	2	2	**4**
	• Occupational activities • Repair and Maintenance	• Occupational exposure to gas leaks and explosions • Confined spaces • Electrocution	• Lack of Health and Safety Training • Not abiding to HSE rules • Not wearing appropriate PPEs • Faulty pipes • Faulty safety harness and masks • Faulty connections • Corrosion • Induced stress • Sabotage	4	3	**12**	• Regular inspection and maintenance of equipments, machineries and vehicles. • Raising awareness on occupational hazards and electric hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road. • In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital. • Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour Rules, 2015. • All other facilities (toilet, canteen, overtime hours, leaves etc.) should be followed as stipulated in Labour Rules, 2015 • Equipments, machineries and electric wires should be checked for current and voltage ratings. When using an extension cable, its wire rating should match with the equipment wire rating. • Ensure the proper cathodic protection on pipelines as per standard procedure to prevent rusting	2	2	**4**

Hazard points	Project Activities	Potential hazard	Cause Analysis	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							• Ensure proper connection of pipelines • Inspect pipelines for cracks and faults. Make prompt repairs if found. • Ensure regular communications with outside when entering underground. • Use proper safety precautions (e.g. PPEs, oxygen masks etc.) when working at confined spaces • Switch off power before doing any electrical maintenance work. Inform supervisor and respected machine operator before starting any electrical work. Inform them again after the electrical works are done.			

5.4.7 Emergency Response Plan

138. Emergency Response Plans are developed to address a range of plausible hazard scenarios that are unplanned and to emphasize the tasks required to respond to a physical event. The Emergency Response Plan for the proposed power plant and also associated gas pipeline has been developed listing various actions to be performed in a very short period of time in a predetermined sequence if it is to deal major and minor accidents effectively and efficiently. The primary objectives of the plan are:

- Providing clear lines of authority and communication during incident and crisis events
- Providing means by which trained people and resources are available to those managing the incident or crisis event
- Keeping the workplace safe and to achieve minimal incidents for health hazard; as well as keeping the impacts on the environment, materials, machineries and equipments from these unplanned events to a minimum.

139. Possible emergency events include:

- Fire and explosion;
- Immediate medical emergency due to injuries;
- Leakage of hazardous materials, such as, oil;
- Natural disaster; and
- Civil disturbance/terrorist activities

140. Emergency events are broken down to three level tiers; tier 1, 2 and 3. Tier 1 has the lowest threat level and Tier 3 has the highest threat level.

141. In the case of an emergency event, the Incident Response Team (IRT) at plant site would be mobilized with the Emergency Response Group (ERG) (Chaired by the Chief Engineer of NWPGCL located at NWPGCL head office in Uttara) coordinating and overseeing arrangements to ensure that the IRT meets its emergency management obligations.In the case of Tier 1 emergencies, the cases are escalated primarily to site specific IRTs only. Tier 2 involves ERG providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and for providing operational response to any emergency situation which may occur in the affected(such as, fire, explosion, coal spillage and various social crisis). The Incident Management Team (IMT) (also located at NWPGCL head office in Uttara) is activated in the case of Tier 3 incidents and responsible to define and control strategy for those incidents. The following table (**Table 5.14**) shows the emergency response escalation protocol for different levels of emergencies.

Table 5.14: Emergency Response Escalation Protocol

Impact/ Consequence	Health & Safety	Natural Environment	Reputation Government Community Media	Financial $	Civil Unrest Hartals		Definition	Country Threat Level	Escalation →				Site specific IRT Members
Tier 1	Minor injury – First Aid treatment.	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols.	Minimal impact to reputation.	Financial loss <$50,000	Situation generally stable with some protests / Hartals against government		Incidents that are containable by the Operations' Site Incident Response Team (IRT)	**Insignificant Low**	Operation Sites	Plant Manager	**IRT**	ERG Leader	Plant Manager other **IRT** members **ERG - as required**
Tier 2	Moderate injury- Medical Treatment, Lost Time injury	Impact on fauna, flora and/or habitat but no negative effects on ecosystem, may require immediate regulator notification.	Moderate to small impact on business reputation.	Financial loss >$50,000	Security unrest appears to escalate to regular outburst - but **authorities appear to be capable of maintaining control**		Incidents that require Dhaka based ERG, governmental and regulatory support	**Medium High**	**ERG**	ERG Leader	Chief Engineer NWPGCL **activates Dhaka ERG**	**Inform Member-Generation**	ERG Leader – Chief Engineer other ERG members **ERG - activated for EHS / Security issues**
Tier 3	Injury requiring ISOS activation. Permanent disabling injury and or long term off work and fatality.	Long term impact of regional significance on sensitive environmental features, likely to result in regulatory intervention/action	Significant impact on business reputation/ or international media exposure.	Financial loss greater than $100,000.	Confirmed direct threat to foreign business interest or against expatriates **Situation certain to escalate further beyond Government control**		Incidents when there are multiple injuries or fatalities requiring IMT support and also international support, regulatory and public relations assistance.	**High Extreme**	**IMT**	IMT Leader **activates IMT**	Director Technical	**Managing Director-NWPGCL IMT**	**IMT** other **IMT** members **IMT - activated**

The Incident Response Team (IRT)

142. The Incident Response Team (IRT), based at plant location, is trained and responsible for dealing with all envisaged incidents and emergency situations which may occur at the location. Where additional support in the way of resources and advice may be required by the IRT at a remote location whichwill be requested through and provided by the Emergency Response Group (ERG) of Dhaka Office. On all occasions when an IRT is mobilized due to an incident or emergency situation, the ERG Manager must be notified immediately.

143. The IRT will be headed bythe Plant OHSE Managerand will include senior staff from the Human Resources (HR), Health Safety Environment (HSE) and Logistics department within the plant.

The Emergency Response Group (ERG)

144. The Emergency Response Group (ERG) is based in the NWPGCL Head Office in Biddyut Bhaban, Dhaka and will be chaired by the (Chief Engineer),who will also nominate an Emergency Response Coordinator to coordinate with representatives from various agencies and also senior staff from HR, Finance, HSE, Logistic, Security, IT, and public affairs department within NWPGCL. ERGwill be responsible for providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and will provide operational response to any emergency situation that may occur. The function of the ERG is to coordinate and oversee arrangements to ensure that the IRT meets its emergency management obligations. ERG should develop a plan, in consultation with the appointed OHSE Manager where it should describe how to handle both the "technical" crises e.g. fire, explosion, oil spill, and "social" crises e.g. illness, injury, kidnap, civil unrest. On all occasions that the ERG is mobilized due to an incident or emergency situation the Managing Director must be notified immediately.

The Incident Management Team (IMT)

145. The Incident Management Team (IMT) is the corporate body located in the NWPGCL headquarters in Biddyut Bhaban, Dhaka, with the responsibility to define and control strategy for major incidents. A strategic response is defined as a situation arising from a single or multiple incidents or emergencies that escalate to a point beyond which significant damage to the Company's business could result in, including commercial and reputation damage, significant financial loss, shareholders' loss of confidence and damages resulting from litigation. When a potential strategic situation appears, the IMT will be mobilized to manage issues pertaining to the reputation and the continued commercial wellbeing of the Company. The IMT may however also be called upon to address some of the tactical roles that would normally be the responsibility of the ERG, for example, if the Dhaka Office were out of action or in the event of an evacuation from a country, which may equally limit the ERG's capability.

146. The IMT is chaired by the Managing Director of NWPGCL and includes high level representation from the Ministry of Power, Energy and Mineral Resources, Army, Police Department, Fire Department, District Commissioner's Office and the Disaster Management Bureau (DMB) of the Bangladesh Government.

5.4.8 Safety Training

147. In order to reduce the risks associated with accidents, internal and external threats, and natural disaster, a safety training program is essential for workers in plant operation and also associated gas pipeline. There should be regular training programs on safety for the workers to increase their awareness and also to reduce the risks. Provision of yearly professional training for health and safety, would enhance the effectiveness of safety. Safety training should be planned for the local people living around the project area so that they can be aware about the risk possessed by the project and can take appropriate preparedness (**Table 5.15**).

Table 5.15: Training schedule that may be adopted for safety

Target trainee	Training schedule
Worker	Four trainings per year
Professional	Two trainings per year
Local people	Two trainings per year
Drivers	Four trainings per year
Safety professional	Two trainings per year

148. In addition, there must be a discussion and awareness session for increasing awareness on safety in each and every kind of meeting. Tool box meeting and job safety analysis should be regularly practiced by the employee. Further details on the type of trainings to be provided will be discussed in the separate Emergency Response report.

5.4.9 OHS Training

149. The on-site OHSE Manager in conjunction with the (health and safety officer, environmental officer and relevant stakeholders/organization heads) will be responsible for the development of the OHS training plan. The (OHSE Manager) will be responsible for ensuring that the appropriate employees receive training required under the plan. The company's human resources representative will be responsible for ensuring that all employees receive introductory training on the OHS Management System.

5.4.10 Training Procedure

Task-Specific Training

150. A training program will need to be developed to ensure that employees are capable of accomplishing the tasks required to meet OHSE objectives and targets. The program will identify training topics, who should receive the training, when training should be given, and the training method. The program will also distinguish between training conducted to comply with OHS regulations and other trainings.

151. A training needs assessment for the employees should be made. The OHSE Manager will review past training and the nature of the employee's work. Based on this review, specific training requirements for each type of employee will be documented.

152. The OHSE Manager shall document the OHSE Training Program.

153. The training plan shall be implemented by the OHSE Manager. Upon completion of training by employees, the OHSE Manager shall make the Superintendent Engineer and Chief Engineeraware of the training completed. The OHSE Manager shall document the training completed form and Training Log.

154. Specific documentation pertaining to training received shall be maintained by the operational work areas for a minimum of two years, or as required by regulation.

155. Training effectiveness will be evaluated to ensure that the OHS Management System (MS) is being implemented effectively when changes are made to significant risks, objectives, targets or operational controls. Improvements to the training plan will be made accordingly.

General EMS Training

- All employees shall receive introductory training to make them aware of the OHS Management System.
- The human resources representative shall be responsible for coordinating the effort to assure that all new and existing employees have received suitable training.

5.4.11 Frequency of training

156. The training plan shall be updated whenever changes are made to the significant risks, objectives, targets, or operational controls. General OHS training shall be made available on a continual basis to ensure that new employees are made aware of the OHS MS.

Table 5.16: Draft OHSE Training Plan

Training Subject	Target Personnel
OHS Management System awareness	All staff members (including contractors)
Emergency response and management	IRT, ERG and IMT team
Handling, use & disposal of hazardous material	Workers with authorized access to hazardous material storage areas and required to use hazardous material during their works
Waste Management	All staff members
Defensive and Evasive training- Efficient & safe driving practices, including road & vehicle restrictions	Drivers & mobile plant operators
Actions to be taken in the event of major or minor pollution event at river/plant site	All staff
Use of flexible booms and surface skimmers in event of pollution event in water bodies	All crew members stationed at the Pollution Control Vessel
Pollution prevention: Best practice	All staffs
Health & Safety: Safe way to work & hazard awareness	All staff members
Health & Safety: Safe use of cranes and equipment	Operators of cranes& equipment
Front line leadership and project management training	Senior management of NWPGCL

Training Subject	Target Personnel
Health & Safety: Working at height	Crane operator
Health & Safety: Working near/on water	All staffs working on jetty strengthening and unloading coal from ship
Health & Safety: Use of PPE	All staff members
Emergency procedures and evacuation	All staffs
Fire fighting	All staffs
Health & Safety: Confined space entry	Designated workers
Health & Safety: Lifting and rigging	Crane operator and all riggers
Awareness raising on risks, prevention and available treatment of vector-borne diseases	All staffs
Cultural sensitivities of the local population	On induction of all non-local staff

5.4.12 Documenting and Reporting

157. Implementation status of the safety plans should be monitored and documented regularly. Monthly monitoring report should be prepared based on regular inspection and should be submitted to the Superintending Engineer of the Project. Any kind of incidents or even near misses should be documented and reported to the Superintending Engineer.

5.4.13 Occupational Health, Safety and Environment Team

158. There should be provision of Occupational Health, Safety and Environment Team with responsibility of implementation, inspection, documentation, and reporting of the safety plans. The team will also be responsible for implementing emergency plans under the Directorate of Environment, Health and Safety. The team should be a combination of multi-disciplinary professionals. The team composition could be as:

- Occupational Health, Safety and Environment Manager (Team Leader)
- Health and Safety Officer
- Environmental Officer
- Fire Safety Manager
- Chief Security Officer
- Security Officer
- Chief Medical Officer
- Medical Officer
- Rescue Officer

6.0 ANALYSIS OF ALTERNATIVES

159. Aside from economic, financial, safety and engineering factors, the potential environmental and social impacts have been carefully considered in selecting the best route for the gas distribution pipeline. Both the "no project" and "with project" options have been studied.

6.1 "No project" option

160. The "no project" option means that the area along the proposed alignment will remain the same as the current condition. However, the supply of natural gas for the Rupsha 800 MW Combined Cycle Power Plant (CCPP) will not be provided and NWPGCL will be compelled to use HSD as the primary fuel when a better and more environment-friendly fuel can be used. A "no project" option will entail that the planned economic development and business opportunities within southwestern Bangladesh may not altogether happen due to lack of reliable power, and thus, will be an opportunity cost for GoB. **Table 6.1** presents a comparison of "with project" and "no project" options.

Table 6.1: Comparison of "with project" and "no project" options

Description	"With Project" Option	"No Project" Option
Supply of natural gas to the proposed 800 MW Rupsha CCPP	Provides a stable and reliable flow of natural gas for power generation	No additional power generation capacity
Economic development	More opportunities for southwestern part of Bangladesh as a result of reliable power supply	Minimal, if any, due to lack of reliable power supply
Potential impacts to ecologically-sensitive areas	No protected areas or national parks along the gas pipeline route. Associated potential impacts can be readily mitigated by adherence to applicable design standards and specifications, compliance to relevant regulations, and implementation of best practice engineering processes and procedures.	None
Potential impacts to terrestrial flora and fauna	Pipeline will be underground. The selected alignment will be along the easement of existing roads. The area is not known to host endangered or protected species of flora and fauna. No matured trees will be cleared.	None
Fugitive greenhouse gas (GHG) emissions	Pipeline design specifications and standards will ensure "no leak." SCADA will monitor the operation of the pipeline at all	No GHG contribution

Description	"With Project" Option	"No Project" Option
	times.	
Disruption to local residents along the pipeline route	Potential impacts or disruption to daily activities will be minimal (i.e., temporary and short duration during construction/installation). Any disruption can be mitigated by proper construction planning and scheduling of activities.	None
Employment	Job opportunities will be created during project implementation.	None

6.2 "With project" options considered for the gas distribution pipeline routes

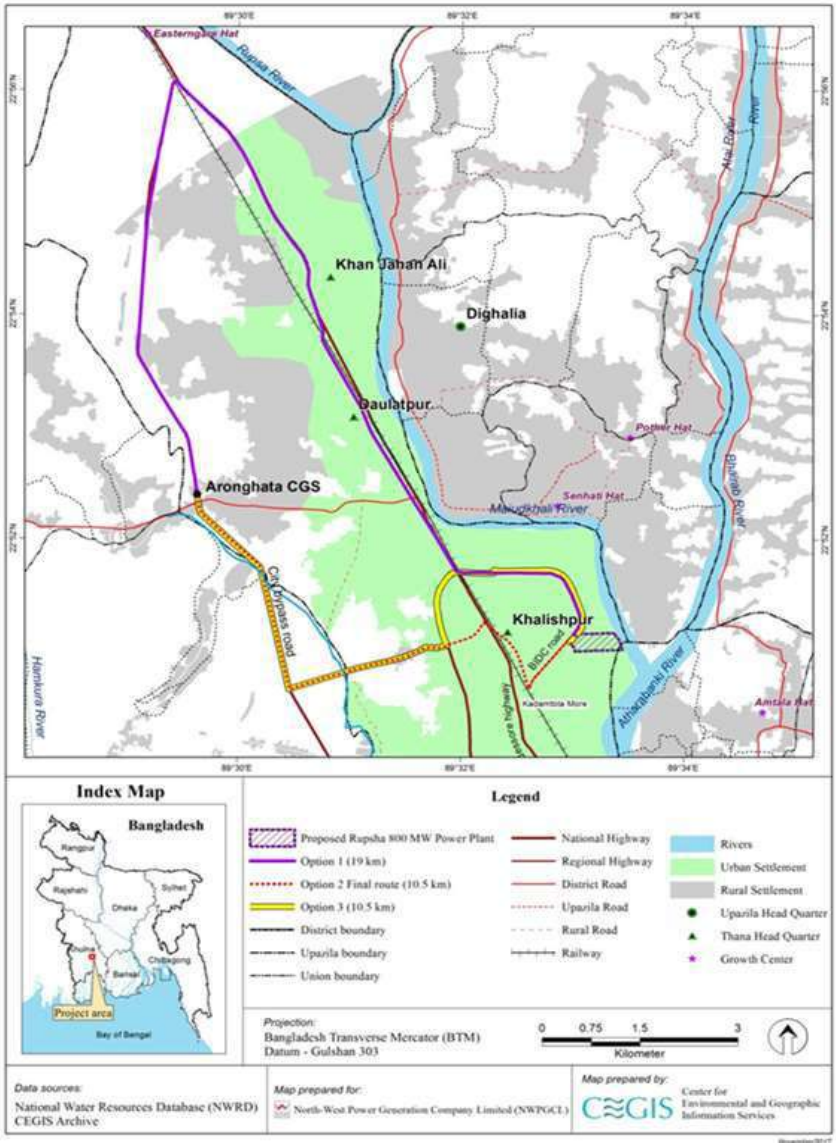
161. The required route will start from the existing Khulna City Gas Station (CGS) in Arongghata, Khulna until the proposed Rupsha 800 MW CCPP in Khalishpur, Khulna with offtake to the existing Khulna 225 MW CCPP in Goalpara. Three options have been carefully studied and these are given in **Table 6.2** and **Table 6.3.**

Table 6.2: Route options for the gas pipeline from Khulna CGS to Rupsha 800 MW CCPP

Description	Option 1	Option 2 (final option)	Option 3
Diameter of gas pipeline – 24 in			
Length, km	19.3	10	10
Number of bends	17	14	19
Number of structures to be disturbed	2,500	25	180
Major road crossing	5	3	3
Rail crossing	3	2	1
River crossing		2	

162. Based on the options given in **Table 6.2**, the best route will be Option 2 as this will incur the least disturbance to structures, road and railroad crossing, and number of bends along the pipeline. **Figure 6.1** presents the three route options considered.

Figure 6.1: Route options considered (24-in gas pipeline route)



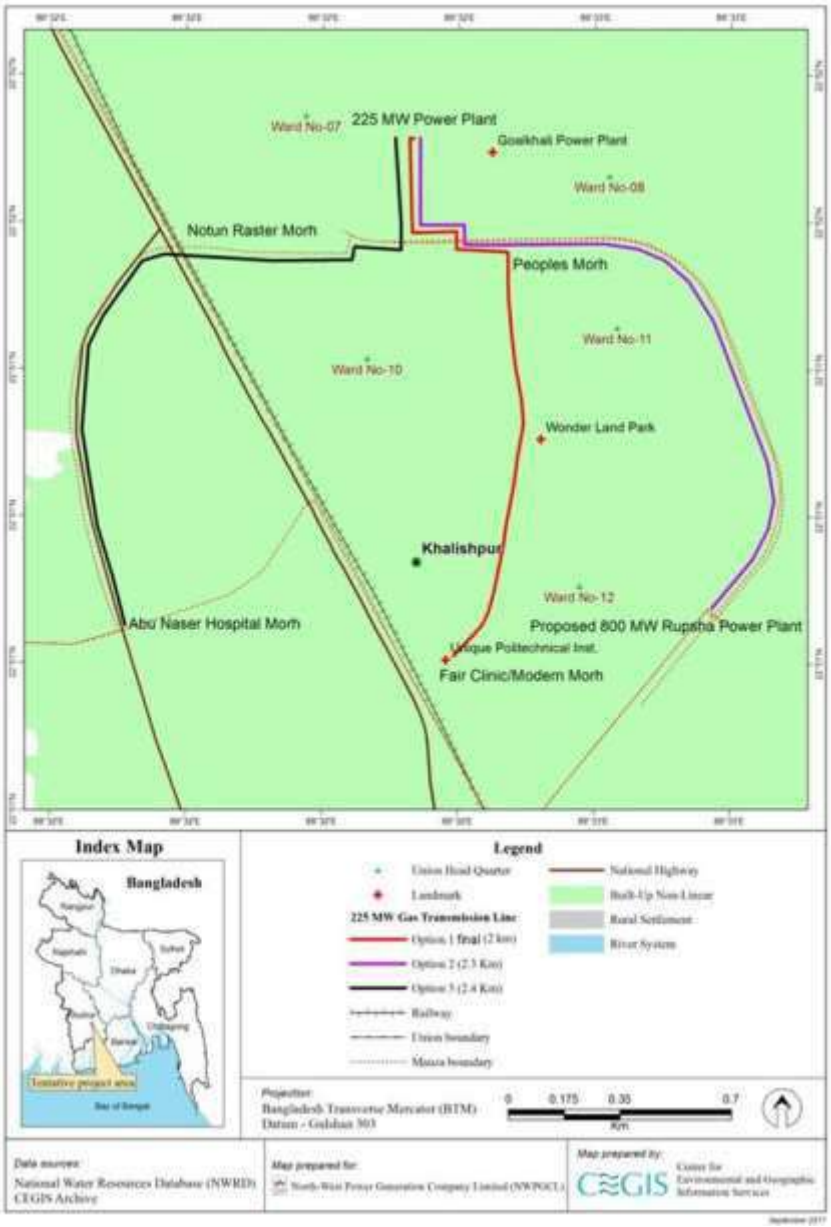
163. **Table 6.3** gives the options considered for the offtake gas pipeline route to the existing Khulna 225 MW CCPP while **Figure 6.2** shows the route options.

Table 6.3: Route options for the offtake gas pipeline to Khulna 225 MW CCP

Issues	Option 1 (final option)	Option 2	Option 3
Diameter of gas pipeline – 20 in			
Length, km	2	2.3	2.4
Number of bend	4	4	4
Number of structures to be disturbed	12	50	80
Major road crossing	2	0	1
Rail crossing	1	1	2

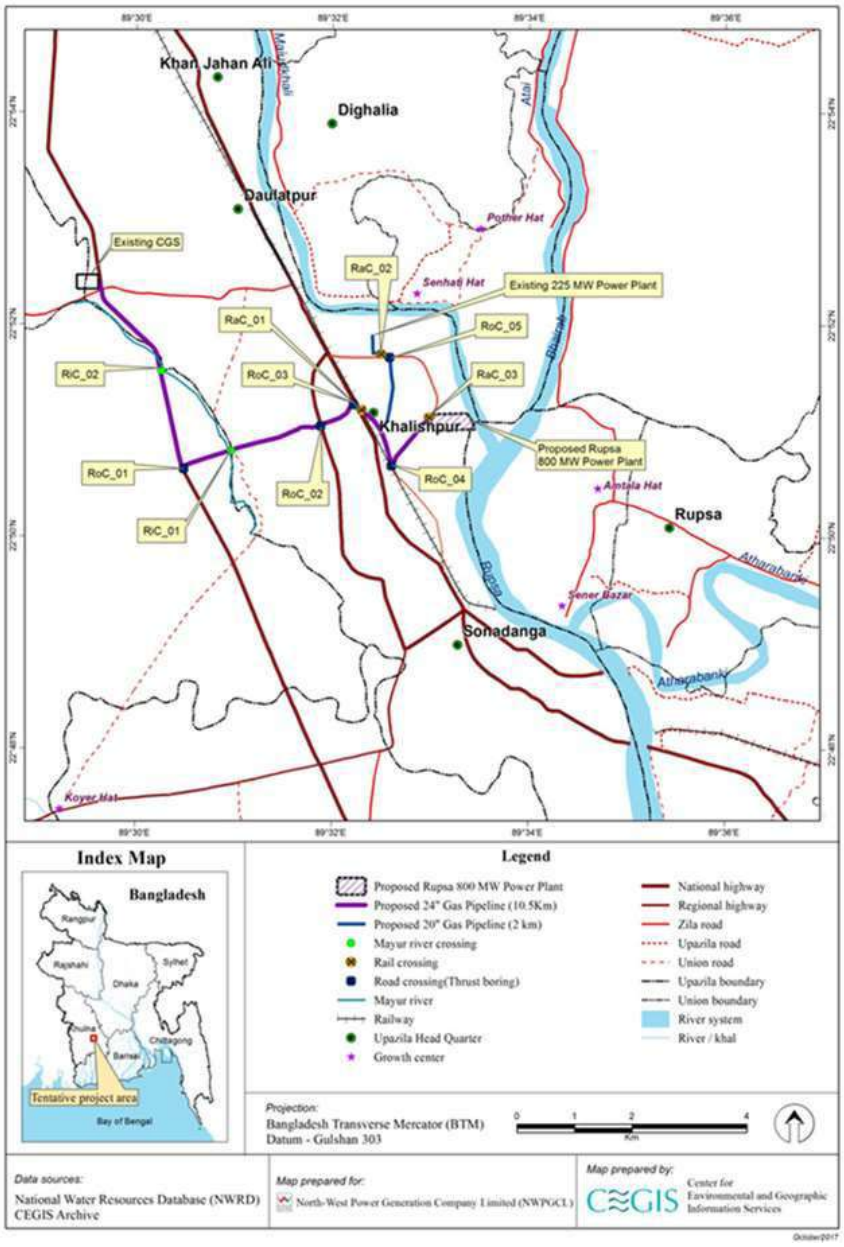
164. From the options considered, it shows that Option 1 is the best route as this will have the least disturbance.

Figure 6.2: Route options considered (20-in gas pipeline route)



165. From the options selected, Figure 6.3 shows the locations of the roads, rail, and river crossings.

Figure 6.3: Location of crossings



7.0 INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1 Introduction

166. Consultations for Component 2 were conducted as part of the requirements of the DoE and ADB's SPS 2009. The main objective is to involve stakeholders throughout the project implementation and to know their concerns and perceptions about the project. Specific objectives of consultations include the following:

a) To ensure peoples' participation in the proposed project;
b) To inform key stakeholders about the project, its environmental implications within the project area, potential environmental impacts and mitigation measures, project benefits, and about the "cut-off date" for persons directly affected by the project;
c) To determine the perceptions of the people about the project and share experiences of the participants on similar projects;
d) To understand and create awareness of problems in the project area;
e) To discuss and propose possible solutions to the problems identified;
f) To describe the mechanism for handling potential grievance related to the project; and,
g) To inform stakeholders on access to information about the project.

7.2 Approach and Methodology

167. Stakeholders were classified into primary and secondary stakeholders. These stakeholders are characterized as the following:

a) Primary stakeholders

168. These are persons who will be along the right-of-way (RoW) of the pipeline route that may be directly affected during construction and operation phase. Primary stakeholders may be farmers, fishers, small business community, ambulant vendors as well as households to be displaced, women groups, and wage laborers.

b) Secondary stakeholders

169. These are persons or organizations that will not be directly affected but may have interests that can contribute to the projector may affect decision-making in some areas. Secondary stakeholders may include relevant government agencies like Road Development Authority, Department of Environment, community-based organizations, NGOs, and other interested individuals or groups.

170. Component 2 will affect 37 structures along the pipeline route, will cross five roads, three railway points, and Mayur River in two locations.

171. Checklists were used to guide the consultations to ensure that the discussions are focused and relevant. A summary includes information about the project, proposed implementation schedule, and potential project impacts. Views and concerns of the participants were recorded and their questions were properly responded to by NWPGCL and their consultants.

7.3 Consultations during the preparation of the EIA

172. A total of six consultation events were conducted from 12-14 June 2017 by the CEGIS, the consultant of NWPGCL, and participated by 31 persons (see **Table 7.3**). These consultations were key informant interviews (KII) and informal interviews done in Arongghata, Ward No 9, and Ward No. 12 in the district of Khulna (see **Table 7.1** and **Figure 7.1**). In addition, final Public Consultation (workshop) including Public Disclosure was conducted on 21st October 2017, the details of which are attached in **Annex 2.** The meetings/discussions locations are presented in **Table 7.1** below:

Table 7.1: Location of consultations

District	Thana	Municipality/ Union	Type of Consultation	Venue	Date
Khulna	Daulatpur	Aronghata	KII	Arongghata Bypass	12/6/2017
	Khalishpur	Ward No. 9	KII	Beside Abu Naser Hospital	12/6/2017
	Khalishpur		KII	Refugee Colony road	13/6/2017
	Khalishpur	Ward No. 12	KII	BL College road	13/6/2017
	Sonadanga	-	KII	SGCL Office, Khulna	12/6/2017
	Khalishpur	Ward No. 12	Informal interview	Lebutola Point	14/6/2017
Khulna	Khalishpur	13 no. ward, Khulna City Corporation	Workshop	IEB conference room, Khalishpur	21/10/2017

7.4 People's perceptions of the Project

173. During these consultations, CEGIS discussed the project to the participants including those persons that will be directly affected. Apparently, the people within the project area are aware of the project from other consultants who frequently visited the sites. The participants showed positive attitude and support towards the project. The RoW along the pipeline route is owned by the Government. The people in the project area are aware of the probable project impacts. During the consultation, local people identified some issues as follows:

1) Provision of relocation notice before the start of construction activities
2) Consider providing the affected persons with at least three months to move their structures prior to construction
3) In case NWPGCL would consider compensating encroachers for their structures, they requested to make the compensation procedure easy and on time
4) They requested to avoid religious structures. If it is unavoidable, then NWPGCL needs to renovate those structures properly and within a shortest possible time.
5) To take extra care in managing spoils disposal
6) Construction activities should be undertaken during the dry season
7) Construction activities for road and rail crossing should be done within very short time and renovate it immediately to minimize local disturbance and reduce inconvenience to local people.

8) NWPGCL to ensure that construction activities will not affect their daily life and livelihood.

174. The participants during consultations did not show negative attitude towards this project. A summary is given in **Table 7.2**. Participants are listed in **Table 7.3.**

Table 7.2: Summary of consultations

Issues Raised	Suggested Measures
• People will be in trouble if construction activities will start without any notice • Process for getting compensation is very complex • Accident risks to workers and children within the area • Crossing of gas pipeline to railway and roads may cause problems on transportation and communications during construction • Poor socioeconomic conditions of persons that may be affected • Construction activities during the monsoon season may cause inconvenience to affected people and road users • Poor spoils management may cause problems for the local people during construction	• To inform affected people at least a month before construction • Provide guidelines for getting compensation to make it easier • Need contingency fund for affected neighboring people to address accidental issues during implementation period. • Provide clear and visible danger signs/posters to avoid accident at pipeline construction site. • Proper awareness program about accidents risks should be included for the neighboring people. • Construction activities on road and rail crossings should be done in the shortest possible time and renovation works done right after to minimize the inconveniences to the local residents. • Some informal settlers should be considered as vulnerable group. Compensation should be completed before the start of construction works. • Construction activities should be initiated and completed within the dry season. • Implement a good and effective spoils management system.

Table 7.3: List of the participants

No.	Name	Occupation	Address
1	Engr. AhsanulHaquePatoary	GM, SGCL	Sonadanga, Khulna
2	Engr. Moshiur Rahman	NWPGCL official	Khalishpur, Khulna
3	AkramSarder Tulu	Agriculture	Bypass point, Khulna
4	Ishak Mollik	Agriculture	Bypass point, Khulna
5	Sheikh Bellal Hossain	Business	Bypass point, Khulna
6	Md. Roni Morol	Business	Arongghata
7	Md. Motlur Rahman	Business	Arongghata
8	Md. Azad Hossain	Business	Lebutola More
9	Ojifa Begum	Business	Lebutola More
10	Md. Jaber Ali	Business	Lebutola More
11	Monirul Islam	Business	Lebutola More

No.	Name	Occupation	Address
12	Rubel Hossain	Business	Goalkhali
13	Md. Kamal Sheikh	Business	Goalkhali
14	Hasina Begum	Business	Goalkhali
15	Md. Abdul Mannan	Business	Khalishpur
16	Md. Mujibur Rahman	Business	Khalishpur
17	Md. SamsulAlom	Business	Khalishpur
18	Md. Abdur Rashid	Business	Khalishpur
19	Md. Anowar Munshi	Business	Khalishpur (Kodomtola)
20	Md. Sattar Islam	Business	Khalishpur (Kodomtola)
21	Md. Rajon	Business	Khalishpur (Kodomtola)
22	Md. AbdurRohim	Business	Khalishpur (Kodomtola)
23	Nironjon	Business	Khalishpur (Kodomtola)
24	Md. Shorif	Business	Alomnagor
25	Md. Shekh Abdul Rashid	Business	Lebutola More
26	Md. Asadul	Business	Mohsin college gate
27	Md. Moinul Islam	Business	Khalishpurmeghamor
28	Md. Afsul	Business	Khalishpurmeghamor
29	Md. Idrish Ali	Business	Khalishpurmeghamor
30	Md. Salim Sheikh	Business	Khalishpurmeghamor
31	Md.Obydur Islam	Business	wonderland park

175. Consultations with stakeholders will continue during the implementation of Component 2, natural gas pipeline. A communication strategy plan will be prepared with the technical support of a Consultant. This will ensure that stakeholders are engaged, as and when needed.

176. A project summary will be posted in the website of NWPGCL. In addition, a one-page flyer on project brief including details on grievance redress mechanism, and contact person in case of complaints and/or concerns will be prepared in Bangla and will be made available at the field office of PMU in Khaliaspur, Khulna and at the NWPGCL office in Dhaka. More details on Component 2 will also be available from the EIA posted on the website of ADB.

Figure 7.1: Consultation sessions with stakeholders

KII with an owner of a structure that will be affected

KII with General Manager, Sundarban Gas Company Limited

8.0 GRIEVANCE REDRESS MECHANISM

8.1 Current system at NWPGCL

177. NWPGCL manages grievance and/or complaints through the Grievance Redress System (GRS) which is required by the GoB and part of the mandatory Annual Performance Agreement (APA). This agreement will be signed and renewed annually between NWPGCL and GoB.

178. GRS requires the NWPGCL to designate a staff as Focal Point whose name and contact details are disclosed at the website of NWPGCL. Compliance to the GRS is a Performance Indicator in the APA. NWPGCL has designated its Focal Point as required by GRS with the details disclosed in its website.

179. The GRS consists of specified roles, rules, and procedures for resolving complaints, grievances, disputes, or conflicts systematically. The objective is to provide an effective and objective way of lodging and resolving complaints on public service delivery.

8.2 Grievance system required by SPS 2009

180. A grievance redress mechanism (GRM) will be set up once ADB funding for Component 2 becomes effective. Similar to GRS, the GRM aims to provide stakeholders with a clear and simple way of filing a complaint on the environmental performance of Component 2. According to SPS 2009, the GRM will address complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate and readily accessible to the affected persons at no costs and without retribution. Given these requirements, handling of potential complaints/grievance on the implementation of Component 2 will be as follows:

181. **Information disclosure.** NWPGCL will post signboards at the construction sites on the grievance mechanism including the details of the contact person who will take grievance. Details of the grievance mechanism together with the project brief will be posted in the website of NWPGCL.

182. **Procedure.** The GRM will provide three-tier entry points in grievance redress. Two grievance redress committees (GRCs) will be formed: (i) local grievance redress committee (LGRC); and (ii) project grievance redress committee (PGRC). Grievances considered minor such as increased dust level at the construction site and immediate vicinity can be resolved onsite at the LGRC level within 7 days from receipt of complaint. Other complaints not resolved at the LGRC level will be forwarded to PGRC which will take two weeks (or 14 days) to resolve. Meetings of the LGRC will be held onsite (PMU office) and members may do site visits to check or verify the issue. Complainants will be informed of the status of resolution.

183. **Composition.** NWPGCL will ensure the representation of women in the members of the GRCs.

(a) **LGRC** – members will include (i) Deputy Manager/Executive Engineer (Environment) of PMU, (ii) Ward member, (iii) community representative, (iv) representative of women affected persons, and (v) EPC Contractor representative

(b) **PGRC** – members will include (i) Project Director(PD), NWPGCL as the Chairperson, (ii) Environment staff of Project Management and Construction

(PMC) consultant, and (iii) representative of civil society nominated by PD with the help of PMC.

184. **Responsibilities.** GRCs will be expected to: (i) resolve grievances filed in writing or by phone to any member of the PMU, (ii) convene at least once a month to review grievances lodged (if any), (iii) record the grievances and resolve the issues within 15 days or a maximum of 30 days from the date the grievance was filed, and (iv) report to the complainant(s) the status of grievance resolution and the decisions made.

9.0 ENVIRONMENTAL MANAGEMENT PLAN

185. The environmental management plan (EMP) covers measures that will be conducted in every phase of implementing Component 2 to ensure that adverse impacts are minimized and positive impacts enhanced. Aside from the mitigation measures, the EMP also includes the required monitoring and implementation arrangements with cost estimates.

9.1 Implementation Arrangements

186. NWPGCL has a total of six staff on environmental, chemical and safety managing the environment, health, and safety (EHS) concerns related to their operations. According to the Annual Report 2015-2016 of NWPGCL, additional eight staff will be recruited to enhance the technical capacity on EHS.

187. For the Rupsha 800 MW CCPP, NWPGCL will set up a PMU who will be responsible for project management and safeguards compliance monitoring of the EPC contractor during the construction stage. Component 2 will be managed and supervised also by the PMU. NWPGCL will require the EPC Contractor to recruit an environmental staff (or a Consultant) who will be primarily responsible for ensuring that the EMP is properly implemented during construction. This requirement for the EPC Contractor will be included in the Bidding documents. The Environmental staff (or consultant) of the EPC Contractor will coordinate and liaise with the PMU (NWPGCL) on compliance to ADB requirements, relevant government agencies and local authorities on clearances (as needed), and will prepare the environment section of the Project's Quarterly Progress Report (QPR) submitted by the EPC Contractor to the PMU. The environment section in the Project's QPR will be summarized by the PMU Environmental staff and submitted to ADB during construction phase as semi-annual environmental monitoring reports to ADB (see **Annex 4** for the format of environmental monitoring report). The semi-annual environmental monitoring reports are posted on ADB's website as required by SPS 2009 and PCP 2011. NWPGCL will submit the environmental monitoring reports starting from the date the loan becomes effective.

188. Should there be any change in the route of the gas distribution pipeline, length, and diameter of the pipe, or design of the gas distribution pipeline system, this EIA will be revised and/or updated and submitted to ADB prior to any construction works. The PMU Environmental staff together with NWPGCL Environmental staff will revise or update the EIA and submit to ADB for review. The revised and/or updated EIA of Component 2 will be re-posted on the ADB website to comply with the disclosure requirements of SPS 2009 and PCP 2011.

189. Before the start of any construction work, the PMU will inform the EPC Contractor on their responsibility to comply with the EMP and the requirements of DoE and ADB. The specific responsibilities of the EPC Contractor on the implementation and compliance to the EMP, environmental monitoring, and submission of environmental compliance status during the construction phase will be monitored by the PMU and the NWPGCL Corporate Environment staff (or Consultant).

190. During the operation phase, PMU will assign a staff (or Consultant) who will be responsible to handle the associated environmental issues and compliance to DoE and ADB's environmental requirements. Submission of environmental monitoring reports by NWPGCL to ADB during the operation phase will be annually. These environmental monitoring reports will be reviewed by ADB and will post them into their website as required by SPS 2009 and PCP 2011.

191. In case of non-compliance to any environmental covenant in the loan agreements, NWPGCL will prepare a corrective action plan (CAP) describing the process and the time-bound actions that will be undertaken to ensure compliance. The CAP will be submitted to ADB for review and disclosure to ADB's website.

9.2 Mitigation Plan

192. **Table 9.1** presents the mitigation plan for various resources that may be affected by the implementation of Component 2.

Table 9.1: Mitigation Plan

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
Pre-Construction Phase					
Socio-economic Condition					
Employment	Temporary loss for small-scale business due to alignment of gas distribution pipeline.	Compensation to affected persons based on the requirements of GoB and ADB.	Cost included in the Resettlement Plan of Component 2.	PMU (NWPGCL)	GoB, NWPGCL (Corporate Office), ADB
Construction Phase					
Physical Environment					
Noise	Potential increase in ambient noise level due to construction activities, use of heavy equipment, and construction vehicles.	Noise-generating construction activities will be done only during daytime. Ambient noise limits set by Noise Pollution Control Rule 2006 will be complied.	No cost involved	EPC Contractor	PMU
		Driving speed of construction vehicles will be monitored Unnecessary use of noise generating equipment and device such as whistle, megaphones, etc. will be avoided.	No cost involved		
		Noise-generating construction activities will be stopped during school hours, madrasa, and prayer time at mosque.	No cost involved		
		Noise-generating activities will be enclosed.	Included in project cost		
		Orientation, labor training and awareness building will be undertaken at the construction site to ensure that workers understand	5.0		

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
		compliance to environmental requirements of DoE and ADB.			
		A Construction Management Plan which includes a traffic management plan will be required from the EPC Contractor and approved by PMU.	3.0		
Air quality	Potential increase in dust level and vehicular emissions that may affect ambient air quality.	Temporary fencing and enclosures will be installed.	3.0	EPC Contractor	PMU
		Regular spraying of water to dust generating and opened areas.	1.5		
		Vehicles transporting dust-generating materials will be covered.	0.5		
		Road easement excavated will be covered with tarpaulin.	1.5		
		Stockyard will be covered properly during non-working period.			
Water Resources					
Creeks and small streams including Mayur River	Potential for congestion due to poor management of spoils during earth moving works Water may become turbid due to erosion of soil excavated.	To the extent possible, construction works will be schedule during the dry season.	No cost involved	EPC Contractor	PMU
		Backfilling of the trenches after the laying of the gas distribution pipeline will be conducted properly in the shortest possible time. Good housekeeping will be implemented at all times in construction sites. River banks will be stabilized as soon as it is ready.	Included in the project cost		
Agricultural Resources					
Agricultural land along the gas distribution pipeline route	Agricultural production and related impact on crop.	Agricultural land was avoided in the selection of the pipeline route. Excavated soils materials will be	No cost involved	EPC Contractor	PMU

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
		properly stacked for backfilling the trenches. Loose soil will be compacted to minimize erosion. Good housekeeping will be enforced at all times in the construction sites. Proper garbage bins will be provided at designated areas.			
Fisheries Resources					
Fish Production	Potential fragmentation and loss of fish pond Potential degradation of quality fish pond	Construction of temporary bamboo fencing between trench and gher area to avoid disturbance of fish culture.	1.0 (bamboo fencing including labour cost)	EPC Contractor	PMU
		To the extent possible, construction works will be done during dry season (i.e. November to April because Golda is not cultured during this period)	No cost involved	EPC Contractor	PMU
		The excavated earth should be backfilled after laying the pipe properly.	No cost involved	EPC Contractor	PMU
		Gher owner will be compensated properly and timely for standing crops (fish) as per the cost estimation in RP.	Cost estimates included in RP	PMU, NWPGCL (Environment Unit)	NWPGCL (Corporate Unit) and ADB
Ecological Resources					
Terrestrial vegetation	Vegetation clearing of privately-owned trees/vegetation along the pipeline route	Use barren or fallow land for storing materials and vehicle maneuvering area. Compensation will be provided to tree owners.	Compensation budget is included to RAP	NWPGCL (Environment Unit)	NWPGCL (Corporate Unit) and ADB

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
	Clearing of vegetation owned by Roads Authority along the road affected by the pipeline route.	Replanting of trees at designated areas identified in consultation with the DoE and Roads Authority.	4.0	NWPGCL (Environment Unit), PMU	NWPGCL (Corporate Unit)
Socio-economic Condition					
Traffic condition/mobility	Potential traffic congestion adjacent to the route of Component 2 as some portion will use the existing road easement.	Alternative arrangement to be implemented using Steele plate if required during construction works.	1.0 (for establishing temporary road)	EPC Contractor	PMU
		Clear and visible traffic and warning signs will be installed at the construction sites considering children, women, elderly and persons with disability. Installation of temporary road crossings for children, women, elderly, and persons with disability disabled.	1.0		
		Traffic Management Plan will be prepared by the EPC Contractor and approved by the PMU.	1.0		
		HDD will be used at road, railway, and river crossings to ensure short duration disturbances and minimize traffic congestion.	Include in the Project Cost		
		Traffic enforcers will be assigned based on the Traffic Management Plan to avoid traffic congestion and inconvenience to local residents.	1.5		
Community safety	Risks of accident	Provision of contingency fund to address safety risks to affected neighboring people.	3.0	EPC Contractor	PMU
		Provision of appropriate safety and warning signs along the pipeline construction sites.	0.5		

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
		Conduct orientation and awareness program on safety and emergency preparedness to local residents along the pipeline route.			
Employment	Creation of employment opportunities.	Local skilled labor will be given preference and local unskilled labor will be given priority for construction works. To target at least 30% local labor recruitment.	NA	EPC Contractor	PMU
Operation Phase					
Physical Environment					
Surface water and groundwater quality.	Potential deterioration of water quality due to improper disposal of wastewater from pigging operations.	Personnel who will undertake pigging will have the required license and experience to do the work. Wastewater from pigging operations will be disposed of properly following the relevant water quality standards in ECR 1997. Disposal Plan should be developed after pigging operation. Pigging materials should be treated to meet the GoB requirement.	Included in the project cost.	Pigging Contractor (SGCL)	PMU
Occupational and public safety	Risks of fire and explosion due to gas leaks along the pipeline.	Pipeline will be designed and constructed following the Bangladesh Natural Gas Safety Rules 1991, ASTM, ASME and other international standards. SCADA will monitor the pipeline operations 24 hrs every day to detect any leaks. Valves will automatically	Included in the project cost.	SGCL	PMU in coordination with the Disaster Management Unit of GOB.

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
		shut off in case of leak. Clear and visible signs and danger warnings will be provided along the pipeline route. Appropriate and standard markers for gas distribution system will be installed.			
Terrestrial vegetation	Risk of damage of the saplings due to different causes.	Regular monitoring the saplings. Re-plantation of the damaged saplings.	1	SGCL / FD / RHD	PMU
Noise	Noise will be generated at the RMS point.	Appropriate like noise barrier to be installed to reduce noise level.	0.5	SGCL	PMU
Decommissioning Phase/Site Closure					
Wastes	Generation of wastes from decommissioning activities such as construction debris, waste materials, used equipment & temporary structures.	Develop a detail decommissioning plan by the proponent. All of the demolished materials, sewage and other hazardous waste to be disposed as per ECR, 1997 and IFC standard as appropriate. Stabilization of all project sites. Spoil heaps will be stabilized and re-vegetated. Care will be taken to ensure all the sites are properly restored and effectively reestablished. During site closure, GoB and ADB Guidelines will be followed.	5.0	Contractor (SGCL)	PMU

Environmental Component	Environmental Impacts	Mitigation Measures	Cost (Lac Tk.)	Institutional Responsibilities	
				Implementation	Supervision
Socio-economic Condition					
Occupational and public safety	Risks of accident	Develop a detail decommissioning plan by the proponent. Contingency fund will be provided to cover the cost in the event of accident.	2.0	Contractor (SGCL)	PMU
		Total EMP cost	**36.0**		

9.3 Monitoring Plan

193. The following **Table 9.2** present the different monitoring plans that will be implemented during construction and operation phase. Results from the implementation of these plans will be included in the environmental monitoring reports to be submitted to ADB.

Table 9.2: Monitoring Plan and related Tentative Cost

Indicator	Locations	Frequency	Monitoring Agency	Monitoring Responsibility	Monitoring Cost (in BDT Lakh)
Construction Phase					
Air Quality	Along the gas distribution line	Queerly (8 hrs in three sensitive locations)	EPC Contractor	PMU	3.0
Noise level	Along the gas distribution line and near the important institutions like schools, community hospitals, mosques, etc.	Weekly	EPC Contractor	PMU	1.0
Traffic Congestion	Toiyobnagar Mor, Notun Bazaar-Boyra Bazaar Mor, Khulna-Jessore Highway and BIDC Road.	Daily (Observation)	EPC Contractor	PMU	0.5
Soil Quality Nitrogen (N), Phosphorous (P), Potassium (K), Iron (Fe), lead (Pb), Mercury (Hg), Cupper (Cu)	Selected sites along the pipeline route (e.g., near agricultural land), valves and metering stations.	Once in two locations	EPC Contractor	PMU	0.3
Fish Production of the fish pond/gher	Along pipeline route where gher has been crossed.	Quarterly consultation with the fish farmer.	EPC Contractor	PMU	0.5
Cut off trees and Plantation	Along pipeline route	As needed during clearing.	EPC Contractor	PMU	0.5
Safety and health condition of workers, project personnel and surrounding people	Along pipeline route	Weekly	EPC Contractor	NWPGCL (Corporate Unit)	1.0
Overall sanitation and drinking water	Along pipeline route	Weekly	EPC Contractor	NWPGCL (Corporate Unit)	0.5

Indicator	Locations	Frequency	Monitoring Agency	Monitoring Responsibility	Monitoring Cost (in BDT Lakh)
facilities					
Operation Phase					
Noise	Receptors like settlements, schools, mosques, and community hospitals near or adjacent to valves and RMS	Once a month	SGCL	PMU	Project Cost
Vegetation growth	Gas pipelines alignment	Half yearly (5 years)	SGCL	PMU	Project Cost
Occupational and public safety	Along pipeline route	Quarterly	SGCL	NWPGCL (Corporate Unit)	Project Cost
				Total Monitoring Cost	**7.3**

10.0 CONCLUSION AND RECOMMENDATION

194. Component 2 is an integral part of Rupsha 800 MW CCPP which will address one of the recommendations of the Power System Master Plan 2016 to diversity the use of fuel for power generation. Implementation of Component 2 will enhance the power generation capacity of Bangladesh to address the growing demand for electricity.

195. Component 2 is the gas distribution pipeline route system consisting of about 10 km, 24" diameter pipeline and 2 km, 20" diameter pipeline from the existing Khulna CGS in Arongghata to Rupsha 800 MW CCPP and branch off from the 24" diameter pipeline to the existing Khulna 225 MW CCPP.

196. The EIA for Component 2 was prepared following the requirements of the DoE and ADB. The pipeline route will cause five road crossings, three railway crossings and two river crossings along Mayur River. HDD will be used in installing the pipeline in these crossings to minimize environmental impacts and disturbance to local people. Other potential environmental impacts during construction include increased level of noise and dusts, generation of waste from construction works, clearing of 370 trees, disturbance to local traffic at road and railway crossings, occupational and public safety risks. These temporary and of short duration impacts can be easily mitigated. Mitigation measures for these impacts are included in the EMP and the parameters for monitoring have been identified in the environmental monitoring plan. Component 2 will be designed, constructed, supervised by technical consultants, and operated by experienced engineers, technical staff, and natural gas consultants.

197. Stakeholders were consulted during the preparation of the EIA in June and October 2017. People within the pipeline route generally supported the implementation of Component 2 in anticipation of employment opportunities but concerned about the process of compensation. A GRM will be set up by PMU consistent with the requirements of GoB and ADB. A project brief in English and in Bangla with details on the GRM will be made available at the NWPGCL office in Khulna and in Dhaka. Consultations will continue in varying degrees throughout the project's lifecycle. Awareness and information campaign on safety of living near gas pipeline systems will be conducted by NWPGCL in consultation to the public.

198. This draft EIA will be disclosed at the ADB website in accordance with SPS 2009 and PCP 2011. Prior to construction works all the relevant permits required for Component 2 will be obtained by NWPGCL.

Annex 1
ToR of EIA for Component 2 Approved by DoE

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, Paribesh Bhaban
E-16 Agargaon, Sher-e-Bangla Nagar, Dhaka-1207
www.doe.gov.bd

Memo No: DoE/Clearance/5668/2016/ 477 Date: 03 /11/2016

Subject: Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) in favor of Construction of Gas Transmission Pipelines under Proposed Khulna LNG Based 750-850 MW Combined Cycle Power Plant Project at Khalishpur, Khulna .

Ref : Your application on 08.09. 2016.

With reference to your letter dated 08.09.2016 for the subject mentioned above, the Department of Environment hereby gives exemption from IEE and approval of ToR for Environmental Impact Assessment (EIA) in favour of Construction of Gas Transmission Pipelines under Proposed Khulna LNG Based 750-850 MW Combined Cycle Power Plant at Khalishpur, Khulna subject to fulfilling the following terms and conditions.

I. The Project Authority shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said Project in accordance with the TOR submitted to the DOE and additional suggestions provided herein.

II. The EIA report should be prepared in accordance with following indicative outlines:

A. Executive summary

B. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)

C. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

D. The Project (Location detail and concise description of the project/interventions and relevant activities)

E. Baseline Environmental Condition should include, inter alia, following:

- Physical Environment: Geology, Topology, Geomorphology, Soils, Meteorology, Hydrology, Seabed Morphology and Seismic activity
- Biological Environment: Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora & Fauna
- Environment Quality: Air, Water, Soil and Sediment Quality and Noise

F. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition
- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste
- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors

G. Identification and Evaluation of Potential Impacts (identification and assessment positive and negative impacts likely to result from the proposed project)

H. Management Plan/Procedures:
For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures and those which are immitigable, will be identified as residual impacts. Both technical and financial plans shall be incorporated for proposed mitigation measures.

An outline of the Environmental Management Plan shall be developed for the project.

In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

I. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

J. Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

K. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, The Project Authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, The Project Authority shall not start operation of the project.

V. The The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable Environmental Clearance fee in a treasury chalan, the applicable 15% VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Khulna Divisional Office of DOE in Khulna with a copy to the Head Office of DOE in Dhaka.

03.11.2016

(Syed Nazmul Ahsan)
Director (Environmental Clearance, c.c)
Phone # 02-8181673

Project Director
Khulna LNG Based 750-850 MW
Combined Cycle Power Plant Construction Project
North-West Power Generation Company Ltd.
Bidyut Bhaban (Level-14)
1, Abdul Gani Road, Dhaka-1000.

Copy Forwarded to :

1) Private Secretary to the Hon'ble Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Khulna Divisional Office, Khulna.
3) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Annex 2
Public Disclosure Meeting

Introduction

The Center for Environmental and Geographic Information Services (CEGIS) organized a public disclosure meeting on behalf of Northwest Power Generation Company Limited (NWPGCL), for exposure of the proposed "Rupsha 800MW combined cycle power plant Project" at the conference room of Khulna Engineers Institute at Khalishpur, Khulna on 21 October 2017.

Objectives

The overall objective of the consultation was to explore the peoples' perception and attitudes towards the proposed project and to provide informations regarding the findings of EIA study. The specific objectives were to:

- Aware the local people about the proposed project;
- Sharing the information to the participants about EIA and RP findings;
- Explore the problems of the study area;
- Share experiences of the participants over the years;
- Unveil the potential negative or positive impacts of the proposed project;
- Outline potential mitigation measures for negative impacts and enhancement measures for the positive impacts; and
- Ensure the peoples' participation in the proposed project.

Approaches of the Public Disclosure Meeting

The main purpose of the PDM was to disclose the findings of EIA and RP study to the key stakeholders and take suggestions/opinions from them. To serve that purpose it was mandatory to gather key stakeholders at a certain venue.

Identification of Stakeholders

Stakeholders included all those who would affect and/or would be affected by policies, decisions or actions within a particular system. Stakeholders included groups of people, organizations, institutions and sometimes-even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

Primary Stakeholders

Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed project, the primary stakeholders include the people whose land will be affected and who are living within the project area.

Secondary Stakeholders

This category of secondary stakeholders pertains to those who may not be directly impacted but have interest to contribute in the study, play a role in implementation at some stage, or decision making on project aspects. In this project, secondary stakeholders include PDB, Local Government Institutions (LGIs), local public representatives, other relevant government agencies, academia, journalists, NGOs and general public at large.

Time, Date and Venue Selection

Venue, date and time of meeting was selected in consultation with the local administration, local government, local people, the project proponent and the consultant. The local people and local government selected an agreed venue e.g. Khulna Engineers Institute at Khalishpur, having easy accessibility and which is likely to be neutral. Date and time was also finalized in the similar way considering availability of the participants, ensuring the maximum participation and compliance with the other arrangement.

Enlisting and Invitation

A comprehensive list of potential stakeholders was prepared through the consultation. This list was intended to cover all sorts of interest groups, occupational groups, socially acceptable and knowledgeable peoples.

Table A.1: Invitation list of consultation meetings

SL. NO	Organization/Persons	No. of invitations
1.	Representative of Government Institutions (DC, DoE, Forest etc.)	21
2.	Representatives Khulna City Corporation	03
3.	Academia/School (Teacher, Managing committee and Students)	07
4.	Project proponent	05
5.	Representative of NGOs	02
6.	Representative of Journalists	03
7.	Representative of Fisherman community	05
8.	Representative of Affected parsons of Gas Transmission line	03
9.	Representative of Affected parsons of Overhead Transmission line	03
10.	Political leader	03
11.	Local elite persons	15
	Total	**70**

To make the meeting successful and to ensure maximum participation, an advertisement was published in the local daily newspaper.

দৈনিক পূর্বাঞ্চল

The Daily Purbanchal

www.purbanchal.com

বিজ্ঞপ্তি

রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে ২০২১ সালের মধ্যে দেশের সকল ঘরে বিদ্যুৎ পৌঁছে দিতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সরকারের এ লক্ষ্য পূরণের উদ্দেশ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানি লিঃ (বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ডের একটি প্রতিষ্ঠান) খুলনার খালিশপুরে ক্ষমতা ৮০০ মেঃ ওঃ কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র বাস্তবায়নের কাজ হাতে নিয়েছে। উক্ত প্রকল্প বাস্তবায়নের ফলে সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব সমীক্ষা করার জন্য পানি সম্পদ মন্ত্রণালয়ের অধীনস্থ CEGIS - কে দায়িত্ব দেয়া হয়েছে। এরই অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারী ও বেসরকারী প্রতিষ্ঠান এবং জনগণের সুচিন্তিত মতামত ও পরামর্শ গ্রহণের লক্ষ্যে আগামী ২১ অক্টোবর, ২০১৭ইং তারিখ রোজ শনিবার সকাল ১১:০০ ঘটিকায় খুলনার খালিশপুরস্থ ইঞ্জিনিয়ার্স ইন্সটিটিউট-এর সম্মেলন কক্ষে একটি মতবিনিময় সভার আয়োজন করা হয়েছে। উক্ত মতবিনিময় সভায় উপস্থিত থেকে এ বিষয়ে আপনাদের সুচিন্তিত মতামত প্রদান করার জন্য অনুরোধ করা যাচ্ছে।

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Consultation Instrument

Checklist: A comprehensive checklist and questionnaire covering all possible issues to be addressed was prepared through consultation with the multidisciplinary study team. This checklist was used in the meeting to unveil peoples' perception and opinion along with suggestions

Attendance list: An inventory of the participants was maintained in attendance sheet containing contact number. Camera: For visualizing the participants, photographs were taken using camera. These photos are presented in this chapter. Photos of the meeting participants are presented at the end of this chapter.

Consultation Participants

The main participants of the consultation meetings included public representative of Government Institutions, Khulna City Corporation, Academia/School representative, Project proponent, NGOs, Journalists, Fisherman community, Affected parsons of Gas Transmission line, Affected parsons of Overhead Transmission line, Political leader Local elite persons, of the nearby "Rupsha 800MW combined cycle power plant Project" areas. A total of 64 participants attended these consultations in which 52 is male and rest of female.

The stakeholders have right to know about the activities, pattern and impacts of the project. In doing so, a brief description on project was distributed to each participant:

নর্থওয়েস্ট পাওয়ার জেনারেশন কোম্পানী কতৃক অত্র এলাকায় গৃহীত খুলনা ৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিক কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র এবং সংশ্লিষ্ট উপাদান সমূহের তথ্য, খুলনা

✓ সভার মূল উদ্দেশ্য

- আজকের সভার মূল উদ্দেশ্য হচ্ছে প্রস্তাবিত ২ X ৪০০ (৮০০) মেগাওয়াট গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প ও অত্র প্রকল্প সংশ্লিষ্ট উপাদান সমূহ স্থাপিত হলে প্রকল্প সংলগ্ন এলাকায় কী ধরণের পরিবেশগত ও আর্থ-সামাজিক প্রভাব পড়তে পারে এ সম্বন্ধে এলাকার জনগোষ্ঠীর মতামত গ্রহণ করা।
- একই সাথে প্রকল্প নকশা ও নির্মাণ পর্যায়ে জনগণের প্রস্তাব নেওয়া যাতে প্রকল্প বাস্তবায়নে তাদের আকাঙ্খার প্রতিফলন ঘটে।

✓ প্রস্তাবিত প্রকল্প ও সংশ্লিষ্ট বিষয়াদি

- *বাংলাদেশ সরকার ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের লক্ষ্যে একটি মহাপরিকল্পনা, **Power System Master Plan** প্রণয়ন করে, যার মূল প্রতিপাদ্য বিষয় হচ্ছে:*

- জ্বালানীর বহুমুখীকরণ যেমন: গ্যাস, এলএনজি, কয়লা, এইচএসডি, ফার্নেস অয়েল নবায়নযোগ্য জ্বালানি ইত্যাদি।
- জ্বালানীর উৎস সনাক্তকরণ ও এর সর্বোত্তম ব্যবহার নিশ্চিত করণ।
- জ্বালানী উৎসের ও সরবরাহের সুবিধাদির ভিত্তিতে বিদ্যুৎ প্রকল্প নির্মাণের স্থান নির্বাচন।
- বিদ্যুতের ক্রমবর্ধমান চাহিদার উপর ভিত্তি করে উৎপাদন ক্ষমতা বৃদ্ধি করা, যা জাতীয় বিদ্যুৎ গ্রীডের মাধ্যমে নিরবিচ্ছিন্নভাবে বিদ্যুৎ সরবরাহ করতে পারবে।

- *রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, '২০১০ ও ২০১৬' এর আলোকে দেশের সর্বস্তরে বিদ্যুৎ পৌছে দেয়ার লক্ষ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ **(NWPGCL)** খুলনা জেলায় গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প নির্মাণ করে ১০০০ মেগাওয়াটের অধিক বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে।*

✓ পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণ সংক্রান্ত তথ্য সংগ্রহ ও প্রয়োজনীয় পরীক্ষানিরীক্ষা

- ***CEGIS** এই প্রকল্পটির পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণে দায়িত্বপ্রাপ্ত হয়ে বিভিন্ন পর্যায়ে এলাকার জনগনের সাথে এই বিষয়ে আলাপ আলোচনা করে পরিবেশ ও আর্থ-সামাজিক প্রেক্ষাপটের বর্তমান অবস্থা বিশ্লেষণ করার চেষ্টা করেছে এবং পর্যবেক্ষণ করার জন্য সংশ্লিষ্ট অফিসগুলো থেকেও তথ্য সংগ্রহ করে, যেমন:*

- কৃষি অফিস থেকে ফসল, ফসলী জমি ও সেচ সংক্রান্ত তথ্য।
- মৎস্য অফিস থেকে মাছ ও মাছের আধার সংক্রান্ত তথ্য।
- ইউনিয়ন পরিষদ থেকে সামাজিক ও অর্থনৈতিক বিষয়াদি সংক্রান্ত বিভিন্ন তথ্য।
- বিভিন্ন প্রকার শিল্প থেকে নির্গত দূষণ সম্পর্কিত তথ্য সংগ্রহ।

- *প্রকল্প এলাকার বিভিন্ন বৈশিষ্ট সঠিকভাবে বিশ্লেষণ করার নিমিত্তে নিম্নলিখিত পরীক্ষা-নিরীক্ষা করা হয়:*

- ভূ-তাত্বিক জরিপ যার মাধ্যমে প্রকল্প এলাকার মাটি ওভূ-গর্ভস্থ পানি সম্বন্ধে ধারণা পাওয়া।
- বন্যার পানির সর্বোচ্চ উচ্চতার বিষয়টি বিশ্লেষণ করে কতটুকু মাটি ভরাট করতে হবে তা জানা ।
- পানির গুণাগুণ বোঝার জন্য ভূ-গর্ভস্থ ও ভূ-পরিস্থ পানি পরীক্ষা-নিরীক্ষা করা হয়।
- বায়ুর দূষণ মাত্রা বোঝার জন্য বায়ু পরীক্ষা-নিরীক্ষা করা হয়।
- শব্দ দূষণ মাত্রা বোঝার জন্য শব্দ দূষণ যন্ত্র ব্যবহার করা এবং প্লান্ট থেকে ৫০০ মি. চারপাশে শব্দ দূষণ পরিমাপক যন্ত্রের মাধ্যমে শব্দের তীব্রতা মাপা হয়।

- *পরিবেশগত ও সামাজিক প্রভাব বিশ্লেষণের জন্য প্লান্টকে কেন্দ্র করে চারপাশে ১০ কি.মি এলাকা পর্যবেক্ষণ করা হয়েছে*

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (পরিবেশগত প্রভাব বিশ্লেষণ)

▪ *৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিকবিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- বিভিন্ন সংবেদনশীল এলাকায় বায়ু দূষণের মাত্রা মাপা হয়েছে এবং বায়ু দূষণের ক্ষেত্রে ক্যাল্পআপ মডেলের মাধ্যমে CO_2, SO_x NO_x বিশ্লেষণ করে দেখা গেছে উল্লিখিত দূষণের মাত্রা বাংলাদেশ ও আন্তর্জাতি গ্রহনযোগ্য সীমার নীচে আছে।
- শব্দ দূষণের মাত্রা উল্লিখিত শব্দ দূষণ নিয়ন্ত্রন বিধি-২০০৬ এর গ্রহনযোগ্য সীমার নীচে থাকবে।
- মেশিন চালুকালে ভূ-কম্পনের মাত্রা সহনশীল পর্যায়ে থাকবে।
- প্রকল্প চালু করার সময় কুলিং টাওয়ার এর জন্য ভৈরব নদ থেকে একালীন ৬০,০০০ ঘন মিটার পানি উত্তলন করা হবে এবং পরবর্তীতে প্রকল্প চালু অবস্থায় ভৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
- ভূ-গর্ভস্থ পানিদূষণের মাত্রা বর্তমানে উল্লিখিত ইসিআর- ১৯৯৭ এর গ্রহনযোগ্য সীমার নীচে থাকবে।
- বিদ্যুৎ কেন্দ্র থেকে নির্গমিত সকল তরল পদার্থ পরিশোধিত করে গ্রহণযোগ্য সীমার মধ্যে রাখতে হবে নচেৎ পরিবেশ বিপন্ন হবে।
- কৃষিক্ষেত্রে পানির কোন সংকট হবে না এবং মাছ চাষের উপর কোন বিরুপ প্রভাব পড়বে না।
- ২১৫ টি গাছের উপর প্রভাব পড়বে যা আইউসিএন এর লাল তালিকা বহির্ভূত।

▪ *গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- উল্লিখিত গ্যাস পাইপলাইন প্রকল্প বাস্তবানের ফলে বায়ু দূষণ, শব্দ দূষণ, বর্জ্য দূষণ, পানি দূষণ অথবা সংশ্লিষ্ট এলাকায় পানির কোন অভাব দেখা দেবে না। এছাড়া উক্ত প্রকল্পের কারণে কৃষি জমি ও মাছ চাষ প্রকল্পের কোন ক্ষতি হবে না। তবে ১০.৫০ কিমি পাইপলাইনের জন্য কিছু গাছের উপর প্রভাব পড়বে যা বাংলাদেশ সরকার উল্লিখিত সিডিউল বহির্ভূত। উল্লেখ্য, উক্ত প্রকল্পের কারণে কোন প্রাণি বা সর্বতভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব পড়বে না।

▪ *ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- উল্লিখিত ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবানের ফলে বায়ু দূষণ, শব্দ দূষণ, বর্জ্য দূষণ, পানি দূষণ অথবা পানির কোন অভাব দেখা দেবে না। উক্ত ২৯ কিমি ২৩০ কেভি লাইন কোন প্রাণি, কৃষি জমি এবং নদীসহ সার্বিকভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব ফেলবে না।

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (আর্থসামাজিক প্রভাব বিশ্লেষণ)

- গ্যাস ও তেল ভিত্তিক ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ প্রকল্প স্থাপনের জন্য খুলনা সরকারি নিউজপ্রিন্ট মিলের পরিত্যক্ত ৫০ একর জমি নেয়া হয়েছে। উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি পরিবার স্থানান্তরিত হওয়ার কারণে অর্থনৈতিকভাবে প্রভাবিত হবে। অত্র প্রস্তাবিত প্রকল্প এলাকায় কোন আদিবাসি ও ঝুকিপূর্ণ পরিবার নেই।
- অত্র প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প এলাকায় বর্তমানে অবস্থিত ০১ টি বালক উচ্চ বিদ্যালয় ও ০১ টি বালিকা উচ্চ বিদ্যালয় স্থানান্তরিত করা হবে। ২১৫ টি গাছ ক্ষতিগ্রস্থ হবে।
- গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত রাস্তা সংলগ্ন সড়ক ও জনপথের জমির উপর স্থাপিত হবে। এ ক্ষেত্রে মুচি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে নিকটবর্তী পরিত্যক্ত জায়গায় স্থানান্তরিত করা হবে এবং ৩২৬ টি গাছ ক্ষতিগ্রস্থ হবে। ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ী নিকটবর্তী স্থানে স্থানান্তরিত হবে ও ৪০ টি গাছ ক্ষতিগ্রস্থ হবে। উল্লেখ্য কোন স্থাপনা ক্ষতিগ্রস্থ হবে না।
- ২৯ কিমি ওভারহেড ট্রান্সমিশন লাইন প্রকল্প কৃষি জমি, নদী এবং কিছু বাড়ী, সামাজিক প্রতিষ্ঠানের উপর দিয়ে যাবে তবে কোন প্রত্নতাত্ত্বিক এবং ঐতিহাসিক স্থাপনার উপর দিয়ে যাবে না। উল্লিখিত প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবার স্থায়ীভাবে ক্ষতিগ্রস্থ হবে যার মধ্যে ০৫ টি পরিবারের বসতবাড়ীও ক্ষতিগ্রস্থ হবে এবং ক্ষতিগ্রস্থদের মধ্যে ০২ টি পরিবার ঝুকিপূর্ণ । এছাড়া উক্ত প্রকল্পের কারণে শস্য ও ০১ টি মাছের ঘের সাময়িকভাবে ক্ষতিগ্রস্থ হবে।

✓ পরিবেশগত প্রশমন ব্যবস্থা

- *বায়ু দূষণ মোকাবেলায় করণীয়:*

  - Advance Dry Low NOx Burner যা বায়ুর একরকম দূষণ (NOx)-কে নিয়ন্ত্রণ করবে।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা বায়ু দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - প্রধান ও বাইপাস চিমনীর উচ্চতা যথাক্রমে ন্যূনতম ৬০ মি. ও ৫০ মি. হতে হবে যাতে প্লান্ট নিঃসরিত ধোঁয়া আকাশে মিলিয়ে যায় এবং পরিবেশের উপর ক্ষতিকর প্রভাব না ফেলে।

- *পানি দূষণ মোকাবেলায় করণীয় :*

  - কুলিং টাওয়ারের কারণে কোন প্রকার গরম পানি নদীতে পড়বে না।
  - প্লান্ট হতে নির্গত পানি যথাযথ পরীক্ষা-নীরিক্ষার পর পুণ:ব্যবহার করা হবে;যা পরিবেশের উপর কোন ক্ষতিকর প্রভাব ফেলবে না।
  - তেল ও গ্রীজ পানি থেকে আলাদা করণের জন্য সেন্ট্রিফিউগাল যন্ত্রের ব্যবহারের ব্যবস্থা রাখা হয়েছে। আলাদাকৃত তেল এলাকার ভেন্ডরদের কাছে বিক্রি করা হবে।
  - বিদ্যুৎকেন্দ্র থেকে নিঃসরিত তরল: আধুনিক বর্জ্য ব্যবস্থাপনার (ETP) মাধ্যমে পরিশ্রুত করা হবে। ফলে নদীর মাছ ও পানির তেমন কোন ক্ষতি হবে না।
  - প্রস্তাবিত বিদ্যুৎকেন্দ্রে পয়:নিষ্কাশন ব্যবস্থাপনারও সুবিধা থাকবে।

- *পানি উত্তোলন সীমিতকরণ ব্যবস্থা:*

  - প্রকল্প চালু অবস্থায় ভৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
  - উল্লেখ্য, সর্ত অনুসারে প্রকল্প চালু রাখার জন্য কখনই ভূ-গর্ভস্থ পানি উত্তলন করা হবে না।
  - উক্ত বিদ্যুৎ কেন্দ্রে বসবাসকৃত জনসাধারনের খাবার পানির জন্য খুলনা ওয়াসা কতৃক পাইপ লাইন দ্বারা সরবরাহকৃত পানি ব্যবহার করা হবে।

- *শব্দ দূষণ মোকাবেলায় করণীয়:*

  - আধুনিক প্রযুক্তি সম্বলিত মেশিনারী স্থাপন করা।
  - ঘূর্ণন মেশিনারীর জন্য শব্দ দূষণ প্রতিরোধী হুড বা ঢাকনার ব্যবস্থা করা।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা শব্দ দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - শব্দ দূষণ কমানোর জন্য প্রযোজ্য স্থানে স্তর ভিত্তিক দেশীয় জাতের গাছ লাগানো।
  - ঘূর্ণন মেশিনারীর ভিতরে যারা কাজ করবে তাদেরকে অবশ্যই পিপিই (PPE) যেমন: ইয়ার প্লাগ, মাফলার ইত্যাদি পরতে হবে।
  - ধোঁয়া বের হওয়ার পথে চিমনীতে সাইলেন্সার লাগানো।
  - শব্দ প্রশমনীয় দেয়াল নির্মাণ করা।

- *কম্পন মোকাবেলায় করণীয়:*

  - সীম (প্লেট ১/১০০০ ইঞ্চি) প্রযুক্তির ব্যবহার করা।

- *পরিবেশ ও জলজ প্রাণি ব্যবস্থাপনায় করণীয়:*

  - প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ কেন্দ্র হতে নির্গমিত সকল তরল বর্জ্য ও পয়:নিষ্কাশন যথাক্রমে ইটিপি (ETP) ও এসটিপি (STP) এর মাধ্যমে পরিশোধিত করে যথোপযুক্ত বাংলাদেশ বিধি ও আইএফসি (IFC) গাইডলাইনের গ্রহণযোগ্য সীমার মধ্যে রাখা হবে যাতে ডলফিন সহ পরিবেশ ও জীববৈচিত্র দূষনের প্রভাব মুক্ত থাকে।

- গ্যাস লাইন ও OHT line এর ক্ষেত্রে প্রকল্প এলাকার কর্মচারীদের বাসস্থানের পয়:নিষ্কাশন পরিশোধনের মাধ্যমে বাংলাদেশ বিধির (ECR,1997) গ্রহণযোগ্য সীমার মধ্যে রাখা হবে।
- অত্র প্রকল্প চালু অবস্থায় EMP সংশ্লিষ্ট পর্যবেক্ষণ ব্যবস্থা নিয়মিত বলবৎ থাকবে এবং উক্ত পর্যবেক্ষণ এর আওতায় প্রকল্প এলাকার পরিবেশ ও জীববৈচিত্র (ডলফিন সহ) এর উপর নিরীক্ষা করা হবে এবং প্রয়োজনীয় প্রশমন পরিকল্পনা অনুযায়ী ব্যবস্থা নেয়া হবে।

✓ আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা

▪ *৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- অত্র প্রকল্পটি বাস্তবায়নের জন্য উল্লিখিত খুলনা সরকারি নিউজপ্রিন্ট মিলের পরিত্যক্ত ৫০ একর জমি সরকারি প্রথা অনুসারে নির্ধারিত মূল্য পরিশোধ সাপেক্ষে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ এর অনুকূলে বরাদ্দ দেয়া হয়েছে।
- অত্র প্রস্তাবিত প্রকল্প এলাকার উল্লিখিত ০২ টি বিদ্যালয় (০১ টি বালক ও ০১ টি বালিকা) পরিত্যক্ত পেপার মিলের অবশিষ্ট (৩৭.৬০ একর) জমির উপর পুণর্নির্মিত হবে যা পাওয়ার প্লান্টের সীমানার বাইরে অবস্থিত। এবং উক্ত বিদ্যালয় দুটিতে উন্নতমানের পাকা ইমারতসহ প্রয়োজনীয় আধুনিক সুযোগ সুবিধা যথা: কম্পিউটার ল্যাব, বিজ্ঞানাগার, পাঠাগার, খেলার মাঠ, সুপেয় পানি,সৌচাগার, ইত্যাদির সুব্যবস্থা থাকবে।
- উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি স্থানান্তরিত পরিবারকে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ কতৃক ক্ষতিপূরণ দেয়া হবে।
- উক্ত প্রকল্প এলাকা সংলগ্ন মসজিদ ও কবরস্থানের সংস্কার করা হবে এবং প্রকল্পসহ সর্বসাধারনের ব্যবহারের জন্য ব্যবস্থা থাকবে।

▪ *গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত সড়ক ও জনপথের জমির উপর অনুমতি সাপেক্ষে স্থাপিত হবে। উক্ত প্রকল্পে মুচি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে অর্থনৈতিক ক্ষতির জন্য ক্ষতিপূরণ প্রদান করা হবে। এছাড়া ৩২৬ টি গাছের ক্ষতিপূরণ প্রদান করা হবে । উল্লেখ্য, ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ীকে অর্থনৈতিক ক্ষতিপূরণ ও ৪০ টি গাছের জন্য ক্ষতিপূরণ দেয়া হবে।

▪ *ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- অত্র প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবারকে ক্ষতিপূরণ দেয়া হবে যারা স্থায়ীভাবে ক্ষতিগ্রস্থ হবে এবং এদের মধ্যে ০২টি পরিবার ঝুকিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে শস্য ও ০১ টি মাছের ঘেরের সাময়িকভাবে ক্ষতির ক্ষতিপূরণ দেয়া হবে।

সারসংক্ষেপ

- ❖ প্রকল্পের পরিবেশগত প্রভাব প্রশমনের সুপারিশসমূহ যথাযথভাবে বাস্তবায়ন করা।
- ❖ প্রকল্পের আর্থ-সামাজিকসুপারিশসমূহ, সরকারি ও উল্লেখযোগ্য উদাহরণ/অনুশীলন বাস্তবায়ন করা।
- ❖ যথাযথভাবে পরিবেশগত নিরীক্ষণ কার্যক্রম পরিচালনা করা এবং প্রয়োজনীয় পদক্ষেপ গ্রহন করা।
- ❖ আর্থ-সামাজিক বিষয় সংক্রান্ত অভিযোগ ও অসন্তুষ লিপিবদ্ধ করা ও তা প্রশমনের ব্যবস্থা নেয়া।
- ❖ আমরা প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক বিষয়ের উপর আপনার সুচিন্তিত মতামত/মন্তব্য গ্রহণ করবো যা EIA প্রতিবেদনে লিপিবদ্ধ করা হবে।
- ❖ অত্র প্রকল্প চলাকালীন ইএমপি (EMP) সংশ্লিষ্ট বিষয়ের সার্বক্ষণিক পর্যবেক্ষণ ব্যবস্থা বলবৎ থাকবে এবং ডলফিন সহ পরিবেশ ও জীববৈচিত্রের জন্য প্রয়োজনীয় টেকসই রক্ষণাবেক্ষণ পরিকল্পনা করা হবে।

Findings from the Public Disclosure Meeting

The Chief Guest of the Public Disclosure Meeting was Muhammad Moniruzzaman Moni, Mayor khulna City Corporation. The program was presided over by S.M Kurshid Ahmed Tona counselor, 13 no. ward, Khulna City Corporation, Md. Mofazzol Hossain Sarkar, Chief Engineer, Goalpara Power Station, Md. Shahidul Morsalin Joarder, Chief Engineer, NWPGCL. Different government officials, Ward Counselors from different unions, NGO representatives, Journalists, political leader, freedom fighter, UP members, farmers and fishermen from the study area were present in the meeting. Mr. Md. Sharif Hossain Sourav from CEGIS started the meeting with an introductory speech. Dr. Kazi Md Noor Newaz, Advisor and Team leader of the study team, CEGIS, made a power point presentation of the key report of the project. A brief description about the project was delivered by Mr. Hasmot Ali, Executive Engineer, NWPGCL.

Following the presentation, all the participants took part in an open discussion. They made various types of comments after the presentation of Dr. Kazi Md Noor Newaz. Their comments are given below:

The people's opinions and queries shared in the open discussion are given below:

Issues raised by the participants	**Feedback from the NWPGCL and CEGIS**
Modern technology should be adopted.	Latest available technology will be adopted for the proposed power plant to reduce air emission, noise level and water extraction within appropriate GOB and IFC acceptable limit and some of the specific options are as follows: - To control SO_x, NO_x, latest technology will be applied. - Noise and vibration level will be within acceptable limit of GOB and IFC guidelines as appropriate during project implementation period. - The height of the chimney will be 60 meter and bypass chimney will be 50 meter height - Closed cycle cooling tower which require minimum water - No extraction of ground water for plant operation - Water will be extracted from Bhairab River as a source of surface water. And only 0.12 % of the total discharge of the Bhairab river will be extracted per hour for operation of the proposed power plant. - ETP will be installed to treat and keep all discharges from the proposed power plant within acceptable limit of GOB and IFC as appropriate. - STP will be installed to treat and keep all sewage discharges within acceptable limit of GOB and IFC as appropriate. - Govt. policy and SPS (2009) will be

	applied during project implementation period as required.
Local experts like experienced university (Khulna University) teacher should be taken part of the power Plant intervention.	It is suggested that relevant teachers from Khulna University may discuss with local NWPGCL relevant technical staff and share their opinions to include in the documents. If necessary, the Khulna University staff may also contact with CEGIS or get access in the document while it will be posted in the web site by ADB and Proponent.
All the mitigation measures must be materialized.	All the development work will be monitored from the construction phase.
The study may be carefully reviewed to focus for people and gain optimum target.	- Construction phase to power plant will be monitored step by step. - All the steps will be taken to obtain optimum goal.
Health safety and security should be established all around the project.	- All the safety measures will be ensured following GOB and ADB/IFC guidelines. The labours will be trained. - awareness programme will be taken. - Fast aid box and trained Physician will be ensured. - Appropriate PPE for workers and staff
All machinery should be modernized	
The location of the schools (both Boys and Girls) shall be fixed as early as possible	- Currently schools (Boys and Girls) are risky for the students and needs to be shifted as early as possible. - The locations of both Schools shall be fixed based on considering environmental and social issues before submission of the final report to ADB and GOB. - Two modern multi-storeyed schools buildings will be established with modern school furniture. - Two school buses (a bus per school) and laboratory with modern instruments, furniture will be bought. - A solar panel will be installed to support during load- shedding of electricity if it occurs. - a play ground (bigger one than the existing one) facility for the students will be ensured. - The schools will be established completely before shifting. The school building construction will begin according to the newsprint authority and BCIC. - A clinic with ambulance service will be established.

	- ensuring safe drinking water, there will be a proper system of water purification. - ADB and NWPGCL will implement it.
The mosque should be renovated and developed	The mosque will be modernized and reformed. Graveyard of martyrs will be well decorated with proper respect.
Fisherman livelihood will be at the risk and disrupted. They need to migrate for better livelihood	- We (NWPGCL assigned CEGIS) have made a study in buffer zone considering 10 km and found no impact on river ecology. - No impact will be found on the Bhoirab and Atai River.
Rehabilitation programme should be introduced for the affected fisherman	Such type of programme will not be needed.
All the Newsprint mill security guard should be employed in the New Power plant	- Newsprint mill has another place, factory with machinery and administrative office. All the security guard will be employed by the Khulna newsprint mill authority in other place. - If we (NWPGCL) have the opportunities of employing the security guard, we would take necessary action regarding the point. - In regard to the permanent employment in power plant, Bangladesh service rule will be followed.
The environmental impact must be addressed with care to protect fish and biodiversity	IUCN recommendations on biodiversity and related management will be followed for dolphin management and future monitoring activities as well. In this regard, we (NWPGCL) have to wait up to that level for future plan for Bio-diversity management.
Is there any experience of NWPGCL regarding this type of project in Bangladesh?	NWPGCL is an experienced and reputed company to the related field and related type of gas based power plant. It has already implemented some project like this. Even in Goalpara, they have a power plant (225 MW).
Technical issues are not clearly understood. Is there any video document of power plant having gas based technology? if yes, please show us.	There are video documentaries regarding the gas based power plant. But due to inaccessibility we cannot show the video filming. It can be watched from internet.
Is there any plan of government for providing electricity for all houses?	Government already has a vision to provide electricity to every home within 2021 (Vision 2021).

The people showed nothing negative towards the project, but they urged to maintain all the environmental, social and safety issues during construction and production as well.

Concluding Remarks

The answers to all questions were given by the relevant project personnel following the open discussion session. Then Mr. Md. Shahidul Morsalin Joarder, Chief Engineer and Project Director NWPGCL expressed his opinion about the project. Then the president of this assembly Mr. S.M Khurshid Ahmed Tona counselor, 13 no. ward, Khulna City Corporation concluded the PDM by thanking all the participants.

Photographs of the PCM

Photograph 1:	Photograph 2:
	
Photograph 3:	Photograph 4:
	

Photograph 5:	Photograph 6:
	
Photograph 7:	**Photograph 8:**
	
Photograph 9:	**Photograph 10:**
	

Photograph 11:	Photograph 12:
	

List of participants of PCM conducted on 21st October 2017:

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়ঃ সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১.	[illegible]	মেয়র, [illegible] সিটি কর্পোরেশন	udayan29@yahoo.com	[illegible]
২.	[illegible]	কাউন্সিলর - ১৩ [illegible]	01711-309022	[illegible] 21/10/17
৩.	মোঃ [illegible]	প্রধান [illegible]	01711-422470	[illegible] 21/10/17
৪.	জাহিদুর রফিক	প্রধান প্রকৌশলী নওপাজেকো	01755-630025	21.10.17
৫.	মোঃ [illegible] রহমান	উপ-প্রকল্প পরিচালক, খুলনা ৮০০ মেঃওঃ [illegible]	01730-066987	21.10.17
৬.	Shariful Islam	Consultant / ADB	01778580756	
৭.	RUBY SOCORRO ARICO	ADB - ENVIRONMENT CONSULTANT	—	
৮.	Shamsuddin Ahmed	ADB - Consultant (Gas Sector Specialist)	shams7.bd@gmail.com	
৯.	Nazmun Nahar	ADB BRM	nnahar@adb.org	Nahar
১০.	[illegible]	[illegible]	[illegible]	[illegible]
১১.	[illegible]	[illegible]	01733847872	[illegible]
১২.	মোঃ মিলন	০৬ নং ওয়ার্ড	[illegible]	
১৩.	Saleha Yaseen	salehayaseen@gmail.com		
১৪.	Aziz Yusupov	Energy Spec. ADB	ayusupov@adb.org	
১৫.	Md. Shahidul [illegible] Joarder	প্রকল্প পরিচালক, (প্রধান প্রকৌশলী)	pd.kng.nwpgcl@gmail.com 01730066985	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	Syed Imdad Hossain	Manager, GTCL Aronggbata, KGI	Gossain.unimelb @gmail.com 01709639723,	
১৭.	Engr. Nizam Uddin	Manager, SoC 01711043978	uddinengrnizam @gmail.com	
১৮.	Abdullah-Al-Mamun	Asst. Teacher 01710027985	eua_mamun @yahoo.com	
১৯.		ABC PRESS	01718444611	
২০.	Mushuda Parveen	Manager(EHS)(Incharge) NWPGCL	Parwin@nwpgcl.org.bd 01777736469	21.10.17
২১.	Md. Jamal Uddin	AM (EHS) NWPGCL	Jamaleny466@gmail.com	21.10.17.
২২.	MD. HASMAT ALI	XEN NWPGCL	hasmat@nwpgcl.org.bd	21.10.17
২৩.	Ziaul Alam Khan	General Secretary AL-13		21/10/17
২৪.	Md Zakir Hossai	13 No Wards Office	01712179692	
২৫.	[illegible]	১৩ নং ওয়ার্ড	০২৬২৫-২৮২৮৪	
২৬.	[illegible]	১৬ নং ওয়ার্ড	০১৩৩৪৭০৪৭২	
২৭.	[illegible]	[illegible]	[illegible]	
২৮.	[illegible]	১৮ নং ওয়ার্ড	01616229292	
২৯.	[illegible]	১৮ নং ওয়ার্ড	01919606047	
৩০.	[illegible]	[illegible]	01926231008	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৩১.	সুকুমার দাস	চন্দনীমহল, ৬নং ওয়ার্ড		সুকুমার
৩২.	মিতু দাস	চন্দনীমহল, ৬নং ওয়ার্ড		মিতু
৩৩.	শচীন বিশ্বাস	চন্দনীমহল, ৬নং ওয়ার্ড		শচীন বিশ্বাস
৩৪.	কার্ত্তিক	১৬ ওয়ার্ড		কার্ত্তিক
৩৫.	মো: টিপু সুলতান	৯নং ওয়ার্ড, চরেরহাট		[signature]
৩৬.	মো: [illegible] করিম	তত্ত্বাবধায়ক, [illegible]		[signature]
৩৭.	জ্যোতির্ময় [illegible]	[illegible]		[signature]
৩৮.	[illegible]			
৩৯.	মো: মশিবুর রহমান	কে.এন.এম	01911710994	[signature]
৪০.	সাহিনা খাতুন	প্রধান শিক্ষক কে.এন.এম স্কুল	01918811008	[signature] 21.10.2017
৪১.	অপর্না রায়	সহকারী শিক্ষক কে.এন.এম মাধ্যমিক বিদ্যালয়	01927406881	[signature] 21.10.17
৪২.	মুক্তা	শিক্ষার্থী নবম শ্রেণী কে.এন.এম মাধ্যমিক	01782550353	Mukta
৪৩.	সাকিনুর	শিক্ষার্থী নবম শ্রেণী কে.এন.এম মাধ্যমিক	01716561451	Sakinur
৪৪.	নুসরাত জাহান পুতুল	শিক্ষার্থী নবম শ্রেণী কে.এন.এম মাধ্যমিক	01948989312	Putul
৪৫.	নুপুর	শিক্ষার্থী নবম শ্রেণী কে.এন.এম মাধ্যমিক	01735276866	NUPUR

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৪৬.	[illegible]	[illegible]	০১৭৫৫০-৪৪২২৪৯	
৪৭.	[illegible]	[illegible] KNM	01979447755	
৪৮.	[illegible]	[illegible]	01912-০৮৫৭৯৬	
৪৯.	[illegible]	[illegible]	01211937716	
৫০.	[illegible]	[illegible]	01720039376	
৫১.	[illegible]	[illegible]	01954443450	
৫২.	[illegible]	শিক্ষক	01716170038	
৫৩.	[illegible]	[illegible]	01777736483	
৫৪.	[illegible]	[illegible]	01948157910	
৫৫.	[illegible]	ADB-[illegible]	—	
৫৬.	Yoojung Jang	ADB - HQ	yjang@adb.org	
৫৭.	ZHAOJING MU	ADB	zhaojingmu@adb.org	
৫৮.	SM Faruk Ahmed	BISS/NESS	01715001106	
৫৯.	[illegible]	[illegible]	01921390469	
৬০.	[illegible]	[illegible]	01716-153633	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ সামাজিক প্রভাব
নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৬১.	মুহাম্মদ আনিসুর রহমান	[illegible]	mazizur@cegisbd.com 01713865523	[signature] 21/10/17
৬২.	খন্দকার রফিকুল ইসলাম	Electrical Engr. CEGIS	01710-564066	[signature]
৬৩.	ড. আমিনুর রহমান	Advisor, CEGIS	[illegible]@cegisbd.com	[signature] 21/10/17
৬৪.	Md. Hasan	AGM. IEB KLN.	0155834883	[signature] 21/10/17
৬৫.				
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৭৫.				

List of invited Government officials with their acknowledgement

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা মতবিনিময় সভার আপত্তন পত্রের প্রাপ্তি স্বীকার

ক্রমিক নং	নাম/পদবী	মোবাইল নং ও ইমেইল	স্বাক্ষর
১.	মেয়র, খুলনা সিটি কর্পোরেশন, খুলনা		
২.	জেলা প্রশাসক, খুলনা।		
৩.	পুলিশ কমিশনার, কেএমপি, খুলনা		
৪.	জেনারেল ম্যানেজার, সুন্দরবন গ্যাস কোম্পানি লিঃ, খুলনা		
৫.	ম্যানেজিং ডিরেক্টর, খুলনা ওয়াসাএবং চেয়ারম্যান, আইইবি, খুলনা		
৬.	ব্যবস্থাপনা পরিচালক, খুলনা নিউজপ্রিন্ট মিলস্ লি ঃ খুলনা		
৭.	পরিচালক, পরিবেশ অধিদপ্তর, খুলনা		
৮.	প্রধান প্রকৌশলী, খুলনা বিদ্যুৎকেন্দ্র, বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড (বিপিডিবি), খুলনা		
৯.	প্লান্ট ম্যানেজার, খুলনা ২২৫ মেঃওঃ সিসিপিপি, এনডব্লিউপিজিসিএল, খুলনা		
১০.	এস এম খুরশিদ আহম্মেদ (টোনা) কাউন্সিলর, ওয়ার্ড-১০, খুলনা সিটি কর্পোরেশন, খুলনা		
১১.	মোঃ সাহিদুর রহমান কাউন্সিলর, ওয়ার্ড-০৮, খুলনা সিটি কর্পোরেশন, খুলনা		
১২.	সভাপতি, খুলনা প্রেসক্লাব, খুলনা		
১৩.	সম্পাদক, খুলনা প্রেসক্লাব, খুলনা		
১৪.	নির্বাহী প্রকৌশলী, বাংলাদেশ পানি উন্নয়ন বোর্ড, খুলনা		
১৫.	বন সংরক্ষক, খুলনা সার্কেল		বন সংরক্ষকের দপ্তর খুলনা সার্কেল বয়রা, খুলনা।

ক্রমিক নং	নাম/পদবী	মোবাইল নং ও ইমেইল	স্বাক্ষর
১৬.	বিভাগীয় বন কর্মকর্তা, বন্য প্রাণী ব্যবস্থাপনা ও প্রকৃতি সংরক্ষণ বিভাগ, খুলনা		
১৭.	জেলা মৎস্য কর্মকর্তা, খুলনা	[illegible] [illegible]	
১৮.	উপ পরিচালক, বাংলাদেশ কৃষি সম্প্রসারণ অধিদফতর, খুলনা		
১৯.	নির্বাহী প্রকৌশলী, গনপূর্ত বিভাগ,-২ খুলনা		
২০.	নির্বাহী প্রকৌশলী, সড়ক ও জনপদ বিভাগ, খুলনা		
২১.	নির্বাহী প্রকৌশলী, বাংলাদেশ কৃষি উন্নয়ন কর্পোরেশন, খুলনা		
২২.	ভারপ্রাপ্ত কর্মকর্তা, খালিশপুর থানা, খুলনা		
২৩.	প্রধান শিক্ষক, খুলনা নিউজপ্রিন্ট মিলস্ স্কুল, খুলনা	[illegible]	
২৪.	ইমাম, খুলনা নিউজপ্রিন্ট মিলস্ মসজিদ, খুলনা		
২৫.	মো: [illegible]	01711 332635	
২৬.	মো: [illegible]	01712-515741	
২৭.	মো: [illegible] -	[illegible]	
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Annex 3
"Chance Find" Procedures for Physical Cultural Resources

1.0 Introduction

These procedures describe the measures to be undertaken if an accidental discovery or chance find, or an encounter with a physical cultural resource (PCR) occurred during the construction phase. The chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by NWPGCL and the EPC Contractor, in consultation with the Department of Archaeology (DOA) or the Ministry of Cultural Affairs to ensure compliance to The Antiquities Act 1968 (amended 1976), National Cultural Policy 2006, and applicable regulations. The PCRP will be included in the Construction Management Plan that will be required from the EPC Contractor. The objectives of these procedures are to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during excavation other earthmoving works and ground alteration along the 12 km gas distribution pipeline route from the Khulna CGS to Rupsha 800 MW CCPP and the existing Khulna 225 MW CCPP.

2.0 Orientation and/or Briefing of Workers

The EPC Contractor, with technical support from the DOA or Ministry of Cultural Affairs and PMU, NWPGCL will conduct an orientation or training for all workers, particularly those who will be involved in earth movements and excavation on how to recognize artifacts that they may potentially encounter or discover. The EPC Contractor will be responsible for creating awareness to construction personnel on the ADB requirements for any unanticipated impacts such as discovery of a physical cultural resource.

An archeological map of Bangladesh (if available) will be obtained from the DOA or other relevant sources to examine if there are potential "hot spots" within the project area. This map will be part of the references on-site to guide the construction supervision staff in determining the potential "hot spots."

3.0 Procedures

3.1 General

In case a PCR was encountered during excavation, construction activities including traffic within a 30.5-meter radius in the area will be stopped immediately by the EPC Contractor. The discovery will be reported by the site engineer or representative from the EPC Contractor to PMU, NWPGCL environment staff (or Consultant). The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken. The construction supervision staff of the EPC Contractor and PMU, NWPGCL site engineer/staff will secure the site to prevent damage, loss or pilferage of removable objects. Site Engineer of PMU, NWPGCL or designated staff will be responsible for coordinating with DOA.

If the encounter involves removable items, a security person will be posted until the representative of DOA or Ministry of Cultural Affairs arrives to assess and determine its value. The DOA staff will be responsible in determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the DOA staff.

If the chance find will have significant cultural value, this may entail consequent changes in the lay-out particularly if the discovery is considered or assessed as remains of cultural or archeological importance that is not removable.

EPC Contractor will not be entitled for compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.2 Assessment and Recovery

Appropriate heavy equipment such as wheel loader will be made available to recover the excavated material from the excavation site to allow the geologist onsite or the DOA staff to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the chance find is part of a large artifact, deposit or structure, the inspection or recording will include photography and video on an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.3 Resumption of Work

The Contractor can continue with excavation and construction works within the affected area after the DOA staff has given clearance. All the discovered objects of value will be given to the Government.

4.0 Reporting

The EPC Contractor will prepare a “Chance Find” Report within a week showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to PMU, NWPGCL who will provide it to the DOA or Ministry of Cultural Affairs. The chance find including measures on how it was dealt with will be included in the EMoP submitted to ADB.

Annex 4
Format of Environmental Monitoring Report

Environmental Monitoring Report

{Annual/Semestral} Report
{Month Year}

BAN: Rupsha 800 MW Combined Cycle Power Plant Project

Prepared by the North-West Power Generation Company Limited for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of {Day Month Year})

{The date of the currency equivalents must be within 2 months from the date on the cover.}

Currency unit	–	{currency name in lowercase (Symbol)}
{Symbol}1.00	=	${ }
$1.00	=	{Symbol_____}

ABBREVIATIONS

{AAA}	–	{spell out (capitalize only proper names)}
{BBB}	–	{spell out}
{CCC}	–	{spell out}

WEIGHTS AND MEASURES

{symbol 1 (full name 1)}	–	{Definition 1}
{symbol 2 (full name 2)}	–	{Definition 2}
{symbol 3 (full name 3)}	–	{Definition 3}

GLOSSARY

{Term 1}	–	{Definition 1}
{Term 2}	–	{Definition 2}
{Term 3}	–	{Definition 3}

NOTE

In this report, "$" refers to US dollars.

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Document stage: Draft
Project Number: 50161-003
May 2018

Bangladesh: Rupsha 800-Megawatt Combined Cycle Power Plant Project

Volume 3
(Component 3–Power Transmission Interconnection)

Prepared by North-West Power Generation Company Limited for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 14 February 2018)

Currency unit	–	taka (Tk)
Tk1.00	=	$0.0120548
$1.00	=	Tk82.96

ABBREVIATIONS

ADB	–	Asian Development Bank
CCPP	–	combined cycle power plant
COD	–	chemical oxygen demand
CITES	–	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DPHE	–	Department of Public Health Engineering
DO	–	dissolved oxygen
DoE	–	Department of Environment
EA	–	executing agency
EC	–	electrical conductivity
ECA	–	Environment Conservation Act
ECC	–	Environmental Clearance Certificate
ECR	–	Environment Conservation Rules
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EMoP	–	Environmental Monitoring Plan
IEE	–	Initial Environmental Examination
MoEF	–	Ministry of Environment and Forests
PMU	–	project management unit
RoW	–	right-of-way
SPS	–	Safeguard Policy Statement

WEIGHTS AND MEASURES

^{o}C	–	degree Celsius
dB(A)	–	A-weighted decibel
decimal	–	unit of area approx. equal to 1/100 acre (40.46 m^2)
ha	–	hectare
JTU	–	Jackson Turbidity Unit
lac	–	100,000
mg/L	–	milligram per liter
ppm	–	parts per million
µg/Nm^3	–	microgram per normal cubic meter
m^2	–	square meter

GLOSSARY

Bangla	–	official language of Bangladesh
gher	–	farming where a pond is dug into a rice field to use for fish farming and with the dugout soil used to create dykes around the pond for growing vegetables (traditional agriculture system in Bangladesh)
hydrostatic testing	–	process of filling a pipeline with water, or a mixture of water and ethylene glycol or methanol to test the structural integrity of the pipeline under pressure
khal	–	Bangla word for a small channel or canal
thana	–	sub-district level of government administration, comprising several unions under the district
union	–	smallest unit of local self-government comprising several villages
upazila	–	Bengali for subdistrict (formerly called *thana*)

NOTE

In this report, "$" refers to United States dollars.

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EXECUTIVE SUMMARY

Introduction

1. North-West Power Generation Company Limited (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB) has taken the initiative to enhance the power generation capacity of Bangladesh to address the growing demand for electricity. This initiative will involve the construction of a new Rupsha 800 MW Combined Cycle Power Plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP will be designed to use natural gas as the main fuel and high speed diesel (HSD) as back-up fuel (about 500 hours maximum annually). The Government of Bangladesh (GoB) has applied for financing of this new power plant from the Asian Development Bank (ADB). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

Project Description

2. Key interrelated project components include: (i) the development and operation of the Rupsha 800 MW gas-fired CCPP (Component 1); (ii) the construction of a gas distribution pipeline and related network infrastructure ensuring reliable supply of fuel to the CCPP (Component 2); (iii) the construction of a power transmission interconnection facility to transfer the generated power to the national grid at the existing substation in Khulna (Component 3); and (iv) capacity strengthening of NWPGCL (Component 4).

3. Component 3 will consist of the power transmission interconnection from the new substation within the Rupsha 800 MW CCPP complex in Khalishpur to the existing 230/132 kV Khulna South substation (SS) located in the outskirt of Khulna City. The power transmission interconnection will involve construction of about 29.3 km, 230 kV double circuit overhead transmission line (24.561 km new transmission line and 4.7 km stringing of an existing single line from Khulna South SS to Mongla transmission line) from the new switchyard at Rupsha 800 MW CCPP to the existing Khulna SS. A total of about 75 transmission towers will be installed consisting of 25 angle towers, 48 suspension towers, and 2 terminal towers. The base of a transmission tower will require about 400 m^2 (20 m x 20 m). The alignment of Component 3 will not traverse areas that are protected by the GoB but will cross three major rivers: Bhairab River (once), Rupsha River (twice), and Atai River (thrice).

4. Occupying an area of 12.96 acres, the Khulna South SS is part of the West Zone Power System Development Project funded by ADB and the Nordic Development Fund, and was commissioned on 29 January 2007. The 4.7 km stringing is part of the 24-km four circuit 230 kV Mongla to Khulna South SS transmission line project of the Power Grid Company of Bangladesh (PGCB) funded by GoB. The 230 kV transmission line from Mongla to Khulna South SS has completed the requirements of the Environmental Conservation Rules (ECR) 1997 of the Department of Environment (DoE) for red category project. Together, these transmission lines form part of the power evacuation interconnection facilities in southwestern Bangladesh.

4. NWPGCL will be the executing agency of the entire project. On 17 October 2015, NWPGCL approved its Environmental, Health & Safety and Social Policy. NWPGCL is also certified in ISO 9001, ISO 14001, BS OSHAS 18001 valid until October 2019.

5. To manage the day-to-day implementation of the project, NWPGCL will create a Project Management Unit (PMU) that will have about 80 staff. NWPGCL will get the necessary technical support from the Sundarban Gas Company Limited (SGCL) for Component 2 and the Power Grid Corporation of Bangladesh (PGCB) for Component 3. The project will have a high-level Project Steering Committee (PSC) consisting of members from various government departments, NWPGCL, PGCB and SGCL will act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB.

Environmental Requirements

6. **National requirements.** The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the ECR 1997. Under these regulations, except for Component 4, all the three components of the Project are "Red" category requiring an environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (ToR) of the EIA for Component 3 was approved by the DoE on 3 November 2016 (see **Annex 1**). NWPGCL has obtained exemptions for submitting an IEE in obtaining the SCC for all the project components as follows:

(1) Component 1 – 5 November 2017; DoE/Clearance/5584/2016/564
(2) Component 2 – 5 November 2017; DoE/Clearance/5668/2016/563
(3) Component 3 – 5 November 2017; DoE/Clearance/5669/2016/549

7. In August 2016, NWPGCL contracted the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, to prepare the EIAs for the three components.

8. **ADB and IsDB requirements.** The project is subject to the environmental requirements of both ADB and IsDB since NWPGCL is seeking their financial support. The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility. Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

9. Under SPS 2009, projects are screened and categorized based on their potential environmental impacts. Following this screening procedure, the project is category A on environment which requires the preparation of an environmental impact assessment (EIA).[1] This EIA (Volume 3) covers the Component 3 of the project.

Description of the Existing Environment

10. The description of the existing environment for Component 3 was based on the areas that will be traversed by the overhead transmission line, the right-of-way (RoW) of 20 m, and

[1] Asian Development Bank Safeguard Policy Statement (SPS 2009), https://www.adb.org/documents/safeguard-policy-statement. (Accessed 23 November 2017)

another 40 m on each side of the RoW. This is referred to as the study area of about 292.61 hectares (ha).

11. Based on the Earthquake Zoning of Bangladesh, Component 3 lies within Zone III (Low Risk) which is the least vulnerable in terms of seismicity compared to the other parts of Bangladesh like Sylhet (Zone 1, high risk). Based on the 30-year meteorological record (1985-2015) from the Bangladesh Meteorological Department, the monthly variation of maximum temperature in Khulna is 30.7ºC to 40.7ºC, while the monthly minimum temperature varies between 6.4ºC to 22.2ºC. The maximum temperature recorded was 40.7ºC in 2014 while a minimum temperature of 6.4°C was recorded in 2003.

12. According to Köppen climate classification, Khulna division falls under Aw category which is characterized by tropical wet and dry climate. The average annual rainfall is recorded at 1,808 mm/year while the monthly average maximum rainfall occurred in July (928 mm/month). The highest yearly rainfall was recorded in 2002 at 2,594 mm/year.

13. Ambient air quality was based on the continuous monitoring through the World Bank-funded Clean Air and Sustainable Environment (CASE) Project of the DoE which started monitoring in November 2011. CASE project monitors the criteria pollutants such as CO, NO_2, O_3, SO_2, PM_{10} and $PM_{2.5}$. Results show that the criteria pollutants of concern in Khulna are PM_{10} and $PM_{2.5}$. Existing sources of air pollution are vehicular emissions, brickfields, power generation, and industries.

14. There are three major rivers within the study area: Bhairab River, Atai River, and Rupsha River which are influenced by the tidal action of the Bay of Bengal. Existing sources of water pollution are navigation, river bank erosion, industries, and domestic wastes. Bhairab River receives most of the wastewater discharges from Khulna City. Existing beneficial uses of these rivers are navigation, subsistence fishing, swimming, industrial purposes, general purpose washing, and agriculture. Culture fisheries occupy about 17.4 ha while capture fisheries covers 17.81 ha. The estimated fish production is about 18 metric tons.

15. According to Bangladesh Bureau of Statistics (BBS) 2012, the total population is 278,187 with a household size of 4. Literacy rate is 60% while employment rate is 41%. About 43% of the population belongs to the age group of 25-59 years old. Main source of drinking water is tube well (97.31%).

Anticipated Impacts and Mitigation Measures

16. Considering the base of a transmission tower as 20 m x 20 m, the area affected and permanently lost due to 75 tower bases will be about 3 ha. With a right-of-way (RoW) of 10 m on each side of the transmission line, the area that will be affected is 49.122 ha. Thus, the total land within the direct impact area will be 52.122 ha. With a buffer of 40 m on each side of the RoW, the total land area that may be indirectly affected will be about 196.488 ha. The alignment of Component 3 will not traverse areas that are protected by the GoB but will cross three major rivers: Bhairab River (once), Rupsha River (twice), and Atai River (thrice).

17. Implementation of Component 3 will involve the following activities: route survey, establishment of construction camps for workers, site preparation and vegetation clearing, erection of towers, stringing of conductors, clearing of RoW, and operation and maintenance of the transmission line.

18. Environmental impacts associated with construction phase are increased dust and noise levels, potential traffic congestion, generation of wastes, impairment of surface water quality in Bhairab River, Atai River, and Rupsha River, loss of about 11.44 tons high yield variety (HYV)crops, clearing of vegetation within 52.122 ha to accommodate the 75 tower bases and RoW, and occupational and safety risks.Construction works may temporarily damage the *ghers* area near the bank of Rupsha River at Tentultola village resulting to a loss of about 81 m^2.

19. Before construction works start, PMU, NWPGCL will conduct orientation to the Engineering, Procurement, and Construction (EPC) Contractor and workers on their roles and responsibilities in complying with the requirements of DoE and ADB, emergency preparedness including awareness on HIV/AIDS to prevent potential incidence in the workplace. A Construction Management Plan (CMP) outlining actions and measures to manage potential environmental impacts during construction phase will be required from the EPC Contractor. The environmental management plan (EMP) will be referred to in the CMP which will be reviewed and approved by PMU, NWPGCL.

20. Erection of about 75 transmission towers will involve considerable excavation works, a "chance find" procedures will guide workers in the event a physical cultural resource may be discovered or affected.

21. EPC Contractor will provide workers with personal protective equipment (PPE) for mandatory use if needed, sanitary facilities, wash areas, safe drinking water, and adequate water supply for general washing purposes. No field camps will be located close to Bhairab River, Rupsha River, Atai River and other water bodies. Construction sites will be provided with first aid kit, garbage bins, fire-fighting equipment, and good housekeeping will be enforced at all times. Clear and visible safety and danger signs will be posted by the EPC Contractor at and around the field camps that may be enclosed to contain dust and reduce ambient noise. Oil-water separator will be used to deal with oily wastes generated. Compliance of EPC Contractor to relevant provisions in ECR 1997 on discharge of wastewater including waste management at the construction sites will be monitored by PMU, NWPGCL.

22. During operation, improper disposal of used mineral oil as insulating medium to electrical equipment in the new substation at Rupsha 800 MW CCPP may affect water quality of Bhairab River and may also cause land contamination.

23. No polychlorinated biphenyls (PCB) or PCB-containing material will be used in Component 3. Excess chemicals that may be needed for construction and operation will be labelled properly and disposed of following its material safety data sheet. EPC Contractor will be encouraged to use non-toxic and biodegradable chemicals on-site.

24. Overhead transmission lines have always been associated with concerns on potential risks of cancer from exposure to electromagnetic field (EMF) from overhead transmission lines and substations. However, in spite of all the studies that have been carried out over the past 30 years, there is still no persuasive evidence that the fields pose any health risks. The World Health Organization (June 2007) recommends using exposure guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP has set the limit of exposure for the general public as: (1) electric field (kV per meter) is 4.17 and (2) magnetic field is 833 milliGauss (mG).

25. The British Columbia Hydro measured the magnetic field levels near their transmission and distribution lines. For 230 kV, the magnetic field level at 0 m from the line is 38 mG, 28 mG

at 10 m, 15 mG at 20 m, 8 mG at 30 m and 5 mG at 40 m.[2] These levels are much lower than the magnetic fields in the house: (1) hairdryer (300 mG), (2) dishwasher (20 mG), and (3) washing machine (20 mG) taken 6 inches from the source.[3]

26. To avoid the impacts of EMF, houses will not be allowed within the RoW of the project. During the design, the transmission line and substation equipment will be rated to ensure EMF is within the permissible limits specified in the EHS guidelines.

Analysis of Alternatives

27. A "no project" option means that the area along the proposed alignment of Component 3 will remain the same as the current condition. However, the power to be generated by the Rupsha 800 MW CCPP will not be evacuated to the national grid. The "with project" option evaluated three routes and the selected alignment will not pass through protected areas, any bird habitats, and dense settlements.

Information Disclosure, Consultation and Participation

28. A total of four consultation events were conducted on 11 November 2016 and on 21 December 2016 by the CEGIS, consultant of NWPGCL for Component 3. Participated by 54 persons, these consultation events were done through key informant interviews, focus group discussions, and public meetings. Consultations were conducted in Dighalia, Batiaghata, and Malapara. Among the concerns raised during the consultations are compensation not only for the crops that may be damaged but also the land that is permanently lost due to tower footings. Overall, the local people within the project area are supportive of Component 3. Consultations will continue and a program for consultation will be finalized by NWPGCL with support from communications expert to ensure that stakeholders are consulted, as and when needed.

29. A project summary with details on grievance redress mechanism (GRM), and contact person in case of complaints will be prepared in Bangla (and English) and will be made available at the field office of PMU in Khaliaspur, Khulna and at the NWPGCL office in Dhaka. More details on Component 3 will also be available from the EIA posted in the website of ADB.

Grievance Redress Mechanism

30. NWPGCL currently manages grievance and/or complaints through the Grievance Redress System (GRS) which is required by the GoB and part of the mandatory Annual Performance Agreement (APA). This agreement will be signed and renewed annually between NWPGCL and GoB.

31. To meet the requirements of SPS 2009, a grievance redress mechanism (GRM) will be set up once ADB funding for Component 3 becomes effective. The GRM will provide three-tier entry points in grievance redress. Two grievance redress committees (GRCs) will be formed: (i) local grievance redress committee (LGRC); and (ii) project grievance redress committee (PGRC). Grievances considered minor can be resolved onsite at the LGRC level within 7 days from receipt of complaint. Other complaints not resolved at the LGRC level will be forwarded to PGRC which will take two weeks (or 14 days) to resolve. Meetings of the LGRC will be held

[2] BC Hydro Power Smart. Understanding Electric and Magnetic Fields. https://www.bchydro.com/.../BCHydro/.../understanding-emf-booklet-jan2017.pdf
[3] US EPA. EMF in Your Environment. December 1992. https://nepis.epa.gov/.

onsite (PMU office) and members may do site visits to check or verify the issue. Complainants will be informed of the status of resolution. The third tier entry point for grievance redress will be the appropriate rule of court. NWPGCL will ensure the representation of women in the members of the GRCs.

(a) LGRC – members will include (i) Deputy Manager/Executive Engineer (Environment) of PMU, (ii) Ward member, (iii) community representative, (iv) representative of women affected persons, and (v) EPC Contractor representative

(b) PGRC – members will include (i) Project Director(PD), NWPGCL as the Chairperson, (ii) Environment staff of Project Management and Construction (PMC) consultant, and (iii) representative of civil society nominated by PD with the help of PMC.

Environmental Management Plan

32. The Corporate environmental staff of NWPGCL and the PMU will monitor the EPC Contractor on its compliance to the EMP. Environmental monitoring plans (EMoPs) have been prepared. A total of BDT 76Lakh has been budgeted for the 3-year implementation of EMP. Environmental monitoring reports will be submitted by PMU to ADB semi-annually during construction phase and annually during operation. The environmental monitoring reports will be posted in the ADB website as required by SPS 2009 and PCP 2011.

Conclusion and Recommendation

33. The EIA for Component 3 was prepared following the requirements of the DoE and ADB. An EMP and EMoP were included in the EIA with cost estimates.

34. The transmission line route was selected considering potential environmental impacts and avoiding areas protected by GoB such as national park, wetlands of wildlife sanctuary. Environmental impacts due to the implementation of Component 3 can be easily mitigated by proper planning, best practices in construction engineering, and compliance to the EMP and environmental requirements of DoE and ADB.

35. Stakeholders have been identified and consulted during the preparation of the EIA and will continue throughout the project cycle. The GRM has been identified and will be set up as soon as the funding of the project becomes effective.

36. This draft EIA will be disclosed at the ADB website as required by SPS 2009 and PCP 2011. Prior to construction works, all the relevant permits required for Component 3 will be obtained by NWPGCL.

1.0 INTRODUCTION

1. The Power System Master Plan 2016 recommends for diversification in the use of fuel for power generation such as domestic and imported coal and natural gas, oil, nuclear power, and renewable energy.[4] Consistent with this, the North-West Power Generation Company Limited (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB) has taken the initiative to enhance the power generation capacity of Bangladesh to address the growing demand for electricity. This initiative will involve the construction of a new Rupsha 800 MW Combined Cycle Power Plant (CCPP) in Khalishpur Upazila, Khulna District in the administrative division of South-Western Bangladesh. The Rupsha 800 MW CCPP will be designed to use natural gas as the main fuel and high speed diesel (HSD) as the back-up fuel (about 500 hours maximum annually). The Government of Bangladesh (GoB) has applied for financing of this new power plant from the Asian Development Bank (ADB). The Islamic Development Bank (IsDB) is expected to co-finance about 20% of the total project cost.

2. The objectives of this initiative include the following:

- To contribute in meeting the demand for electricity and to increase reliability of supply by minimizing load-shedding;
- To support in achieving the vision of GoB, "Power to All by 2021;"
- To reduce the increasing gap between demand and supply of electricity throughout the country;
- To accelerate economic development by providing adequate and reliable power generation;
- To enhance the stability and reliability of the national grid system, and to reduce the systems loss by local generation; and
- To develop human resource through technology transfer.

3. Overall, the goal is to improve the economic growth of Bangladesh by providing a reliable and stable power supply with this initiative.

1.1 Overview of the Project

4. The project targets strengthening energy security in Bangladesh. The country faces serious electricity shortages in the short- to medium-term and needs to secure cost-effective, new and diversified energy sources. Key interrelated project components include: (i) the development and operation of the Rupsha 800 MW gas-fired CCPP; (ii) the construction of a gas distribution pipeline and related network infrastructure ensuring reliable supply of fuel to the CCPP; (iii) the construction of a power transmission interconnection facility to transfer the generated power to the national grid at the existing substation in Khulna; and (iv) capacity strengthening of NWPGCL. The project will establish the first ever power plant to use gas from the Bangladesh gas transmission network, where its gas supply would be attributed to LNG imported into Bangladesh. **Figure 1.1** shows the project.

[4] Ministry of Power, Energy and Mineral Resources, and Bangladesh Power Development Board. People's Republic of Bangladesh Power & Energy Sector Master Plan. http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised.pdf. (Accessed 18 August 2017)

Component 1: Rupsha 800 MW CCPP

5. Rupsha 800 MW CCPP will be built in the (now abandoned) Khulna newsprint factory premises. The power plant will use combined cycle gas turbine technology, comprising two identical generating units, each nominally rated at 400 MW. Each combined cycle unit will consist of one gas turbine and one heat recovery steam generator (HRSG), forming a one-on-one configuration. At full capacity of 800 MW, the Rupsha power plant is capable of meeting 5% of the forecast peak demand of Bangladesh in year 2022. The cooling system will be closed-loop forced-draught cooling tower system that will require 2,010 m^3/hour of water to be taken from the Bhairab River.

Component 2: Gas Supply to the Power Plant

6. Petrobangla, the national gas utility and the single-buyer for the gas industry, will procure liquefied natural gas (LNG) from international sources and deliver regasified LNG to Khulna city gas station (CGS). The regional gas distribution company, Sundarban Gas Company Limited (SGCL) will deliver gas from the existing Khulna CGS in Arongghata to the Rupsha power plant in Khalishpur. A new 24-inch (0.6 m) underground gas pipeline about 10 km long will be installed from Khulna CGS to the Rupsha 800 MW power plant. The gas receiving and metering station (RMS) will be located at the Rupsha power plant. In addition, a new 20-inch (0.5 m) underground gas pipeline 2 km long will be branched off from the line from Khulna CGS to Rupsha power plant, to serve NWPGCL's existing Khulna 225 MW power plant. Owing to non-availability of gas, this 225 MW power plant is presently operating on diesel.

Component 3: Power Transmission Interconnection

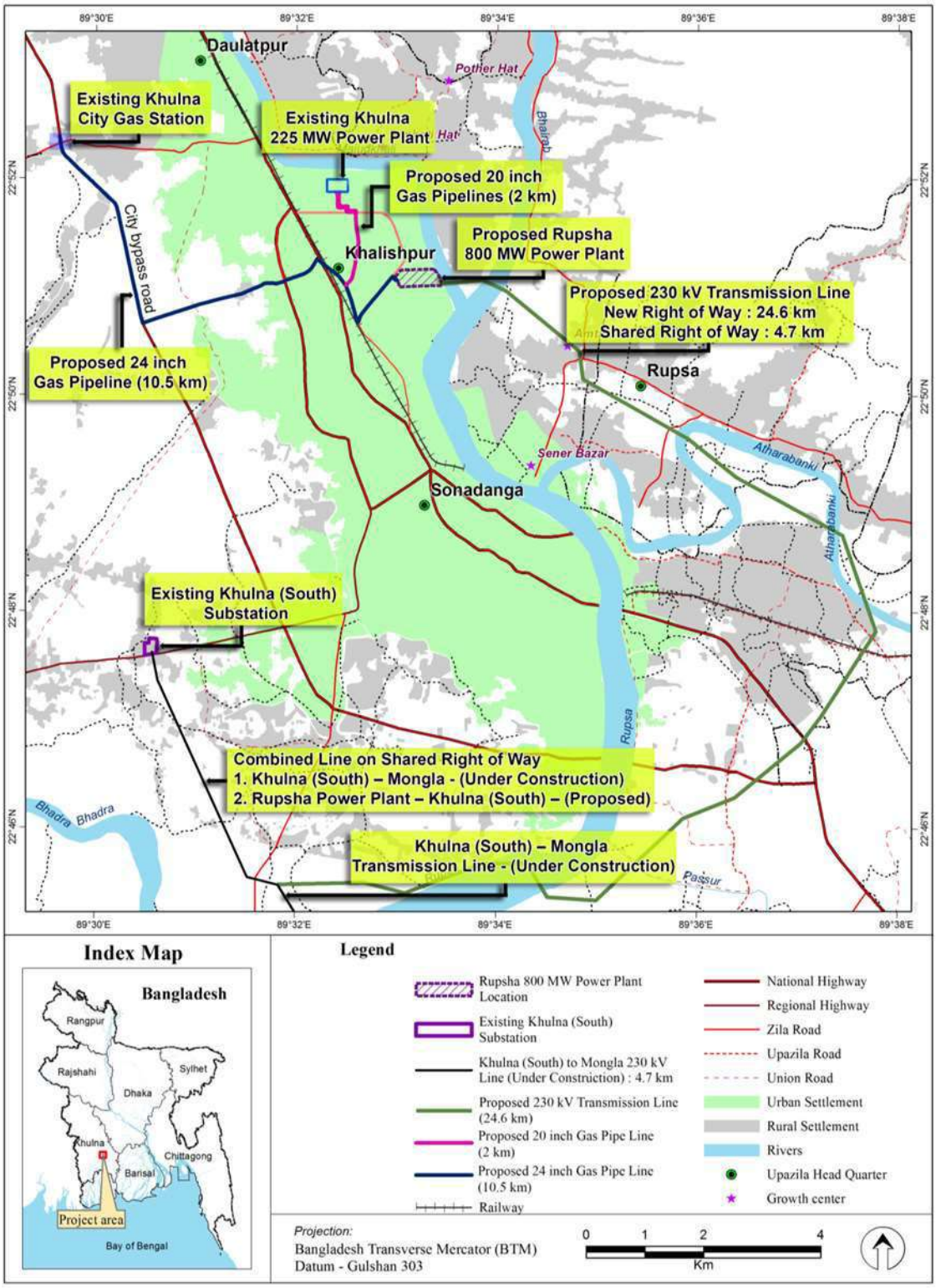
7. Electricity generated in the Rupsha power plant will be stepped-up to the transmission voltage of 230 kilovolt (kV). A new 29.3 km transmission line will be built from Rupsha 800 MW CCPP to the existing Khulna SS. The conductor to be used is twin-ACCC Hamburg[5], and the line will have two circuits, each capable of transferring 1400 MW. The new transmission line will require three main river crossings and three minor river crossings, and would traverse for 29.3 km, mostly through rice fields. Upon reaching the existing Khulna SS, the line will be terminated at two new line bays and termination equipment to be installed under the project. Thereafter, electricity produced at Rupsha power plant will flow into the 230 kV transmission network to serve the electricity demand in Khulna and elsewhere in the country.

Component 4: Capacity Strengthening of NWPGCL

8. Strengthening institutional capacity has the following three major subcomponents: (i) improving project implementation, management, and construction supervision capabilities; (ii) establishing enterprise resource planning (ERP) system in NWPGCL; and (iii) enhancing operation and maintenance practices through procurement and installation of modern and high technology universal power plant operations training simulator. Project management and construction supervision support will be provided for the development of Rupsha power plant. ERP system support includes both hardware and software for introducing computerized management system for NWPGCL. The ERP system will substantially improve business process and NWPGCL's efficiency and transparency by computerizing the Financial Accounting, Budgeting & Costing, Human Resource Management, Procurement Inventory, Planning and Monitoring, Operations & Maintenance and Project Management and Accounting.

[5] Aluminium Conductor Composite Core (ACCC) Hamburg has a current carrying capability of 1440 ampere at 120^0C.

Figure 1.1: Location Map

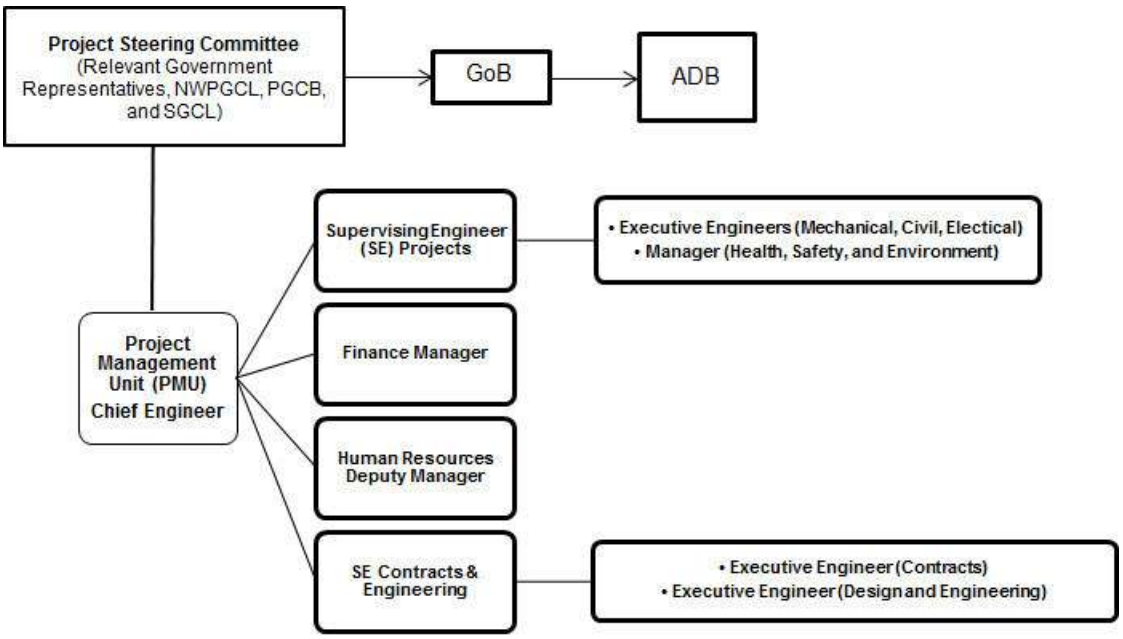


1.2 Project Implementation Arrangements

9. Implementation supervision for the Rupsha 800 MW CCPP, power transmission, and gas distribution facilities will be carried out by the NWPGCL with assistance from a team of international and national implementation consultants. From time to time, assistance will be provided by the Power Grid Company of Bangladesh (PGCB) for Component 3, and the SGCL for Component 2 to ensure that coordination is achieved and implementation progresses smoothly. During construction, further assistance will be provided by SGCL and PGCB for approval of detailed design and drawings submitted by the contractors of Component 2 and Component 3, respectively. This arrangement has worked well for the Bheramara 360 MW CCPP project financed by the Japan International Cooperation Agency (JICA), which is very similar to the Rupsha 800 MW CCPP.

10. NWPGCL is currently setting up the PMU and so far, has assigned limited staff to it. The organogram (see **Figure 1.2**) prepared for the PMU shows the unit will have a compliment of 80 staff. It will be headed by a Chief Engineer, and will have 4 divisions, headed by: (i) Supervising Engineer (SE) Projects; (ii) Manager Finance; (iii) Deputy Manager Human Resources and (iv) SE Contracts & Engineering. SE Projects will have reporting to him, three Executive Engineers, (Mechanical, Civil, and Electrical) and Manager Health, Safety and Environment (HSE) while the SE Contracts& Engineering will have reporting to him Executive Engineer Contracts and Executive Engineer Design and Engineering. In addition, the project will have a high-level Project Steering Committee (PSC) consisting of members from various government departments, NWPGCL, PGCB and SGCL and act as overseer of the project. The steering committee will meet every quarter to monitor progress and will report to the GoB.

Figure 1.2: Project Implementation Arrangements



1.3 The Need for Environmental Assessment

11. The project is subject to the environmental requirements of GoB, ADB, and IsDB since NWPGCL is seeking the financial support of ADB and IsDB.

1.3.1 National Requirements

12. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997. Under these regulations, all the three components of the Project are "Red" category requiring and environmental clearance certificate (ECC). Securing the ECC involves two steps: (i) issuance of locational (or site) clearance certificate (SCC), and then (ii) the ECC. An initial environmental examination (IEE) is required for the SCC and an environmental impact assessment (EIA) is required for the ECC. The terms of reference (TOR) of the EIA needs the approval of the Department of Environment (DoE). The DoE is the authority that regulates and enforces environmental management regulations to ensure that development projects are implemented sustainably, and to conserve and manage the environment in Bangladesh.

13. NWPGCL has obtained exemptions for submitting an IEE and approval of the TOR of the EIA in obtaining the SCC for all the project components as follows:

(1) Component 1 – 5 November 2017; DoE/Clearance/5584/2016/564
(2) Component 2 – 5 November 2017; DoE/Clearance/5668/2016/563
(3) Component 3 – 5 November 2017; DoE/Clearance/5669/2016/549

14. The ToR of the EIA for Component 3 was approved by the DoE on 3 November 2016 (see **Annex 1)**. Without the EIA approved by DoE, NWPGCL cannot open line of credit in favor of importable machineries and cannot start any physical activities for the project. In 2016, NWPGCL has engaged the Center for Environmental and Geographic Information Services (CEGIS) to prepare the EIAs of all the project components required by the DoE.

1.3.2 Environmental requirements of ADB and IsDB

15. Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[6] Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

16. Under SPS 2009, projects that require funding from ADB will be subject to screening and categorization based on their potential environmental impacts. The project has four components: (i) Component 1 – Rupsha 800 MW CCPP, Component 2 – Gas Supply to the Power Plant, Component 3 – Power Transmission Interconnection, and Component 4 – Capacity Strengthening of NWPGCL. Component 4 is not expected to have adverse

[6] IsDB.Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nation's Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

environmental impacts. The project is category A on environment according to ADB's SPS 2009 which requires the preparation of an EIA.[7]

17. The EIA required by ADB was based on the findings of CEGIS and additional research for available secondary data to meet SPS 2009. Aside from the EIA, NWPGCL will provide ADB a copy of the ECC issued by the DoE for all the project components.

1.4 Structure of the Report

18. Following the requirements of SPS 2009, the environmental assessment for the project is presented as follows:

1) Volume 1 – EIA of Component 1;
2) Volume 2 – EIA of Component 2; and
3) Volume 3 – EIA of Component 3.

19. The EIAs of all the project components are based generally on the EIA format given in Annex to Appendix 1 of SPS 2009, pp41-43. This EIA covers Component 3 – Power Transmission Interconnection.

[7]Asian Development Bank Safeguard Policy Statement (SPS 2009), https://www.adb.org/documents/safeguard-policy-statement.

2.0 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 National environmental agency

20. The Ministry of Environment and Forests (MoEF) is the agency responsible for planning, promoting, coordinating and overseeing the implementation of programs and plans regarding environment and forestry. The MoEF deals with all national environmental matters and is responsible for the prevention and control of pollution, forestation and regeneration of degraded areas and protection of the environment, and in the framework of legislations. MoEF also undertakes surveys, impact assessment, pollution control, research, and collection and dissemination of environmental information, as well as environmental awareness among all sectors in Bangladesh.

21. Under the MoEF is the Department of Environment (DoE), which performs regulatory functions. DoE was created in 1989 as the primary government agency responsible for enforcing environmental management regulations to ensure sustainable development and to conserve and manage the environment. The DoE ensures the consistent application of environmental rules and regulations, and provides guidance, training and promotional campaign on improving environmental awareness.

2.2 National environmental regulations

22. The main environmental regulations in Bangladesh are the Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and Environment Conservation Rules (ECR) 1997. ECA 1995 provides the requirements on environmental protection, improvement of environmental standards, and control and abatement of environmental pollution. Through the ECA 1995, the DoE is mandated to undertake any activity needed to conserve and enhance the quality of environment and to control, prevent and mitigate pollution.

23. ECR 1997 provides for the declaration of ecologically-critical areas, categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.; (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for the IEE and the EIA based on categories of industrial and other development interventions. ECA 1995 and ECR 1997 outline the regulatory mechanism to protect the environment in Bangladesh. Aside from ECA 1995 and ECR 1997, **Table 2.1** presents a summary of relevant environmental regulations.

Table 2.1: Relevant national environmental regulations

Regulation	Brief Description	Remarks
Environment Court Act 2000 (amended in 2002 and 2010)	This Act is under the Judiciary and MoEF to ensure the resolution of disputes on environmental and social damages resulting from any development activities. This Act also allows for the completion of environment-related legal proceedings effectively.	NWPGCL will ensure that all potential environmental complaints will be dealt with effectively at the project level through the PMU. SPS 2009 requires setting up of a grievance redress mechanism for projects known to cause potential environmental impacts.
Bangladesh Water	Makes provisions for integrated	Component 3 will cross three major

Regulation	Brief Description	Remarks
Act 2013	development, management, abstraction, distribution, use, protection and conservation of water resources	rivers: Bhairab River, Atai River, and Rupsha River and NWPGCL will ensure compliance of this Act.
Vehicle Act 1927, the Motor Vehicles Ordinance 1983	These are under the Bangladesh Road Transport Authority (BRTA) which regulates vehicular emissions and noise including road safety.	This regulation will be complied with by vehicles that may be used during construction and operation of Component 3.
Factories Act 1965 and Bangladesh Labour 2006, Bangladesh Labor Act 2013	Regulations that aim to protect the interests and rights of the workers and to ensure their safety.	Workers recruited under Component 3 will be provided with PPE (if needed) and will comply with these regulations. No worker under 18 years old will be recruited.
The Forest Act 1927 (amended in 1982 and 1989)	This Act under the MoEF aims to protect the forest resources.	Component 3 will not traverse protected forest area or other forest type.
Telegraph Act 1885	Under the Ministry of Posts and Telecommunications, this provides power to the Telegraph Authority to alter position of gas or water pipes or drain (Sect. 14, a and b).	The route for Component 3 was selected considering this Act.
Electricity Act 1910	Relates to the supply and use of electrical energy, allows any person to secure a license to supply energy and to put down or place electrical supply lines for the transmission of energy. Sect 19(1) of the Act provides that the licensee, in the exercise of any of the powers conferred by or under this Act, will cause as little damage, detriment and inconvenience as may be, and will make full compensation for any damage, detriment or inconvenience caused by the licensee or by any one employed by the licensee.	Component 3 referred to the applicable provisions in this Act.
The Antiquities Act 1968 (amended 1976)	Regulation on the preservation and protection of antiquities.	NWPGCL will have a “chance find” procedures (see **Annex 5**).
Natural Water Bodies Protection Act 2000	According to this Act, the character of water bodies i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans formulated under the laws establishing the municipalities in division and district towns shall not be changed without approval of concerned ministry. This Act is under the Rajdhani Unnayan Kartipakkha/Town Development Authority/Municipalities.	Any part of Component 3 that will cross rivers, ponds, canals, and drainage channels will refer to this Act and will secure the required approval and clearances.
Wildlife (Protection and Safety) Act 2012	Provides for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Under this Act, hunting, trapping, killing of wildlife are strictly prohibited.	Component 3 will not affect areas of habitats known to host wildlife. Route is along urban areas.
Noise Pollution	Provides guidelines on receptor areas:	Associated noise-generating

Regulation	Brief Description	Remarks
Control Rules 2000 (amended 2006)	silent, residential, mixed, commercial or industrial, and sets the limits to noise levels based on receptor areas. Defines daytime hours as 6AM to9PM and nighttime from 9PM to 6AM.	activities of Component 3 will comply with the limits.
National River Protection Act 2013	Creation of National River Protection Commission to manage and control water and environmental pollution, etc., and ensure socio-economic development of a multi-use and rational use of natural resources.	Component 3 will ensure compliance to relevant provisions of this Act
The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	Provides for the requirements for the protection and conservation of fish. This Act defines fish as "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, molluscs, echinoderms and frogs at all stages in their life history."	Component 3 will cross Bhairab River, Rupsha River, and Atai River and will ensure that no protected fish species under this Act will be destroyed or affected. Any potential impact will be mitigated.

Source: ADB Consultant, November 2017

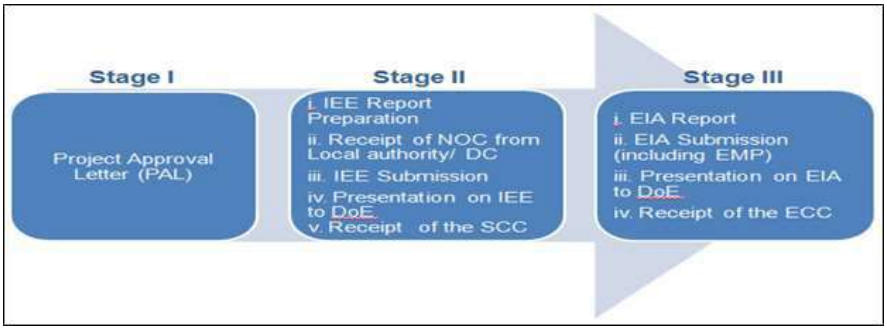
2.3 Overview of the environmental approval process

24. Section 12 of ECA 1995 provides that no industrial unit or project can be established or undertaken without securing an environmental clearance certificate (ECC) from the DoE. Following the requirements of ECR 1997, the DOE has classified various development interventions according to the potential adverse environmental impacts for the purpose of issuing the ECC. This classification includes: (i) green, (ii) orange-A, (iii) orange-B, and (iv) red. Green category refers to industries or projects considered to be relatively pollution-free, thus, no environmental study will be required while the Red category refers to industries/projects which may cause significant adverse environmental impacts and therefore, require an EIA.

25. For projects and industrial units classified as Orange-A, Orange-B, and Red (those that may have potential adverse environmental impacts), securing the ECC involves two steps: (i) issuance of site clearance certificate (SCC), and then (ii) the ECC.

26. SCC will be issued by the DoE upon approval of the IEE, receipt of the No Objection Certificate (NOC), which a "proof of authorization" to initiate a project, and the ToR of the EIA while the ECC will be issued upon the approval of the EIA. The project proponent cannot open line of credit in favor of importable machineries and cannot start any physical activities for the project without the EIA approved by the DoE. **Figure 2.1** shows the process of obtaining the ECC for Red category project.

Figure 2.1: Process of obtaining ECC



2.3.1 National environmental requirements for Component 3

27. According to ECR 1997, Component 3 is Red category requiring an SCC and an ECC. The NOC from the local government, Aviation Authority, and the Department of Forest have been obtained. On 5 November 2017, NWPGCL has obtained for Component 3 the exemption from the DoE for submitting an IEE and approval of the ToR of the EIA (DoE/Clearance/5669/2016/549).

2.4 Relevant International Environmental Agreements

28. **Table 2.2** lists the applicable international environmental agreements where Bangladesh is a signatory which can provide guidance during the implementation of Component 3.

Table 2.2: Relevant international environmental agreements

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972)	Defines and provides for the conservation of world`s heritage by listing the natural and cultural sites whose value should be preserved.	3 November 1983	23 November 1972	Component 3 will have “chance find” procedures
Convention on Biological Diversity (1992)	A framework for biodiversity and requires signatories to develop national strategies (National Biodiversity Strategy and Action Plan) for the conservation and sustainable use of biological diversity.	3 May 1994	29 December 1993	Any replacement of cleared vegetation resulting from Component 3 will be consistent with the objectives and priorities of the current Action Plan.
Convention on International Trade in Endangered	Addresses the exploitation patterns and overharvesting	20 November 1981	1 July 1975	Component 3 will ensure that it will not cause any harvesting

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
Species of Wild Fauna and Flora (Washington 1973) – also known as CITES	that threaten species of flora and fauna. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.			and exploitation of wild flora and fauna during implementation.
Vienna Convention for the Protection of the Ozone Layer	A framework for efforts to protect the globe's ozone layer by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.	2 August 1990	22 March 1985	Component 3 will not use chemicals that can affect the ozone layer like methyl chloroform, a solvent generally used for industrial processes.
Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer)	Designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.	2 August 1990	1 January 1989	Component 3 will not use chemicals that can cause harm to the ozone layer.
Kyoto Protocol (1997)	Commits its Parties to set internationally-binding emission reduction targets. This agreement is linked to the United Nations Framework	22 October 2001	16 February 2005	Component 3will ensure zero or minimal fugitive natural gas emissions.

International Environmental Agreement	Description	Date Ratified	Date Entered into Force	Comments
	Convention on Climate Change (UNFCCC).			
UNFCCC (1992)	Aims to achieve stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system.	15 April 1994	21 March 1994	Component 3 will ensure any operation related to its implementation will comply with this agreement.
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	Aims to reduce the amount of waste produced by signatories and regulate the international traffic in hazardous wastes.	1 April 1993	5 May 1992	Component 3 will ensure that disposal of chemicals used (if and when needed) will follow the instructions in the material data safety sheet.

Source: ADB Consultant, November 2017

2.5 Environmental requirements of ADB and IsDB

29. SPS 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. The IsDB is still in the process of preparing its Statement on Environmental and Social Safeguards Principles, and Commitments to Environmental and Social Responsibility.[8] Given this, ADB and IsDB agreed to adopt SPS 2009 as the unified approach to documentation, consultation, and disclosure requirements to be complied by NWPGCL for this project.

2.5.1 ADB

30. SPS 2009 consists of three key safeguard areas, (i) environment, (ii) involuntary resettlement, and (iii) indigenous peoples; aims to avoid adverse project impacts to both the environment and the affected people; minimize, mitigate and/or compensate for adverse project impacts; and help Borrowers to strengthen their safeguard systems and to develop their capacity in managing the environmental and social risks.

31. During the project identification stage, ADB uses a categorization system to indicate the significance of potential environmental impacts and is determined by the category of its most environmentally-sensitive component, including direct, indirect, cumulative, and induced impacts

[8] IDB. Statement by Dr. Ahmad Mohamed Ali, President, IDB. United Nation as Conference on Sustainable Development (Rio +20), 20-22 June 2012. http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Internet/English/IDB/CM/About%20IDB/President%20IDB%20Group/PS_UN_ConferenceSustainableDevelopment_20June2012.pdf. (Accessed 6 December 2017)

within the project's area of influence. The project categorization system and the assessment required is described in **Table 2.3**.

Table 2.3: SPS 2009 environmental categorization

Category	Definition	Assessment Requirement
A	Likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the sites or facilities subject to physical works.	Environmental impact assessment (EIA)
B	Likely to have adverse environmental impacts that are less adverse than those of Category A. Impacts are site-specific, few if any of them irreversible, and in most cases mitigation measures can be designed more readily than Category A.	Initial Environmental Examination (IEE)
C	Likely to have minimal or no adverse environmental impacts.	No environmental assessment is required but the environmental implications of the project will be reviewed.
FI	Project involves investment of ADB funds to or through a financial intermediary (FI).	FIs will be required to establish an environmental and social management commensurate with the nature and risks of the FI's likely future portfolio to be maintained as part of the FI's overall management system.

Source: ADB. Safeguard Policy Statement 2009, p. 19. http://www.adb.org/sites/default/files/institutional-document/32056/safeguard-policy-statement-june2009.pdf.

2.5.1.1 Environmental requirements of ADB for Component 3

32. Based on SPS 2009, Component 3 is category A given that it is an auxiliary part of the Rupsha 800 MW CCPP. The EIA of Component 3 is referred to in the overall project environmental assessment as Volume 3. This draft EIA was based on the findings of CEGIS and additional research for available secondary data to meet SPS 2009. Aside from this draft EIA, the NWPGCL will provide ADB with a copy of the ECC issued by the DoE for Component 3.

2.5.1.2 Disclosure requirements

33. Aside from SPS 2009, the Public Communications Policy (PCP) 2011 provides for the requirements of disclosure for project information of projects and grants funded by ADB. Consistent with SPS 2009, PCP 2011 requires the disclosure of documents submitted by the borrower and/or client:

(i) a draft EIA report for category A project, at least 120 days before Board consideration;
(ii) a draft EARF, where applicable, before appraisal;[9]
(iii) the final EIA or IEE, upon receipt by ADB;

[9] If no further mission for appraisal is required, the document will be posted before the management review meeting or the first staff review meeting for sovereign projects, or before the final investment committee meeting for non-sovereign projects, as applicable (ADB procedures).

(iv) a new or updated EIA or IEE, and a corrective action plan, if any, prepared during project implementation, upon receipt by ADB; and,
(v) the environmental monitoring reports, upon receipt by ADB.

34. To meet the disclosure requirements of ADB, the EIA of Component 3 will be disclosed to ADB website at least 120 days prior to Board consideration of the project by ADB Management.

2.5.2 IsDB

35. On 8 December 1974, the IsDB was created as an international financial institution in accordance with the Articles of Agreement signed and ratified by all member countries done in the City of Jeddah, Kingdom of Saudi Arabia.[10] Consisting of 57 member countries in Africa, Asia, Europe, and Latin America, IsDB aims to foster the economic development and social progress in its member countries, and Muslim communities in non-member countries. Among others, IsDB is already a key player in the clean energy sector, with investments of around $ 1 billion between 2010 and 2012.[11] Since inception, IsDB has funded about $2.75 billion in renewable energy projects and has allocated 6% of its operation to climate change mitigating projects.[12]

36. During the projects' appraisal/negotiations stage in the IsDB's project cycle, activities cover the review and assessment of the following major aspects of a project: technical, institutional, economic, financial, social, and environmental impact.

37. IsDB is ADB's third-largest multilateral partner for project cofinancing since December 2015 and has signed a framework cofinancing agreement in September 2008 and was extended until 2017.[13]

2.6 Comparison of environmental safeguard principles between ADB and Bangladesh

38. **Table 2.4** presents a summary comparing the environmental safeguard principles of ADB and the Government of Bangladesh (GoB).

Table 2.4: Comparison of environmental safeguard principles

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
1	Use of screening process to determine the appropriate environmental assessment	Uses sector-specific rapid environmental assessment checklist for screening and assigns categories based on potential impacts: • A - EIA required (irreversible, diverse or unprecedented	ECA 1995 and ECR 1997 set screening criteria to classify industries/projects based on potential environmental impacts as follows: Green (pollution-free), Orange-A, Orange-B and Red (cause	No major gaps

[10] Islamic Development Bank, About IsDB. http://www.isdb.org/irj/portal/anonymous?NavigationTarget=navurl://24de0d5f10da906da85e96ac356b7af0
[11] UN Environment. UNEP and Islamic Development Bank Sign Agreement on Environmental Conservation. 20 January 2016. http://web.unep.org/newscentre/unep-and-islamic-development-bank-sign-agreement-environmental-conservation. (Accessed 6 December 2017)
[12] IsDB. What do Islamic Bank Care About the Environment: Role of Islamic Development Bank in Financing Sustainable Development. 6 March 2017.
[13] Asian Development Bank-Islamic Development Bank Partnership and Cofinancing Guide. 2016

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
		adverse environmental impacts) • B - IEE required • C - no environmental assessment required but a review of environmental implications • FI - ESMS required	significant environmental impacts). The screening criteria is based on project or industry type and do not consider the scale and location. The category determines the level of environmental assessment.	
2	Conduct an environmental assessment	• EIA and IEE - Identify potential impacts on physical, biological, physical cultural resources, and socioeconomic aspects in the context of project's area of influence (i.e., primary project site and facilities, and associated facilities) • ESMS for FIs	• Industry/project category • Green- no environmental assessment required • Orange A - no IEE or EIA required but must provide process flow, lay-out showing effluent treatment plant, etc. • Orange B - IEE required • Red - both IEE and EIA are required	No major gaps
3	Examine alternatives	• Analyze alternatives to the project's location, design, and technology • Document rationale for selecting the particular project location, design, and technology • Consider "no project" alternative	• Regulations (i.e., ECA 1995 and ECR 1997) do not require specifically the identification and analysis of alternatives	Not required by law but the ToR for EIA to be approved by the DoE now includes a discussion on analysis of alternatives.
4	Prepare an environmental management plan (EMP)	• EMP to include monitoring, budget and implementation arrangements	• EMP and procedures for monitoring included in the IEE and EIA (i.e., Orange-A, Orange-B, and Red category projects)	No major gaps
5	Carry out meaningful consultation	• Starts early and continues during implementation • Undertaken in an atmosphere free of intimidation • Gender inclusive and responsive • Tailored to the needs of vulnerable groups • Allows for the incorporation of all relevant views of stakeholders • Establish a grievance redress mechanism	• Public consultation and participation are not mandatory based on ECA 1995 and ECR 1997 • Grievance redress mechanism is not mentioned in ECA 1995 and ECR 1997 • EIA format required by DoE includes stakeholders' consultation	Approval of the ToR of EIA by DoE now includes consultation with stakeholders.
6	Timely disclosure of draft environmental assessment (including the EMP)	• Draft EIA report posted on ADB website at least 120 days prior to Board consideration • Draft EA/EARF prior to appraisal • Final or updated EIA/IEE upon receipt • Environmental monitoring	• No requirement for public disclosure of environmental reports but DoE posts the Minutes of the Meeting on the application for environmental clearance certificate to its website, http://www.doe-	Still no requirement for public disclosure of environmental assessment

SPS 2009			GoB	Gaps (if any)
No.	**Principles**	**Delivery Process**		
		report submitted by borrowers upon receipt	bd.org/minutes.php	
7	Implement EMP and monitor effectiveness	• Prepare monitoring reports on the progress of EMP • Retain qualified and experienced external experts or NGOs to verify monitoring information for Category A projects • Prepare and implement corrective action plan if non-compliance is identified • Requires submission of quarterly, semi-annual, and annual reports to ADB for review	• ECC is subject to annual renewal based on compliance of the conditions set by DoE	No major gaps
8	Avoid areas of critical habitats (use of precautionary approach to the use, development and management of renewable natural resources)	Provides guidance on critical habitats	• ECA 1995 and ECR 1997 identifies ecologically-critical areas and the rules to protect them	No major gaps
9	Use pollution prevention and control technologies and practices consistent with international good practices	• Refers to World Bank's Environmental Health and Safety (EHS) General Guidelines 2007 (or any update) • If national regulations differ, more stringent will be followed • If less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification	• Effluent standards, ambient and emission standards included in ECA 1995 and ECR 1997 • Ambient noise levels included in Noise Pollution Control Rules 2006	No major gaps
10	Provide workers with safe and healthy working conditions	• Refers to WB EHS General Guidelines 2007 (or any update)	• Occupational health and safety standards included in the Factories Act 1965, the Bangladesh Labour Law 2006, and the Bangladesh Labor Act 2013.	No major gaps
11	Conserve physical cultural resources (PCR) and avoid destroying or damaging them	• Use of field-based surveys and experts in the assessment • Consult affected communities on PCR findings • Use chance find procedures for guidance	• Preservation and protection of cultural resources are within the Antiquities Act 1968.	No major gaps

Source: ADB Environmental Consultant, November 2017

3.0 DESCRIPTION OF THE PROJECT

3.1 Background

39. Component 3 will consist of the power transmission interconnection from the new substation within the Rupsha 800 MW CCPP complex in Khalishpur to the existing Khulna South Substation (SS) located in the outskirt of Khulna City. Power Grid Company of Bangladesh (PGCB) will provide the technical support to NWPGCL for Component 3.

3. Occupying an area of 12.96 acres, the Khulna South SS is part of the West Zone Power System Development Project funded by ADB and the Nordic Development Fund and was commissioned on 29 January 2007. The 4.7 km stringing is part of the 24-km four circuit 230 kV Mongla to Khulna South SS transmission line project of PGCB which was funded by GoB. The 230 kV transmission line from Mongla to Khulna South SS has completed the requirements of ECR 1997 by the DoE for red category project. Together, these transmission lines form part of the power evacuation interconnection facilities in southwestern Bangladesh.

40. Electricity generated in the Rupsha 800 MW CCPP will be stepped-up to the transmission voltage of 230 kilovolt (kV). A new transmission line of about 29.3 km will be built from Rupsha 800 MW CCPP to the existing Khulna SS. The conductor to be used is twin-ACCC Hamburg[14], and the line will have two circuits, each capable of transferring 1,400 MW. The new transmission line will require three main river crossings and three minor river crossings and will traverse mostly through rice fields. Upon reaching the existing Khulna SS, the line will be terminated at two new line bays and termination equipment to be installed under the project. Thereafter, electricity produced at Rupsha 800 MW CCPP will flow into the 230 kV transmission network to serve the electricity demand in Khulna and elsewhere in the country. **Figure 3.1** presents the location of Component 3.

Figure 3.1: Location map of Component 3

[14] Aluminium Conductor Composite Core (ACCC) Hamburg has a current carrying capability of 1440 ampere at 120^0C.

3.2 Features of Component 3

41. Component 3 will involve the construction of about 29.3 km, 230 kV double circuit overhead transmission line (24.561 km new transmission line and 4.7 km stringing) from the new switchyard of Rupsha 800 MW CCPP to the existing Khulna SS.

42. A total of 75 transmission towers will be installed consisting of 25 angle towers, 48 suspension towers, and 2 terminal towers. The base of a transmission tower will require about 400 m^2 (20 m x 20 m). The 4.7 km transmission line will involve stringing to make it double circuit from Khulna SS to Mongla transmission line.

3.2.1 Physical Features of the transmission line

43. Physical features of the 230 kV overhead transmission line (OHTL) is given in Table 3.1. OHTL will be double circuit and conductor materials will be made of aluminum alloy. Transmission towers to support the OHTL will be made of steel and of two types: (i)tension, and (ii) suspension. Tension towers will be installed in angles and suspension towers (see Figure 3.2) will be installed along the line as load bearing support. Disc type insulator will be used in the poles to bear the wire (Figure 3.3).

Table 3.1: Physical Features of 230 kV transmission line

Physical Features	Attribute
Voltage Rating	230 kV
Type of Transmission Line (T/L)	Double circuit
Width of T/L Right of Way (RoW)	100 meters (40 m left + 20m DIA + 40 m right)
Type of Line Support	Steel 230 kV lattice Towers
Conductor Material	ACSR Mallard
Line Insulator	Disc type, Porcelain
Type of Connection	230 kV substation from the Rupsha 800 MW CCPP in Khalispur (Khulna) to the existing 230/132 kV Khulna South (Khulna)

Source: PGCB, 2016

Figure 3.2: Type of transmission tower

Figure 3.3: Disc insulators for transmission line

3.3 Project Activities

44. The construction activities associated with Component 3 will include the installation of transmission towers and stringing of conductors along the 24.561 km, 230 kV transmission line, stringing of 4.7 km, 230 kV transmission line, and construction of anew 230 kV substation within the Rupsha 800 MW CCPP in Khaliaspur, Khulna. Some activities include the following:

3.3.1 Construction phase

3.3.1.1 Civil works

45. *Piling work.* Basement of the lattice tower will be pile foundation. There will be piles at the top of it and a pile cap in each leg of the tower. For piling work, a boring will be made in the soil using drilling rig. Bentonite slurry or steel tube will be used to stabilize the bore hole. Reinforcement cage will be placed and consequent concrete casting will be performed. For pile foundation, at least 3 piles and mostly 4 piles are cast in general. The number and depth of pile will depend on the results of geotechnical investigation.

46. *Excavation*. After completion of piling work, the top soil of the piles will be excavated up to a specified depth using excavators.

47. *Pile cap casting*. At the finishing of excavation, top and bottom reinforcements will be placed the concreting of pile cap will be performed. The pile cap transfers load to the subsoil through the piles.

48. *Tower Erection*. The steel sections of the tower will be joined by bolt to erect the tower. Crane may be used to lift the steel sections at different elevation.

49. **Figure 3.4** shows the associated civil works.

Figure 3.4: Associated civil works in transmission line

placing of steel ring bunds

tower piling works

pile cap reinforcement

Casting CC into tower foundation

Placing tower on its foundation

Tower erection work

3.3.1.2 Electrical works

50. Installation of equipment will include circuit breakers, transformers, lightning arresters, panel boards, batteries and battery charger insulators, current transformer, potential transformers, etc. Figure 3.5 shows some associated electrical works.

51. After completion of the building, all equipment will be installed at the substation as per design specification and standard. For Component 3, substation materials may be procured from foreign countries. Local materials like bricks, sand, cement, rods, etc. will be used for the installation works.

52. Transformers are heavy equipment and its transportation may require grading of river embankment along Bhairab River, Atai River and Rupsha River, and skidding through open field. Compensation to damages will be provided to the land owners.

Erection of Tower. The towers will be constructed to take the load of the tower, conductors, accessories as well as wind load and earthquake load. The towers in paddy fields will have proper clearance to maintain sag (lowest point on line). At homesteads, if any, the sag will be above the canopy.

Drawing of OHTL. The transmission line will be drawn keeping suitable clearance at all locations. The lowest sag point will be considered in drawing stringing.

53. *Testing and commissioning of equipment*. Once all the equipment have been installed, they will be tested according to specifications and standards of GoB and international industry requirements. After successful completion of these tests, the OHTL and substation will be commissioned.

Figure 3.5: Associated electrical works

Welding of reinforcement

Tower erection works

Conductor stringing

3.3.2 Operation phase

54. Post construction phase will cover final installation of the safety measures in the substations and transmission towers such as fire-fighting equipment system following the appropriate specifications, and the emergency first aid kits installed at strategic locations within the substations. Trained security personnel will be deployed to ensure peace and security within the property perimeter.

55. Except for vegetation management on the RoW, OHTL requires very little intervention during normal operation. The RoW allows for safety margin between the OHTL and the surrounding structures and vegetation. The RoW also provides a space for ground inspections and repairs, if needed. Other activities during operation phase are training and preparedness during emergency and disaster by NWPGCL staff who will be involved in the O&M of Component 3 including the orientation to emergency restoration system (ERS). ERS will be used for early restoration in the event of natural disasters or other emergencies.

4.0 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

4.1 Project's Area of Influence – Component 3

56. The area will cover the new substation from the Rupsha 800 MW CCPP, the 230 kV transmission line route and right-of-way (RoW) until the end of connection to Khulna SS of PGCB. This area is where the potential impacts of Component 3 may be expected. A 20 m RoW from the transmission line (i.e., 10 m each side from the alignment) has been defined as the direct impact area (DIA) and a 40m buffer along both sides (i.e., 40 m+40m = 80m) of the power transmission line has been considered as the general impact area (GIA). Thus, a total of 100 m RoW was considered in describing the existing environment.

57. Component 3 will be about 29.3 km (24.561 km new construction and 4.7 km stringing), 230 kV overhead double circuit transmission line (OHTL) from the switch yard of Rupsha 800 MW CCPP in Khalishpur to the existing Khulna SS.

4.2 Physical environment

58. The description of the physical environment was based on secondary data available from sources such as Bangladesh Geological Society (BGS), National Water Resources Database (NWRD), nearest station of Bangladesh Meteorological Department (BMD) located in Khulna, etc.

4.2.1 Physiography

59. Component 3 falls under two physiographic units. The northern part of the OHTL is aligned NNW to SSE and this part falls under the High Ganges River Floodplain physiographic unit while the southern part is aligned NNE to SSW within mostly under the Ganges Tidal Flood Plain physiographic unit and partly under High Ganges River Floodplain of Bangladesh. Generally, the Ganges River sediments are rich in easily weatherable minerals. Soil patterns of the Ganges Tidal Flood Plain are simpler than they are in river floodplains. The ground elevation of the area compared to mean sea level is very low, about two and half meters (2.5 m). The physiographic map of the project area is shown in **Figure 4.1**.

4.2.2 Seismicity

60. BGS has published an Earthquake Zoning Map of Bangladesh based on seismic intensity. They have divided the country into three zones depending on the seismic intensity as Zone I (High Risk), Zone II (Moderate Risk) and Zone III (Low Risk). **Figure 4.2** shows the seismic map of Bangladesh.

61. Component 3 lies within Zone III (Low Risk). The project area is the least vulnerable in terms of seismicity compared to the other parts of Bangladesh like Sylhet (Zone 1). While situated in the least vulnerable area on seismicity, Component 3 will be designed following the Bangladesh Building Code 2006 (or latest approved code). Historical record of major earthquakes from 1997 to 2016 originating in Bangladesh shows a magnitude in the Richter scale ranging from 4.2 to 5.6 and for the last 450 years, a maximum of about 8.8 in Chittagong-Arakan.

Figure 4.1: Physiographic map of Bangladesh

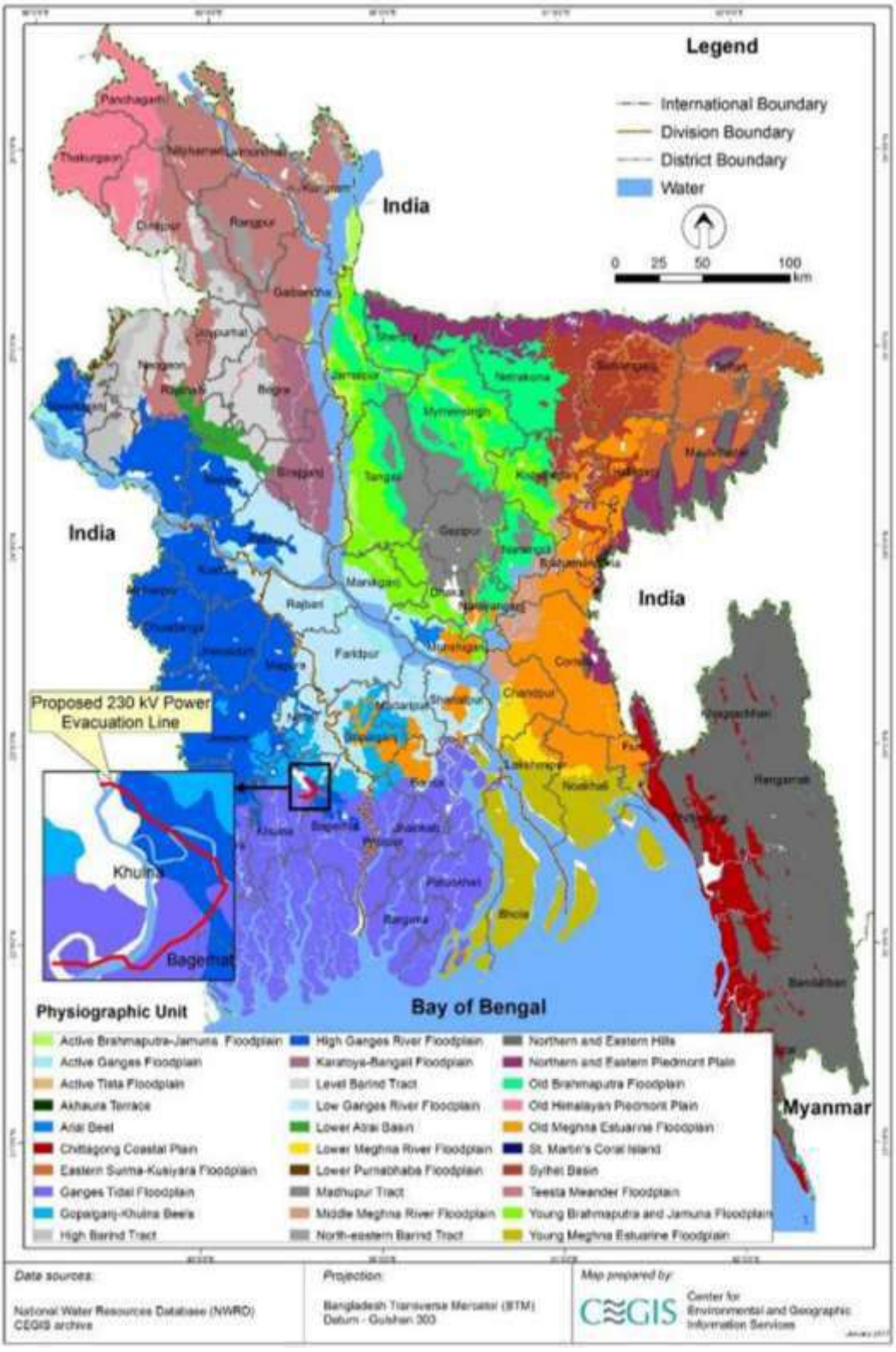


Figure 4.2: Seismic map of Bangladesh

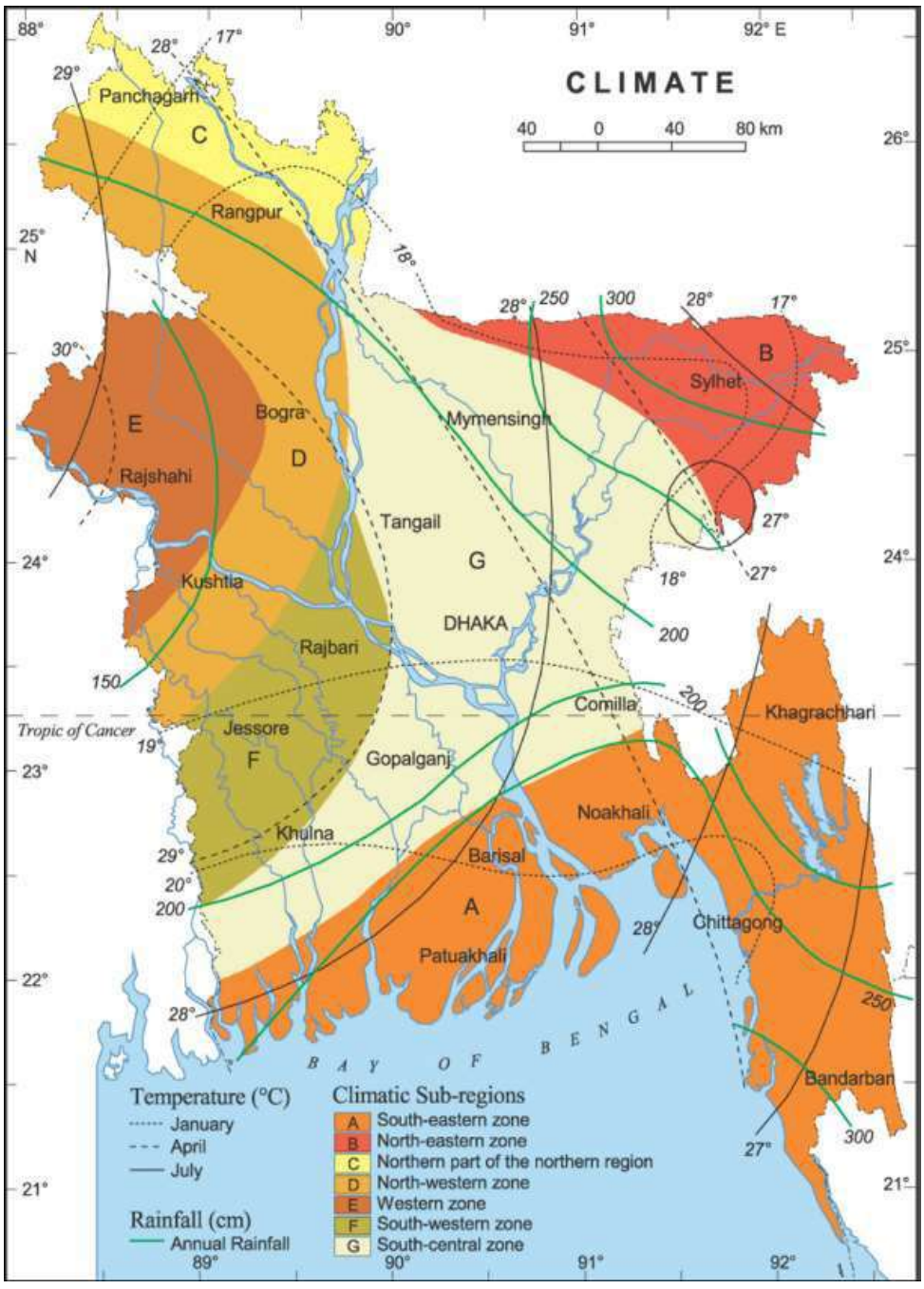
4.2.3 Climate

62. According to Köppen climate classification, Khulna division falls under Aw category which is characterized by tropical wet and dry climate.[15] Khulna experiences hot and humid summer and dry winter. According to these climatic characteristics, Bangladesh is divided into seven different climatic sub-regions. Under these climatic sub-regions, Component 3 fall under category G", which is the south-central climatic sub-region of the country (**Figure 4.3**). In general, this zone receives abundant rainfall. This is a transitory zone between the South-

[15] https://en.climate-data.org/region/2263/

eastern, North-western and South-western zones and most of the severe hail storms, nor'westers and tornadoes have been recorded in category G area.

Figure 4.3: Climatic sub-regions of Bangladesh



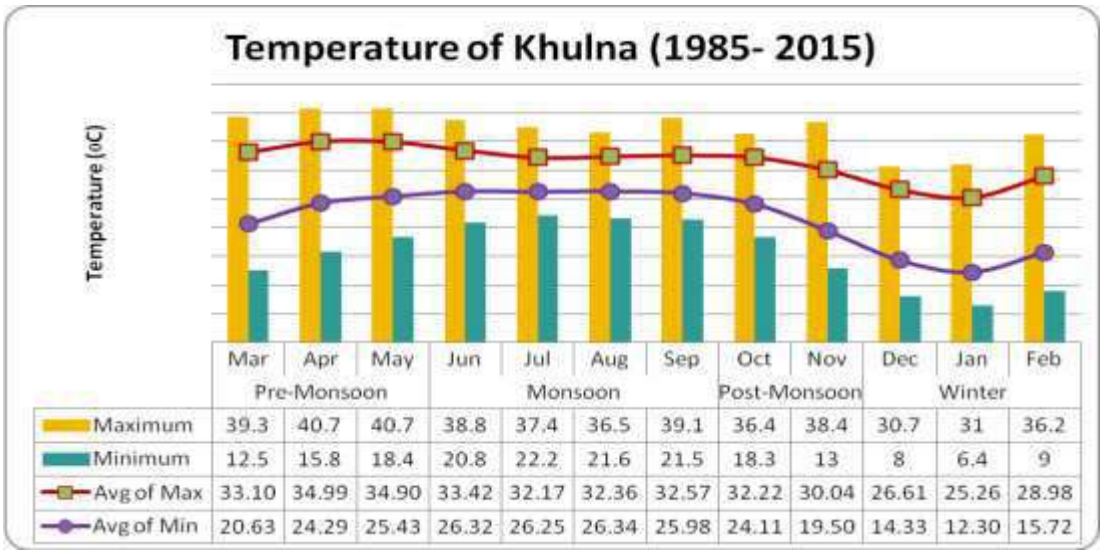
Source: ASB, 2006

Temperature

63. Based on the 30-year historical record from the BMD Khulna station (1985-2015) on temperature, monthly variation of maximum temperature is 30.7^{0}C to 40.7^{0}C, while the monthly

minimum temperature varies between 6.4^{0}C to 22.2^{0}C. The maximum temperature in Khulna station was 40.7^{0}C recorded in 2014 while a minimum temperature of 6.4^{o}C was recorded in 2003.

Figure 4.4: Monthly temperature variation at Khulna Station

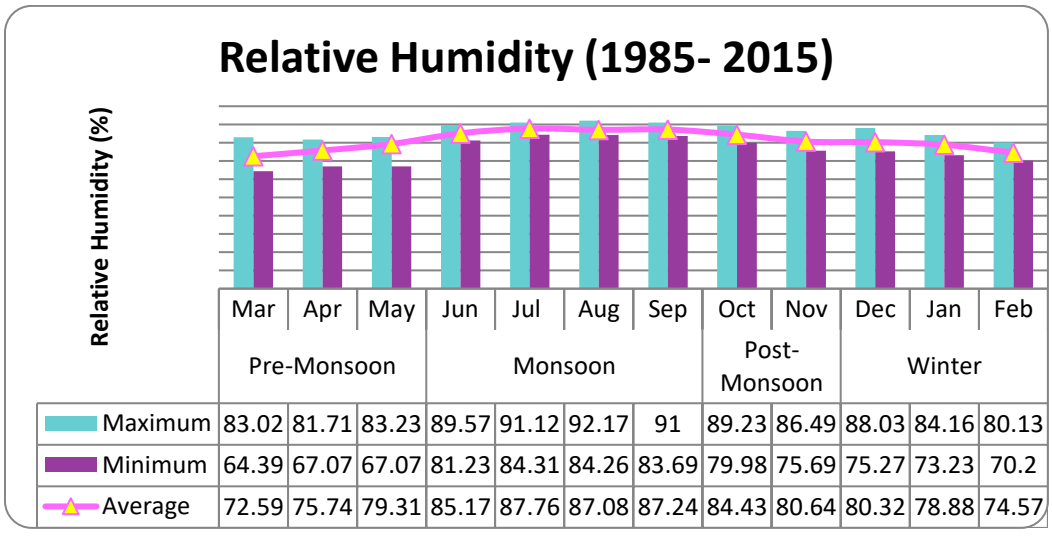


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	39.3	40.7	40.7	38.8	37.4	36.5	39.1	36.4	38.4	30.7	31	36.2
Minimum	12.5	15.8	18.4	20.8	22.2	21.6	21.5	18.3	13	8	6.4	9
Avg of Max	33.10	34.99	34.90	33.42	32.17	32.36	32.57	32.22	30.04	26.61	25.26	28.98
Avg of Min	20.63	24.29	25.43	26.32	26.25	26.34	25.98	24.11	19.50	14.33	12.30	15.72

Humidity

64. Humidity is directly related with temperature fluctuation of a region. The average humidity recorded at the Khulna station remains highest from June to October while the monthly variation of the average relative humidity is 87.76% to 72.59%. Monsoon (June to September) is the most humid months, whereas from winter season to pre-monsoon, i.e., December to May, the weather remains relatively dry. **Figure 4.5** shows the average humidity within the last 30 years.

Figure 4.5: Seasonal Change of Relative Humidity at Khulna Station (1985-2015)

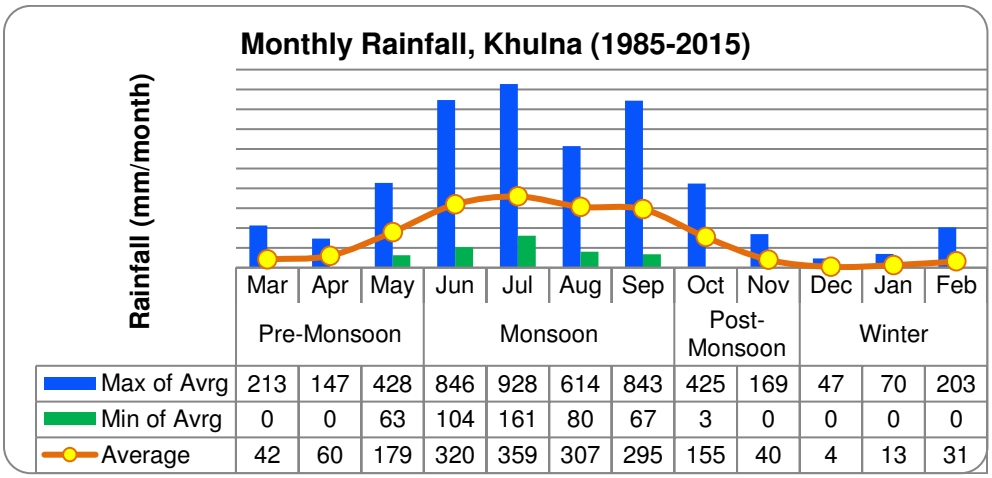


	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	83.02	81.71	83.23	89.57	91.12	92.17	91	89.23	86.49	88.03	84.16	80.13
Minimum	64.39	67.07	67.07	81.23	84.31	84.26	83.69	79.98	75.69	75.27	73.23	70.2
Average	72.59	75.74	79.31	85.17	87.76	87.08	87.24	84.43	80.64	80.32	78.88	74.57

Rainfall

65. The average annual rainfall is recorded at 1,808 mm/yr. Monthly average maximum rainfall occurred in July (928 mm/month) and monthly average minimum rainfall recorded during winter season (see **Figure 4.6**). This suggests that the rainy season is very prominent in this region. The average monthly rainfall during monsoon in Khulna is 320 mm. Records show that the maximum rainfall during the monsoon season (June-September) ranges from 614mm/month to 928 mm/month while the minimum rainfall during the monsoon ranges from 67mm/month to 161mm/month. Winter from December to February is the driest season and the average winter rainfall is 16.14mm/month. The highest yearly rainfall was recorded in 2002 at 2,594 mm/year.

Figure 4.6: Change in Rainfall at Khulna station (1985-2015)



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max of Avrg	213	147	428	846	928	614	843	425	169	47	70	203
Min of Avrg	0	0	63	104	161	80	67	3	0	0	0	0
Average	42	60	179	320	359	307	295	155	40	4	13	31

Windspeed and direction

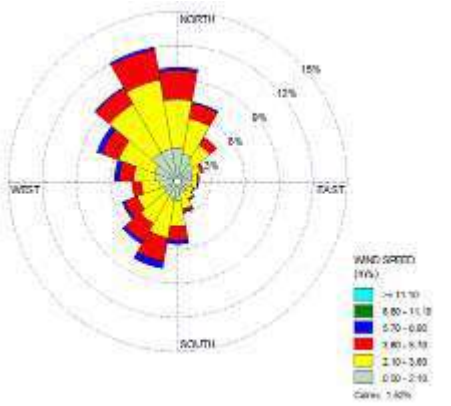
66. The maximum yearly windspeed recorded in Khulna station is 120.38 km/hr during 1997 and 2007.

67. The direction of wind varies depending on the seasons. The whole year has been categorized into four clusters of months and these are: Cluster 1: January-March, Cluster 2: April-June, Cluster 3: July to September, and Cluster 4: October to December. Wind speed data and direction have been obtained from the analysis of upper atmospheric data collected for last three years from Lakes Environmental, Canada.

68. During Cluster 1 and Cluster 4 (a & b of **Figure 4.7**), wind direction is predominantly from north and northwest to southeast direction, and for Cluster 2 and Cluster 3 (c & d of Figure 4.7), it is predominantly from south and southwest to north and northeast. The annual wind rose diagrams of 8 and 36 directions (e & f of Figure 4.7) show the wind direction predominantly towards the northeast.

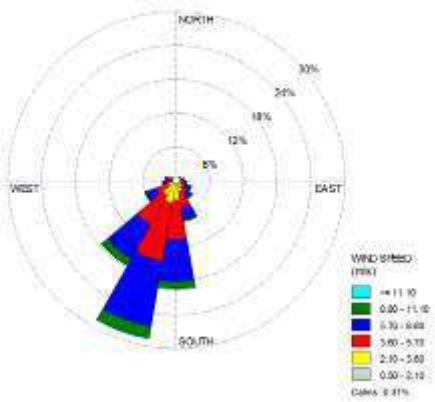
69. In Cluster 1, calm wind prevails for 1.52% of total period, similarly it is 0.31% for Cluster 2, 0.72% for Cluster 3, and 3.17% for Cluster 4. Calm wind prevails for 1.33% for annual 8-direction and 1.77% for annual 36-direction wind rose diagrams, respectively

Figure 4.7: Wind rose diagram



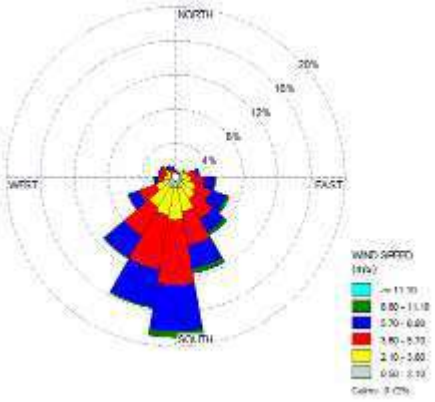
a)

Cluster 1: Wind rose diagram for Jan-Mar



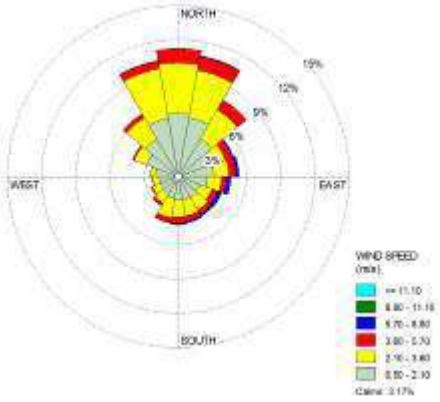
(b)

Cluster 2: Wind rose diagram for Apr-Jun



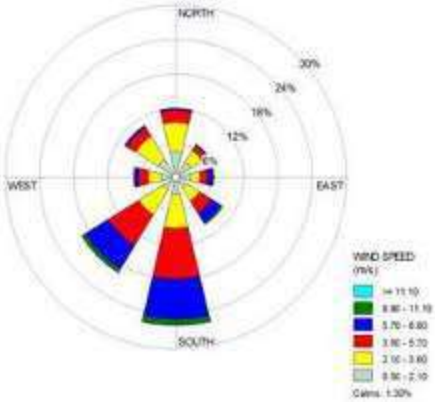
(c)

Cluster 3: Wind rose diagram for Jul-Sep



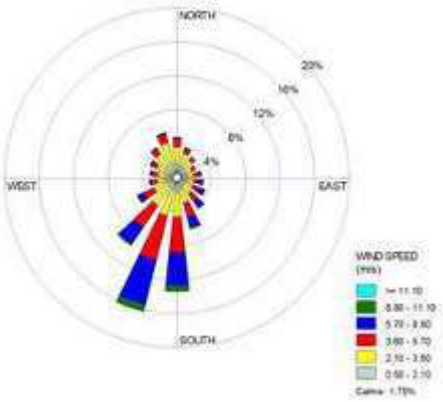
(d)

Cluster 4: Wind rose diagram for Oct-Dec



(e)

Annual wind rose diagram (8 directions)



(f)

Annual wind rose (36 directions)

4.2.3 Ambient air quality and noise

Ambient air quality

70. Ambient air quality is characterized by the presence of criteria pollutants. Major criteria pollutants are particulate matter (PM_{10} and $PM_{2.5}$), NO_2, CO, SO_2 and ozone (O_3). The DoE has set the national ambient air quality standards for these pollutants in ECR, 2005. These standards aim to protect against adverse human health impacts.

71. Air pollution due to enhanced anthropogenic activities has become an important environmental concern in Bangladesh urban areas in view of its adverse health effects. In this connection, the criteria pollutants of eight major cities in Bangladesh are continuously monitored since November 2011 through the Clean Air and Sustainable Environment (CASE) Project of the DoE funded by the World Bank.[16]

72. Khulna is the third largest city in Bangladesh which has been remarked as industrial city. The population of the city, under the jurisdiction of the Metropolitan Area is 1,435,422 living in an area of about 59.6 km^2. It is one of the important industrial and commercial areas of the country. Mongla, the second seaport of Bangladesh situated on its outskirts, about 40 km south from Khulna City.

73. Khulna is located in south-western part of Bangladesh and on the banks of the Rupsha River and Bhairab River. Considering the importance of Khulna City, one continuous air monitoring stations (CAMS-9)[17] has been established to monitor the criteria pollutants under the CASE Project. It is located in the Department of Social Forestry Office Campus at Baira, which is around 2.5 km from the Rupsha 800 MW CCPP. Ambient air quality data from CAMS-9 is used to describe the existing environment within the project area.

74. CASE project monitors the criteria pollutants such as CO, NO_2, O_3, SO_2, PM_{10} and $PM_{2.5}$. Monitoring is performed to demonstrate attainment or non-attainment of national ambient air quality standards to assess the trends of air pollution levels. Results of ambient air quality monitored by CAMS-9 in 2013, 2014 and 2015 are given in **Table 4.1** while a comparison of ambient air quality standards is given in **Table 4.2**. Based on these results, the criteria pollutants of concern are PM_{10} and $PM_{2.5}$.

Table 4.1: Ambient air quality results at Khulna CAMS Station

Criteria Pollutants	Standard Concentration (ECR 2005)		2013	2014	2015
	Period	µg /m^3	µg /m^3	µg /m^3	µg /m^3
Carbon Monoxide (CO)	8 Hr	10,000µg /m^3	1,790	1,020	550
	1 Hr	40,000 µg/m^3	1,590	860	460
Sulphur Dioxide (SO_2)	24 Hr	365µg/m^3	16.7	12.1	31.4

[16] Ministry of Environment and Forests, Clean Air and Sustainable Environment, http://case.doe.gov.bd/index.php?option=com_content&view=article&id=29&Itemid=7.
[17] Located at latitude 22.83 N and longitude 89.53 E

Nitrogen Dioxide (NO_2)	24 Hr	-	27.07	DNA	122.76
Particulate Matter (PM_{10})	24 Hr	150 µg/m^3	132	219	93.5
Particulate Matter ($PM_{2.5}$)	24 Hr	65 µg/m^3	76.0	102	83.6

Table 4.2: Comparison of ambient air quality standards

Pollutant	Averaging Period	Bangladesh Standards[a]	WHO[b] Guideline Values (µg/m^3)	US EPA Standards (µg/m^3)[d]
CO	8-hour	10,000 µg/m^3 (9 ppm)	10,000[c]	10,000
	1-hour	40,000 µg/m^3 (35 ppm)	30,000[c]	40,000
Pb	Annual	0.5 µg/m^3	0.5	-
NO_x	Annual	100 µg/m^3 (0.053 ppm)	-	-
TSP	8-hour	200 µg/m^3	-	-
PM_{10}	Annual	50 µg/m^3	20	revoked
	24-hour	150 µg/m^3	50	150
$PM_{2.5}$	Annual	15 µg/m^3	10	15
	24-hour	65 µg/m^3	25	35
O_3	1-hour	235 µg/m^3 (0.12 ppm)	-	235
	8-hour	157 µg/m^3 (0.08 ppm)	100	157
SO_2	Annual	80 µg/m^3 (0.03 ppm)	-	78
	24-hour	365 µg/m^3 (0.14 ppm)	20	365

CO = carbon monoxide; NO_x = nitrogen oxide; O_3 = ozone; Pb = lead; PM_{10} = particulate matter with a diameter of not more than 10 microns; $PM_{2.5}$ = particulate matter with a diameter of not more than 2.5 microns; SO_2 = sulfur dioxide; S.R.O. = US EPA = United States Environmental Protection Agency; TSP = total suspended particulates; WHO = World Health Organization; µg/m^3 = micrograms per cubic meter; ppm = parts per million; - = no value.
Sources: [a]S.R.O. No: 220-Law,2005; [b]WHO, 2005; [c]WHO, 2000; and [d]US EPA, 2006.

Ambient noise level

75. Noise is generated in this area due to the movement of vehicles and vessels like bus, micro, auto, van, motorbike, trawler, engine boat, launch and other local machines which ply all day long. Noise Pollution Control Rules 2006 has specified noise level limits based on location sensitivity. Based on these rules, the area is considered as commercial area. Results of ambient noise level measurements indicate that daytime noise limits are met (**Table 4.3**). **Figure 4.8** shows the noise sampling stations.

Table 4.3: Results of ambient noise level measurements

21-23 December 2016

Sample ID	Location	GPS Coordinates	Day Time Monitoring Result Leq (dBA)	ECR, 2006 (Day) Leq (dBA)
NL01	Sholpur Fisheries Community	N 22° 51' 6.9" E 89° 33' 31.5"	58.8	70
NL02	Sholpur Zugihati Govt. Primary School	N 22° 50' 28.5" E 89° 33' 35.7"	58.1	70
NL03	Abdoli turning point of Shener Bazaar and Easybike Stand	N 22° 50' 21.1" E 89° 34' 45.8"	76.1	100
NL04	Bottola Turning Point	N 22° 49' 25.8" E 89° 35' 28.9"	67.9	85
NL05	Fakirhat – Khulna Bypass Highway Road	N 22° 47' 40.9" E 89° 37' 31.6"	68.8	85

NL06	Mongla-Khulna Highway Road	N 22° 46' 51.4" E 89° 36' 56.3"	73.4	85
NL07	Jebusa village Road	N 22° 46' 15.9" E 89° 36' 7.5"	69.3	85
NL08	Putimari Bazaar, Lobonchora.	N 22° 45' 42.1" E 89° 33' 43.4"	60.2	85

Source: Field visit, CEGIS, December 21-23,2016

Figure 4.8: Location of water and noise sampling stations

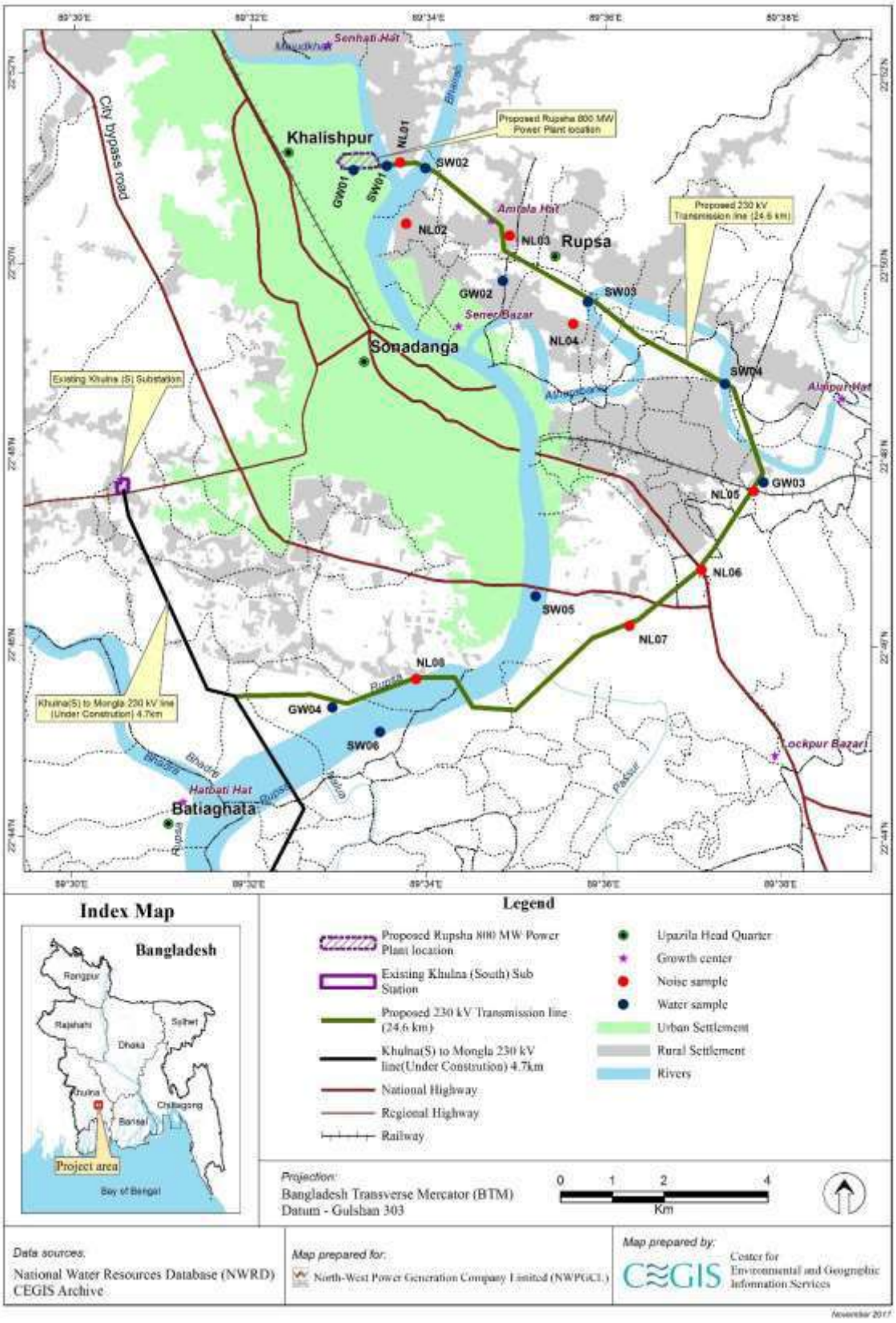


Figure 4.9: Noise Level Measuring Location **Figure 4.10; Noise Level Measuring Location**

(In front of Putimari Bazaar, Lobonchora)

(Sholpur Zugihati Govt. Primary School)

4.3 Water Resources

4.3.1 Surface Water

76. Component 3 will cross three major rivers: Bhairab, Atai and Rupsha which are tidal in nature and the width of these rivers are 270m, 320m and 500m, respectively. The route along the stretch of the Bhairab River will be located downstream on the left river bank. There are no khals or channels along the right bank of the Bhairab River. The Bhairab River receives most of the wastewater discharges in Khulna City.

Surface Water Quality

77. Water quality test has been performed in and around the project area for both surface and ground water during pre-monsoon and monsoon period. In Situ tests for seven parameters of six surface water samples have been conducted following standard practice during field visit on 21 December 2016. The measured values of pH, DO, EC, TDS and Salinity are presented in **Table 4.4** (locations in **Figure 4.8**).

Table 4.4: In-situ surface water quality measurements (post-monsoon)

Sampling Station	Coordinates	pH	DO ppm	BOD_5 at 20°C	TDS ppm	EC	Salinity (ppt)	Temperature (°C)
SW01	22°51'4.77"N 89°33'22.41"E	8.38	7.8	0.7	100	210	0	36
SW02	22°51'3.42"N 89°33'48.46"E	8.47	6.89	0.89	117	245	0	32
SW03	22°49'39.59"N 89°35'38.73"E	8.38	5.9	0.7	110	230	0	30
SW04	22°48'48.25"N 89°37'11.76"E	8.45	6.2	0.55	165	320	0	33
SW05	22°46'34.53"N 89°35'4.00"E	8.25	6.92	1.02	185	355	0	30
SW06	22°45'8.69"N 89°33'18.88"E	8.1	6.48	2.28	130	290	0	34
ECR 1997, Schedule 3 (assumed that river water usable for fisheries)		6.5-8.5	5 or higher	6 or less				20-30

Source: CEGIS study team, 21-23 December 2016.

78. The central laboratory of the Department of Public Health Engineering (DPHE) tested and analyzed the 18 parameters of surface water quality (**Table 4.5**). ECR 1997 does not include surface water quality standards.

Table 4.5: Results of surface water quality analyses

No.	Water Quality Parameters	Unit	SW 01	SW02	SW 03	SW04	SW05	SW06	Analysis Method	LOQ
01	Alkalinity	mg/L	120	123	125	103	153	125	Titrimetic	-
02	Arsenic	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	AAS	0.001
03	Calcium	mg/L	18.68	16.77	15	15.5	16.6	13.6	AAS	0.17
04	COD	mg/L	40	48	20	20	16	32	CRM	-
05	Chloride	mg/L	18	16	20	17	18	16	Titrimetic	-
06	Silica	µS/cm	15.5	42.9	34	50	45	37	Multimeter	-
07	Hardness	mg/L	143	185	173	143	158	145	Titrimetic	-
08	Iron	mg/L	2.38	2.32	2.45	3.06	2.85	3.21	AAS	0.05
09	Lead	mg/L	0.008	0.007	0.004	0.003	0.005	0.004	AAS	0.001
10	Magnesium	mg/L	3.5	38	3.6	3.3	3.2	3.4	AAS	0.05
11	Nitrogen	mg/L	3.1	3.8	1.2	0.7	1.3	0.8	UVS	0.10
12	Phosphate	mg/L	1.56	2.02	1.30	2.51	1.24	1.33	UVS	0.98
13	Potassium	mg/L	2.0	3.0	3.0	2.0	2	2	AAS	-
14	Sodium	mg/L	21	19	18	19	20	16	AAS	0.34
15	Sulphate	mg/L	2	1	1.0	1	2	4	UVS	1.0
16	TSS	mg/L	6	6	7	6	6	7	Multimeter	-
17	Turbidity	NTU	66	60	65	69	67	59	Turbidity meter	-
18	Oil and Grease	mg/L	<5.0	<5.0		<5.0			APHA 5220.B	10

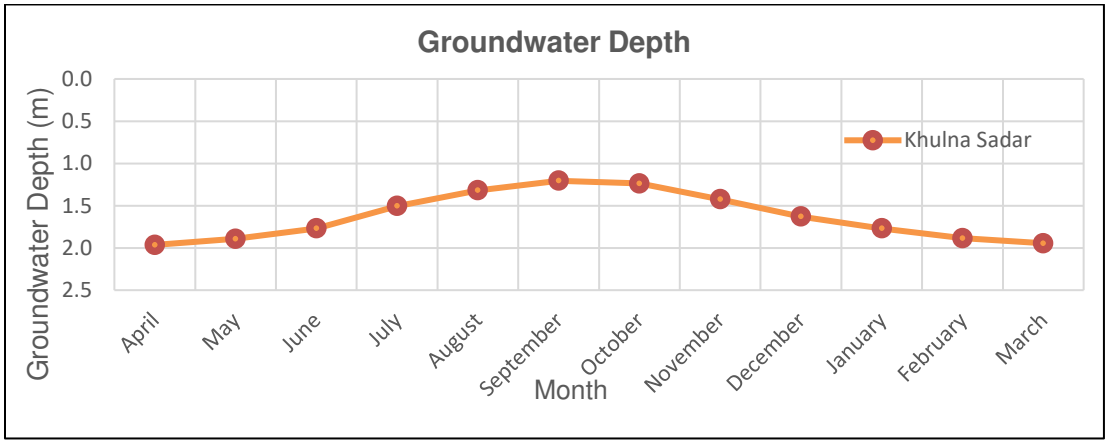
AAS = atomic absorption spectrophotometer; CRM = closed reflex methods; LOQ = limit of quantification; NM = not measured; UVS = UV-visible spectrophotometer.

Figure 4.11: Sample test and collection from the Bhairab and Rupsha River

Groundwater

79. Groundwater level data has been collected from Khulna Sadar observation well to find the status of groundwater availability in the study area. **Figure 4.12** shows monthly variation of ground water depth from 1978 to 2013. According to the figure, groundwater level in study area usually starts to deplete at later stages of pre-monsoon (end of April) and continues up to the middle of October. Thereafter, at the beginning of post-monsoon the aquifer recharge begins.

Figure 4.12: Average monthly groundwater depth (1978 – 2013)



Source: BWDB

Groundwater quality

80. The quality of groundwater has been tested in and around the project area. Four samples of ground water were collected on 21 December 2016 during field visit. Results of analyses are given in **Table 4.6** (sampling stations shown in **Figure 4.8**).

Table 4.6: In- situ groundwater quality measurements

Sampling Location	Coordinates	pH	DO ppm	BOD_5 at 20°C	EC (m^S/cm)	TDS ppm	Salinity (ppt)	Temp. (°C)	Time
GW01	Deep tube well of 250 ft depth 22°51'2.07"N 89°32'59.85"E	7.45	1.7	0.5	1530	760	2	28	11:20am
GW02	Deep tube well of 600 ft depth 22°49'52.75"N 89°34'41.14"E	7.9	5.99	0.64	1820	910	3	26	10:15am
GW03	Deep tube well of 400 ft depth 22°47'46.47"N 89°37'38.14"E	4.51	2.5	0.2	1260	630	2	27	16:45pm
GW04	Deep tube well of 500 ft depth 22°45'24.07"N 89°32'46.70"E	7.75	4.8	0.5	1570	780	2	26	12:30pm
ECR 1997 (Schedule 3) (drinking water standards)		6.5-8.5	6	0.2	-	1,000	0	20-30	-

Source: CEGIS field study, December 21-23, 2016.

81. Ten water quality parameters were analyzed and tested by the central laboratory of the DPHE. The results are given in **Table 4.7** (sampling locations shown in **Figure 4.8**).

Table 4.7: Results of groundwater quality analyses

No.	Water Quality Parameters	Unit	GW01	GW02	GW03	GW04	LOQ	ECR 1997 (mg/L) (drinking water standards)	WHO Guidelines (mg/L)
01	Arsenic	mg/L	0.002	0.001	0.001	0.001	0.001	0.05	0.01
02	Calcium	mg/L	29.6	34.7	49.3	48.3	0.17	75	-
03	COD	mg/L	4	4	4	4	-	4	-
04	Chloride	mg/L	332	461	210	348	-	150-600	-
05	Silica	mg/L	31	33	33	42	-	-	-
06	Hardness	mg/L	353	315	350	405	0.05	200-500 (as $CaCO_3$)	-
07	Iron	mg/L	3.03	5.37	4.38	6.52	0.001	0.3-1.0	-
08	Lead	mg/L	0.015	0.015	0.013	0.002	0.10	0.05	0.01
09	Nitrogen	mg/L	0.87	1.2	1.6	1.1		1.0	-
10	Phosphate	mg/L	0.16	0.37	1	0.50	0.98	6.0	-
11	Sulphate	mg/L	5	5	3	2	1.0	400	-

Source: DPHE, December 2016.

4.3.2 Water resources issues and functions

Water Use

82. Water is used for domestic, agriculture, fisheries and other commercial purposes. The water of Bhairab River is used for fisheries, shrimp farming and agricultural purposes. The consumption of water mainly takes place at the left bank of Bhairab River. Local people opined that they prefer Shallow Tube Wells (STWs) for drinking (where the layer of Deep Tube Wells (DTWs) aquifer becomes contaminated) water source to meet up their daily requirements. For other domestic uses, STWs and surface water sources are also used. Overall, water availability in the study area is not a major concern as local people expressed that they have sufficient surface and groundwater sources to meet up their daily need for drinking and domestic purposes.

Flooding

83. Flooding is common every year in the study area like other areas in Bangladesh. The main causes of flooding are heavy rainfall, tidal water intrusion and storm surge. During monsoon season, extreme flooding submerges some areas by about 1.0 feet – 2.5 feet and extends for about 7-30 days.

Salinity

84. Saline intrusion from tidal action is another issue in the study area. In-situ measurement shows that salinity of groundwater ranges from 2 ppt to 3 ppt within the study area. According to local people, salinity becomes an issue during the months of July to October.

Riverbank erosion

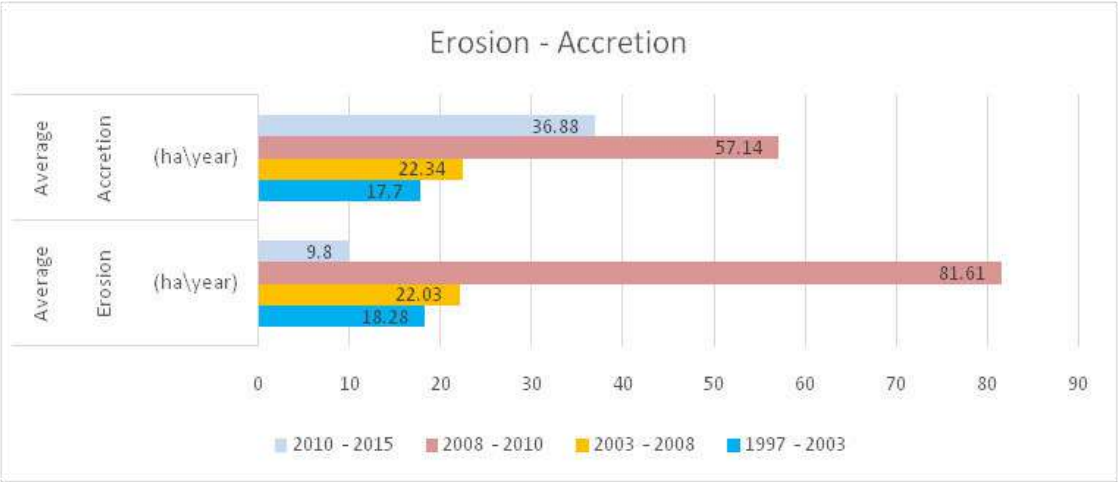
85. The Bhairab, Atai and Rupsha River have tremendous pattern and attitude of shifting every year. The detail of shifting is listed below in **Table 4.8** and **Figure 4.13**. During 1997-2003, there were much erosion than accretion in those rivers within the study area, but after constructing sheet piles and riverbank protection works at several segments of Bhairab and Rupsha River, the erosion becomes negligible. The erosion – accretion analysis has been performed by CEGIS using four satellite images of 1997, 2003, 2008, 2010 and 2015. GIS and remote sensing tools and technologies have been used for this assignment. Bank lines of those five years have been delineated following the CEGIS defined methodologies.

Table 4.8: Summary of erosion accretion in the study area

Duration	Total Erosion in the study area (ha)	Average Erosion (ha/year)	Total Accretion in the study area (ha)	Average Accretion (ha/year)
1997 - 2003	109.65	18.28	106.18	17.70
2003 - 2008	101.19	22.03	111.67	22.34
2008 - 2010	163.21	81.61	114.28	57.14
2010 - 2015	48.94	9.8	184.40	36.88

Source: CEGIS analysis result January,2017

Figure 4.13: Rate of Erosion and Accretion in the Study Area



Source: CEGIS analysis result January 2017.

Navigation

86. Bhairab River and Rupsha River are major navigation routes crossing the project area. According to the BIWTA categorization, these rivers are categorized as class II and class I navigation route, respectively. This route is extensively used for the transportation of goods and people. Local people use small boats and trawlers for local transportation of goods and other vessels like ships, barges, cargo for transportation across the country through these rivers. It is estimated that about 45km navigation route exists within the study area.

4.4 Land Resources

4.4.1 Soil Characteristics

87. According to Water Resources Planning Organization (WARPO), five land types classes: F0, F1, F2, F3 and F4 have been classified in terms of depth of flooding on agriculture land. Land type data source is SOLARIS-SRDI, 2006 and our field observation in December 2016. The project area is within the High Land (F0) (8%), Medium High Land (F1) (70%), Medium Low Land (F2) (13%), and Low Land (F3) (9%).

88. The drainage characteristics have been divided into six classes from the agriculture point of view, e.g. Excessively Drained, Well Drained, Moderately Well Drained, Imperfectly Drained, Poorly Drained and Very Poorly Drained (SRDI; 1988). In the study area three types of drainage characteristics were identified: Imperfectly Drained (26%), Poorly Drained (52%) and Very Poorly Drained (22%).

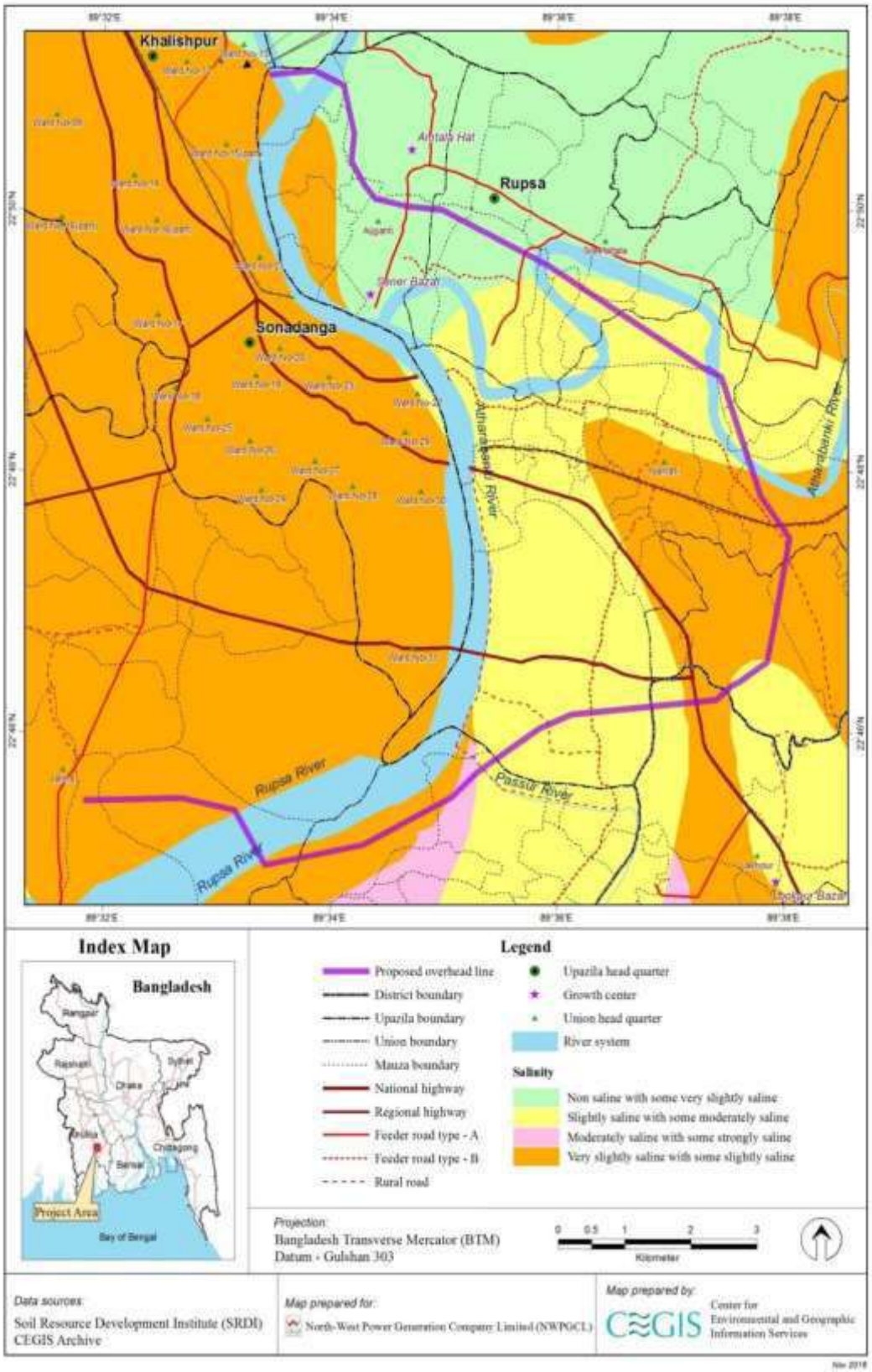
89. CEGIS estimation from SOLARIS-SRDI (2006) data showed that soil salinity of the study area (including project area) increased gradually over the year. Local farmers reported that soil and water salinity gradually increased with the dry season from January and reached maximum level in March to April then subsequently decreased due to the onset of monsoon rainfall. Detailed soil salinity of the study area is presented in **Table 4.9** and **Figure 4.14**.

Table 4.9: Soil salinity in the study area

No	Soil Salinity Characteristics	Soil salinity class	Study Area	
			Area (Acre)	% of Net Cultivable Area (NCA)
1	Non-saline with some very slightly saline (S1)	2.0-4.0	14	2
2	Very slightly saline with some slightly saline (S2)	4.1 - 8.0	145	24
3	Slightly saline with some moderately saline (S3)	8.1 - 12.0	203	33
4	Moderately saline with some strongly saline (S4)	12.1 - 16.0	247	41
		Total	**609**	**100**

Source: SRDI; 2006

Figure 4.14: Soil salinity in the study area



4.4.2 Land Use

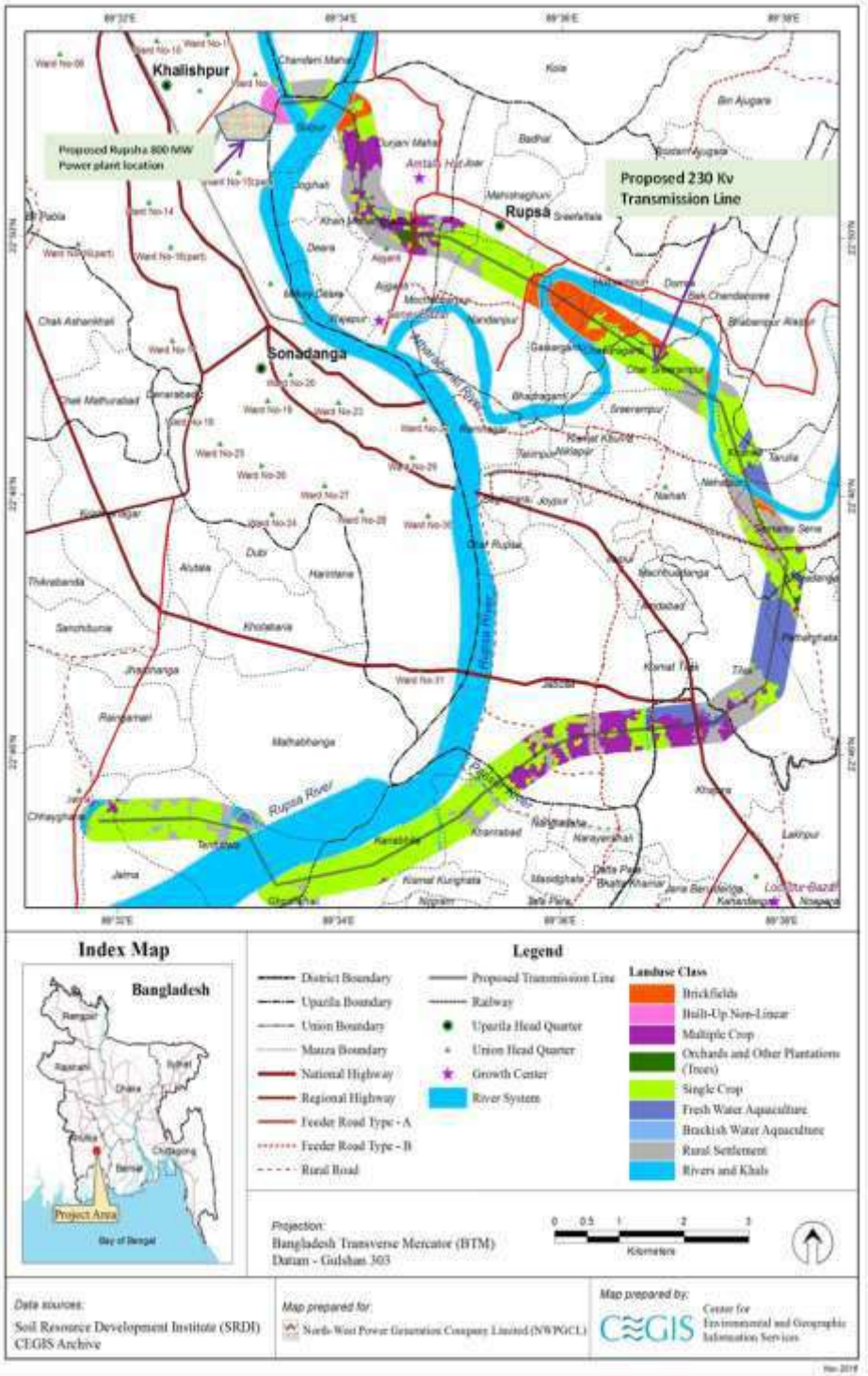
90. The study area for Component 3 is about 609 acres, of which 427 acres (70%) is net cultivable area (NCA). The remaining 30% is covered by brackish water aquaculture, brickfields, built-up non-linear, fresh water aquaculture, orchards and other plantations (trees), rivers and khals, and rural settlements, respectively. Details of land use/land cover of the study area are presented in **Table 4.10** and **Figure 4.15**.

Table 4.10: Land use in the study area

Land use	Area (Acre)	% of Total area
Brackish Water Aquaculture	3	0.5
Brickfields	32	5.3
Built-Up Non-Linear	2	0.3
Fresh Water Aquaculture	40	6.6
Multiple Crop	82	14
Orchards and Other Plantations (Trees)	4	0.7
Rivers and Khals	44	6.6
Rural Settlement	57	9.4
Single Crop	345	56.6
Total	**609**	**100**

Source: NWRD and rapid eye image analysis and field visit in December 2016.

Figure 4.15: Land use in the study area



4.4.3 Fisheries Resources

Fish habitats

91. Fish habitats of the study area are classified into two broad categories: capture fisheries and culture fisheries. The capture fisheries comprise mainly of river and khal, whereas culture fisheries are represented by brackish water aquaculture (*Bagda Gher*) and fresh water aquaculture (*Galdagher*).

92. Major rivers: Bhairab River, Atai River, and Rupsha Rivers are tidal in nature. These rivers function as fish habitat for major carp, cat fish, bagda, galda and other inland fresh water fishes. A number of khals maintain connectivity with these rivers. Most of the connecting khals are seasonal which functions only during the wet season. Water availability in these khals vary from mid-May to mid-October. Different types of fish habitat in the study area are shown in **Figure 4.16**.

Figure 4.16: Different fish habitats in the study area

Reach of the Bhairab River over which transmission line crosses

Shrimp farm (Bagda gher) over which transmission line crosses

Reach of the Rupsa River over which transmission line crosses

Fish habitat assessment

93. Based on land use data, culture fisheries (Bagda and Galdagher) occupy 43 acres and capture fisheries (river and khal) occupy 44 acres. Fish habitat status of the study area is shown in **Table 4.11.**

Table 4.11: Status of fish habitat in the study area

Sl.	Fisheries Category	Habitat Types	Area (acre)
1	**Capture Fisheries**	River and khal	44
Sub-total			44
2	**Culture Fisheries**	Brackish water aquaculture (Bagdagher)	3
3			
4		Fresh water aquaculture (Galdagher)	40
Sub-total			**43**
Grand Total			**87**

Source: CEGIS estimation based on GIS imagery, December 2016.

Fish production assessment

94. The estimated total fish production in the study area is about 18 metric tons (MT). Out of this estimate, about 3 MT comes from capture fisheries and about 15 MT comes from culture fisheries (**Table 4.12**).

Table 4.12: Fish habitat and production in the study area

Sl. No	Categories	Type of Habitat	Production (MT)
1	**Capture Fisheries**	River and khal	3
1.	**Culture Fisheries**	Brackish water aquaculture (Bagdagher) and cultured fish	1
2.		Fresh water aquaculture (Galdagher) and cultured fish	14
		Sub total	15
		Grand total	**18**

Source: CEGIS Estimation based FRSS, 2015 and Field Observation December 2016.

Fish biodiversity

95. **Figure 4.17** shows the fish species found in the study area while **Table 4.13** and **Table 4.14** give the list of fish species and their conservation status.

Figure 4.17: Available fish species in the study area

Assemblage of Tengra *(Mystustengara)*

Assemblage of Shing (Heteropneustesfossilis)

Table 4.13: Capture fish species in the study area

Sl.	Scientific Name	Local Name	IUCN Conservation Status (Bangladesh)	IUCN Conservation Status (Global)
1	*Leander styliferus*	Icha	NL	NL
2	*Macrobrachium spp.*	Golda	NL	NL
3	*Penaeus monodon*	Bagda	NL	NL
4	*Penaeusindicus*	Chaka chingri	NL	NL
5	*Metapenaeusensis*	Harinachingri	NL	NL
6	*Labeorohita*	Rui	LC	LC
7	*Catlacatla*	Catla	LC	NE
8	*Cirrhinuscirrhosus*	Mrigel	NT	VU
9	*Labeobata*	Bata	LC	LC
10	*Puntius ticto*	Tit punti	LC	LC
11	*Glossogobiusgiuris*	Bele	LC	LC
12	*Mystustengara*	Tengra	LC	LC
13	*Channa punctatus*	Taki	LC	LC
14	*Channastriatus*	Shol	LC	LC
15	*Mastacembelusarmatus*	Baim	EN	LC
16	*Heteropneustesfossilis*	Shing	LC	LC
17	*Colisafasciata*	Khalisa	LC	LC
18	*Lepidocephalusguntea*	Gutum	LC	LC
19	*Anabas testudineus*	Koi	LC	DD

DD = data deficient; LC = least concern; NE = not evaluated; NL = not listed, VU = vulnerable; NT= near threatened.
Source: Red list of IUCN Bangladesh, 2016.

Table 4.14: Culture fish species in the study area

Sl.	Scientific Name	Local Name	IUCN (Bangladesh)	IUCN (Global)
1	*Labeorohita*	Rui	LC	LC
2	*Penaeus monodon*	Bagdachingri	NL	NL
3	*Catlacatla*	Catla	LC	NE
4	*Cirrhinuscirrhosus*	Mrigel	NT	VU
5	*Hypophthalmichthyes molitrix*	Silver carp	Exotic	
6	*Ctenopharyngodonidela*	Grass carp	Exotic	
7	*Cyprinuscarpio*	Mirror carp	Exotic	
8	*Oreochromismossambicus*	Tilapia	Exotic	

NT = near threatened; LC = least concern; NL = not listed; NE = not evaluated; VU = vulnerable.
Source: Red list of IUCN Bangladesh, 2016.

4.5 Biological environment

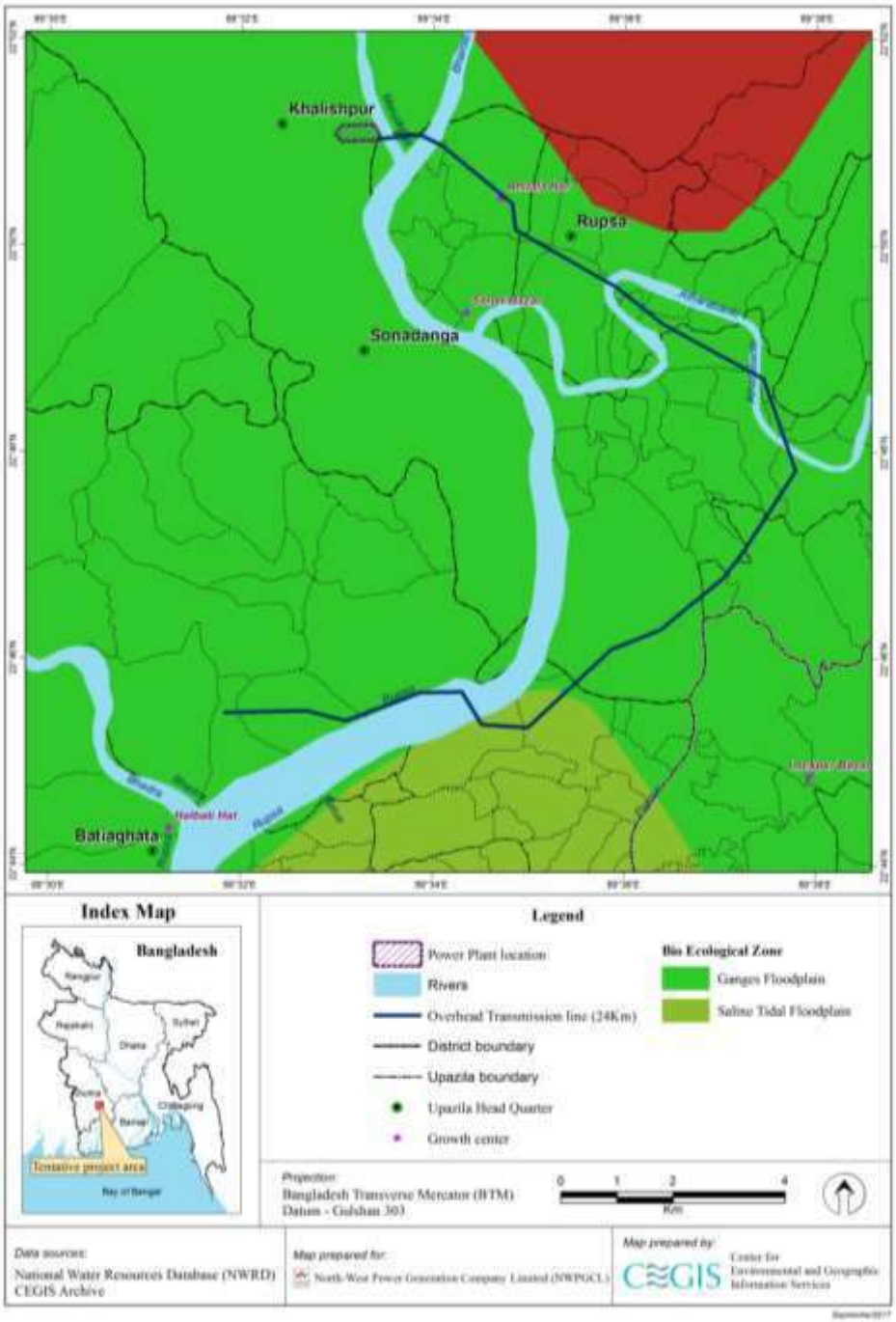
96. Major types of ecosystem are: i) homestead vegetation, ii) crop field vegetation, iii) roadside vegetation, and iv) riparian vegetation. Study area is mainly crop field vegetation.

4.5.1 Bio-ecological zones

97. The International Union for Conservation of Nature (IUCN) has divided Bangladesh into 25 bio-ecological zones (Nishat et al. 2002) within the context of physiographic units and biological diversity. Each of the bio-ecological zone represents the overall ecological situation of an area in the country. The study area is within two different bio-ecological zones: Ganges

floodplain, and Saline tidal floodplain (**Figure 4.18**). The bio-ecological zones consist of Ganges Floodplain, 29.5 acres (8.7%) and Saline tidal floodplain, 308.88 acres (91.3%).

Figure 4.18: Bio-ecological zone within the study area



4.5.3 Floral diversity in the study area

98. The types of vegetation within the study area are shown in **Figure 4.19**. Homestead vegetation is characterized by fruit-bearing trees, timber trees, and vegetable (**Figure 4.19**). The common cultivated plants are Betel nut palm (*Areca catechu*), coconut (*Cocos nucifera*), Indian Lilac (*Azadirachta indica*), West Indian mahogany (*Swietenia macrophylla*), Jackfruit (*Artocarpus heterophyllus*), etc. Homestead vegetation provides good shelter and habitat for local animals like birds, reptiles and amphibians. **Table 4.15** presents the plant species commonly found along the transmission line route.

Figure 4.19: Types of vegetation within the study area

Homestead vegetation

Roadside vegetation

Crop field vegetation

River side vegetation

Table 4.15: Common plant species along the transmission line route

Sl.	Local Name	Scientific Name	IUCN Conservation Status (Global)	IUCN Conservation Status (Bangladesh)
1	Amra	*Spondias dulcis*	Not Assessed	Not Assessed
2	Bara Mahogonii	*Swietenia macrophylla*	Vulnerable (A cultivated species in Bangladesh and not listed as Vulnerable)	
3	Jum	*Syzygium cumini*	Not Assessed	
4	Jamrul	*Syzygium samarangense*	Not Assessed	
5	Tentul	*Tamarindus indica*	Not Assessed	
6	Sagun	*Tectona grandis*	Not Assessed	
7	Arjun	*Terminalia arjuna*	Not Assessed	
8	Bohara	*Terminalia bellirica*	Not Assessed	
9	Khatbadam	*Terminalia cattapa*	Not Assessed	
10	Baroi	*Ziziphus mauritiana*	Not Assessed	
11	Royel Plam	*Roystonea regia*	Not Assessed	
12	Raindee Kory	*Samanea saman*	Not Assessed	
13	Aum	*Mangifera indica*	Data Deficient	
14	Safoda	*Manilkara zapota*	Not Assessed	
15	Karnaga	*Millettia pinnata*	Not Assessed	
16	Sajna	*Moringa oleifera*	Not Assessed	
17	Kala	*Musa sapientum*	Not Assessed	
18	Kadam	*Neolamarckia cadamba*	Not Assessed	
19	Jalpai	*Olea europaea*	Not Assessed	
20	Khegur	*Phoenix sylvestris*	Not Assessed	
21	Khatgolap	*Plumeria rubra*	Not Assessed	
22	Debdaru	*Polyalthia longifolia*	Not Assessed	
23	Peara	*Psidium guajava*	Not Assessed	
24	Ulatkambol	*Abroma augusta*	Not Assessed	
25	Akashia	*Acacia auriculiformis*	Not Assessed	
26	Bel	*Aegle marmelos*	Not Assessed	
27	Karoi	*Albizia lebbeck*	Not Assessed	
28	Chatim	*Alstonia scholaris*	Not Assessed	
29	Ata	*Annona reticulata*	Not Assessed	
30	Supari	*Areca catechu*	Not Assessed	
31	Khanthal	*Artocarpus heterophyllus*	Not Assessed	
32	Dewa	*Artocarpus lakoocha*	Not Assessed	
33	Kamranga	*Averrhoa carambola*	Not Assessed	
34	Neem	*Azadirachta indica*	Not Assessed	
35	Shimul	*Bombax ceiba*	Not Assessed	
36	Tal	*Borassus flabellifer*	Not Assessed	
37	Papya	*Carica papaya*	Not Assessed	
38	Batabilebu	*Citrus grandis*	Not Assessed	
39	Narikel	*Cocos nucifera*	Not Assessed	
40	Sisso	*Dalbergia sissoo*	Not Assessed	
41	Krishnochura	*Delonix regia*	Least Concern	
42	Chalta	*Dillenia indica*	Not Assessed	
43	Bilati Gab	*Diospyros blancoi*	Not Assessed	
44	Eucalyptus	*Eucalyptus sp*	Not Assessed	
45	Bot	*Ficus benghalensis*	Not Assessed	
46	Gamari	*Gmelina arborea*	Not Assessed	

Sl.	Local Name	Scientific Name	IUCN Conservation Status (Global)	IUCN Conservation Status (Bangladesh)
47	Jarul	*Lagerstroemia speciosa*	Not Assessed	
48	Ipil	*Leucaena leucocephala*	Not Assessed	
49	Lichu	*Litchi chinensis*	Not Assessed	

99. Component 3 will also traverse agricultural land. The crop field vegetation consists of highland and medium highland. This area is mostly utilized for rice monoculture as well as different types of economic crops. Aside from economic crops being cultivated, there are varieties of weeds in the area: Bermuda grass (Cynodon dactylon), Spider wort (Commelina bengalensis), Peruvian primrose (Ludwigia peruviana), Busket grass (Oplisma burmaniaii), Mutha grass (Cyperus rotandus), Dollar weed (Hydrocotyle spp.), Carpet grass (Azonopus compressus), Indian heliotrope (Heliotropium indicum), spiny pigweed (Amaranthus spinosus), and Croton (Croton bonplandianum) were observed. Other vegetation commonly observed in freshwater ditches includes: water hyacinth (Eichhornia crassipes), water lettuce (Pistia stratiotes), floating fern (Salvinia natans), common duckweed (Lemna perpusilla), and water velvet (Azolla pinnata).

100. Component 3 will also cross roads and rivers. Road side vegetation includes Indian Gum Arabic Tree (Acacia nilotica), Broad leafed Mahogany (Swietenia macrophylla), Silk tree (Albizia richardiana), and lebbek tree (Albizia lebbeck), which are very common.

101. Different types of aquatic flora within the study area are listed in Table 4.16.

Table 4.16: List of common aquatic plant species in the study area

Sl.	Category	Local Name	Scientific Name
1	Submerged	Jhangi	*Hydrilla verticillata*
2		Bicha	*Vallisneria spiralis*
3		Ghechu	*Aponogeton natans*
4	Free floating	Kachuripana	*Eichhornia crassipes*
5		Topapana	*Pistia stratiotes*
6		Tetulpana	*Salvinia natans*
7		Khudipana	*Lemna perpusilla*
8		Azola	*Azolla pinnata*
9	Rooted floating	Sada sapla	*Nymphae nouchali*
10	Sedges and Meadows	Kolmi	*Ipomoea aquatica*
11		Dhol kolmi	*Ipomoea fistulosa*
12		Keshordam	*Ludwigia adscendense*
13		Helencha	*Alternanthera philoxiroides*

Source: Field survey and local people interview; June 2017.

4.5.4 Faunal diversity in the study area

Amphibians

102. The skipper frog *(Euphlyctis cyanophlyctis)* is commonly found all year round. There is an abundance of bullfrogs *(Hoplobactruchus tigerinus)* during the monsoon season and they are found in ditches and other marshy places. Common toad *(Duttaphrynus melanostictus)* and cricket frog *(Fejervarya limnocharis)* are also found in the study area.

Birds

103. Terrestrial bird species include: Black Drongo, Brown Shrike, Jungle Myna, Rock pigeon, House crow, House Sparrow, Common Myna, Large-billed crow, Spotted Dove, Little Cormorant, Long tailed Shrike, Pied Myna, and Black Crowned Nigh Heron.

Reptiles

104. The species include: Common skunk *(Mabuya carinata*), garden lizard *(Calotes versicolor),* Bengal Monitor *(Varanusbengalensis),* Water Monitor (*Varanus salvator*), Common vine Snake, Painted Bronzeback tree snake, Common Bronzeback, Tree Snake Common Wolfe Snake, Indo Chinese rat Snake, and Checkered Keel back.

Mammals

105. Common species are House Mouse (*Mus musculus*), Asian House Shrew (*Suncus murinus*), Common Mongoose (*Herpestes edwarsii*), Jungle Cat (*Felis chaus*), Small Indian Civet (*Viverrricula indica*), Indian Palm Civet (*Paradoxurus hermaphroditus*), Asiatic Jackal (*Canis aureus*), short-nosed bat (*Cynopterus sphinx*), and Indian Flying Fox (*Pteropus giganteus*). Gangetic River Dolphins (*Platanista gangetica gangetica*) were seen during survey. Table 4.17 gives the list of faunal species.

Table 4.17: List of faunal species in the study area

English Name	Scientific Name	IUCN Bangladesh (2015)	IUCN Global Status	CITES Appendices
Mammals				
Common House Rat	*Rattus*	Least Concern	Least Concern	Not Listed
House mouse	*Mus musculus*	Least Concern	Least Concern	Not Listed
Field Mouse	*Mus booduga*	Least Concern	Least Concern	Not Listed
Grey Musk Shrew	*Suncus murinus*	Least Concern	Least Concern	Not Listed
Common mongoose	*Herpestes edwardsi*	Least Concern	Least Concern	III
Jungle Cat	*Felis chaus*	Near Threatened	Least Concern	Not Listed
Greater Short nosed Fruit Bat	*Cynopterus sphinx*	Least Concern	Least Concern	Not Listed
Small Indian Civet	*Viverrricula indica*	Near Threatened	Least Concern	Not Listed
Indian Palm Civet	*Paradoxurus hermaphroditus*	Least Concern	Least Concern	III
Asiatic Jackal	Canis aureus	Least Concern	Least Concern	III
Indian Flying Fox	*Pteropus giganteus*	Least Concern	Least Concern	Not Listed
Gangetic River Dolphin	*Platanista gangetica*	Vulnerable	Endangered	I
Birds				
Magpie Robin	*Copsychus saularis*	Least Concern	Least Concern	Not Listed
Barn Owl	*Tyto alba*	Least Concern	Least Concern	Not Listed
Black-hooded Oriole	*Oriolus xanthornus*	Least Concern	Least Concern	Not Listed
Rock Dove	*Columba livia*	Least Concern	Least Concern	Not Listed
Spotted Dove	*Streptopelia chinensis*	Least Concern	Least Concern	Not Listed
Common Kingfisher	*Alcedo atthis*	Least Concern	Least Concern	Not Listed
Bronzed Drongo	*Dicrurus aeneus*	Least Concern	Least Concern	Not Listed
House Crow	*Corvus splendens*	Least Concern	Least Concern	Not Listed

English Name	Scientific Name	IUCN Bangladesh (2015)	IUCN Global Status	CITES Appendices
Common Mynah	*Acridotheres tristis*	Least Concern	Least Concern	Not Listed
Red-vented Bulbul	*Pycnonotus cafer*	Least Concern	Least Concern	Not Listed
Brahminy Kite	*Haliastur indus*	Least Concern	Least Concern	Not Listed
Black Kite	*Milvus migrans*	Least Concern	Least Concern	Not Listed
Amphibians				
Bull Frog	*Hoplobactrachus tigerinus*	Least Concern	Least Concern	II
Tree Frog	*Rana temporalis*	Least Concern	Least Concern	Not Listed
Cricket Frog	*Rana limnocharis*	Least Concern	Least Concern	Not Listed
Common Toad	*Bufo melanosticus*	Least Concern	Least Concern	Not Listed
Green Frog	*Euphlyctis hexadactylus*	Least Concern	Least Concern	II
Reptiles				
House Lizard	*Hemidactylus brooki*	Least Concern	Least Concern	Not Listed
House Lizard	*Hemidactylus frenatus*	Least Concern	Least Concern	Not Listed
Common Garden Lizard	*Calotes versicolor*	Least Concern	Least Concern	Not Listed
Water Monitor	*Varanus salvator*	Vulnerable	Least Concern	
Bengal Monitor	*Varanus bengalensis*	Near Threatened	Least Concern	I
Stripes Keelback	*Amphiesma stolata*	Least Concern	Least Concern	Not Listed
Olive Keelback	*Atretium schistosum*	Least Concern	Least Concern	III
Rat Snake	*Ptyas mucosus*	Least Concern	Least Concern	II

Source: CEGIS Field visit, literature review, and interview of local people, June 2017.

4.6 Socio-economic conditions

106. Primary data were collected using tools and techniques such as Rapid Rural Appraisal, Key Informant Interview (KII), observations and informal consultations. Secondary data were collected from Bangladesh Bureau of Statistics (BBS) 2012 and other available government publications.

4.6.1 Demographic Profile

107. **Location.** According to Spatial GIS Analysis (CEGIS 2016), the study area consists of seven (7) unions and one (1) ward (ward no. 13) under Khalishpurthana in Khulna City. The upazilas are: Batiaghata, Dighalia and Rupsha under Khulna district and one under Fakirhatupazila of Bagerhat district.

108. **Population.** There are 66,109 households in the study area and has a total population of 278,187. The population consists of 142,001 males (51%) and 136,186 females (49%). The male-female ratio is 105 which is higher than the national figure of 100.3 (BBS, 2012).

109. **Household size.** The average household size is 4.2 compared to the national average of 4.4 (BBS, 2012).

110. **Age structure.** Prime working age group (25-59 years old) dominates the population (43%) followed by children, 30% (with age group 0-14 years old). About 26% of the population belongs to the age group 30-49 years old and the lowest, about 3% belongs to the age group of 60-64 years old. This classification is important as the size of young population (under age 15)

would need more investment in education and health while size of older populations (ages 65 and over) would need more investments in the health sector.

111. **Housing condition.** On average, 14.1% of the households are in pucca, 51.2% are kutcha, 30.6% are in semi pucca while the rest of the households are in Jhupri house (4.1%).

112. **Literacy rate.** Literacy rate is 60% compared to the national rate of 52%. Male population accounts for62% and female accounts for 57%.

113. **Employment.** About 41% is employed in different sectors of which 34% are male and 7% are female. About 34.4% of people are engaged in household work while 24.2% are not working.

114. **Occupational pattern.** Main occupation is service (47.8%) in which38.2%is male and 9.6% is female. This is followed by people engaged in agriculture (27.1%) and about 25.1% are engaged in industrial work.

115. **Labor availability and wage rate.** Daily wage rate varies between 400Tk to 500Tk (**Table 4.18**). A few migrant laborers stay in the study area all year round and return to their homes at the end of the year with all their income. Women's participation in the agricultural sector is negligible.

Table 4.18: Labor availability and wage rate in the study area

Type		Male			Female		
		Labor Availability	Average Wage Tk/day		Labor Availability	Average Wage Tk/day	
			Max.	Min.		Max.	Min.
Farming	Skilled	High	400	300	Nil	-	-
	Non-Skilled	High	350	300	Low	300	250
Non-Farming	Skilled	Medium	500	400	Low	400	300
	Non-Skilled	High	350	300	Medium	250	200

Source: CEGIS fieldwork, 2016.

116. **Population migration.** Seasonal labor migration is such that during the rainy season, they remain out of work and thus, migrate temporarily to other districts for livelihood. They migrate to Dhaka, Sylhet and Mymensingh where they work as laborer, rickshaw puller, small scale businessman, etc. (**Table 4.19**).

Table 4.19: Migration status in the study area

Type of Migration	Labor Migration-Out		Labor Migration-In	
	Place of destination	% of total population	Place of origin	% of total population
Seasonal labour migration	Dhaka, Chittagong	8%	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	15%
Permanent household migration	Dhaka, Chittagong	2%	Bagerhat, Gopalganj, Pirojpur, Barisal, Jhalokathi, Satkhira	1%

Source: CEGIS fieldwork, 2016.

117. **Drinking water.** About 97.3% of the population gets drinking water from tube wells, 1.4% is dependent on tap water, and 1.3% depends on other sources such as pond, river and canal.

118. **Sanitation.** About 17.6% of the population still has no sanitary toilet. More than half of the population (81.2%) has sanitary toilet facilities of which 34.8% are water-sealed and 46.4% are non-water-sealed. Still about 1.1% of the population does not have sanitary facilities.

119. **Electricity.** BBS (2012) data shows that about 71.9% of the households are consuming grid electricity to meet their daily demand, the rest on solar energy.

120. **Transportation.** Modes of transport available are roadway, railway and waterway. The main roadway is Jessore-Khulna highway road, Khulna-Bagerhat–Pirojpur road which is connected to the southern part of Bangladesh. One of the major roads is Khulna to Dhaka via Gopalganj and Mawaghat. There is railway connection in Khulna and an airport in Jessore district. Water transport is mainly through Bhairab River, Rupsha River and Passur River.

121. **Community health** Local people in the study area reported that the most prevalent diseases in the study area are diarrhea, typhoid, pneumonia, jaundice, skin diseases, etc. Children are mostly affected by water-borne diseases. Instant health facility is inadequate in nearby areas except the city corporation area. Hyper tension/high blood pressure is also increasing among the people. Disability is also found in the study area. Total disability is about 1.5%.

122. **Health services.** There is a 250-bed capacity health complex at Boyra. Patients from different districts go to Boyra for better medical treatment. There are a number of private clinics in Khulna city where people can get better medical treatment.

123. **Availability of health services and facilities.** About 48% of patients go to trained physician as people have easy access to the trained physician in Khulna city. About 25% people in the study area go to paramedic doctor and about 22% patients go to quack doctors. Local people are nowadays much more aware about their health. They have eagerness to receive health treatment from trained physicians but all of them are not able to do that due to inadequate financial capability and availability of health facility.

124. **Literacy rate.** Literacy rate in the area is 71% where male accounts for 74% and female 68%

125. **Vulnerability to natural disaster.** Khulna is situated in the natural disaster prone area. Local people opined that waterlogging, salinity intrusion, cyclone, surge, river erosion are the main natural disasters in the study area. These occur almost every year in this area.

126. **Safety nets.** Major social safety nets and poverty reduction programs in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social security among the targeted poor households and vulnerable communities. A number of local, national and international NGOs are working in the study area. The main activities of these NGOs are operating microcredit programs among the rural poor and landless women/men.

5.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

127. Considering the base of a transmission tower as 20mx20m, the area affected due to 75 tower bases will be about 3 hectares (ha). With the RoW of 10 m on each side of the transmission line, the area that will be affected is 49.122 ha. Thus, the total land within the direct impact area will be 52.122 ha. With a buffer of 40 m on each side of the RoW, the total land area that may be indirectly affected will be 196.488 ha.

128. Environmental components likely to be impacted by Component 3 are referred to as important environmental components (IECs) and important social components (ISCs). For Component 3, the IECs and ISCs likely to be impacted by the pre-construction, construction, operation and decommissioning are selected as follows:

5.1.1 Selection of IECs and their Rationale

Table 5.1: IECs on physical-chemical environment

IECs	Rationale for selection
Ambient air quality	Construction and operation of OHTL will generate minimal amount of air pollutants such as particulate matter (PM), hydrocarbons, nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), heavy metals from the operation of trucks, heavy equipment and from activities such as excavation of foundation for the bases of the transmission line towers. These may impact air ambient quality.
Ambient noise quality	Noise pollution during construction phase may come from the operation of construction equipment, vehicular movements, construction works and other noise-generating activities of settlements. Elevated noise level may cause inconvenience and annoyance of the settlements within the study area.

Table 5.2: IECs on water resources

IECs	Rationale for selection
Surface and Groundwater Quality	Construction of OHTL may affect nearby surface water quality due to the excavation of the foundation for the bases of the transmission line. This may potentially cause siltation. During operation, groundwater may be a source of domestic water supply which may be contaminated with hazardous wastes coming from the drainage of the electrical substation. The hazardous wastes may be used mineral oil disposed from the electrical equipment such as transformers.
River bank erosion	Protection measures against erosion and construction of adequate anchorage against flotation, collapse or lateral movement shall be followed according to the design for both river banks where the OHTL will cross.
Flooding	Design and management of towers will include flooding elevation in Bhairab River, Atai River, and Rupsha River.

Table 5.3: IECs on land and agriculture resources

IECs	Rational for selection
Soil quality for agricultural purposes	There will be permanent land loss if agricultural land would be converted to non-agricultural land to accommodate the base of the transmission towers. Installation of towers will involve excavation of soilwhich may affect soil quality.
Soil/Land contamination	During operation of the electrical substations, used insulating mineral oil from electrical equipment such as transformer, if not disposed off properly, may cause land contamination. The mineral oil to be used should be free fromPCB.

IECs	Rational for selection
	There can be also soil/land contamination due to improper solid wastes disposal from the construction and operation phases of the transmission line component of the project.
Change of land use	Land use may be changed with the presence of transmission towers.Agricultural land may be permanently lost due to tower footings. As a result, present crop land might be changed into non-crop land.
Change in surface topography or terrain	During construction and operation, there may be continuous soil erosion in unavoidable steep location of transmission towers that may cause permanent changes in landform, topography and slope.
Loss of crop production	During construction, standing crops in the area might be affected with a possibility of change in crop production. Use of heavy equipment and movement of vehicles may cause loss of crops.
Intercropping	Intercropping may be affected due to the installation of towers.
Impairment of visual aesthetics	Aesthetics and urban landscape may be affected by the presence of transmission towers.

Table 5.4: IECs on fisheries resources

IECs	Rationale for selection
Fish habitat	About 75 towers will be erected along the OHTL route. Installation of these towers may cause temporary damage to fish habitat or new fish habitat may be created at the center of the tower footings.
Fish disease and mortality	Use of chemicals and mineral oil from substation in Rupsha 800 MW CCPP may affect the culture fish species, particularly Bagda and Galda.
Fish production	Inundation of the tower base exposing soil with poor nutrient content in selected area may affect fish production

Table 5.5: IECs on ecological resources

IECs	Rationale for selection
Terrestrial vegetation	Terrestrial vegetation provides food and shelter to local birds and various animals. Construction activities may require clearing of terrestrial vegetation and operation phase requires vegetation management along the RoW and restriction of vegetation height below the transmission line.
Wildlife habitat and their disturbance	Movement of local wildlife may be disturbed due to construction activities and vegetation management along the RoW during the operation phase.

Table 5.6: ISCs on socio-economic aspects

ISCs	Rationale for selection
Land price	Land affected by the tower footings may be devalued. Land development between transmission towers and below the transmission line will be restricted affecting land value.
Employment opportunities	Employment opportunities will be created during the construction and operation phase.
Human health and safety	Working on heights and other construction activities may pose occupational and safety risks. Exposure of workers maintaining the OHTL may also pose health risks.
Regional and national development	Economic development largely depends on the availability of a reliable power supply. Uninterrupted power supply is expected to improve productivity and development.

5.2 Analysis of potential impacts

Impact assessment methodology

129. Potential environmental and social impacts were identified based on-site visits, interviews with affected persons, stakeholder engagement, environmental sampling, collection of relevant and available secondary data, review of relevant project documents such as Feasibility Study, survey reports, etc. Significance of potential impacts was assessed using the criteria and methodology given below.

Impact magnitude

130. The potential impacts have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. The magnitude of potential impacts has been identified according to the categories outlined below.

Table 5.7: Parameters for determining magnitude

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

Sensitivity of Receptor

131. The sensitivity of receptor has been determined based on review of the population (including proximity/numbers/vulnerability) and presence of features on the site or the surrounding area. Criteria for determining receptor sensitivity are given in **Table 5.8**.

Table 5.8: Criteria for determining sensitivity

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

Assigning significance

132. Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in **Table 5.9**.

Table 5.9: Significance of impact criteria

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

Impact matrix

133. Potential environmental impacts on the IECs during pre-construction, construction, and operation phases of Component 3 are presented in a matrix form in **Table 5.10.**

Table 5.10: Impact matrix of Component 3

IECs/Issues	Potential Impacts	Sensitivity	Magnitude	Significance Prior to Mitigation
Pre-construction Stage				
Physical-Chemical Environment and Water Resources				
Ambient air quality	Vehicular emissions; dust from excavation works, land clearing, and material stockyards may affect ambient air quality	Medium	Minor	Minor Adverse

IECs/Issues	Potential Impacts	Sensitivity	Magnitude	Significance Prior to Mitigation
Ambient noise	Noise level may increase due to mobilization of vehicles and unloading of materials.	Medium	Minor	Minor Adverse
Quality of surface and groundwater	N/A	N/A	N/A	N/A
Riverbank erosion	Regular erosion of river bank	High	Moderate	Major Adverse
Flooding	Minor impact	Low	Minor	Minimal Adverse
Land and Agricultural Resources				
Soil quality for agricultural purposes	N/A	N/A	N/A	N/A
Soil/Land contamination	N/A	N/A	N/A	N/A
Land use	Would be partially impacted	Low	Minor	Minimal Adverse
Crop production	Would be highly impacted	Medium	Moderate	Moderate Adverse
Change in topography/ terrain	N/A	N/A	N/A	N/A
Impairment of visual aesthetics	N/A	N/A	N/A	N/A
Fisheries Resources				
Fish habitat	Fish habitat quantity and quality will be the same	Low	Minor	Minimal Adverse
Fish disease and mortality	There will be no change	Low	Minor	Minimal Adverse
Fish production	There will be no effect	Low	Minor	Minimal Adverse
Socioeconomic Resources				
Land price	No minimal impact	Low	Minor	Minimal Adverse
Employment opportunities	Temporary or minimal opportunities at this stage	Medium	Moderate	Moderate Beneficial
Human health and safety	No impact	Low	Minor	Minimal Adverse
Regional and national development	No impact	Medium	Moderate	Moderate Beneficial
Construction Stage				
Physical-Chemical Environment and Water Resources				
Ambient air quality	Suspended particulate matter from excavation works and land clearing including vehicular emissions may affect workers and community	Medium	Moderate	Moderate Adverse
Ambient noise	Mobilization of heavy equipment and machineries, use of construction vehicles, transport of materials, and construction activities may increase ambient noise level. Exposure to high level ambient noise may cause anxiety and disturbance to workers and community.	Medium	Moderate	Moderate Adverse

IECs/Issues	Potential Impacts	Sensitivity	Magnitude	Significance Prior to Mitigation
Quality of surface and groundwater	Potential for siltation at Bhairab River, Atai River and Rupsha River due to construction works at river crossings.	Medium	Moderate	Moderate Adverse
Riverbank erosion	Potential erosion due to ground movements along the river crossings at Bhairab River, Atai River, and Rupsha River. A total of 6 river crossings will result from Component 3.	High	Major	Moderate
Flooding	Potential flooding during monsoon season along the crossings at Bhairab River, Atai River, and Rupsha River.	Medium	Moderate	Moderate Adverse
Land and Agricultural Resources				
Soil quality for agricultural purposes	During construction, top soil at the tower footings may be eroded during excavation.	High	Major	Moderate
Soil/Land contamination	N/A	N/A	N/A	N/A
Land use	Would be partially impacted as agricultural land may be permanently lost due to the tower footings	Medium	Moderate	Moderate Adverse
Crop production	May be moderately affected due to crop loss at the tower footings and in the clearing for RoW	Medium	Moderate	Moderate Adverse
Change in topography/terrain	Excavation works for the transmission towers may affect topography	Low	Minor	Minimal Adverse
Impairment of visual aesthetics	N/A	N/A	N/A	N/A
Fisheries Resources				
Fish habitat	Construction activities may temporarily affect fish habitat	Medium	Minor	Minor Adverse
Fish disease and mortality	There will be no change	Low	Minor	Minimal Adverse
Fish production	Fish production will have same as base condition	Low	Minor	Minimal Adverse
Terrestrial Resources (Flora and Fauna)				
Terrestrial vegetation	Vegetation clearing may be required at the tower footings and RoW	Medium	Moderate	Medium
Wildlife habitat and their disturbance	Route will be mainly in urban areas. Habitat in the areas affected may not host wildlife	Medium	Moderate	Medium
Socioeconomic Resources				
Compensation for crop damage	Standing crops at the tower footings and RoW may be damaged	Medium	Moderate	Moderate Adverse
Land price	Value of land may be temporarily	Medium	Moderate	Moderate Adverse

IECs/Issues	Potential Impacts	Sensitivity	Magnitude	Significance Prior to Mitigation
	affected			
Temporary employment opportunity	Both technical and non-technical laborers will be required	Medium	Moderate	Moderate Beneficial
Human health and safety	Workers may be exposed to occupational health risks and safety hazards	Medium	Minor	Minor Adverse
Regional and national development	May create development opportunities in anticipation of stable power supply	Medium	Moderate	Moderate Beneficial
Operation Stage				
Physical-Chemical Environment and Water Resources				
Ambient air quality	No or minimal impact	Low	Minor	Minimal Adverse
Ambient noise	No or minimal impact	Low	Minor	Minimal Adverse
Quality of surface and groundwater	No or minimal impact	Low	Minor	Minimal Adverse
Riverbank erosion	No or minimal impact	Low	Minor	Minimal Adverse
Flooding	No or minimal impact	Low	Minor	Minimal Adverse
Land and Agricultural Resources				
Soil quality for agricultural purposes	May result to permanent loss of agricultural land due to tower footings	Low	Minor	Minimal Adverse
Soil/Land contamination	Potential for spill or improper disposal of mineral oil used as insulating oil in transformers. No use of PCB or PCB-containing material will be allowed.	Low	Minor	Minimal Adverse
Land use	No impact	Low	Minor	Minimal Adverse
Crop production	Tower footings may have minimal impact on crop production due to permanent loss of agricultural land.	Medium	Minor	Minor Adverse
Change in surface topography/ terrain	Transmission towers may have minimal impact on topography	Low	Minor	Minimal Adverse
Impairment of visual aesthetics	N/A	N/A	N/A	N/A
Fisheries Resources				
Fish habitat	No change expected	Low	Minor	Minimal Adverse
Fish disease and mortality	Potential for higher mortality rate after the first year of tower installation	Medium	Moderate	Moderate Adverse
Fish production	May improve after completion of construction works	Medium	Minor	Minor beneficial
Terrestrial Resources (Flora and Fauna)				
Terrestrial vegetation	Restriction of vegetation height below the transmission line	Low	Minimal	Low
Wildlife habitat and their disturbance	Flyway paths of bats may be affected by the transmission towers (e.g. Greater shortnosed fruit bat (*Cynopterus sphinx*), Indian Flying Fox (*Pteropus giganteus*)	Low	Minimal	Low

IECs/Issues	Potential Impacts	Sensitivity	Magnitude	Significance Prior to Mitigation
Socioeconomic Resources				
Compensation	Permanent loss of land at the tower footings	Medium	Moderate	Moderate Adverse
Land price	No land value at the tower footings; development restrictions below the transmission line and between towers may affect land value	Medium	Moderate	Moderate Adverse
Employment opportunity	Jobs will be created directly due to Component 3 and indirectly through businesses and development resulting from the availability of power supply	Medium	Minor	Minor beneficial
Human health and safety	Occupational and community safety risks	Low	Moderate	Minimal Adverse
Regional and national development	Availability of a stable and reliable power supply may improve productivity and national development.	Medium	Moderate	Moderate Beneficial

5.3 Impact Assessment

5.3.1 Pre-construction stage

Ambient air quality

134. Exhaust from vehicles usually operating within the area may contribute to impairment of ambient air quality. Fugitive dust emissions from the material stockyards may also affect ambient air quality. Impacts to ambient air quality will be temporary at this stage and maybe characterized as minimal adverse**.**

Mitigation measures

135. Regular maintenance of vehicles may improve combustion efficiency of engines. Water can be sprayed to unpaved roads and stockyards can be covered to contain dust or generation of suspended particulates. Area allocated as stockyard for construction materials will be enclosed to minimize dispersion of dusts.

Ambient noise

136. At this stage, there are no activities that generate noise associated with Component 3. Sources of noise are from activities of settlements living close to the transmission line route.

Surface and groundwater quality

137. During pre-construction stage, there will be no impacts on the surface and groundwater quality resulting from Component 3.

Potential riverbank erosion

138. Without considering the potential for riverbank erosion along the Bhirab River, Atai River, and Rupsha River, the significance of this impact will be major. The selected alignment will cause a total of six crossings on these rivers.

Mitigation measures

139. An expert will review the structural design, specifications and plans for construction of the transmission towers that will be erected close to the banks of these rivers as well as the activities to be done at the six river crossings to ensure that Component 3 will not cause undue riverbank erosion on these rivers.

Residual impact

140. With mitigation, the residual impact will be moderate.

Intercropping

141. Intercropping and related activities may be potentially affected due to detailed ground survey activities along the transmission line route.

Mitigation measure

142. Consultations between the surveyors and the appropriate community representative will be undertaken. Affected area will be informed of the survey schedule.

5.3.2 Construction Stage

Impairment of visual aesthetics/Impact on urban landscape

143. Site preparations and land clearing may temporarily affect aesthetics and urban landscape. This impact is considered minimal adverse.

Mitigation measures

144. Good housekeeping at the construction site will be enforced at all times. Garbage bins will be provided by the EPC Contractor for proper disposal of solid wastes generated.

Residual impact

145. With mitigation, the significance of the impact will be low.

Ambient air quality

146. Site preparation along the transmission line route, land clearing and excavation works, use of construction vehicles, mobilization of heavy equipment and machineries, use of diesel generators as back-up power supply, and transport of construction materials may generate dusts and emissions affecting ambient air quality. Vehicular emissions will contribute to GHG emissions. This impact is characterized as **minimal adverse.**

Mitigation measures

147. The following measures will be implemented: (i) require EPC Contractor to monitor the maintenance of construction vehicles, (ii) water will be sprayed to unpaved roads and opened land areas, as and when necessary, to minimize dust dispersion, (iii) vehicles transporting construction materials generating dusts will be covered with tarpaulin, (iv) stockyards of construction materials will be covered including opened areas during off-work, and (v) construction area with excavation works and opened land areas will be temporarily enclosed to contain dust generated.

Residual impact

148. With mitigation, significance of this impact will be low.

Ambient noise

149. Construction activities such as civil works, use of heavy equipment and machineries, welding and electrical works may increase the ambient noise level at the construction site. Prolonged exposure to elevated noise level may cause hearing impairment to workers and annoyance to local people. This impact is characterized as minimal adverse.

Mitigation measures

150. Workers assigned to noise-generating activities will be provided with ear muffs and will be rotated every 4 hours to minimize exposure. Construction activities that generate noise will be undertaken only during daytime. Machines and vehicle engines not in use will be turned off. Drivers of vehicles used in construction will be instructed not to use horns or sirens unnecessarily. Noise-generating activities will be enclosed to minimize the noise level.

Residual impact

151. With mitigation, the level of significance of this impact will be low.

Generation of wastes at construction site and field camps

152. Workers and construction activities will generate wastes. Improper collection and disposal of solid waste generated may pose safety and health risks both to workers and the community. Aside from this, mismanaged solid waste will be unsightly and unhygienic. Oily wastes from machine workshops and vehicle maintenance may cause land contamination. This impact is considered moderate adverse.

Mitigation measures

153. The EPC Contractor will be required to have a Waste Management Plan approved by PMU, NWPGCL. Garbage bins will be provided at the construction sites and EPC Contractor will make arrangement with the local government institution managing solid wastes for collection and proper disposal to designated sites. Good housekeeping will be enforced at all times that workers found not in compliance will be dealt with accordingly. Practice of reuse, reduce and recycle will be adopted to decrease the volume of generated waste from construction activities and to maximise the resource recovery of materials. Workers will be encouraged to sort the solid wastes at source prior to disposal. Oily wastes will be passed through an oil-water separator before discharge.

154. EPC Contractor will provide workers with sanitary facilities, wash areas, safe drinking water, and adequate water supply for general washing purposes. Compliance of EPC Contractor to relevant provisions in ECR 1997 on discharge of wastewater including waste management at the construction sites will be monitored by PMU, NWPGCL.

Residual impact

155. With mitigation, the significance of this impact will be low.

Flooding

156. Bhairab River, Atai River, and Rupsha River are influenced by tidal action from the Bay of Bengal. Construction works at the six river crossings may potentially cause flooding during high tide. This impact may be considered moderate.

Mitigation measures

157. Construction work schedule at the river crossings will consider tidal influence to avoid potential flooding. Highest flood level at the river crossings will be incorporated in the design and construction of the transmission towers.

Residual impact

158. With mitigation, the significance level of this impact will be low.

Impact on surface and groundwater quality

159. Construction works at the river crossings in Bhairab River, Atai River and Rupsha River may affect surface water quality. Excavated soil and opened land areas near the river banks including spoils disposal may cause erosion.

160. Oily wastes and accidental spill of liquid fuel may find its way to the rivers and ground water. Improper collection and disposal of solid wastes generated by workers may also find its way to the rivers. Field camps close to the rivers may cause degradation of surface water quality from wastes generated by workers.

Mitigation measures

161. No field camps will be located close to Bhairab River, Rupsha River, Atai River and other water bodies. The EPC Contractor will be required to prepare CMP that will address, among others, field camps, provision to workers of sanitary facilities, safe drinking water, wash areas away from water bodies, and adequate water supply for general purpose washing. EPC Contractor and its workers will be required to observe proper waste disposal and proper sanitation.

162. All construction vehicles and equipment will be maintained in proper conditions. EPC Contractor will use silt traps and erosion control measures where the construction is carried out in close proximity to the drains and water bodies to avoid entering of cement particles, rock, rubbles and waste water to the surrounding water bodies.

Impact on soil quality

163. During site preparation, vegetation clearing will be required and will involve excavation works for the foundation of the transmission towers. Improper handling of excavated soil, spoils disposal, and generation of wastes at the construction site may affect soil quality of adjacent land.

Mitigation measures

164. Construction activities will be limited to designated areas. Proper storage of chemicals such as lubricants will be implemented. Areas for machine repair and other mechanical work that may require mineral oil or lubricants will be line with impermeable material to prevent land contamination. Excess chemicals that may be needed for construction will be disposed of following its material safety data sheet (MSDS). EPC Contractor will be encouraged to use non-toxic and biodegradable chemicals on-site. Solid waste generated on-site will be collected and disposed of properly.

Impact on terrain and topography

165. During construction, erosion might occur in the location of towers in steep terrain.

Mitigation measures

166. Construction works will be scheduled, to the extent possible, during the dry season. Where required, erosion control and slope protection measures will be provided. Stabilization of embankment with grasses or other soil cover will be conducted as soon as necessary.

Change in land use

167. Mobilization of construction equipment, machineries, and vehicles, and transport of construction materials will require space for storage and parking. Areas for field camps will also require space. A total of about 3 ha will be lost permanently to tower footings and about 49.122 ha will be RoW. These interventions may affect the existing land use.

Mitigation measures

168. Use of space for stockyard and parking will secure permits and approval from respective local government institutions. EPC Contractor will be required to use only the designated areas indicated in the permits. Compliance will be monitored by PMU, NWPGCL. Except for the towers, space to be used during construction for storage and parking will be rehabilitated to a condition similar to before construction.

Loss of crop production

169. Vegetation and standing crops along the RoW will be cleared and stringing of conductors may also affect standing crops. It is estimated that about 11.44 tons of crops (HYV Aman: 3.42 tons, HYV Boro: 6.0 tons, Kheshari: 0.9 tons and Sesame: 1.12 tons) may be affected by these activities.

Mitigation measures

170. Construction work schedule will consider harvest time of farmers that may be affected to minimize crop damage. Any crop damage that may be incurred due to Component 3 will be properly compensated.

171. Farmers will be informed way ahead (before start of cropping season) about the construction activities and schedule, so they would not take any initiative for crop cultivation in the affected areas. Farmers will be given the chance to harvest their crops before the EPC Contractor will start construction works.

Fish habitat loss

172. Construction works may temporarily damage the *ghers* area especially the *gher* near the bank of Rupsha River at Tentultola village. Temporary loss of gher area is about 0.02 acre (2 decimal). During tower installation, the nutrient-rich soil will be excavated which may affect the habitat quality of the gher.

Mitigation measures

173. Construction of temporary bund around the base of the tower will be undertaken to protect the other part of the gher. Top soil removed for the base of the towers will be set aside and returned to the adjacent area after construction.

Impact on fish production

174. Loss of fish production is about10 kg due to construction of tower in the gher which is insignificant. However, habitat quality due to exposure of nutrient deficient subsoil may affect fish production.

Mitigation measures

175. Construction of temporary bund around the base of the tower will be undertaken to avoid disturbance of fish culture within the gher. Consideration of work schedule for erection of towers will be taken to avoid the period January to August. Any damage to gher production will be properly and timely compensated.

Impact on terrestrial vegetation

176. Vegetation along the RoW will be cleared during construction. No plant species of conservation status along the RoW.

Mitigation measures

177. Construction works will not be scheduled during harvest time to minimize damage to cash crops. If work schedule cannot be adjusted, land owners will be properly compensated for any crop damage along the RoW. EPC Contractor will be required to clear vegetation only in designated areas. Agricultural activities within the RoW will be allowed after construction but with restrictions to height of vegetation. Only plants such as sugarcane, corn, rice, etc. that are less than 3 m tall will be allowed for cultivation.

Effect on local workforce

178. During construction, there will be employment opportunities as well as opportunities for local people to engage in small-scale and temporary business opportunities of selling food, temporary accommodation, etc. due to the presence of workers.

Mitigation measures

179. EPC Contractor will be required to give priority to local hiring especially to non-skilled workers. This will be monitored by PMU, NWPGCL. For recruitment of skilled workers, local labour will be given preference.

Impacts to health and safety

180. Construction works along the transmission line route, which is located mostly in urban areas with river crossings, may pose safety risks to workers and the community. Exposure to sources of increased dust and noise levels may also pose health risks to workers and the community.

Mitigation measures

181. EPC Contractor will require workers to wear safety gears (helmets, safety belts, masks, gloves and boots) provided to them to minimize safety and accident risks. Toolbox meetings will be held before workers go to the work assigned to them. First aid kits and fire-fighting units will be made available at the construction sites. Before start of construction works, the EPC Contractor and PMU, NWPGCL will provide orientation and brief training to workers on emergency preparedness, and create awareness on the potential for sexually-transmitted disease in the workplace. The EPC Contractor will be required to provide affordable group medical and accident insurance to their workers or arrange with the local health facilities to provide assistance in the event of emergency. Recruitment of workers below 18 years old will be strictly prohibited. EPC Contractor (and subcontractors) will be required to comply with all relevant regulations on labour, occupational health and safety. PMU, NWPGCL will monitor compliance.

5.3.3 Operation stage

Presence of transmission towers may affect aesthetics and urban landscape

182. OHTL generally follows the easement of existing urban roads and may just blend with the urban landscape. There is no known building structure of conservation status along the transmission line route.

Impact on riverbank erosion

183. The level of significance of this impact is considered as low. Design of transmission towers crossing the rivers will incorporate the potential for riverbank erosion.

Mitigation measure

184. Planting/revegetation along the river bank side affected by Component 3 will be undertaken to minimize potential erosion.

Residual impact

185. With mitigation, significance of the impact will be low.

Impact on water quality and potential land contamination

186. Improper disposal of used mineral oil as insulating medium to electrical equipment in the substation may affect water quality and cause land contamination. Use of PCB in Bangladesh has been stopped in the 1980s. However, some equipment imported in 2000 was found to be labelled as with PCB-content. On 15 March 2005, DoE issued a letter to BPDB and other relevant organizations requesting that they buy PCB-free transformers, transformer oil, and capacitors, store all unserviceable oil in safe and secure locations, and ensure that out-of-service equipment and oils are not sold in the market for other uses.[18]

Mitigation measures

187. No PCB or PCB-containing material will be used in Component 3. Used mineral oil (replacement of PCB) as transformer oil is considered hazardous wastes and will be handled properly based on relevant regulations and international environmental agreements such as Stockholm Convention and the Basel Convention. Used mineral oil will be stored in plastic drums with proper labeling. Disposal of excess and used mineral oil will follow the accompanying material safety data sheet (MSDS).

Loss of crop production

188. About 3 ha of land will be permanently lost due to the tower footings and cultivation of some plants/crops will be restricted along the RoW.

Enhancement measure

189. Agricultural activities within the RoW will be allowed after construction but with restrictions to height of vegetation. Only plants such as sugarcane, corn, rice, etc. that are less than 3 m tall will be allowed for cultivation. Given the ground clearance at the base of the towers, farmers can still opt to use the land below the towers for cultivation of low growth crops.

Impact on terrestrial vegetation

190. Planting trees and cultivation of crops higher than 3 m along the RoW will be restricted. Vegetation that grew after construction phase will be trimmed regularly to maintain the height restrictions for safety reasons.

Mitigation measures

191. Restriction in vegetation height is to ensure that the required vertical spacing between the conductors and the vegetation is maintained for safety reasons. NWPGCL will continue dialogue with farmers (as needed) to remind them of the height restrictions on vegetation along the RoW. Any crop that may be damaged due to maintenance of the OHTL will be properly compensated.

[18] Department of Environment, Ministry of Environment and Forests, Bangladesh National Implementation Plan (NIP)For Management of Persistent Organic Pollutants (POPs), January 2007.

Impact on wildlife habitat and their disturbance

192. Component 3 is not close to protected areas or national parks. However, birds may be attracted to the presence of transmission towers. The risk of bird electrocution due to the presence of transmission towers may be likely and may affect bat species such as Indian flying fox (*Pteropus giganteus*).

Mitigation measures

193. Transmission lines are designed to have ground wire spacing and lightning arresters as safety features to generally protect the public (and birds). Spot checks/ocular inspection of wildlife crossing and bird electrocution (if any) will be included as part of maintenance work along the transmission line. NWPGCL staff assigned to maintenance works will be trained to create awareness.

Exposure of community to OHTL

194. Presence of transmission line may pose potential hazards such as electrocution, lightning strike, etc., due to accidental failure of power transmission. Maintenance of RoW may disturb communities living close to the RoW. Overhead transmission lines have always been associated with concerns on potential risks of cancer from exposure to electromagnetic field (EMF) from overhead transmission lines and substations. However, in spite of all the studies that have been carried out over the past 30 years, there is still no persuasive evidence that the fields pose any health risks. The World Health Organization (June 2007) recommends using exposure guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP has set the limit of exposure for the general public as: (1) electric field (kV per meter) is 4.17 and (2) magnetic field is 833 milliGauss (mG). The British Columbia Hydro measured the magnetic field levels near their transmission and distribution lines.[19] For 230 kV, the magnetic field level at 0 m from the line is 38 mG, 28 mG at 10 m, 15 mG at 20 m, 8 mG at 30 m and 5 mG at 40 m. These levels are much lower than the magnetic fields in the house: (1) hairdryer (300 mG), (2) dishwasher (20 mG), and (3) washing machine (20 mG) taken 6 inches from the source.[20] To avoid the impacts of EMF, houses will not be allowed within the RoW of the project. During the design, the transmission line and substation equipment will be rated to ensure EMF is within the permissible limits specified in the EHS guidelines.

Mitigation measures

195. Clear and visible danger and warning signs will be posted at designated areas to alert the community of the safety risks. In addition, transmission towers are equipped with danger boards, barbed wire, and galvanized ground wire for earthing purposes. NWPGCL staff assigned to maintenance works, inspection and security personnel will conduct ocular inspection regularly to prevent vandalism and pilferage of cables that may cause accidents or electrocution.

196. Power transmission systems like Component 3 are designed with protection system that shuts off during power overload or similar emergencies. As well, an emergency preparedness

[19] BC Hydro Power Smart. Understanding Electric and Magnetic Fields. https://www.bchydro.com/.../BCHydro/.../understanding-emf-booklet-jan2017.pdf.
[20] US EPA. EMF in Your Environment. December 1992. https://nepis.epa.gov/

and response mechanism will be employed by the NWPGCL. As part of consultations, NWPGCL will conduct information campaign to local people to enhance awareness on living safely near the power transmission systems.

5.4 Hazard and risk assessment

5.4.1 Hazard assessment process

197. The steps followed in this preliminary hazard and risk assessment are as follows:

- Identification of Hazards
- Analysis of Causes
- Assessment of Likelihood
- Identification of Existing Safeguards
- Risk Ranking for Prioritization of Corrective Actions
- Recommended Actions and Safety Measures

5.4.2 Hazard identification, classification and potential hazard points

Construction and operation

198. Potential hazard points based on hazard classification and the type of hazard occurrences from the hazard points are listed in **Table 5.11**.

5.4.3 Hazard Consequence & Frequency Scales

199. Potential impacts from Component 3 have been scaled and prioritized based on the magnitude of those potential impacts (consequence) and the likelihood of them occurring (frequency). The consequence of the impacts is classified and illustrated in **Table 5.12**.

Table 5.11: Potential hazard identification for Component 3

Location of hazard	Project Activities	Potential hazard	Root/main Causes	Possible consequences
Construction stage				
Construction site	Mobilizing machines, equipment and vehicles for site clearance activities	• Trips and falls • Cuts and bruises	• Fatigue or prior illness/sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	• Health injury • Disability • Life loss
	Construction of structures and its foundation, cutting, welding, painting works, drilling work, etc.	• Accidents (burns, electric shocks etc.) • Injuries from falls and slips • Inhalation of dust • Cuts and bruises	• Fatigue or prior illness/sickness • Electric failure • Mechanical failure • Unrated or faulty cables • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night (for those working overtime) • Not properly checking for faults in machineries • Not using appropriate PPE during work	• Physical injury • Disability • Life loss
	Erection of heavy structures	• Falling of heavy objects/debris from height • Tipping off heavy solid objects during erection. • Mechanical failure of lorries/cranes may lead to accidents	• Mechanical failure • Faulty equipment, steel wires, ropes and machineries • Lack of proper maintenance • Negligence of crane operators and constructions workers	• Environmental damage • Blockage of access roads • Severe injuries/ disabilities • Fatality
	Work at heights	• Accidents • Injuries from falls and slips (e.g. broken bones,	• Fatigue or prior sickness • Lack of safety protocols (e.g. not wearing safety harness and other protective gears) • Not maintaining a designated place for	• Physical injury • Disability • Fractures

Location of hazard	Project Activities	Potential hazard	Root/main Causes	Possible consequences
		fractures, traumas, etc.) • Fatalities	backfilling storage • Not maintaining enough lighting during the night	
	Vehicle movement	• Noise generation • Accident • Emission from vehicles • Spread of dust and minute particles due to vehicle movement.	• Running engine, hydraulic horns, etc. • Mechanical failure • Old engine or engine parts/lack of maintenance	• Injuries • Health problems (e.g. respiratory, hearing and/or cardiac, asthma problems) • Fatalities • Disabilities
	Occupational Hazard	• Cuts, bruises and burns • Falls, slips and trips • Health injuries • Sickness and illness	• Lack of safety awareness • Carelessness in maintaining safety protocols • Use of faulty machineries and equipment • Improper hygiene • Prior sickness or illness • Heavy workload	• Health injuries (burns, anxiety, depression, etc.) • Disabilities • Fatalities
Operation stage				
• Cable Gallery • Switchyards • Transformer area • Transmission line area	• Stepping up voltage via transformer • Switchyard to transmit electricity to national grid	• Fire due to resulting arc flash/arc blast • Other electric hazard due to unprotected cables • Slips and trips from unorganized/lose cables lying in the floor	• Short circuit in control room and switch gears • Faulty cables and wires • No safe connection to earth • Not maintaining risk evaluation form before starting work • Negligence of maintenance workers • Bringing in conductive materials during maintenance work • Not disconnecting electricity supply from live connections before maintenance work • Not wearing appropriate PPEs during maintenance work • Not de-energizing machines or equipment before maintenance work • Using cables with different voltage and current ratings • Unorganized cable	• Health injury from electric shock, fires, etc. • Fatality from electric shock, fires and so forth. • Electric burns

Location of hazard	Project Activities	Potential hazard	Root/main Causes	Possible consequences
	Sabotage of equipment	• Loss of power/electricity • Possible physical harm	• Lack of on-site security measures • Unrest amongst workers	• Indefinite power outage • Loss in economy • May affect any further industrial development • Possible injuries/hospitalizations

Table 5.12: Hazard Consequence Scale

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Duration of potential impact	Temporary with no detectable potential impact	Limited to construction period	Medium Term (1 to 2 years)	Long term (more than 2 years)	Permanent Damage
Spatial extent of the potential impact	Specific location within project component or site boundaries with no detectable potential impact	Within project boundary	Beyond immediate project components, site boundaries or local area	Widespread far beyond project boundaries with some community and wildlife habitat coverage	Beyond project boundaries extending to widespread communities and wildlife habitat
Reversibility of potential impacts	Baseline remains almost constant	Baseline returns naturally or with limited intervention and within a few months	Potential impact requires a year or so for recovering with some interventions to return to baseline	Potential impact is long-term, requiring considerable intervention to return to baseline	Potential impact is effectively permanent, with little to no chance of returning to baseline
Compliance to Legal Standards before Mitigation Measures	Complies with all minimum requirements only some improvement opportunities to strengthen good practices	Meets minimum national standard limits or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Complies partially with limits given in national standards but breaches international lender guidelines	Completely breaches national standards and or international guidelines/ obligations
Extent of health injuries	Minor pain, scratch, discomfort requiring no medical attention	Health injuries can be cured with first aid and/or some medical attention	Health injury requires hospitalization; may require long term recuperation; may lead to long term absence from work	Health injury may lead to permanent disability; few fatalities of workers and or community people	Fatalities of workers more than five (5) and or community people more than two (2)
Impact on wildlife	Minimal disturbance within compliance	Disturbing habitat of wildlife causing discomfort	Disturbing habitat of wildlife causing decrease of prey and forcing them to relocate	Impact leading to deaths of any endangered species and decrease of their food source	Impact may lead to deaths of two or more endangered marine mammals and/or five of other endangered species

Criteria for determining the frequency of the potential hazard being occurred are outlined in Table 5.13.

Table 5.13: Criteria for Determining Frequency of the Potential Hazard

Frequency Scale Determination	Definition
1 (Rare)	Rare chance of occurrence, if not at all
2 (Low)	Very minimal chance of occurring
3 (Medium)	May occur considering if the conditions are abnormal or exceptional
4 (High)	Occurs more frequently without prior warnings
5 (Almost Certain)	Occurs under typical conditions

5.4.4 Developing Risk Matrix

200. Following the consequence and frequency scales, a risk matrix was developed after analyzing the potential hazards of Component 3. **Table 5.13** shows the risk matrix for the potential hazards and how frequently they may occur. In **Table 5.14**, the risk evaluation based on the type of activities and potential hazards are shown.

Table 5.14: Risk Matrix of Potential Hazards/Impacts

Frequency (F) of Hazards ↓	Hazard Consequence (C) →				
	1 (Insignificant)	**2 (Minor)**	**3 (Moderate)**	**4 (Major)**	**5 (Severe)**
1 (Rare)	1	2	3	4	5
2 (Low)	2	4	6	8	10
3 (Medium)	3	6	9	12	15
4 (High)	4	8	12	16	20
5 (Almost Certain)	5	10	15	20	25

Color Legend:

Red (15-25)	*≡ Top Priority*	*: Action with follow-up Verification & Validation by Authority needed before allowing work*
Orange (10-14)	*≡ High Priority*	*: Action needed under follow-up Supervision before allowing work*
Yellow (5-9)	*≡ Medium Priority*	*: Need maintaining with routine monitoring & reporting*
Green (1-4)	*≡ Low Priority*	*: Only for awareness; no Intervention Action needed to start work*

201. The risk for the potential hazard/impact is evaluated based on the combination of the hazard consequence and their frequency (NHS, 2008). In order to calculate the potential risk, the frequency of impact is multiplied with consequences. E.g. Level 1 of frequency of a hazard (Rare) is multiplied with Level 1 of hazard consequence (insignificant) to give a total score of 1 (1X1=1) and so on. In that regards, a score between 1 to 4 is considered low priority; a score between 5 to 9 is considered medium priority and; a score between 10 to 14 is considered high priority and; a score between 15 to 25 is considered top priority.

5.4.5 Risk Estimation, Evaluation and Management Plan

202. Based on the hazard consequence and frequency scales, potential risk of a particular hazard/impact is estimated and given a score. The score is given in terms of the presence

and absence of safeguards. The final evaluation of the potential risks is determined based on combined score of hazard consequence and its frequency. **Table 5.15** shows the risk evaluation (risk ranking) of project activities and its subsequent hazards (both before and after implementing safety measures).

Table 5.15: Risk evaluation for Component 3

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Construction Stage										
• Construction site	Mobilizing machines, equipment and vehicles for site clearance activities	• Trips and falls • Cuts and bruises	• Fatigue or prior illness/sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	3	3	**9**	• Arranging toolbox meeting before going out for work • Cable/wire needs to be check regularly • Regular inspection and maintenance of equipment • A thorough lorry driver selection process via interviews, checking whether they have the proper licenses and from past experiences • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road after the selection process is complete • Limiting movement of vehicles after sunset and before sunrise • Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs.	2	2	**4**
	Construction of structures and its foundation, cutting, welding,	• Accidents (burns, electric shocks etc.) • Injuries	• Fatigue or prior illness/sickness • Electric failure • Mechanical failure	3	2	**6**	• Arranging toolbox meeting before going out for work (during each construction activities.). Provide each worker with a safety checklist and safety permit (based on their work) before starting work.	2	2	4

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
	painting works, drilling work, etc.	from falls and slips • Inhalation of dust ▪ Cuts and bruises	• Unrated or faulty cables • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night (for those working overtime) • Not properly checking for faults in machineries • Not using appropriate PPE during work				• Regular inspection and maintenance of equipment, machineries and especially, safety harness. • Maintain a registry for any faulty equipment found; inform site contractors and they should replace those immediately. • No work should be done until the faulty machineries are replaced and tested. • Regular health and safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. • Enclosing the area with yellow barricade tape and restricting outside access to local people during the whole construction process. • Spraying water on dust to minimize its spread via wind; put stockpile at a designated place and cover them with GI sheet; put up GI sheet fencing around the construction site. • Equipment, machineries and electric wires should be checked for current and voltage ratings. When using an extension cable, its wire rating should match with the			

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							equipment wire rating. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken • Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour Rules, 2015[21]. • Maintenance of an accident registry book			
	Erection of heavy structures	• Falling of heavy objects or debris from height • Tipping off heavy solid objects during erection. • Mechanical failure of lorries/ cranes	• Mechanical failure • Faulty equipment, steel wires, ropes and machineries • Lack of proper maintenance • Negligence of crane operators and constructions workers	3	3	**9**	• Regular inspection and maintenance of equipment, machineries, vehicles and especially, safety straps of pulleys. • Maintain safe vehicle speed limit at the construction site. Proper traffic guidelines and regulations as per The Motor Vehicle Rules, 1984, should be ensured. • Maintain a registry for any faulty equipment found; inform site contractors and have them replace those immediately. • No work should be done until the faulty machineries are replaced and tested. • Regular health and safety training and fire	2	2	**4**

[21] Bangladesh Labour Rules (2015). *Ministry of Labour and Employment*. Retrieved from http://www.dpp.gov.bd/upload_file/gazettes/14079_83432.pdf.

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
		may lead to accidents					fighting drills to all construction workers, including the proper use of PPEs during work. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken. • Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour Rules, 2015[22]. • Maintenance of an accident registry book. • Monthly health check-up of workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital.			
	Working at heights or elevation	• Accidents • Injuries from falls and slips (e.g. broken	• Fatigue or prior sickness • Lack of safety protocols (e.g. not wearing safety harness	3	3	**9**	• Regular inspection and maintenance of equipment, safety harness and machineries. • Maintain a registry for any faulty equipment/safety harness found; inform site contractors and have them replace	2	2	**4**

[22] Bangladesh Labour Rules (2015). *Ministry of Labour and Employment*. Retrieved from http://www.dpp.gov.bd/upload_file/gazettes/14079_83432.pdf.

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
		bones, fractures, traumas, etc.) • Fatalities	and other protective gears) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night				those immediately. • No work should be done until the faulty machineries/safety harness are replaced and tested. • Regular health and safety to all construction workers working at height, including the proper use of PPEs/safety harness during work. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken. • Maintenance of an accident registry book. • Monthly health check-up of workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital.			
	Vehicle movement	• Noise generation • Accident • Emission from vehicles • Spread of dust and	• Running engine, hydraulic horns, etc. • Mechanical failure • Old engine or engine parts/lack of maintenance	3	3	**9**	• Regular inspection and maintenance of equipment, machineries and vehicles. • Maintain safe vehicle speed limit at the construction site. Proper traffic guidelines and regulations as per The Motor Vehicle Rules, 1984, should be ensured. • Noise emission should be controlled as per ECR, 2006 guidelines	2	2	**4**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
		minute particles due to vehicle movement.					• Regular spraying of water (at least twice a day) at earthen road networks should be done at the construction site.			
Operation Phase										
• Cable Gallery • Switchyards • Transformer area • Transmission line area	• Stepping up voltage via transformer • Switchyard to transmit electricity to national grid	• Fire due to resulting arc flash/arc blast • Other electric hazard due to unprotected cables • Slips and trips from unorganized/lose cables lying in the	• Short circuit in control room and switch gears • Faulty cables and wires • No safe connection to earth • Not maintaining risk evaluation form before starting work • Negligence of maintenance workers • Bringing in conductive	4	4	**16**	• Installation and monitoring of fire defense and fighting systems. • Checking the insulation of the wire, along with the wire's voltage and electric ratings. Change wires if ratings do not match with the power supply or if the insulation is damaged • Proper earthlings should be made to avoid electric shocks. • Open wires should be passed through a plastic pipe to avoid exposing them with outside contact. • Switch off power before doing any electrical work. Inform supervisor and respected officers before starting any electrical work (Lockout/Tag Out)[23]. Inform them again after the electrical	2	2	**4**

[23] Canadian Centre for Occupational Health and Safety (2013). OSH Answers Fact Sheets – *Lockout/Tag out*. Retrieved from https://www.ccohs.ca/oshanswers/hsprograms/lockout.html

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
		floor	materials during maintenance work • Not disconnecting electricity supply from live connections before maintenance work • Not wearing appropriate PPEs during maintenance work • Not de-energizing machines or equipment before maintenance work • Using cables with different voltage and current ratings				works are done. • De-energizing of equipment, machineries and transformers before doing maintenance work. • Maintenance workers should regularly maintain a risk evaluation form, starting which equipment is being maintained/repaired, their voltage and current capacity and the appropriate PPE for the job. • The risk evaluation form should be assessed and cleared by the supervisor before staring any maintenance work. • All power transformers and transmission should be fitted with lightning arrester to protect from lightning strikes. • Switchyards should be fitted with circuit breaker in case of short circuit or during an unusual surge of electrical current. • When working with exposed live wire/machines, the maintenance worker should maintain distance of 6 meters from the live exposed part[24].			

[24] Parmar, J (2012). Electrical Engineer Portal. *Electrical Safety Standards for LV/MV/HV (Part-2)*. Retrieved from http://electrical-engineering-portal.com/electrical-safety-standards-for-lvmvhv-part-2#16

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
			• Unorganized cable				• Maintenance worker must avoid bringing any conductive material whilst any maintenance works. Any conductive materials, such as metal key-chains, coins, watches etc. should be removed. • Maintain a safe distance from the rights-of-way (RoW). Don't raise any construction under the RoW. • Any cranes or vehicles passing through a high voltage overhead transmission line should have a minimum 1 meter distance from the overhead transmission line. • Place "electrical hazard" or "high voltage" signs on all switchboards and power transformers. • Restrict access to power transmission area, switchyards and control area to power plant officials and maintenance workers only. • Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and fire fighting drills to all officers and plant workers, including the proper use of PPEs during work • Monthly health check-up of officers and			

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)	Hazard Frequency (Before Safety Measures)	Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital • Maintain safety precaution measure in case of an accident such as, maintaining first aid, on-site medical center, doctors, nurses, ambulance services etc.			
	• Sabotage of equipment	• Loss of power/electricity • Fire hazard • Possible physical harm	• Lack of on-site security measures • Unrest amongst workers	4	2	**8**	• Increased on-site security measures • Maintaining entry-exit registry of workers and/or visitors • Elect a representative amongst the worker groups who will discuss and advocate their grievances and problems to the plant authorities.	2	2	**4**

6.0 ANALYSIS OF ALTERNATIVES

203. Aside from the economic, financial, safety and engineering factors, the potential environmental and social impacts have been carefully considered in selecting the best route for the overhead transmission line. Both the "no project" and "with project" options have been studied.

6.1 "No project" option

204. The "no project" option means that the area along the proposed alignment will remain the same as the current condition. However, the power to be generated by the Rupsha 800 MW CCPP will not be evacuated to the national grid. A "no project" option will entail that the proposed and planned economic development and business opportunities within southwestern Bangladesh may not altogether happen due to lack of reliable power, and thus, will be an opportunity cost for GoB. **Table 6.1** presents a comparison of "with project" and "no project" options.

Table 6.1: Comparison of "with project" and "no project" options

Description	"With Project" Option	"No Project" Option
Power transmission interconnection from the Rupsha 800 MW CCPP to the national grid	Provides a stable and reliable power with Component 3	No additional power generation capacity
Economic development	More opportunities for southwestern part of Bangladesh as a result of a stable and reliable power supply	• Minimal, if any, due to lack of reliable power supply • Development plan may be restricted by the availability of power supply
Potential impacts to ecologically-sensitive areas	Route selected does not pass through protected areas or national parks. Potential impacts due to the implementation of Component 3 can be readily mitigated by compliance to relevant regulations, EMP, and industry safety design standards and specifications, etc.	None
Potential impacts to terrestrial flora and fauna	RoW along the transmission line route will not pass through protected areas	None
Fugitive GHG emissions	Will use air insulated switchgear for the 230 kV substation in Rupsha 800 MW CCPP. No GHG expected GHG emissions.	No GHG contribution
Disruption to local residents along the transmission line route	Potential disruption to daily activities will be minimal (i.e., temporary and short duration during construction/installation). Any disruption can be managed by consultation, implementation of environmental management plan (EMP), proper construction planning and scheduling of activities.	None
Employment	Creation of job opportunities with the	None

Description	"With Project" Option	"No Project" Option
	implementation of Component 3.	

6.2 "With project" options considered for Component 3

205. Three options were considered in selecting the transmission line route from the 230 kV substation in Rupsha 800 MW CCPP to the existing Khulna SS (see Figure 6.1).

Figure 6.1: Location of Component 3

206. The following criteria were considered during the route selection:

a) Existence of open agricultural land;
b) Distance from connecting road should not to be more than 1 km;
c) Avoid: settlements and urban areas (as much as possible), river crossings, and water bodies.

207. Aside from these criteria, the Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution of the World Bank Group was also referred to.[25]

Table 6.2: Route options for Component 3

Description	Option 1	Option 2 (Final)	Option 3
Route length, km	23.2	24.561	10.9
Presence of urban area	No	No	Yes
Density of settlements	Medium	Low	High

[25] International Finance Corporation, Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution, http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines. (Accessed 16 November 2017)

Description	Option 1	Option 2 (Final)	Option 3
Existing power transmission line	N/A	1	1
Presence of existing important infrastructure	Medium	Low	High
Number of river crossing	4	6	N/A
Cost effectiveness	Medium (OHT)	Low (OHT)	High (underground T/L)
Presence of reserved forest	No	No	No
Any ecologically critical area (ECA)	No	No	No
Any bird habitat and declared Important Bird Area (IBA)	No	No	No

208. From the options considered, Option 2 appears to be the most suitable route for further evaluation.

7.0 INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1 Introduction

209. Consultations for Component 3 were conducted as part of the requirements of the DoE and ADB's SPS 2009. The main objective is to involve stakeholders throughout the project implementation and to know their concerns and perceptions about the project. Specific objectives of consultations include the following:

a) To ensure peoples' participation in the proposed project;
b) To inform key stakeholders about the project, its environmental implications within the project area, potential environmental impacts and mitigation measures, project benefits, and about the "cut-off date" for persons directly affected by the project;
c) To determine the perceptions of the people about the project and share experiences of the participants on similar projects;
d) To understand and create awareness of problems in the project area;
e) To discuss and propose possible solutions to the problems identified;
f) To describe the mechanism for handling potential grievance related to the project; and,
g) To inform stakeholders on access to information about the project.

7.2 Approach and Methodology

210. Stakeholders were classified into primary and secondary stakeholders. These stakeholders are characterized as the following:

a) Primary stakeholders

211. These are persons who will be along the RoW of the pipeline route that may be directly affected during construction and operation phase. Primary stakeholders of Component 3 may include teachers, students, and different local occupational groups.

b) Secondary stakeholders

212. These are persons or organizations that will not be directly affected but may have interests that can contribute to the projector may affect decision-making in some areas. Secondary stakeholders may include relevant government agencies like local government institutions, PGCB, Road Development Authority, DoE, community-based organizations, NGOs, and other interested individuals or groups.

213. Checklists were used to guide the consultations to ensure that the discussions are focused and relevant. A summary includes information about the project, proposed implementation schedule, and potential project impacts. Views and concerns of the participants were recorded and their questions were properly responded to by NWPGCL and their consultants.

7.3 Consultations during the preparation of the EIA

214. A total of five consultation events were conducted on 11 November, 201621 December 2016 and 21 October 2017 by the CEGIS. These consultations were workshop, key informant

interviews (KII), Focus Group Discussion (FGD) and Informal Interviews done in Khulna (IEB conference hall), Dighalia, Batiaghata, and Malapara. the list of participants and photos of consultations (12/11/2016 and 21/12/2016) are given in **Annex 3** and **Annex 4.** In addition, the details of the Public Consultation held on 21st October 2017 are attached in **Annex 2**.

Table 7.1: Location of consultations

Division	District	Upazila	Meeting type	Meeting Place	Date
Khulna	Khulna	Dighalia	FGD and KII	Chandoni Mahal village	21/12/2016
		Batiaghata	Group Discussion and KII	Tetultola village	21/12/2016
		Batiaghata	Group Discussion and KII	Puthimari village	21/12/2016
		Malapara	FGD	Malapara	12/11/2016
Khulna	Khulna	13 no. ward, Khulna City Corporation	Workshop	IEB conference room, Khalishpur	21/10/2017

7.4 People's perceptions of the Project

215. At the outset of the interviews and discussions, an overview of Component 3 including the ongoing activities of NWPGCL and PGCB, and the EIA process was shared with the participants. Key environmental and socio-economic aspects listed below were discussed:

- Land price of different places
- Perceptions to the existing Electricity Act
- Compensation method and policy
- Positioning of the angle points
- Price of crop, trees, and different structures
- Cropping pattern and intensity
- Occupation and employment (unemployment/availability of labor, etc.)
- Social Safety & Security (availability of law enforcement agencies, social unrest issues, etc.)
- Quality of life (poor housing and sanitation facilities, drinking water, fuel and fodder, etc.)
- Condition of infrastructure throughout the RoW

216. CEGIS, the environmental and social consultants of NWPGCL, discussed with the participants the different physical interventions involved in the implementation of Component 3 and the potential environmental impacts. The participants are not aware of Component 3 but showed positive attitude towards its implementation. However, they identified some problems and suggested measures (see **Table 7.2**). They urged NWPGCL to mitigate/address the issues they raised.

Table 7.2: Summary of consultations

Issues Raised	Suggested Measures
• Compensation for standing crops only is not sufficient as the land below the base of transmission tower will be permanently unusable	• Compensation process in the existing Electricity Act should be revised • Construction activities will be done after crop harvesting time initiate

Issues Raised	Suggested Measures
• After installation of tower the land will lose its selling value • Restrictions on development in land areas between two towers will be permanent loss to land owners • Complex compensation process • Damage to standing crops due to construction activities • Noise from land development, mobilization of equipment for stockpiling materials and construction activities may damage listening ability; and may deteriorate mental and physical condition of the people residing adjacent to the project site	• Just compensation to land owners not only for standing crops but also for the permanent loss of land below the transmission towers, restrictions to development in their own land due to the presence of transmission towers • Crop compensation should be given to affected land owners within a shortest possible time • Value of damages for crops and land price should consider not only government rate but also justified by the market price • Consider provision of livelihood trainings so that affected people can engage in different occupation • There should be an option for local people to be engaged in the construction activities to create employment opportunity • During recruitment, local people would be considered as the first priority • A meeting should be arranged to identify suitable hours for transport of construction material to minimize the risks of accidents • Construction activities that generate elevated noise level should not be done during night time • A neutral monitoring agency should be engaged for monitoring the construction and post construction activities of the project

217. Consultations with stakeholders will continue during the implementation of Component 3, power transmission interconnection. A communications strategy plan will be prepared by PMU, NWPGCL with technical support from a Consultant. This will ensure that stakeholders are engaged, as and when needed.

218. A project summary will be posted in the website of NWPGCL. In addition, a one-page flyer on project brief including details on grievance redress mechanism, and contact person in case of complaints and/or concerns will be prepared in Bangla and will be made available at the field office of PMU in Khaliaspur, Khulna and at the NWPGCL office in Dhaka. More details on Component 3 will also be available from the EIA posted in the website of ADB.

8.0 GRIEVANCE REDRESS MECHANISM

8.1 Current system at NWPGCL

219. NWPGCL manages grievance and/or complaints through the Grievance Redress System (GRS) which is required by the GoB and part of the mandatory Annual Performance Agreement (APA). This agreement will be signed and renewed annually between NWPGCL and GoB.

220. GRS requires the NWPGCL to designate a staff as Focal Point whose name and contact details are disclosed at the website of NWPGCL. Compliance to the GRS is a Performance Indicator in the APA. NWPGCL has designated its Focal Point as required by GRS and the details disclosed in its website.

221. The GRS consists of specified roles, rules, and procedures for resolving complaints, grievances, disputes, or conflicts systematically. The objective is to provide an effective and objective way of lodging and resolving complaints on public service delivery.

8.2 Grievance system required by SPS 2009

222. A grievance redress mechanism (GRM) will be set up once ADB funding for Component 3 becomes effective. Similar to GRS, the GRM aims to provide stakeholders with a clear and simple way of filing a complaint on the environmental performance of Component 2. According to SPS 2009, the GRM will address complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate and readily accessible to the affected persons at no costs and without retribution. Given these requirements, handling of potential complaints/grievance on the implementation of Component 3 will be as follows:

223. **Information disclosure.** NWPGCL will post signboards at the construction sites on the grievance mechanism including the details of the contact person who will take grievance. Details of the grievance mechanism together with the project brief will be posted in the website of NWPGCL.

224. **Procedure.** The GRM will provide three-tier entry points in grievance redress. Two grievance redress committees (GRCs) will be formed: (i) local grievance redress committee (LGRC); and (ii) project grievance redress committee (PGRC). Grievances considered minor such as increased dust level at the construction site and immediate vicinity can be resolved onsite at the LGRC level within 7 days from receipt of complaint. Other complaints not resolved at the LGRC level will be forwarded to PGRC which will take two weeks (or 14 days) to resolve. Meetings of the LGRC will be held onsite (PMU office) and members may do site visits to check or verify the issue. Complainant will be informed of the status of resolution.

225. **Composition.** NWPGCL will ensure the representation of women in the members of the GRCs.

(a) **LGRC** – members will include (i) Deputy Manager/Executive Engineer (Environment) of PMU, (ii) Ward member, (iii) community representative, (iv) representative of women affected persons, and (v) EPC Contractor representative

(b) **PGRC** – members will include (i) Project Director(PD), NWPGCL as the Chairperson, (ii) Environment staff of Project Management and Construction (PMC) consultant, and (iii) representative of civil society nominated by PD with the help of PMC.

226. **Responsibilities.** GRCs will be expected to: (i) resolve grievances filed in writing or by phone to any member of the PMU, (ii) convene at least once a month to review grievances lodged (if any), (iii) record the grievances and resolve the issues within 15 days or a maximum of 30 days from the date the grievance was filed, and (iv) report to the complainant(s) the status of grievance resolution and the decisions made.

9.0 ENVIRONMENTAL MANAGEMENT PLAN

227. The environmental management plan (EMP) covers measures that will be conducted in every phase of implementing Component 3 to ensure that adverse impacts are minimized and positive impacts enhanced. Aside from the mitigation measures, the EMP also includes the required monitoring and implementation arrangements with cost estimates.

9.1 Implementation Arrangements

228. NWPGCL has a total of six staff on environmental, chemical and safety managing the environment, health, and safety (EHS) concerns related to their operations. According to the Annual Report 2015-2016 of NWPGCL, additional eight staff will be recruited to enhance the technical capacity on EHS.

229. For the Rupsha 800 MW CCPP, NWPGCL will set up a PMU who will be responsible for project management and safeguards compliance monitoring of the EPC contractor during the construction stage. Component 3 will be managed and supervised also by the PMU. NWPGCL will require the EPC Contractor to recruit an environmental staff (or a Consultant) who will be primarily responsible for ensuring that the EMP is properly implemented during construction. This requirement for the EPC Contractor will be included in the Bid documents. The Environmental staff (or consultant) of the EPC Contractor will coordinate and liaise with the PMU (NWPGCL) on compliance to ADB requirements, relevant government agencies and local authorities on clearances (as needed), and will prepare the environment section of the Project's Quarterly Progress Report (QPR) submitted by the EPC Contractor to the PMU. The environment section in the Project's QPR will be summarized by the PMU Environmental staff and submitted to ADB during construction phase as semi-annual environmental monitoring reports (see **Annex 6** for the format of environmental monitoring report). The semi-annual environmental monitoring reports are posted to ADB's website as required by SPS 2009 and PCP 2011. NWPGCL will submit the environmental monitoring reports starting from the date the loan become effective.

230. Should there be any change in the OHTL route, this EIA will be revised and/or updated and submitted to ADB prior to any construction works. The PMU Environmental staff together with NWPGCL Environmental staff will revise or update the EIA and submit to ADB for review. The revised and/or updated EIA of Component 3 will be re-posted to the ADB website to comply with the disclosure requirements of SPS 2009 and PCP 2011.

231. Before the start of any construction work, the PMU will inform the EPC Contractor on their responsibility to comply with the EMP and the requirements of DoE and ADB. The specific responsibilities of the EPC Contractor on the implementation and compliance to the EMP, environmental monitoring, and submission of environmental compliance status during the construction phase will be monitored by the PMU and the NWPGCL Corporate Environment staff (or Consultant).

232. During the operation phase, PMU will assign a staff (or Consultant) who will be responsible to handle the associated environmental issues and compliance to DoE and ADB's environmental requirements. Submission of environmental monitoring reports by NWPGCL to ADB during the operation phase will be annually. These environmental monitoring reports will be reviewed by ADB and will post them into their website as required by SPS 2009 and PCP 2011.

233. In case of non-compliance to any environmental covenant in the loan agreements, NWPGCL will prepare a corrective action plan (CAP) describing the process and the time-bound actions that will be undertaken to ensure compliance. The CAP will be submitted to ADB for review and disclosure to ADB's website.

9.2 Mitigation and enhancement plan

234. **Table 9.1** presents the environmental management plan for various resources that may be affected by the implementation of Component 3.

Table 9.1: Environmental Management Plan

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
Physical-Chemical Environment and Water Resources						
Pre-construction phase						
Potential for riverbank erosion along the Bhirab River, Atai River, and Rupsha River	An expert will review the structural design, specifications and plans for construction of the transmission towers that will be erected close to the banks of these rivers as well as the activities to be done at the six river crossings	-	-	Included in the project cost	NWPGCL Contractor	NWPGCL
Construction phase						
Impairment of ambient air quality	• Regular spraying of water to dust-generating areas • Covering excavated soil/dump during off-work with tarpaulin • Provide temporary enclosure of dust-generating construction area/activities • Trucks transporting construction materials that generate dust will be covered • Implement traffic management to minimize vehicular emissions	-	-	1.5	EPC Contractor	PMU, NWPGCL
Potential increase in ambient noise level	• Ambient noise level monitoring will be done • Provide temporary enclosure of noise-generating activities and equipment • Construction works will be limited to daytime only • Drivers will be instructed to avoid unnecessary use of horn	-	-	0.5	EPC Contractor	PMU, NWPGCL
Degradation of water quality in Bhairab River, Atai River, and Rupsha River due to construction works at the river crossings	• No field camps will be located adjacent to these rivers • Good housekeeping will be enforced at all times. Bins will be provided on-site for proper collection of wastes • Oil-water separator will be used to handle oily waste • EPC Contractor will be required to prepare Waste Management Plan • Observation of proper solid waste disposal and proper sanitation	-	-	1.5	EPC Contractor	PMU, NWPGCL

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
	Workshop for vehicle, equipment and machineries repair will be lined with impermeable material to prevent land contamination and potential river pollution of greasy material/residue					
Operation phase						
Improper disposal of used mineral oil from the new substation in Rupsha 800 MW CCPP may affect water quality of Bhairab River, groundwater, and may cause land contamination.	• No PCB or PCB-containing material will be used in Component 3 • Used mineral oil (replacement of PCB) as transformer oil is considered hazardous wastes and will be handled properly based on relevant regulations and international environmental agreements such as Stockholm Convention and the Basel Convention. Used mineral oil will be stored in plastic drums with proper labeling. • Disposal of excess and used mineral oil will follow the accompanying material safety data sheet (MSDS)	-	-	1.5	PMU, NWPGCL	NWPGCL (Corporate Unit)
Land and agriculture resources						
Pre-construction phase						
Loss of crop production during the survey	• Compensation will be provided for any damage incurred during the survey • Inform farmers of the survey schedule to minimize disturbance	-	-	Included in the project cost	EPC Contractor	PMU, NWPGCL
Construction phase						
Vegetation and standing crops along the RoW will be cleared and stringing of conductors may also affect standing crops. About 11.44 tons of crops may be affected by these activities.	• Construction work schedule will consider harvest time of farmers that may be affected to minimize crop damage • Crop damage that may be incurred due to Component 3 will be properly compensated • Farmers will be informed way ahead on the construction activities and schedule • Farmers will be given the chance to harvest their crops before construction works.	-	-	N/A	EPC Contractor	PMU, NWPGCL
Soil quality may be affected due to wastes generation, soil erosion, and surface	• Construction activities will be limited to designated areas • Proper storage of chemicals onsite	-	-	NA	EPC Contractor	NWPGCL

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
runoff	• Excess chemicals will be disposed of following its MSDS • EPC Contractor will be encouraged to use non-toxic and biodegradable chemicals on-site • Solid waste generated on-site will be collected and disposed of properly • The installation of natural or synthetic liners beneath chemical storage tanks. • Minimization of on-site water and chemical usage (oil, lubricants and fuel) • Limiting the exposure of the soil to accidental releases of pollutants					
Operation phase						
Soil quality may be affected due to maintenance of OHTL	Fuel and lubricants will be stored in drums or tanks and will be placed on an impermeable surface	-	-	Included in the O& M cost	PMU, NWPGCL	NWPGCL (Corporate Unit)
Loss of crop production About 3 ha of land will be permanently lost due to the tower footings and cultivation of some plants/crops will be restricted along the RoW.	• Agricultural activities within the RoW will be allowed after construction but with restrictions to height of vegetation • Only plants such as sugarcane, corn, rice, etc. that are less than 3 m tall will be allowed for cultivation • Given the ground clearance at the base of the towers, farmers can still opt to use the land below the towers for cultivation of low growth crops	Conduct orientation to farmers if they opt to cultivate area below the tower footings	-	3.0	PMU, NWPGCL	NWPGCL (Corporate Unit)
Fisheries Resources						
Construction phase						
Bagda and Galdagher will be temporarily damaged due to installation of tower in Tentultola village.	• Construction of temporary bund around the base of the tower to protect the other part of the gher • Preserve top soil of the base of constructed tower and spread over same places after construction activities.	**-**	**-**	**-**	EPC Contractor	PMU, NWPGCL
Temporary loss of fish production	• Construction of temporary bund around the base of the tower to avoid disturbance of fish culture within the gher	**-**	**-**	**-**	EPC Contractor	PMU, NWPGCL

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
	• Project work will avoid January to August to minimize loss of fish production • If schedule cannot be adjusted, gher owners will be properly compensated					
Ecological Resources						
Construction phase						
Vegetation along the RoW will be cleared during construction.	• No plant species of conservation status along the RoW • Construction works will not be scheduled during harvest time to minimize damage to cash crops • If work schedule cannot be adjusted, land owners will be properly compensated for any crop damage along the RoW • EPC Contractor will be required to clear vegetation only in designated areas • Agricultural activities within the RoW will be allowed after construction but with restrictions to height of vegetation • Only plants such as sugarcane, corn, rice, etc. that are less than 3 m tall will be allowed for cultivation	-	-	Included in the project costs	EPC Contractor	PMU, NWPGCL
Operation phase						
• Planting trees and cultivation of crops higher than 3 m along the RoW will be restricted. • Vegetation that grew after construction phase will be trimmed regularly to maintain the height restrictions for safety reasons.	• Restriction in vegetation height is to ensure that the required vertical spacing between the conductors and the vegetation is maintained for safety reasons • NWPGCL will continue dialogue with farmers (as needed) to remind them of the height restrictions on vegetation along the RoW • Any crop that may be damaged due to maintenance of the OHTL will be properly compensated	-	-	6.00	PMU, NWPGCL	NWPGCL (Corporate Unit)
• Component 3 is not close to protected areas or national parks • birds may be attracted to	• Transmission lines are designed to have ground wire spacing and lightning arresters as safety features to generally protect the public (and birds)	-	-	1.00	PMU, NWPGCL	NWPGCL (Corporate Unit)

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
the presence of transmission towers. • The risk of bird electrocution due to the presence of transmission towers may be likely and may affect bird species such as Indian flying fox (*Pteropus giganteus*).	• Spot checks/ocular inspection of wildlife crossing and bird electrocution (if any) will be included as part of maintenance work along the transmission line • NWPGCL staff assigned to maintenance works will be trained to create awareness .					
Socioeconomic condition						
Construction phase						
• There will be employment opportunities • There will be opportunities for local people to engage in small-scale and temporary business opportunities of selling food, temporary accommodation, etc. due to the presence of workers.	• EPC Contractor will be required to give priority to local hiring especially to non-skilled workers • This will be monitored by PMU, NWPGCL. For recruitment of skilled workers, local labour will be given preference	-	Provision of contingency budget in case of accidents	5.00	LGI and EPC contractor	PMU, NWPGCL
• Construction works along the transmission line route, which is located mostly in urban areas with river crossings, may pose safety risks to workers and the community. • Exposure to sources of increased dust and noise levels may also pose health risks to workers and the community	• EPC Contractor will require workers to wear safety gears (helmets, safety belts, masks, gloves and boots) provided to them to minimize safety and accident risks • Toolbox meetings will be held before workers go to the work assigned to them • First aid kits and fire-fighting units will be made available at the construction sites • Before start of construction works, the EPC Contractor and PMU, NWPGCL will provide orientation and brief training to workers on emergency preparedness, and create awareness on the potential for sexually-transmitted disease in the workplace • The EPC Contractor will be required to provide affordable group medical and accident insurance to their workers or arrange with the local health facilities to	-	Special or contingency fund will be allocated to cover accident costs	6.00	Project authority and EPC contractor	PMU, NWPGCL

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
	provide assistance in the event of emergency • Recruitment of workers below 18 years old will be strictly prohibited • EPC Contractor (and subcontractors) will be required to comply with all relevant regulations on labour, occupational health and safety. PMU, NWPGCL will monitor compliance • Worker colonies will comply with good housekeeping • Noise barrier will be installed in areas and equipment with high level noise • EPC Contractor will provide workers with sanitary facilities, safe drinking water, wash area, adequate water for washing purposes, fire-fighting unit, etc. • A registered doctor or health professional will be detailed at the field office or onsite					
Operation phase						
Employment opportunity	Skilled jobs may be required during O&M	-	N/A	-	PMU, NWPGCL	NWPGCL (Corporate Unit)
• Presence of transmission line may pose potential hazards such as electrocution, lightning strike, etc., due to accidental failure of power transmission. • Maintenance of RoW may disturb communities living close to the RoW.	• Clear and visible danger and warning signs will be posted at designated areas to alert the community of the safety risks • Transmission towers are equipped with danger boards, barbed wire, and galvanized ground wire for earthing purposes • NWPGCL staff assigned to maintenance works, inspection and security personnel will conduct ocular inspection regularly to prevent vandalism and pilferage of cables that may cause accidents or electrocution. • Power transmission systems like Component 3 are designed with protection system that shuts off during power overload or similar emergencies. • An emergency preparedness and response mechanism will be employed by the NWPGCL	-	N/A	4.00	PMU, NWPGCL	NWPGCL (Corporate Unit)

Impact	Mitigation/Compensation	Enhancement	Contingency Plan	EMP cost (BDT)	Responsible Unit	Supervision
	• NWPGCL will conduct information campaign to local people to enhance awareness on living safely near the power transmission systems					

9.3 Environmental Monitoring Plan (EMoP)

235. The following tables present the different monitoring plans that will be implemented during construction and operation phase. Results from the implementation of these plans will be included in the environmental monitoring reports to be submitted to ADB. Implementation of Component 3 will be carried out under the overall supervision of the Project Director, NWPGCL.

Table 9.2: EMoP for river bank and flooding

Project phase	Parameter/ Indicator	Locations	Method of Measurement	Frequency	Monitoring Agency
Construction Phase	River bank and flooding	At every bank side tower location	Direct observation	Daily	EPC Contractor (with their Experts as required)
Operation Phase	River Bank and flooding	At every bank side tower location	Direct observation	Yearly at the end of monsoon	Project Director, NWPGCL

Table 9.3: Environmental Parameter for EMoP

Issues of monitoring	Parameters	Measurement unit
Water Pollution	Turbidity	JTU
	DO	mg/l
	pH	-
	BOD_5	mg/l
	COD	mg/l
	Arsenic	mg/l
	Iron	mg/l
	Coliform (fecal)	N/100ml
	Manganese	mg/l
Air Pollution	SPM (PM_{10} or $PM_{2.5}$)	$\mu g/Nm^3$
	Carbon Monoxide	$\mu g/Nm^3$
	SO_2	$\mu g/Nm^3$
	NO_2	$\mu g/Nm^3$
Noise Pollution	Ambient noise level	dB(A)

Table 9.4: EMoP for agricultural resources

Project stage	Parameters/ Indicators	Locations	Method of Measurement	Frequency	Monitoring Agency
Construction phase	Crop compensation for the affected land owners/ share croppers	• Substation in Rupsha 800 MW CCPP • 230 kV transmission line route	Ocular inspection, FGD with affected persons, transect survey.	Twice or once a month	PMU, NWPGCL
Post-Construction phase	Land recovery after wastes removal by contractor.	• Substation in Rupsha 800 MW CCPP • Every tower sites, stringing of conductors (new power lines).	Ocular inspection/spot check	Once a month	PMU, NWPGCL

Table 9.5: EMoP for fisheries resources

Project stage	Parameter/ Indicator	Locations	Method of measurement	Frequency	Monitoring agency
Construction phase	Soil Management	Ghers	Physical Observation	Two times (dry and wet season) during construction	PMU, NWPGCL with help of DoF

Table 9.6: EMoP for ecological resources

Project stage	Parameter/ Indicator	Location	Method of measurement	Frequency	Monitoring agency
Construction phase	Terrestrial vegetation	Proposed transmission lines and tower sites	Direct observation	Twice a year	EPC Contractor (with their Expert as required)
	Wildlife habitat and their disturbance	Under transmission lines and tower sites	Transect Survey	Twice a year	EPC Contractor (with their Expert as required)
Operation phase	Terrestrial vegetation	Under transmission lines and tower sites	Direct observation	Quarterly	Project Director, NWPGCL
	Wildlife habitat	Under transmission lines and tower sites	Direct observation	Half-yearly	Project Director, NWPGCL

Table 9.7: EMoP for socio-economic resources

Parameter/Indicator	Locations	Method of measurement	Frequency	Monitoring agency
Pre-construction Phase				
Perception of affected land owners	At the tower point location	Inspection and consultation with the land owners	Weekly	EPC Contractor
Availability of safe drinking water, sanitary facilities	Project area	Inspection and interview of workers and project personnel	Quarterly	EPC Contractor
Implementation of general guidelines on worker's health and safety	As specified in the general guidelines	Inspection and interview of workers and project personnel followed by a checklist	Quarterly	EPC Contractor
Emergency Preparedness	Project site	Visual Inspection and Record Checking	Yearly	PMU, NWPGCL
Construction Phase				
• Drinking water and sanitation • General condition of workplace	Construction sites	Interview, ocular inspection	Weekly	EPC Contractor
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	EPC Contractor
Safety of workers monitoring and reporting accidents	At work sites	Visual inspection of usage of PPE, Safety Sign, Safety Documentation, safety training, etc.	Daily	EPC Contractor
Emergency Response Facilities	At project sites	Inspection of Emergency Preparedness and Response mechanism and facilities	Monthly	EPC Contractor

Parameter/Indicator	Locations	Method of measurement	Frequency	Monitoring agency
Grievance Redress Mechanism	At project site, field office	Inspection of the complaint register	Monthly	EPC Contractor
Operation Phase				
Grievance Mechanism	At project site	Inspection of the complaint register/grievance form and interviewing local people	Six-monthly	NWPGCL
Emergency Response Plan	Project site	Inspection of Emergency Preparedness and Response mechanism	Quarterly	NWPGCL
Health and Safety Preparedness	Project site	Inspection of training list, safety meetings records, means of awareness growing	Quarterly	NWPGCL
Community Relation	Nearby Community	Inspection of community relation maintaining procedures, relation building activities, FGD with community	Quarterly	NWPGCL

9.4 EMP Budget

236. For implementing the EMP, Table-9.1 indicated around BDT 30 lakh. in addition, two more items such as training (lump sum BDT 5 lakh) and occupational Health and safety (lump sum BDT 8 lakh) altogether BDT 43 lakh will be required. Therefore, EMP BDT 43 lakh and EMoP BDT 33 lakh total (BDT 43 + 33) = BDT 76 lakh as shown in Table 9.8 below will be required. The budget estimates cover a three-year EMP implementation.

Table 9.8: EMP Budget Estimates

Item	Quantity	Rate/Ref.	Total Taka (lakh)
Implementation of EMP	-	Table 9.1	30
Training of professionals and workers about accidental cases and safety measures	-	Lump sum	5
Occupational Health, Safety and security	-	Lump sum	8
Sub total			**43**
Monitoring Plan	**From revenue budget**		
Consultant (for environmental and social monitoring)	3 years	Lump sum	20
Transport (for monitoring team)	3 years	Lump sum	2
Reporting and others (Yearly DoE renewal cost)		Lump sum	2
Vegetation trimming and plantation	3 years	Lump sum	6
Wildlife occurrence (including Bat, Birds)	3 years	Lump sum	3
Sub Total			**33**
Total Cost			**76**

10.0 CONCLUSION AND RECOMMENDATION

237. Component 3 is an important part of the Rupsha 800 MW CCPP that will provide the necessary infrastructure to enhance the power generation capacity of Bangladesh in addressing the increasing demand for electricity. The transmission line route was selected after careful consideration of several factors including environmental and social aspects. As a result, no areas protected by GoB such as national park or sanctuary will be traversed by the transmission line route. However, three major rivers in Khulna will be crossed over: Bhairab River (once), Rupsha River (twice), and Atai River (thrice).

238. Component 3 consists of a new substation in Rupsha 800 MW CCPP and about 29.3 km, 230 kV overhead transmission line terminating in the existing Khulna SS. This draft EIA for Component 3 was prepared based on the requirements of the DoE and ADB.

239. Affected persons along the transmission line route were consulted including other secondary stakeholders. During the preparation of this EIA, five consultations were completed in November 2016, December 2016 and October 2017. Stakeholder consultations will continue until the operation phase. The GRM will be set up to deal with potential complaints on Component 3. NWPGCL will create a PMU to handle the daily management of implementing Component 3.

240. Identified environmental impacts such as increased level of noise and dusts, generation of waste from construction works, clearing of vegetation, disruption to navigation, and potential water pollution in the three major rivers due to Component 3 can be easily mitigated by compliance to EMP, requirements of DoE and ADB, effective project planning, and best practice construction engineering. A budget estimate of BDT 76 lakh is allocated for the EMP (including EMoP).

241. Access to information by interested individuals will be through a project summary at the NWPGCL website, one-page flyer on project info which includes details on grievance redress mechanism and contact person. Additional information will be through this draft EIA which will be posted in ADB website as required by PCP 2011 and SPS 2009.

Annex 1
TOR of EIA for Component 3 Approved by DoE

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, E-16 Agargaon
Sher-e-Bangla Nagar, Dhaka-1207
www.doe.gov.bd

Memo No: DoE/Clearance/5669/2016/476 Date: 03/11/2016

Subject: Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (TOR) for Environmental Impact Assessment (EIA) in favour of Construction of Power Evaquation Line under Proposed Khulna LNG Based 800 MW Combined Cycle Power Plant Project at Khulna.

Ref: Your Application dated 10/10/2016.

With reference to your letter dated 10/10/2016 for the subject mentioned above, the Department of Environment hereby gives exemption from IEE and approval of TOR for Environmental Impact Assessment (EIA) Study in favor of Construction of Power Evaquation Line under Proposed Khulna LNG Based 800 MW Combined Cycle Power Plant Project at Khulna subject to fulfilling the following terms and conditions:

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein.

II. The project authority shall prepared individual EIA report for Each Component and the EIA reports should be prepared in accordance with following indicative outlines:

1. Executive summary.
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references).
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared).

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project.

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Noise, Vibration, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition
- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste
- Economy and employment: employment structure and cultural issues in employment
- Agriculture: activities, communities, commercial important, resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

   Appropriate models shall be used for prediction of potential impacts of the project on surface water and ambient air quality using updated data. Model prediction shall be compared with national water and air quality standards and specific sensitivity data of the organisms known to be present in the project area (likely impacted area) for impact assessment.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Risk assessment, risk management, system of valuation of environmental and properties damage, damage compensation issues shall be addressed

11. Conclusion and Recommendations

1. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

II. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

III. The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public), NOC from concerned authority for cutting/razing/dressing of hill or hilly land (if it is required) and NOC from other relevant agencies for operational activity etc. to the Khulna Divisional Office of DOE in Khulna with a copy to the Head Office of DOE in Dhaka.

03.11.2016

(Syed Nazmul Ahsan)
Director (Environment Clearance, c.c)
Phone # 02-8181673

Project Director
Proposed Khulna LNG Based 800 MW
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Copy Forwarded to :

1) Private Secretary to the Hon'ble Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Khulna Divisional Office, Khulna.
3) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Annex 2

Public Disclosure Meeting

Introduction

The Center for Environmental and Geographic Information Services (CEGIS) organized a public disclosure meeting on behalf of Northwest Power Generation Company Litd. (NWPGCL), for exposure of the proposed "Rupsha 800MW combined cycle power plant Project" at the conference room of Khulna Engineers Institute at Khalishpur, Khulna on October 21, 2017.

Objectives

The overall objective of the consultation was to explore the peoples' perception and attitudes towards the proposed project and to provide information regarding the findings of EIA study. The specific objectives were to:

- Aware the local people about the proposed project
- Sharing the information to the participants about EIA and RP findings
- Explore the problems of the study area;
- Share experiences of the participants over the years;
- Unveil the potential negative or positive impacts of the proposed project;
- Outline potential mitigation measures for negative impacts and enhancement measures for the positive impacts.
- Ensure the peoples' participation in the proposed project;

Approaches of the Public Disclosure Meeting

The main purpose of the PDM was to disclose the findings of EIA and RP study to the key stakeholders and take suggestions/opinions from them. To serve that purpose it was mandatory to gather key stakeholders at a certain venue.

Identification of Stakeholders

Stakeholders included all those who would affect and/or would be affected by policies, decisions or actions within a particular system. Stakeholders included groups of people, organizations, institutions and sometimes-even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

Primary Stakeholders

Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed project, the primary stakeholders include the people whose land will be affected and who are living within the project area.

Secondary Stakeholders

This category of secondary stakeholders pertains to those who may not be directly impacted but have interest to contribute in the study, play a role in implementation at some stage, or decision making on project aspects. In this project, secondary stakeholders include PDB, Local

Government Institutions (LGIs), local public representatives, other relevant government agencies, academia, journalists, NGOs and general public at large.

Time, Date and Venue Selection

Venue, date and time of meeting was selected in consultation with the local administration, local government, local people, the project proponent and the consultant. The local people and local government selected an agreed venue e.g. Khulna Engineers Institute at Khalishpur, having easy accessibility and which is likely to be neutral. Date and time was also finalized in the similar way considering availability of the participants, ensuring the maximum participation and compliance with the other arrangement.

Enlisting and Invitation

A comprehensive list of potential stakeholders was prepared through the consultation. This list was intended to cover all sorts of interest groups, occupational groups, socially acceptable and knowledgeable peoples.

Table A1: Invitation list of Consultation meeting

SL.NO	Organization/Persons	No. of invitation
1.	Representative of Government Institutions (DC, DoE, Forest etc.)	21
2.	Representatives Khulna City Corporation	03
3.	Academia/School (Teacher, Managing committee and Students)	07
4.	Project proponent	05
5.	Representative of NGOs	02
6.	Representative of Journalists	03
7.	Representative of Fisherman community	05
8.	Representative of Affected parsons of Gas Transmission line	03
9.	Representative of Affected parsons of Overhead Transmission line	03
10.	Political leader	03
11.	Local elite persons	15
Total		**70**

To make the meeting successful and to ensure maximum participation, an advertisement was published in the local daily newspaper:

দৈনিক পূর্বাঞ্চল

The Daily Purbanchal

বিজ্ঞপ্তি

রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে ২০২১ সালের মধ্যে দেশের সকল ঘরে বিদ্যুৎ পৌঁছে দিতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সরকারের এ লক্ষ্য পূরণের উদ্দেশ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানি লিঃ (বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ডের একটি প্রতিষ্ঠান) খুলনার খালিশপুরে রূপসা ৮০০ মেঃ ওঃ কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র বাস্তবায়নের কাজ হাতে নিয়েছে। উক্ত প্রকল্প বাস্তবায়নের ফলে সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব সমীক্ষা করার জন্য পানি সম্পদ মন্ত্রণালয়ের অধীনস্থ CEGIS - কে দায়িত্ব দেয়া হয়েছে। এরই অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারী ও বেসরকারী প্রতিষ্ঠান এবং জনগণের সুচিন্তিত মতামত ও পরামর্শ গ্রহণের লক্ষ্যে আগামী ২১ অক্টোবর, ২০১৭ইং তারিখ রোজ শনিবার সকাল ১১:০০ ঘটিকায় খুলনার খালিশপুরস্থ ইঞ্জিনিয়ার্স ইন্সটিটিউট-এর সম্মেলন কক্ষে একটি মতবিনিময় সভার আয়োজন করা হয়েছে। উক্ত মতবিনিময় সভায় উপস্থিত থেকে এ বিষয়ে আপনাদের সুচিন্তিত মতামত প্রদান করার জন্য অনুরোধ করা যাচ্ছে।

আর-৩৩০১

Consultation Instrument

Checklist: A comprehensive checklist and questionnaire covering all possible issues to be addressed was prepared through consultation with the multidisciplinary study team. This checklist was used in the meeting to unveil peoples' perception and opinion along with suggestions.

Attendance list: An inventory of the participants was maintained in attendance sheet containing contact number. Camera: For visualizing the participants, photographs were taken using camera. These photos are presented in this chapter. Photos of the meeting participants are presented at the end of this chapter.

Consultation Participants

The main participants of the consultation meetings included public representative of Government Institutions, Khulna City Corporation, Academia/School representative, Project proponent, NGOs, Journalists, Fisherman community, Affected parsons of Gas Transmission line, Affected parsons of Overhead Transmission line, Political leader Local elite persons, of the nearby "Rupsha 800MW combined cycle power plant Project" areas. A total of 64 participants attended these consultations in which 52 is male and rest of female.

The stakeholders have right to know about the activities, pattern and impacts of the project. In doing so, a brief description on project was distributed to each participant:

নর্থওয়েস্ট পাওয়ার জেনারেশন কোম্পানী কতৃক অত্র এলাকায় গৃহীত খুলনা ৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিক কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র এবং সংশ্লিষ্ট উপাদান সমূহের তথ্য, খুলনা

✓ সভার মূল উদ্দেশ্য

- আজকের সভার মূল উদ্দেশ্য হচ্ছে প্রস্তাবিত ২ x ৪০০ (৮০০) মেগাওয়াট গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প ও অত্র প্রকল্প সংশ্লিষ্ট উপাদান সমূহ স্থাপিত হলে প্রকল্প সংলগ্ন এলাকায় কী ধরণের পরিবেশগত ও আর্থ-সামাজিক প্রভাব পড়তে পারে এ সম্বন্ধে এলাকার জনগোষ্ঠীর মতামত গ্রহণ করা।
- একই সাথে প্রকল্প নকশা ও নির্মাণ পর্যায়ে জনগণের প্রস্তাব নেওয়া যাতে প্রকল্প বাস্তবায়নে তাদের আকাঙ্খার প্রতিফলন ঘটে।

✓ প্রস্তাবিত প্রকল্প ও সংশ্লিষ্ট বিষয়াদি

- *বাংলাদেশ সরকার ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের লক্ষ্যে একটি মহাপরিকল্পনা, **Power System Master Plan** প্রণয়ন করে, যার মূল প্রতিপাদ্য বিষয় হচ্ছে:*

- জ্বালানীর বহুমুখীকরণ যেমন: গ্যাস, এলএনজি, কয়লা, এইচএসডি, ফার্নেস অয়েল নবায়নযোগ্য জ্বালানি ইত্যাদি।
- জ্বালানীর উৎস সনাক্তকরণ ও এর সর্বোত্তম ব্যবহার নিশ্চিত করণ।
- জ্বালানী উৎসের ও সরবরাহের সুবিধাদির ভিত্তিতে বিদ্যুৎ প্রকল্প নির্মাণের স্থান নির্বাচন।
- বিদ্যুতের ক্রমবর্ধমান চাহিদার উপর ভিত্তি করে উৎপাদন ক্ষমতা বৃদ্ধি করা, যা জাতীয় বিদ্যুৎ গ্রীডের মাধ্যমে নিরবিচ্ছিন্নভাবে বিদ্যুৎ সরবরাহ করতে পারবে।

- *রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, '২০১০ ও ২০১৬' এর আলোকে দেশের সর্বস্তরে বিদ্যুৎ পৌঁছে দেয়ার লক্ষ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ **(NWPGCL)** খুলনা জেলায় গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প নির্মাণ করে ১০০০ মেগাওয়াটের অধিক বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে।*

✓ পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণ সংক্রান্ত তথ্য সংগ্রহ ও প্রয়োজনীয় পরীক্ষানিরীক্ষা

- ***CEGIS** এই প্রকল্পটির পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণে দায়িত্বপ্রাপ্ত হয়ে বিভিন্ন পর্যায়ে এলাকার জনগনের সাথে এই বিষয়ে আলাপ আলোচনা করে পরিবেশ ও আর্থ-সামাজিক প্রেক্ষাপটের বর্তমান অবস্থা বিশ্লেষণ করার চেষ্টা করেছে এবং পর্যবেক্ষণ করার জন্য সংশ্লিষ্ট অফিসগুলো থেকেও তথ্য সংগ্রহ করে, যেমন:*

- কৃষি অফিস থেকে ফসল, ফসলী জমি ও সেচ সংক্রান্ত তথ্য।
- মৎস্য অফিস থেকে মাছ ও মাছের আধার সংক্রান্ত তথ্য।
- ইউনিয়ন পরিষদ থেকে সামাজিক ও অর্থনৈতিক বিষয়াদি সংক্রান্ত বিভিন্ন তথ্য।
- বিভিন্ন প্রকার শিল্প থেকে নির্গত দূষণ সম্পর্কিত তথ্য সংগ্রহ।

- *প্রকল্প এলাকার বিভিন্ন বৈশিষ্ট সঠিকভাবে বিশ্লেষণ করার নিমিত্তে নিম্নলিখিত পরীক্ষা-নিরীক্ষা করা হয়:*

- ভূ-তাত্বিক জরিপ যার মাধ্যমে প্রকল্প এলাকার মাটি ওভূ-গর্ভস্থ পানি সম্বন্ধে ধারণা পাওয়া।
- বন্যার পানির সর্বোচ্চ উচ্চতার বিষয়টি বিশ্লেষণ করে কতটুকু মাটি ভরাট করতে হবে তা জানা ।
- পানির গুণাগুণ বোঝার জন্য ভূ-গর্ভস্থ ও ভূ-পরিস্থ পানি পরীক্ষা-নিরীক্ষা করা হয়।
- বায়ুর দূষণ মাত্রা বোঝার জন্য বায়ু পরীক্ষা-নিরীক্ষা করা হয়।
- শব্দ দূষণ মাত্রা বোঝার জন্য শব্দ দূষণ যন্ত্র ব্যবহার করা এবং প্লান্ট থেকে ৫০০ মি. চারপাশে শব্দ দূষণ পরিমাপক যন্ত্রের মাধ্যমে শব্দের তীব্রতা মাপা হয়।

- *পরিবেশগত ও সামাজিক প্রভাব বিশ্লেষণের জন্য প্লান্টকে কেন্দ্র করে চারপাশে ১০ কি.মি এলাকা পর্যবেক্ষণ করা হয়েছে*

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (পরিবেশগত প্রভাব বিশ্লেষণ)

▪ *৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিকবিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- বিভিন্ন সংবেদনশীল এলাকায় বায়ু দূষণের মাত্রা মাপা হয়েছে এবং বায়ু দূষণের ক্ষেত্রে ক্যাল্পআপ মডেলের মাধ্যমে CO_2, SO_x NO_x বিশ্লেষণ করে দেখা গেছে উল্লিখিত দূষণের মাত্রা বাংলাদেশ ও আন্তর্জাতিক গ্রহনযোগ্য সীমার নীচে আছে।
- শব্দ দূষণের মাত্রা উল্লিখিত শব্দ দূষণ নিয়ন্ত্রন বিধি-২০০৬ এর গ্রহনযোগ্য সীমার নীচে থাকবে।
- মেশিন চালুকালে ভূ-কম্পনের মাত্রা সহনশীল পর্যায়ে থাকবে।
- প্রকল্প চালু করার সময় কুলিং টাওয়ার এর জন্য ভৈরব নদ থেকে একালীন ৬০,০০০ ঘন মিটার পানি উত্তলন করা হবে এবং পরবর্তীতে প্রকল্প চালু অবস্থায় ভৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
- ভূ-গর্ভস্থ পানিদূষণের মাত্রা বর্তমানে উল্লিখিত ইসিআর- ১৯৯৭ এর গ্রহনযোগ্য সীমার নীচে থাকবে।
- বিদ্যুৎ কেন্দ্র থেকে নির্গমিত সকল তরল পদার্থ পরিশোধিত করে গ্রহণযোগ্য সীমার মধ্যে রাখতে হবে নচেৎ পরিবেশ বিপন্ন হবে।
- কৃষিক্ষেত্রে পানির কোন সংকট হবে না এবং মাছ চাষের উপর কোন বিরুপ প্রভাব পড়বে না।
- ২১৫ টি গাছের উপর প্রভাব পড়বে যা আইউসিএন এর লাল তালিকা বহির্ভূত।

▪ *গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- উল্লিখিত গ্যাস পাইপলাইন প্রকল্প বাস্তবায়নের ফলে বায়ু দূষণ, শব্দ দূষণ, বর্জ্য দূষণ, পানি দূষণ অথবা সংশ্লিষ্ট এলাকায় পানির কোন অভাব দেখা দেবে না। এছাড়া উক্ত প্রকল্পের কারণে কৃষি জমি ও মাছ চাষ প্রকল্পের কোন ক্ষতি হবে না। তবে ১০.৫০ কিমি পাইপলাইনের জন্য কিছু গাছের উপর প্রভাব পড়বে যা বাংলাদেশ সরকার উল্লিখিত সিডিউল বহির্ভূত। উল্লেখ্য, উক্ত প্রকল্পের কারণে কোন প্রাণি বা সর্বতভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব পড়বে না।

▪ *ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*

- উল্লিখিত ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবানের ফলে বায়ু দূষণ, শব্দ দূষণ, বর্জ্য দূষণ, পানি দূষণ অথবা পানির কোন অভাব দেখা দেবে না। উক্ত ২৯ কিমি ২৩০ কেভি লাইন কোন প্রাণি, কৃষি জমি এবং নদীসহ সার্বিকভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব ফেলবে না।

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (আর্থসামাজিক প্রভাব বিশ্লেষণ)

- গ্যাস ও তেল ভিত্তিক ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ প্রকল্প স্থাপনের জন্য খুলনা সরকারি নিউজপ্রিন্ট মিলের পরিত্যক্ত ৫০ একর জমি নেয়া হয়েছে। উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি পরিবার স্থানান্তরিত হওয়ার কারণে অর্থনৈতিকভাবে প্রভাবিত হবে। অত্র প্রস্তাবিত প্রকল্প এলাকায় কোন আদিবাসি ও ঝুকিপূর্ণ পরিবার নেই।
- অত্র প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প এলাকায় বর্তমানে অবস্থিত ০১ টি বালক উচ্চ বিদ্যালয় ও ০১ টি বালিকা উচ্চ বিদ্যালয় স্থানান্তরিত করা হবে। ২১৫ টি গাছ ক্ষতিগ্রস্থ হবে।
- গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত রাস্তা সংলগ্ন সড়ক ও জনপথের জমির উপর স্থাপিত হবে। এ ক্ষেত্রে মুচি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে নিকটবর্তী পরিত্যক্ত জায়গায় স্থানান্তরিত করা হবে এবং ৩২৬ টি গাছ ক্ষতিগ্রস্থ হবে। ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ী নিকটবর্তী স্থানে স্থানান্তরিত হবে ও ৪০ টি গাছ ক্ষতিগ্রস্থ হবে। উল্লেখ্য কোন স্থাপনা ক্ষতিগ্রস্থ হবে না।
- ২৯ কিমি ওভারহেড ট্রান্সমিশন লাইন প্রকল্প কৃষি জমি, নদী এবং কিছু বাড়ী, সামাজিক প্রতিষ্ঠানের উপর দিয়ে যাবে তবে কোন প্রত্নতাত্ত্বিক এবং ঐতিহাসিক স্থাপনার উপর দিয়ে যাবে না। উল্লিখিত প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবার স্থায়ীভাবে ক্ষতিগ্রস্থ হবে যার মধ্যে ০৫ টি পরিবারের বসতবাড়ীও ক্ষতিগ্রস্থ হবে এবং ক্ষতিগ্রস্থদের মধ্যে ০২ টি পরিবার ঝুকিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে শস্য ও ০১ টি মাছের ঘের সাময়িকভাবে ক্ষতিগ্রস্থ হবে।

✓ পরিবেশগত প্রশমন ব্যবস্থা

- *বায়ু দূষণ মোকাবেলায় করণীয়:*

  - Advance Dry Low NOx Burner যা বায়ুর একরকম দূষণ (NOx)-কে নিয়ন্ত্রণ করবে।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা বায়ু দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - প্রধান ও বাইপাস চিমনীর উচ্চতা যথাক্রমে ন্যূনতম ৬০ মি. ও ৫০ মি. হতে হবে যাতে প্লান্ট নিঃসরিত ধোঁয়া আকাশে মিলিয়ে যায় এবং পরিবেশের উপর ক্ষতিকর প্রভাব না ফেলে।

- *পানি দূষণ মোকাবেলায় করণীয় :*

  - কুলিং টাওয়ারের কারণে কোন প্রকার গরম পানি নদীতে পড়বে না।
  - প্লান্ট হতে নির্গত পানি যথাযথ পরীক্ষা-নীরিক্ষার পর পুণ:ব্যবহার করা হবে;যা পরিবেশের উপর কোন ক্ষতিকর প্রভাব ফেলবে না।
  - তেল ও গ্রীজ পানি থেকে আলাদা করণের জন্য সেন্ট্রিফিউগাল যন্ত্রের ব্যবহারের ব্যবস্থা রাখা হয়েছে। আলাদাকৃত তেল এলাকার ভেন্ডরদের কাছে বিক্রি করা হবে।
  - বিদ্যুৎকেন্দ্র থেকে নিঃসরিত তরল; আধুনিক বর্জ্য ব্যবস্থাপনার (ETP) মাধ্যমে পরিশ্রুত করা হবে। ফলে নদীর মাছ ও পানির তেমন কোন ক্ষতি হবে না।
  - প্রস্তাবিত বিদ্যুৎকেন্দ্রে পয়:নিষ্কাশন ব্যবস্থাপনারও সুবিধা থাকবে।

- *পানি উত্তোলন সীমিতকরণ ব্যবস্থা:*

  - প্রকল্প চালু অবস্থায় ভৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
  - উল্লেখ্য, সর্ত অনুসারে প্রকল্প চালু রাখার জন্য কখনই ভূ-গর্ভস্থ পানি উত্তলন করা হবে না।
  - উক্ত বিদ্যুৎ কেন্দ্রে বসবাসকৃত জনসাধারনের খাবার পানির জন্য খুলনা ওয়াসা কতৃক পাইপ লাইন দ্বারা সরবরাহকৃত পানি ব্যবহার করা হবে।

- *শব্দ দূষণ মোকাবেলায় করণীয়:*

  - আধুনিক প্রযুক্তি সম্বলিত মেশিনারী স্থাপন করা।
  - ঘূর্ণন মেশিনারীর জন্য শব্দ দূষণ প্রতিরোধী হুড বা ঢাকনার ব্যবস্থা করা।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা শব্দ দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - শব্দ দূষণ কমানোর জন্য প্রযোজ্য স্থানে স্তর ভিত্তিক দেশীয় জাতের গাছ লাগানো।
  - ঘূর্ণন মেশিনারীর ভিতরে যারা কাজ করবে তাদেরকে অবশ্যই পিপিই (PPE) যেমন: ইয়ার প্লাগ, মাফলার ইত্যাদি পরতে হবে।
  - ধোঁয়া বের হওয়ার পথে চিমনীতে সাইলেন্সার লাগানো।
  - শব্দ প্রশমনীয় দেয়াল নির্মাণ করা।

- *কম্পন মোকাবেলায় করণীয়:*

  - সীম (প্লেট ১/১০০০ ইঞ্চি) প্রযুক্তির ব্যবহার করা।

- *পরিবেশ ও জলজ প্রাণি ব্যবস্থাপনায় করণীয়:*

  - প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ কেন্দ্র হতে নির্গমিত সকল তরল বর্জ্য ও পয়:নিষ্কাশন যথাক্রমে ইটিপি (ETP) ও এসটিপি (STP) এর মাধ্যমে পরিশোধিত করে যথোপযুক্ত বাংলাদেশ বিধি ও আইএফসি (IFC) গাইডলাইনের গ্রহণযোগ্য সীমার মধ্যে রাখা হবে যাতে ডলফিন সহ পরিবেশ ও জীববৈচিত্র দূষনের প্রভাব মুক্ত থাকে।

- গ্যাস লাইন ও OHT line এর ক্ষেত্রে প্রকল্প এলাকার কর্মচারীদের বাসস্থানের পয়ঃনিষ্কাশন পরিশোধনের মাধ্যমে বাংলাদেশ বিধির (ECR,1997) গ্রহণযোগ্য সীমার মধ্যে রাখা হবে।
- অত্র প্রকল্প চালু অবস্থায় EMP সংশ্লিষ্ট পর্যবেক্ষণ ব্যবস্থা নিয়মিত বলবৎ থাকবে এবং উক্ত পর্যবেক্ষণ এর আওতায় প্রকল্প এলাকার পরিবেশ ও জীববৈচিত্র (ডলফিন সহ) এর উপর নিরীক্ষা করা হবে এবং প্রয়োজনীয় প্রশমন পরিকল্পনা অনুযায়ী ব্যবস্থা নেয়া হবে।

✓ আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা

▪ *৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- অত্র প্রকল্পটি বাস্তবায়নের জন্য উল্লিখিত খুলনা সরকারি নিউজপ্রিন্ট মিলের পরিত্যক্ত ৫০ একর জমি সরকারি প্রথা অনুসারে নির্ধারিত মূল্য পরিশোধ সাপেক্ষে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ এর অনুকূলে বরাদ্দ দেয়া হয়েছে।
- অত্র প্রস্তাবিত প্রকল্প এলাকার উল্লিখিত ০২ টি বিদ্যালয় (০১ টি বালক ও ০১ টি বালিকা) পরিত্যক্ত পেপার মিলের অবশিষ্ট (৩৭.৬০ একর) জমির উপর পুণর্নির্মিত হবে যা পাওয়ার প্লান্টের সীমানার বাইরে অবস্থিত। এবং উক্ত বিদ্যালয় দুটিতে উন্নতমানের পাকা ইমারতসহ প্রয়োজনীয় আধুনিক সুযোগ সুবিধা যথা: কম্পিউটার ল্যাব, বিজ্ঞানাগার, পাঠাগার, খেলার মাঠ, সুপেয় পানি,সৌচাগার, ইত্যাদির সুব্যবস্থা থাকবে।
- উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি স্থানান্তরিত পরিবারকে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ কতৃক ক্ষতিপূরণ দেয়া হবে।
- উক্ত প্রকল্প এলাকা সংলগ্ন মসজিদ ও কবরস্থানের সংস্কার করা হবে এবং প্রকল্পসহ সর্বসাধারনের ব্যবহারের জন্য ব্যবস্থা থাকবে।

▪ *গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত সড়ক ও জনপথের জমির উপর অনুমতি সাপেক্ষে স্থাপিত হবে। উক্ত প্রকল্পে মুচি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে অর্থনৈতিক ক্ষতির জন্য ক্ষতিপূরণ প্রদান করা হবে। এছাড়া ৩২৬ টি গাছের ক্ষতিপূরণ প্রদান করা হবে । উল্লেখ্য, ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ীকে অর্থনৈতিক ক্ষতিপূরণ ও ৪০ টি গাছের জন্য ক্ষতিপূরণ দেয়া হবে।

▪ *ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা*

- অত্র প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবারকে ক্ষতিপূরণ দেয়া হবে যারা স্থায়ীভাবে ক্ষতিগ্রস্থ হবে এবং এদের মধ্যে ০২টি পরিবার ঝুকিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে শস্য ও ০১ টি মাছের ঘেরের সাময়িকভাবে ক্ষতির ক্ষতিপূরণ দেয়া হবে।

সারসংক্ষেপ

- ❖ প্রকল্পের পরিবেশগত প্রভাব প্রশমনের সুপারিশসমূহ যথাযথভাবে বাস্তবায়ন করা।
- ❖ প্রকল্পের আর্থ-সামাজিকসুপারিশসমূহ, সরকারি ও উল্লেখযোগ্য উদাহরণ/অনুশীলন বাস্তবায়ন করা।
- ❖ যথাযথভাবে পরিবেশগত নিরীক্ষণ কার্যক্রম পরিচালনা করা এবং প্রয়োজনীয় পদক্ষেপ গ্রহন করা।
- ❖ আর্থ-সামাজিক বিষয় সংক্রান্ত অভিযোগ ও অসন্তষ লিপিবদ্ধ করা ও তা প্রশমনের ব্যবস্থা নেয়া।
- ❖ আমরা প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক বিষয়ের উপর আপনার সুচিন্তিত মতামত/মন্তব্য গ্রহণ করবো যা EIA প্রতিবেদনে লিপিবদ্ধ করা হবে।
- ❖ অত্র প্রকল্প চলাকালীন ইএমপি (EMP) সংশ্লিষ্ট বিষয়ের সার্বক্ষণিক পর্যবেক্ষণ ব্যবস্থা বলবৎ থাকবে এবং ডলফিন সহ পরিবেশ ও জীববৈচিত্রের জন্য প্রয়োজনীয় টেকসই রক্ষণাবেক্ষণ পরিকল্পনা করা হবে।

Findings from the Public Disclosure Meeting

The Chief Guest of the Public Disclosure Meeting was Muhammad Moniruzzaman Moni, Mayor khulna City Corporation. The program was presided over by S.M Kurshid Ahmed Tona counselor, 13 no. ward, Khulna City Corporation, Md. Mofazzol Hossain Sarkar, Chief Engineer, Goalpara Power Station, Md. Shahidul Morsalin Joarder, Chief Engineer, NWPGCL. Different government officials, Ward Counselors from different unions, NGO representatives, Journalists, political leader, freedom fighter, UP members, farmers and fishermen from the study area were present in the meeting. Mr. Md. Sharif Hossain Sourav from CEGIS started the meeting with an introductory speech. Dr. Kazi Md Noor Newaz, Advisor and Team leader of the study team, CEGIS, made a power point presentation of the key report of the project. A brief description about the project was delivered by Mr. Hasmot Ali, Executive Engineer, NWPGCL.

Following the presentation, all the participants took part in an open discussion. They made various types of comments after the presentation of Dr. Kazi Md Noor Newaz. Their comments are given below:

The people's opinions and queries shared in the open discussion are given below:

Issues raised by the participants	**Feedback from the NWPGCL and CEGIS**
Modern technology should be adopted.	Latest available technology will be adopted for the proposed power plant to reduce air emission, noise level and water extraction within appropriate GOB and IFC acceptable limit and some of the specific options are as follows: - To control SO_x, NO_x, latest technology will be applied. - Noise and vibration level will be within acceptable limit of GOB and IFC guidelines as appropriate during project implementation period. - The height of the chimney will be 60 meter and bypass chimney will be 50 meter height - Closed cycle cooling tower which require minimum water - No extraction of ground water for plant operation - Water will be extracted from Bhairab River as a source of surface water. And only 0.12 % of the total discharge of the Bhairab river will be extracted per hour for operation of the proposed power plant. - ETP will be installed to treat and keep all discharges from the proposed power plant within acceptable limit of GOB and IFC as appropriate. - STP will be installed to treat and keep all sewage discharges within acceptable limit of GOB and IFC as appropriate. - Govt. policy and SPS (2009) will be applied during project implementation period as required.

Local experts like experienced university (Khulna University) teacher should be taken part of the power Plant intervention.	It is suggested that relevant teachers from Khulna University may discuss with local NWPGCL relevant technical staff and share their opinions to include in the documents. If necessary, the Khulna University staff may also contact with CEGIS or get access in the document while it will be posted in the web site by ADB and Proponent.
All the mitigation measures must be materialized.	All the development work will be monitored from the construction phase.
The study may be carefully reviewed to focus for people and gain optimum target.	- Construction phase to power plant will be monitored step by step. - All the steps will be taken to obtain optimum goal.
Health safety and security should be established all around the project.	- All the safety measures will be ensured following GOB and ADB/IFC guidelines. The labours will be trained. - Awareness programme will be taken. - Fast aid box and trained Physician will be ensured. - Appropriate PPE for workers and staff
All machinery should be modernized	
The location of the schools (both Boys and Girls) shall be fixed as early as possible	- Currently schools (Boys and Girls) are risky for the students and needs to be shifted as early as possible. - The locations of both Schools shall be fixed based on considering environmental and social issues before submission of the final report to ADB and GOB. - Two modern multi-storeyed schools buildings will be established with modern school furniture. - Two school buses (a bus per school) and laboratory with modern instruments, furniture will be bought. - A solar panel will be installed to support during load- shedding of electricity if it occurs. - A play ground (bigger one than the existing one) facility for the students will be ensured. - The schools will be established completely before shifting. The school building construction will begin according to the newsprint authority and BCIC. - A clinic with ambulance service will be established - Ensuring safe drinking water, there will be a proper system of water purification. - ADB and NWPGCL will implement it.
The mosque should be renovated and developed	The mosque will be modernized and reformed. Graveyard of martyrs will be well decorated with proper respect.
Fisher man livelihood will be at the risk and disrupted. They need to migrate for better livelihood	- We (NWPGCL assigned CEGIS) have made a study in buffer zone considering 10 km and found no impact on river ecology.

	- No impact will be found on the Bhoirab and Atai River.
Rehabilitation programme should be introduced for the affected fisherman	Such type of programme will not be needed.
All the Newsprint mill security guard should be employed in the New Power plant	- Newsprint mill has another place, factory with machinery and administrative office. All the security guard will be employed by the Khulna newsprint mill authority in other place. - If we (NWPGCL) have the opportunities of employing the security guard, we would take necessary action regarding the point. - In regard to the permanent employment in power plant, Bangladesh service rule will be followed.
The environmental impact must be addressed with care to protect fish and biodiversity	IUCN-recommendations on biodiversity and related management will be followed for dolphin management and future monitoring activities as well. In this regard, we (NWPGCL) have to wait up to that level for future plan for Bio-diversity management.
Is there any experience of NWPGCL regarding this type of project in Bangladesh?	NWPGCL is an experienced and reputed company to the related field and related type of gas based power plant. It has already implemented some project like this. Even in Goalpara, they have a power plant (225 MW).
Technical issues are not clearly understood. Is there any video document of power plant having gas based technology? If yes, please show us.	There are video documentaries regarding the gas based power plant. But due to inaccessibility we cannot show the video filming. It can be watched from internet.
Is there any plan of government for providing electricity for all houses?	Government already has a vision to provide electricity to every home within 2021 (Vision 2021).

The people showed nothing negative towards the project but they urged to maintain all the environmental, social and safety issues during construction and production as well.

Concluding Remarks

The answers to all questions were given by the relevant project personnel following the open discussion session. Then Mr. Md. Shahidul Morsalin Joarder, Chief Engineer and Project Director NWPGCL expressed his opinion about the project. Then the president of this assembly Mr. S.M Khurshid Ahmed Tona counselor, 13 no. ward, Khulna City Corporation concluded the PDM by thanking all the participants.

Photographs of the PCM

Photograph-1:	Photograph-2:
	
Photograph-3:	Photograph-4:
	
Photograph-5:	Photograph-6:
	

Photograph-7:	Photograph-8:
	
Photograph-9:	Photograph-10:
	
Photograph-11:	Photograph-12:
	

List of participants of PCM conducted on 21st October 2017

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১.	[illegible]	[illegible]	udayan29@yahoo.com	[illegible]
২.	[illegible]	কাউন্সিলর - ১৩ [illegible]	01711-309022	[illegible]
৩.	[illegible]	[illegible]	01711-422470	[illegible]
৪.	জাহিদুর রশিদ	প্রধান প্রকৌশলী [illegible]	01755-630025	[illegible] 21.10.17
৫.	[illegible]	[illegible]	01730-066987	[illegible] 21.10.17
৬.	Shariful Islam	Consultant/ADB	01778580756	[illegible]
৭.	RUBY SOCORRO ARICO	ADB - ENVIRONMENT CONSULTANT	—	[illegible]
৮.	Shamsuddin Ahmed	ADB - Consultant (Gas Sector Specialist)	shams7.bd@gmail.com	[illegible]
৯.	Nazmun Nahar	ADB BRM	nnahar@adb.org	Nahar
১০.	[illegible]	[illegible]	[illegible]	[illegible]
১১.	[illegible]	[illegible]	[illegible]	[illegible]
১২.	মোঃ মিলন	১৩ নং ওয়ার্ড	০১৬১৫-২৮০২৮৪	[illegible]
১৩.	Saleha Yaseen	salehayaseen@gmail.com	—	[illegible]
১৪.	Aziz Yusupov	Energy Spec. ADB	ayusupov@adb.org	[illegible]
১৫.	Md. Shahidul Morsalin Joarder	[illegible]	pd.kng.nwpgcl@gmail.com 01730066985	[illegible]

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	Syed Imdad Hossain	Manager, GTCL Arongghata, KGI	Gossain.unimelb@gmail.com 01709639723	
১৭.	Engr. Nizam Uddin	Manager, SGC 01711043978	uddinengrnizam@gmail.com	
১৮.	Abdullah-Al-Mamun	Asst. Teacher 01710027985	eua_mamun@yahoo.com	
১৯.		ABC PRESS	01719444611	
২০.	Mushuda Parveen	Manager(EHS)(Incharge) NWPGCL	Parveen@nwpgcl.org.bd 01777736469	21.10.17
২১.	Md. Jamal Uddin	AM (EHS) NWPGCL	jamaleny466@gmail.com	21.10.17.
২২.	MD. HASMAT ALI	XEN NWPGCL	hasmat@nwpgcl.org.bd	21.10.17
২৩.	Ziaul Alam Khan	General Secretary AL-13		
২৪.	Md Zakir Hossain	13, No Ward Office	01712179692	
২৫.	মোঃ [illegible]	১৩ নং ওয়ার্ড	০১৬১৫-২৮২৮৪	
২৬.	মোঃ [illegible]	১৬ নং ওয়ার্ড	০১৩৩৪৭৭৭২	
২৭.	[illegible]	[illegible]	[illegible]	
২৮.	মোঃ [illegible]	১৮ নং ওয়ার্ড	০১৬১৫২৭৩৩২	
২৯.	[illegible]	১৮ নং ওয়ার্ড	০১৯১৯৬০৬০৪৭	
৩০.	[illegible]	চন্দনীমহল ৬ নং ওয়ার্ড	01926231008	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৩১.	সুকুমার দাস	চন্দনীমহল, ৬নং ওয়ার্ড		সুকুমার
৩২.	নিত্য দাস	চন্দনীমহল, ৬নং ওয়ার্ড		নিত্য
৩৩.	সচীন বিশ্বাস	চন্দনীমহল, ৬নং ওয়ার্ড		সচীন বিশ্বাস
৩৪.	কার্ত্তিক	১৬ ওয়ার্ড		কার্ত্তিক
৩৫.	মো: টিপু সুলতান	১৩নং ওয়ার্ড, চরেরহাট		[illegible]
৩৬.	মো: রেজাউল করিম	[illegible]		[illegible]
৩৭.	[illegible]	[illegible]		[illegible]
৩৮.	[illegible]			
৩৯.	মো: হাবিবুর রহমান	কে. এম. এম	01911710994	[illegible]
৪০.	সাহিনা খাতুন	প্রবীন শিক্ষক কে এম এম স্কুল	01918811008,	[illegible] 21.10.2017
৪১.	অপর্না রায়	সহকারী শিক্ষক কে.এম.এম মাধ্যমিক	01927406881	[illegible] 21.10.17
৪২.	মুক্তা	শিক্ষার্থী নবম শ্রেণী কে.এম.এম মাধ্যমিক	01782550353	Mukta
৪৩.	সাকিনুর	শিক্ষার্থী নবম শ্রেণী কে.এম.এম মাধ্যমিক	01716561451	Sakinur
৪৪.	নুসরাত জাহান পুতুল	শিক্ষার্থী নবম শ্রেণী কে.এম.এম মাধ্যমিক	01948989312	Putul
৪৫.	নুপুর	শিক্ষার্থী নবম শ্রেণী কে.এম.এম মাধ্যমিক	01735276866	NUPUR

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৪৬.	[illegible]	[illegible]	০১৭৫৫০-৪৪২২৪৩	
৪৭.	[illegible]	[illegible] KNM	01979447955	
৪৮.	[illegible]	[illegible]	01912-[illegible]	
৪৯.	[illegible]	[illegible]	01[illegible]	
৫০.	[illegible]	[illegible]	01720039[illegible]	
৫১.	[illegible]	[illegible]	01954443450	
৫২.	[illegible]	[illegible]	01716170038	
৫৩.	[illegible]	[illegible]	01777736483	
৫৪.	[illegible]	[illegible]	01948157910	
৫৫.	[illegible]	ADB-[illegible]	—	
৫৬.	Yoojung Jang	ADB - HQ	yjang@adb.org	
৫৭.	ZHAOJING MU	ADB	zhaojingmu@adb.org	
৫৮.	SM Faruk Ahmed	BISS/NESS	01715001106	
৫৯.	[illegible]	[illegible]	01921390469	
৬০.	[illegible]	[illegible]	0[illegible]	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ [illegible]
নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থানঃ সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউর্ট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখঃ ২১ অক্টোবর, ২০১৭ খ্রিঃ

সময়: সকাল [illegible]

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
৬১.	মুহাম্মদ আজিজুর রহমান	[illegible] সিইজিআইএস	mazizur@cegisbd.com 01713865523	[signature] 21/10/17
৬২.	প্রকৌশলী রফিকুল ইসলাম	Electrical Engr. CEGIS	01710-564066	[signature]
৬৩.	ড. [illegible]	Advisor, CEGIS	[illegible]@cegisbd.com	[signature] 21/10/17
৬৪.	Md. Hasan	Asst. IEB KLN.	0155834[illegible]	[signature] 21/10/17
৬৫.				
৬৬.				
৬৭.				
৬৮.				
৬৯.				
৭০.				
৭১.				
৭২.				
৭৩.				
৭৪.				
৭৫.				

List of invited Government officials with their acknowledgement

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা মতবিনিময় সভার আপত্রন পত্রের প্রাপ্তি স্বীকার

ক্রমিক নং	নাম/পদবী	মোবাইল নং ও ইমেইল	স্বাক্ষর
১.	মেয়র, খুলনা সিটি কর্পোরেশন, খুলনা		
২.	জেলা প্রশাসক, খুলনা।		
৩.	পুলিশ কমিশনার, কেএমপি, খুলনা		
৪.	জেনারেল ম্যানেজার, সুন্দরবন গ্যাস কোম্পানি লিঃ, খুলনা		
৫.	ম্যানেজিং ডিরেক্টর, খুলনা ওয়াসাএবং চেয়ারম্যান, আইইবি, খুলনা		
৬.	ব্যবস্থাপনা পরিচালক, খুলনা নিউজপ্রিন্ট মিলস্ লি ঃ খুলনা		
৭.	পরিচালক, পরিবেশ অধিদপ্তর, খুলনা		
৮.	প্রধান প্রকৌশলী, খুলনা বিদ্যুৎকেন্দ্র, বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড (বিপিডিবি), খুলনা		
৯.	প্লান্ট ম্যানেজার, খুলনা ২২৫ মেঃওঃ সিসিপিপি, এনডব্লিউপিজিসিএল, খুলনা		
১০.	এস এম খুরশিদ আহম্মেদ (টোনা) কাউন্সিলর, ওয়ার্ড-১০, খুলনা সিটি কর্পোরেশন, খুলনা		
১১.	মোঃ সাহিদুর রহমান কাউন্সিলর, ওয়ার্ড-০৮, খুলনা সিটি কর্পোরেশন, খুলনা		
১২.	সভাপতি, খুলনা প্রেসক্লাব, খুলনা		
১৩.	সম্পাদক, খুলনা প্রেসক্লাব, খুলনা		
১৪.	নির্বাহী প্রকৌশলী, বাংলাদেশ পানি উন্নয়ন বোর্ড, খুলনা		
১৫.	বন সংরক্ষক, খুলনা সার্কেল		বন সংরক্ষকের দপ্তর খুলনা সার্কেল বয়রা, খুলনা।

ক্রমিক নং	নাম/পদবী	মোবাইল নং ও ইমেইল	স্বাক্ষর
১৬.	বিভাগীয় বন কর্মকর্তা, বন্য প্রাণী ব্যবস্থাপনা ও প্রকৃতি সংরক্ষণ বিভাগ, খুলনা		
১৭.	জেলা মৎস্য কর্মকর্তা, খুলনা	মোঃ শফিকুর রহমান ০১৭১২০৬৬১১৮	
১৮.	উপ পরিচালক, বাংলাদেশ কৃষি সম্প্রসারণ অধিদফতর, খুলনা		
১৯.	নির্বাহী প্রকৌশলী, গনপূর্ত বিভাগ,-২ খুলনা	/	
২০.	নির্বাহী প্রকৌশলী, সড়ক ও জনপদ বিভাগ, খুলনা		
২১.	নির্বাহী প্রকৌশলী, বাংলাদেশ কৃষি উন্নয়ন কর্পোরেশন, খুলনা		
২২.	ভারপ্রাপ্ত কর্মকর্তা, খালিশপুর থানা, খুলনা		
২৩.	প্রধান শিক্ষক, খুলনা নিউজপ্রিন্ট মিলস্ স্কুল, খুলনা	০১১৮ ৮১১০০৫	
২৪.	ইমাম, খুলনা নিউজপ্রিন্ট মিলস্ মসজিদ, খুলনা		
২৫.	মো: মাসুদুর রহমান.	01711 332635	
২৬.	মো: [illegible]	01712-515741	
২৭.	মো: [illegible] -	০১৭১২২৭১৬১২	
২৮.			
২৯.			
৩০.			
৩১.			

Annex 3: List of Participants during Focus Group Discussions and Public Consultation Meeting

List of Participants during Focus Group Discussion (Fisherfolks in Malapara)

FGD with Fishermen for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016

Venue: Malapara, Chandnimahal

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
01.	Ajay Biswas	Malopara Chandnimohal	0171283398075	অজয়
02.	Dipan Biswas	"	01682686880	[illegible]
03.	Suman Vadra	"	01726508884	[illegible]
04.	Candan Biswas	"	01729 327965	[illegible]
05.	Kishor Biswas	"	01756787702	কিশোর
06.	Bikas Biswas	"	—	[illegible]
07.	Candana Ray	"	01797291173	চন্দনা রায়
08.	Lilima Biswas	"	01703626645	লিলীমা
09.	Shakti Biswas	"	01762497876	[illegible]
10.	Namita Biswas	Housewife	01726875985	নমিতা বিশ্বাস
11.	Santi Sarker	"	01768509706	শান্তি সরকার
12.	Parbota Biswas	"	01948100385	পার্বতী বিশ্বাস
13.	Kanika Biswas	"		[illegible]
14.	Cumn "	"	01923406251	[illegible]
15.	Je " "	"	01766781702	[illegible]
16.	Kakoli Biswas	"	01728398079	কাকলী বিশ্বাস
17.	Eti Rani	"	01931273238	[illegible]

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
18	Anjona	Malopara, Chardoni Mahal	01770537454	
19	Mita	"	01492239056	
20	Bonna	"	01961152185	
21	Morjina	"	01914456249	
22	Biswajit	"	01492239056	
23	chanki	"	01768509106	
24	Jagonnath	"	01925074723	
25	Polok		01827904666	
26	Anup		01961152185	
27	Nikhil		01756607808	
28	Biswa		01492239056	
29	Eti Biswas		01931273238	
30	Kolpona		01757721865	
31	Amoti		01766288609	
32	Robin Biswas		0	
33	Pappu		01995317251	
34	Mithun		01921193920	
35	Shanti		01961152185	

Table A2: List of Participants in Public Consultation Meeting

No.	Name	Occupation	Address	Mobile Number

No.	Name	Occupation	Address	Mobile Number
1	Motaleb Sarker	Farmer	Chandoni Mahal	01962693632
2	Arun	Fisherman	Chandoni Mahal	
3	Sk. Md. Ripon	Fisherman	Chandoni Mahal	01920175436
4	Sahabuddin	Fisherman	Chandoni Mahal	01743433354
5	Kanchan Bishwas	Fisherman	Chandoni Mahal	01914204284
6	Hassan	Fisherman	Chandoni Mahal	01980127323
7	Faizullah	Trader	Chandoni Mahal	01727381873
8	Makbul Hossain	Farmer	Tetultola, Batiaghata	
9	Modser Mallik	Farmer	Tetultola, Batiaghata	01941967416
10	Delower Hossain	SAAO	Tetultola, Batiaghata	01917953277
11	Abul Basher	Farmer	Tetultola, Batiaghata	
12	A Kader	Business	Tetultola, Batiaghata	01718445008
13	Moniruzaman	Fisherman	Tetultola, Batiaghata	01712963717
14	Bipul Biswas	Fisherman	Puthimari, Jalma	01951905570
15	Abdur Rahim	Trader	Puthimari, Jalma	01946433745
16	Ali Hossain	Fisherman	Puthimari, Jalma	01729952730
17	Shadhon Roy	Fisherman	Puthimari, Jalma	
18	Baburam Mollik	Trader	Puthimari, Jalma	
19	Alamin Kobiraz	Fisherman	Puthimari, Jalma	01960645838

Annex 4 Photographs of Public Consultation Meetings

Group discussion with the local people

Group discussion with the local people

Annex 5
"Chance Find" Procedures for Physical Cultural Resources
Component 3

1.0 Introduction

These procedures describe the measures to be undertaken if an accidental discovery or chance find, or an encounter with a physical cultural resource (PCR) occurred during the construction phase. The chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by NWPGCL and the EPC Contractor, in consultation with the Department of Archaeology (DoA) or the Ministry of Cultural Affairs to ensure compliance to The Antiquities Act 1968 (amended 1976), National Cultural Policy 2006, and applicable regulations. The PCRP will be included in the Construction Management Plan (CMP) that will be required from the EPC Contractor. The objectives of these procedures are to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during excavation other earthmoving works and ground alteration along the 29.3 km, 230 kV overhead transmission line(OHTL) from the new substation in Rupsha 800 MW CCPP to the existing Khulna South substation (SS). About 75 transmission towers will be erected along the OHTL.

2.0 Orientation and/or Briefing of Workers

The EPC Contractor, with technical support from the DOA or Ministry of Cultural Affairs and PMU, NWPGCL will conduct an orientation or training for all workers, particularly those who will be involved in earth movements and excavation on how to recognize artifacts that they may potentially encounter or discover. The EPC Contractor will be responsible for creating awareness to construction personnel on the ADB requirements for any unanticipated impacts such as discovery of a physical cultural resource.

An archeological map of Bangladesh (if available) will be obtained from the DoA or other relevant sources to examine if there are potential "hot spots" within the project area. This map will be part of the references on-site to guide the construction supervision staff in determining the potential "hot spots."

3.0 Procedures

3.1 General

In case a PCR was encountered during excavation, construction activities including traffic within a 30.5 meter radius in the area will be stopped immediately by the EPC Contractor. The discovery will be reported by the site engineer or representative from the EPC Contractor to PMU, NWPGCL environment staff (or Consultant). The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken. The construction supervision staff of the EPC Contractor and PMU, NWPGCL site engineer/staff will secure the site to prevent damage, loss or pilferage of removable objects. Site Engineer of PMU, NWPGCL or designated staff will be responsible for coordinating with DoA.

If the encounter involves removable items, a security person will be posted until the representative of DoA or Ministry of Cultural Affairs arrives to assess and determine its value. The DoA staff will be responsible in determining the appropriate course of action. Further

excavation or earth moving works may be conducted at the distance and demarcation area recommended by the DoA staff.

If the chance find will have significant cultural value, this may entail consequent changes in the lay-out particularly if the discovery is considered or assessed as remains of cultural or archeological importance that is not removable.

EPC Contractor will not be entitled for compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.2 Assessment and Recovery

Appropriate heavy equipment such as wheel loader will be made available to recover the excavated material from the excavation site to allow the geologist onsite or the DoA staff to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the chance find is part of a large artifact, deposit or structure, the inspection or recording will include photography and video on an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.3 Resumption of Work

The Contractor can continue with excavation and construction works within the affected area after the DoA staff has given clearance. All the discovered objects of value will be given to the Government.

4.0 Reporting

The EPC Contractor will prepare a “Chance Find” Report within a week showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to PMU, NWPGCL who will provide it to the DoA or Ministry of Cultural Affairs. The chance find including measures on how it was dealt with will be included in the environmental monitoring report submitted to ADB.

Annex 6 Format of Environmental Monitoring Report

Environmental Monitoring Report

{Annual/Semestral} Report
{Month Year}

BAN: Rupsha 800 MW Combined Cycle Power Plant Project

Prepared by the North-West Power Generation Company Limited for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of {Day Month Year})

{The date of the currency equivalents must be within 2 months from the date on the cover.}

Currency unit	–	{currency name in lowercase (Symbol)}
{Symbol}1.00	=	${ }
$1.00	=	{Symbol_____}

ABBREVIATIONS

{AAA}	–	{spell out (capitalize only proper names)}
{BBB}	–	{spell out}
{CCC}	–	{spell out}

WEIGHTS AND MEASURES

{symbol 1 (full name 1)}	–	{Definition 1}
{symbol 2 (full name 2)}	–	{Definition 2}
{symbol 3 (full name 3)}	–	{Definition 3}

GLOSSARY

{Term 1}	–	{Definition 1}
{Term 2}	–	{Definition 2}
{Term 3}	–	{Definition 3}

NOTE

In this report, "$" refers to US dollars.

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Environmental Impact Assessment — Annexes

May 2018

Bangladesh: Rupsha 800-Megawatt Combined Cycle Power Plant Project

Prepared by North-West Power Generation Company Limited for the Asian Development Bank.

List of Annexes

Annex 1
Approved Terms of Reference (ToR) of EIA for Component 1 by DoE

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, E-16 Agargaon
Dhaka-1207
www.doe.gov.bd

Memo No: Doe/Clearance/5584/2016/564 Date: 05/11/2017

Subject: Exemption from IEE and Approval of Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of Proposed Rupsha 800 MW Combined Cycle Power Plant Project at Khalishpur, Khulna.

Ref: Your Application dated 29/10/2017.

With reference to your letter dated 29/10/2017 for the subject mentioned above, the Department of Environment hereby gives Exemption from IEE and approval of TOR for Environmental Impact Assessment (EIA) in favour of Proposed Rupsha 800 MW Combined Cycle Power Plant Project at Khalishpur, Khulna subject to fulfilling the following terms and conditions:

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein.

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary.
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references).
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared).

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project.

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Noise, Vibration, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

   - Population: Demographic profile and ethnic composition
   - Settlement and housing
   - Traffic and transport
   - Public utilities: water supply, sanitation and solid waste
   - Economy and employment: employment structure and cultural issues in employment
   - Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

   Appropriate models shall be used for prediction of potential impacts of the project on surface water and ambient air quality using updated data. Model prediction shall be compared with national water and air quality standards and specific sensitivity data of the organisms known to be present in the project area (likely impacted area) for impact assessment.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Risk assessment, risk management, system of valuation of environmental and properties damage, damage compensation issues shall be addressed

11. Emergency Response Plan and Disaster Impact Assessment

12. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Khulna Divisonal Office of DOE in Khulna with a copy to the Head Office of DOE in Dhaka.

VI. A soft copy of the image data as well as the maps to be generated from the image shall be submitted to DOE Head Office along with the EIA report.

05.11.2017

(Syed Nazmul Ahsan)
Director (Environment Clearance)
Phone # 02-8181673

Project Director (Chief Engineer)
Rupsha 800 MW CCPP Project
North-West Power Generation Company Limited
UTC Building (Level-3&4), 8 Panthapath
Kawranbazar, Dhaka-1215.

Copy Forwarded to :

1) PS to The Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Secretary, Power Division, Ministry of Power, Energy & Mineral Resources, Bangladesh Secretariat, Dhaka.
3) Chairman, Bangladesh Power Development Board, Biddyut Bhaban, 1, Abdul Goni Road, Dhaka.
4) Director, Department of Environment, Khulna Divisonal Office, Khulna.
5) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Annex 2

"Chance Find" Procedures for Physical Cultural Resources
Component 1 – 800 MW Rupsha CCPP

1.0 Introduction

1. These procedures describe the measures to be undertaken if an accidental discovery or chance find, or an encounter with a physical cultural resource (PCR) occurred during the construction phase. The chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by NWPGCL and the EPC Contractor, in consultation with the Department of Archaeology (DOA) or the Ministry of Cultural Affairs to ensure compliance to The Antiquities Act 1968 (amended 1976), National Cultural Policy 2006, and applicable regulations. The PCRP will be included in the Construction Management Plan that will be required by NWPGCL from the EPC Contractor. The objectives of these procedures are to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during excavation, demolition, other earthmoving works, and ground alteration within the project site for Component 1 – 800 MW Rupsha CCPP in Khalishpur, Khulna.

2.0 Orientation and/or Briefing of Workers

2. The EPC Contractor, with technical support from the DOA or Ministry of Cultural Affairs and PMU, NWPGCL will conduct an orientation or training for all workers, particularly those who will be involved in earth movements and excavation works on how to recognize artifacts that they may potentially encounter or discover. The EPC Contractor will be responsible for creating awareness to construction personnel on the ADB requirements for any unanticipated impacts such as discovery of a physical cultural resource. NWPGCL will ensure compliance of this ADB requirement.

3. An archeological map of Bangladesh (if available) will be obtained from the DOA or other relevant sources to examine if there are potential "hot spots" within the project area. This map will be part of the references on-site to guide the construction supervision staff in determining and recognizing the potential "hot spots."

3.0 Procedures

3.1 General

4. In case a PCR was encountered during excavation, construction activities including traffic within a 30.5-meter radius in the area will be stopped immediately by the EPC Contractor. The discovery will be reported by the site engineer or representative from the EPC Contractor to PMU, NWPGCL environment staff (or Consultant). The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken. The construction supervision staff of the EPC Contractor and PMU, NWPGCL site engineer/staff will secure the site to prevent damage, loss or pilferage of removable objects. Site Engineer of PMU, NWPGCL or designated staff will be responsible for coordinating with DOA.

5. If the encounter involves removable items, a security person will be posted until the representative of DOA or Ministry of Cultural Affairs arrives to assess and determine its value. The DOA staff will be responsible in determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the DOA staff.

6. If the chance find will have significant cultural value, this may entail consequent changes in the lay-out particularly if the discovery is considered or assessed as remains of cultural or archeological importance that is not removable.

7. EPC Contractor will not be entitled for compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.2 Assessment and Recovery

8. Appropriate heavy equipment such as wheel loader will be made available to recover the excavated material from the excavation site to allow the geologist onsite or the DOA staff to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the chance find is part of a large artifact, deposit or structure, the inspection or recording will include photography and video on an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.3 Resumption of Work

9. The Contractor can continue with excavation and construction works within the affected area after the DOA staff has given clearance. All the discovered objects of value will be given to the Government.

4.0 Reporting

10. The EPC Contractor will prepare a “Chance Find” Report within a week showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to PMU, NWPGCL who will provide it to the DOA or Ministry of Cultural Affairs. The chance find including measures on how it was dealt with will be included in the environmental monitoring report submitted to ADB.

Annex 3

List of Species Found within the Study Area

Table 1: Terrestrial vegetation growing within the study area

No.	Scientific Name	Local Name	Habit
Homestead			
1	*Abroma augusta*	Ulatkambal	Shrub
2	*Acacia moniliformis*	Akashmoni	Tree
3	*Aegle marmelos*	Bel	Tree
4	*Albizia lebbeck*	Sirish	Tree
5	*Albizia procera*	Silkaroi	Tree
6	*Albizia richrdiana*	Gogon Sirish	Tree
7	*Alstonia scholaris*	Chatim	Tree
8	*Annona reticulata*	Ata	Tree
9	*Areca catechu*	Supari	Tree
10	*Artocarpus heterophyllus*	Kathal	Tree
11	*Artocarpus lakoocha*	Dewa	Tree
12	*Averrhoa carambola*	Kamranga	Tree
13	*Azadirachta indica*	Nim	Tree
14	*Bambusa sp.*	Bans	Tree
15	*Barringtonia acutangula*	Hijal	Tree
16	*Bombax ceiba*	Shimul	Tree
17	*Borassus flabelifer*	Tal	Tree
18	*Carica papaya*	Papay	Tree
19	*Citrus grandis*	Jambura	Tree
20	*Citrus limon*	Lebu	Shrub
21	*Cocos nucifera*	Narikel	Tree
22	*Crataeva nurvala*	Baroon	Tree
23	*Dillenia indica*	Chalta	Tree
24	*Diospyros blancoi*	Bilatigab	Tree
25	*Diospyros perigrina*	Deshigab	Tree
26	*Erythrina ovalifolia*	Talimandar	Tree
27	*Ficus benghalensis*	Bot	Tree
28	*Ficus religiosa*	Assawath	Tree
29	*Lagerstromia speciosa*	Jarul	Tree
30	*Lennea coromandelica*	Zika	Tree
31	*Litchi chinensis*	Lichu	Tree
32	*Mangifera indica*	Aum	Tree
33	*Moringa oleifera*	Sajna	Tree
34	*Musa sapientum*	Kala	Tree
35	*Neolamarckia cadamba*	Kadam	Tree
36	*Ocimum americanum*	Tulshi	Herb

No.	Scientific Name	Local Name	Habit
37	*Phoneix sylvestris*	Khejur	Tree
38	*Phyllanthus reticulatus*	Amloki	Tree
39	*Polyalthia longifolia*	Debdaru	Tree
40	*Pongamia pinnata*	Karoch	Tree
41	*Psidium guajava*	Peyara	Shrub
42	*Spondias dulcis*	Amra	Tree
43	*Streblus asper*	Sheora	Shrub
44	*Swietenia mahagoni*	Mahogoni	Tree
45	*Syzygium cumini*	Kalojam	Tree
46	*Tamarindus indica*	Tetul	Tree
47	*Tectona grandis*	Segun	Tree
48	*Terminalia arjuna*	Arjun	Tree
49	*Terminalia catappa*	Katbadam	Tree
50	*Trema orientalis*	Jiban	Tree
51	*Trewia nudiflora*	Pitali	Tree
52	*Zizyphus mauritiana*	Baroi	Tree
Crop field			
1	*Acalypha indica*	Muktajhuri	Herb
2	*Achyranthes aspera*	Apang	Herb
3	*Alternanthera sessilis*	-	Herb
4	*Amaranthus spinosus*	Kata note	Herb
5	*Calotropis gigantea*	Akand	Shrub
6	*Calotropis procera*	Akand	Shrub
7	*Carissa carandas*	Karamcha	Shrub
8	*Chenopodium ambrosoides*	Chapali ghash	Herb
9	*Clerodendrum inerme*	Bhant	Herb
10	*Cotula hemispherica*	Kancha ghash	Herb
11	*Crotolaria retusa*	Ban-san	Herb
12	*Croton bonplandianum*	Banjhal	Herb
13	*Cuscuta australis*	Swarnalata	Herb
14	*Cynodon dactylon*	Durba	Herb
15	*Cyperus diformis*	-	Herb
16	*Dentella repens*	Hachuti	Herb
17	*Euphorbia hirta*	Dudhia	Herb
18	*Marsilea quadrifolia*	Susnishak	Herb
19	*Nicotiana plumbaginifolia*	Bantamak	Herb
20	*Nyctanthes arbortristris*	Sefali	Herb
21	*Rhynchospora rufescens*	Shimbhatraji	Herb
22	*Rorippa indica*	Bansarisha	Herb
23	*Saccharum spontaneum*	Kash	Herb
24	*Sacciolepis interrupta*	Nardulla	Herb
25	*Sesbania rostrata*	Dhaincha	Herb

Table 2: The list of terrestrial and wetland wildlife occurring within the study area

No.	English Name	Scientific Name
Birds		
1	Abbott's Babbler	*Malacocincla abbotti*
2	Ashy Wood swallow	*Artamus fuscus*
3	Asian Koel	*Eudynamys scolopaceus*
4	Asian Open bill	*Anastomus oscitans*
5	Asian Palm Swift	*Cypsiurus balasiensis*
6	Barn Owl	*Tyto alba*
7	Baya Weaver	*Ploceus philippinus*
8	Bengal Bush Lark	*Mirafra assamica*
9	Black Drongo	*Dicrurus macrocercus*
10	Black headed Ibis	*Threskiornis melanocephalus*
11	Black Kite	*Milvus migrans*
12	Black-crowned Night Heron	*Nycticorax nycticorax*
13	Black-headed Munia	*Lonchura malacca*
14	Black-hooded Oriole	*Oriolus xanthornus*
15	Black-naped Monarch	*Hypothymis azurea*
16	Black-winged Kite	*Elanus caeruleus*
17	Blue-throated Barbet	*Megalaima asiatica*
18	Brahminy Kite	*Haliastur Indus*
19	Bronze-winged Jacana	*Metopidius indicus*
20	Brown Fish Owl	*Ketupa zeylonensis*
21	Brown Shrike	*Lanius cristatus*
22	Brown-headed Gull	*Larus brunnicephalus*
23	Cattle Egret	*Bubulcus ibis*
24	Chestnut-tailed Starling	*Sturnus malabaricus*
25	Cinnamon Bittern	*Ixobrychus cinnamomeus*
26	Citrine Wagtail	*Motacilla citreola*
27	Clamorous Reed Warbler	*Acrocephalus stentoreus*
28	Common Black-headed Gull	*Larus ridibundus*
29	Common Greenshank	*Numenius nebularia*
30	Common Hawk-Cuckoo	*Hierococcyx varius*
31	Common Iora	*Aegithina tiphia*
32	Common Kestrel	*Falco tinnunculus*
33	Common Kingfisher	*Alcedo atthis*
34	Common Myna	LC *Acridotheres tristis*
35	Common Pigeon	*Columba livia*
36	Common Pochard	*Atthya ferina*
37	Common Redshank	*Tringa tetanus*

No.	English Name	Scientific Name
38	Common Sandpiper	*Actitis hypoleucos*
39	Common Shelduck	*Tadorna tadorna*
40	Common Snipe	*Gallinago gallinago*
41	Common Tailorbird	*Orthotomus sutorius*
42	Common Tern	*Sterna hirundo*
43	Coppersmith Barbet	*Megalaima haemacephala*
44	Cotton Pygmy Goose	*Nettapas coromandelianus*
45	Crested Serpent Eagle	*Spilornis cheela*
46	Dusky Warbler	*Phylloscopus fuscatus*
47	Eurasian Collared Dove	*Streptopelia decaocta*
48	Eurasian Hoopoe	*Upupa epops*
49	Fulvous Whistling Duck	*Dendrocygna bicolor*
50	Fulvous-breasted Woodpecker	*Dendrocopos macei*
51	Garganey	*Anas querquedula*
52	Great Egret	*Casmerodius albus*
53	Great Tit	*Parus major*
54	Greater Coucal	*Centropus sinensis*
55	Green Bee-eater	*Merops orientalis*
56	Grey Heron	*Ardea cinerea*
57	House Crow	*Corvus splendens*
58	House Sparrow	*Passer domesticus*
59	Indian Cormorant	*Phalacrocorax fuscicollis*
60	Indian Cuckoo	*Cuculus micropterus*
61	Indian Pond Heron	*Ardeola grayii*
62	Jungle Babbler	*Turdoides striatus*
63	Jungle Myna	*Acridotheres fuscus*
64	Large-billed Crow	*Corvus macrorhynchos*
65	Lesser Sand Plover	*Charadrius mongolus*
66	Lesser Whistling Duck	*Dendrocygna javanica*
67	Lineated Barbet	*Megalaima lineata*
68	Little Cormorant	*Phalacrocorax niger*
69	Little Egret	*Egretta garzetta*
70	Little Ringed Plover	*Charadrius dubius*
71	Long-tailed Shrike	*Lanius schach*
72	Northern Pintail	*Anas acuta*
73	Olive-backed Pipit	*Anthus hodgsoni*
74	Oriental Magpie-Robin	*Copsychus saularis*
75	Oriental White-eye	*Zosterops palpebrosus*
76	Pacific Golden Plover	*Pluvialis fulva*
77	Paddy field Pipit	*Anthus rufulus*

No.	English Name	Scientific Name
78	Pied Kingfisher	*Ceryle rudis*
79	Pied Myna	*Sturnus contra*
80	Plain Prinia	*Parus inornata*
81	Purple-rumped Sunbird	*Leptocoma zeylonica*
82	Red Turtle Dove	*Streptopelia tranquebarica*
83	Red-vented Bulbul	*Pycnonotus cafer*
84	Red-wattled Lapwing	*Vanellus indicus*
85	River Tern	*Sterna aurantia*
86	Rose-ringed Parakeet	*Psittacula krameri*
87	Rufous Treepie	*Dendrocitta vagabunda*
88	Rufous Woodpecker	*Celeus brachyurus*
89	Scaly-breasted Munia	*Lonchura punctulata*
90	Small Minivet	*Pericrocotus cinnamomeus*
91	Spotted Dove	*Streptopelia chinensis*
92	Spotted Owlet	*Athene brama*
93	Streak-throated Woodpecker	*Picus xanthopygaeus*
94	Striated Babbler	*Turdoides earlei*
95	Striated Heron	*Butorides striata*
96	White Wagtail	*Motacilla alba*
97	White-breasted Water hen	*Amaurornis phoenicurus*
98	White-browed Wagtail	*Motacilla madaraspatensis*
99	White-throated Kingfisher	*Halcyon smyrnensis*
100	Wood Sandpiper	*Numenius glareola*
101	Yellow-billed Egret	*Egretta intermedia*
102	Yellow-footed Green Pigeon	*Treron phoenicopterus*
103	Zitting Cisticola	*Cisticola juncidis*
Mammals		
1	Smoth coated Otter	*Lutrogale perspicillata*
2	Ganges River Dolphin	*Platanista gangetica*
3	Golden Jackal	*Canis aureus*
4	Indian flying Fox	*Pteropus giganteus*
5	Jungle Cat	*Felis chaus*
6	Fishing Cat	*Felis viverrina*
7	Small IndianMongoose	*Herpestes autopunctatus*
8	Field Mouse	*Mus booduga*
9	House Shrew	*Suncus murinus*
10	Asian Palm Civet	*Paradoxurus hermaphroditu*
11	Small Indian Civet	*Viverricula indica*
12	Irrawaddy squirrel	*Callosciurus pygerythrus*
13	Northern palm squirrel	*Funambulus pennantii*

No.	English Name	Scientific Name
14	Greater Bandicot Rat	*Bandicota indica*
Reptiles		
1	Indian Roofed Turtle	*Pangshura tectum*
2	Ganges softshell Turtle	*Aspideteres gangeticus*
3	Spotted Flapshell Turtle	*Lissemys punctata*
4	Common Garden Lizard	*Calotes versicolor*
5	Tokay Gecko	*Gekko gecko*
6	Common House Gecko	*Hemidactylus frenatus*
7	Keeled Grass skink	*Mabuya carinata*
8	Spotted Litter skink	*Sphenomorphus maculatus*
9	Bengal Monitor	*Varanus bengalensis*
10	Water Monitor	*Varanus salvator*
11	Jerdon's Blind Snake	*Typhlops jerdoni*
12	Olive Keelback	*Atretium schistosum*
13	Striped Keelback	*Amphiesma stolatum*
14	Common Smooth Water Snake	*Enhydris enhydris*
15	Common Wolf Snake	*Lycodon aulicus*
16	Indian Rat Snake	*Ptyas mucosus*
17	Checkered Keelback	*Xenochropis piscator*
18	Common Krait	*Bungarus caeruleus*
19	Indian Cobra	*Naja naja*
20	Monocled Cobra	*Naja kaouthia*
Amphibians		
1	Indian Bull Frog	*Hoplobactrachus tigerinus*
2	Ornate Microhylid	*Microhyla ornata*
3	Two-striped Grass Frog	*Sylvirana taipehensis*
4	Asian Brown Tree Frog	*Polypedates leucomystax*
5	Indian Tree Frog	*Polypedates maculatus*
6	Large Tree Frog	*Rhacophorus maximus*

Table 3: The list of wetland plants occurring within the study area

No..	Scientific Name	Local Name	Habit
1	*Alternanthera philoxiroides*	Helencha	*Herb*
2	*Arundo donax*	Baranal	*Herb*
3	*Ceratophyllum desmersum*	Jhangi	*Herb*
4	*Eclipta alba*	Kalokeshi	*Herb*
5	*Eichhornia crassipes*	Kochuripana	*Herb*
6	*Enhydra fluctuans*	Helencha	*Herb*
7	*Fimbristylis milliaceae*	Joina	*Herb*

No..	Scientific Name	Local Name	Habit
8	*Hygroryza aristata*	Putki	*Herb*
9	*Hydrocharis dubia*	-	*Herb*
10	*Ipomoea aquatica*	Kalmi sak	*Herb*
11	*Lemna perpusilla*	Khudipana	*Herb*
12	*Limnophila sessiliflora*	Bijatighas	*Herb*
13	*Ludwigia abscendens*	Keshordam	*Herb*
14	*Ludwigia hyssopifolia*	Keshordam	*Herb*
15	*Mersilea quadrifoliata*	Susnisak	*Herb*
16	*Monochoria hatata*	Kechur	*Herb*
17	*Myriophyllum tetrandrum*	-	*Herb*
18	*Nachamendra alternifolia*	Kaisa	*Herb*
19	*Nymphaea nouchali*	Shapla	*Herb*
20	*Nymphaea stellata*	Nilshapla	*Herb*
21	*Nymphoides indicum*	Panchuli	*Herb*
22	*Phragmites karka*	Nol	*Herb*
23	*Pistia stratiotes*	Topapana	*Herb*
24	*Polygonum barbatum*	Bishkatali	*Herb*
25	*Polygonum glabrum*	Bishkatali	*Herb*
26	*Polygonum lanatum*	Bishkatali	*Herb*
27	*Sagittaria sagittifolia*	Chhotokul	*Herb*
28	*Salvina cucullata*	Kuripana	*Herb*
29	*Scirpus juncoides*	Chisra	*Herb*
30	*Spirodela polyrhiza*	Khudipana	*Herb*
31	*Trapa natans*	Singra	*Herb*
32	*Vallisnaria spiralis*	*Bicha*	*Herb*

Annex 4

Sample Advertisement of the Consultation in the Local Newspaper

দৈনিক পূর্বাঞ্চল

The Daily Purbanchal

www.purbanchal.com

বিজ্ঞপ্তি

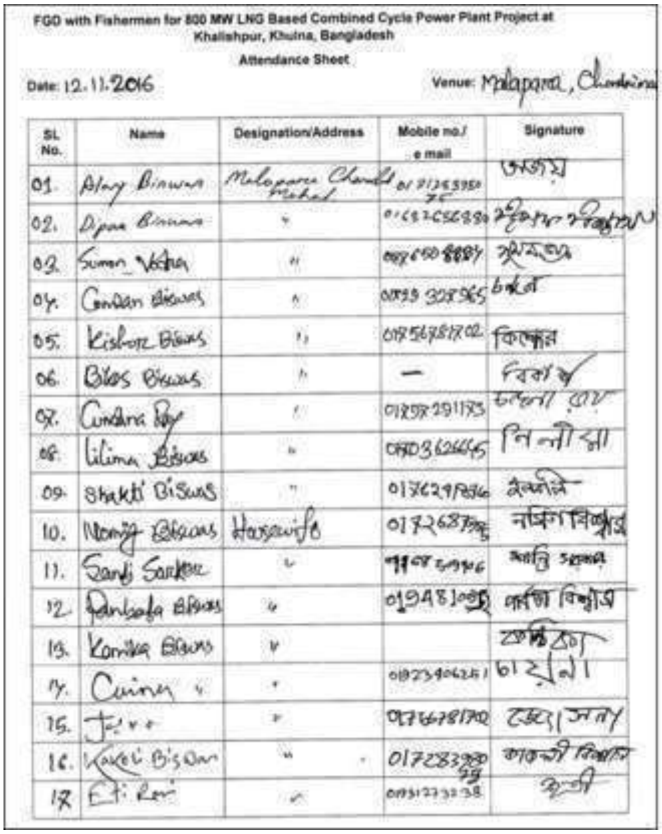
রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে ২০২১ সালের মধ্যে দেশের সকল ঘরে বিদ্যুৎ পৌঁছে দিতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সরকারের এ লক্ষ্য পূরণের উদ্দেশ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানি লিঃ (বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ডের একটি প্রতিষ্ঠান) খুলনার খালিশপুরে রূপসা ৮০০ মেঃ ওঃ কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র বাস্তবায়নের কাজ হাতে নিয়েছে। উক্ত প্রকল্প বাস্তবায়নের ফলে সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব সমীক্ষা করার জন্য পানি সম্পদ মন্ত্রণালয়ের অধীনস্থ CEGIS - কে দায়িত্ব দেয়া হয়েছে। এরই অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারী ও বেসরকারী প্রতিষ্ঠান এবং জনগণের সুচিন্তিত মতামত ও পরামর্শ গ্রহণের লক্ষ্যে আগামী ২১ অক্টোবর, ২০১৭ইং তারিখ রোজ শনিবার সকাল ১১:০০ ঘটিকায় খুলনার খালিশপুরস্থ ইঞ্জিনিয়ার্স ইন্সটিটিউট-এর সম্মেলন কক্ষে একটি মতবিনিময় সভার আয়োজন করা হয়েছে। উক্ত মতবিনিময় সভায় উপস্থিত থেকে এ বিষয়ে আপনাদের সুচিন্তিত মতামত প্রদান করার জন্য অনুরোধ করা যাচ্ছে।

আর-৩৩০১

Annex 5

List of Participants during Consultations

A. 12-13 November 2016



FGO with Fishermen for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016 Venue: Malapara, Chandni [illegible]

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
01.	Alay Biswas	Malapara Chandni Mahal	[illegible]	[illegible]
02.	Dipa Biswas	"	[illegible]	[illegible]
03.	Suman Victor	"	[illegible]	[illegible]
04.	Candan Biswas	"	[illegible]	[illegible]
05.	Kishore Biswas	"	[illegible]	[illegible]
06.	Bikas Biswas	"	—	[illegible]
07.	Candra Roy	"	[illegible]	[illegible]
08.	Lilima Biswas	"	[illegible]	[illegible]
09.	Shakti Biswas	"	[illegible]	[illegible]
10.	Nomita Biswas	Housewife	[illegible]	[illegible]
11.	Sandi Sarker	"	[illegible]	[illegible]
12.	Panbala Biswas	"	[illegible]	[illegible]
13.	Konika Biswas	"		[illegible]
14.	Cuiney	"	[illegible]	[illegible]
15.	[illegible]	"	[illegible]	[illegible]
16.	Kakoli Biswas	"	[illegible]	[illegible]
17.	Eti Rani	"	[illegible]	[illegible]

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
18	Anjona	Malapara Chandni Mahal	[illegible]	[illegible]
19	Mita	"	[illegible]	[illegible]
20	Jhonna	"	[illegible]	[illegible]
21	Moyna	"	[illegible]	[illegible]
22	Biswajit	"	[illegible]	[illegible]
23	Chandi	"	[illegible]	[illegible]
24	Jagannath	"	[illegible]	[illegible]
25	Polok		[illegible]	[illegible]
26	Anup		[illegible]	[illegible]
27	Nikhil		[illegible]	[illegible]
28	Biswa		[illegible]	[illegible]
29	Eti Biswas		[illegible]	[illegible]
30	Kalpona		[illegible]	[illegible]
31	Arati		[illegible]	[illegible]
32	Robin Biswas		0	[illegible]
33	Pappu		[illegible]	[illegible]
34	Mithun		[illegible]	[illegible]
35	Shanti		[illegible]	[illegible]

Fisherfolks in Dighalia

Imam and mosque adherents

Mosque

FGD with Imam and adherent for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016 Venue: IEB, Khulna

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
01.	[illegible]	[illegible]	[illegible]	[illegible]
02.	MD. [illegible]		[illegible]	
03.	MD. SHALIM [illegible]		[illegible]	
04.	MD. GAMAL		[illegible]	
05.	MD. MOKLAS		[illegible]	
06.	[illegible]			
07.	MD. Rabor			
08.	HARUN OR Rosid		[illegible]	
09.	HABIBORRAHMAN		[illegible]	
10.	ASAD HOSSEN			
11.	JAFOR IQBAL			
12.	Ismail gazi		[illegible]	[illegible]
13.	[illegible] ALAM		[illegible]	[illegible]
14.	[illegible]		[illegible]	[illegible]
15.	MD [illegible]		[illegible]	[illegible]
16.	Mahmud [illegible]		[illegible]	[illegible]
17.	MD [illegible]		[illegible]	[illegible]

MOSQUE

Date: 12.11.2016 Venue: IEB, Khulna

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
18	MD [illegible]		[illegible]	[illegible]
19	[illegible]		[illegible]	[illegible]
	[illegible]		[illegible]	
20	Belal Hossain		[illegible]	[illegible]
21	Dr. [illegible]	Env. Advisor CEGIS	[illegible]	[illegible]
22	[illegible]	ADB	[illegible]	[illegible]
23	[illegible]	ADB	[illegible]	[illegible]
24	[illegible] ALI	NWPGCL	[illegible]	[illegible]
25	Engr. Rafiqul Islam	CEGIS	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	ADB	[illegible]	[illegible]

Government officials, school management committee, students, etc.

17 NOVEMBER 2016
IEB CONFERENCE
KHULNA

800 MW KHULNA POWER PROJECT
STAKEHOLDER CONSULTATION MEETING
FGD (BOYS & GIRLS SCHOOL)
TEACHERS & PARENTS

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
1	[illegible]	Environment Spec. [illegible]	[illegible]	[illegible]
2	REISHA JONES	SOCIAL SPECIALIST [illegible]	+6344974627	[illegible]
3	MAHBUBUL HAQUE	K.N.M SCHOOL Ass. teacher	01915199985	[illegible]
4	NAZMUSSAKIB	KNM school Ass. teacher	01961174775	Sakib
5	MITHUN MONDAL	Asst teacher KNM school	01917-565659	[illegible]
6	Afiah Islam	student	01707750[illegible]	Afiah
7	SALMA BEGUM	Guardian KNM school	01611180083	Salma
8	SUFIA BEGUM	Guardian KNM school	01947298516	[illegible]
10	Chowdhury Habibur Rahman	SMC	0191171[illegible]	[illegible]
11	Shahina Khatun	Head teacher K.N.M school	0191[illegible]	[illegible]
12	Fariha Rahman	student	0171[illegible]	Fariha
13	Yoojung Jang	ADB	+63 [illegible]	[illegible]
14	Yun Zhou	ADB	+63 [illegible]	[illegible]
15	Dr. Kazi Noor [illegible]	CEGIS	01817549[illegible]	[illegible]
16	Jalal Ahmed Chowdhury	CEGIS	0193824[illegible]	Jalal
17	Ronab K. [illegible]	Environmental Expert CEGIS	01717530[illegible]	[illegible]
18	SM Khan Shildmand	Gunsilon	01711309022	[illegible]
19	Engr. Rafiul Islam	Electrical Engr.	01510 561066	[illegible]

FGD with Teachers and guardians for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

17 NOV 2016

Date: 17-11-2016 Venue: IEB, Khulna

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
1.	SM Khan Shildmand	Gunsilon	01711309022	[illegible]
2.	shahina khatun	K.N.M. school Head teacher	0191[illegible]	[illegible]
3.	Md. Shahjahan Jamaad	Attatch to Planning member	0171-508465	[illegible]
4.	Sm Faruk Ahmed		01715001106	[illegible]
5.	Kazi TALATH[illegible]	[illegible]	01920039374	Kabilat
6.	Shadat Ripon	[illegible] print	0171157[illegible]	
7.	Jamal	[illegible]	01727426405	
8.	Ismail gazi	Khalishpur	0171779460	[illegible]
9.	Faruk Hossain	Khalishpur		[illegible]
10	SK TIPU Sultan	KHALISHPUR	01711190770	[illegible]

B. 21 October 2017

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১.	[illegible]	[illegible]	[illegible]	[illegible]
২.	[illegible]	[illegible]	01711-389022	[illegible]
৩.	[illegible]	[illegible]	01711-422470	[illegible]
৪.	[illegible]	[illegible]	01785-650025	[illegible] 21.10.17
৫.	[illegible]	[illegible]	01730-066787	[illegible] 21.10.17
৬.	Shariful Islam	Consultant/ ADB	[illegible]	[illegible]
৭.	Ruby Dcorra Africa	ADB - Consultant	—	[illegible]
৮.	Shamsuddin Ahmed	ADB - Consultant (Gas Sector Specialist)	[illegible]@gmail.com	[illegible]
৯.	[illegible] Nahar	ADB BRM	nnahar@adb.org	[illegible]
১০.	[illegible]	[illegible]	[illegible]	[illegible]
১১.	[illegible]	[illegible]	01533847872	[illegible]
১২.	[illegible]	[illegible]	[illegible]	[illegible]
১৩.	Saleh [illegible]	[illegible]@gmail.com		[illegible]
১৪.	Aziz Yusupov	Energy Spec ADB	[illegible]@adb.org	[illegible]
১৫.	Md Shahidul [illegible] Joarder	[illegible]	[illegible]@gmail.com 017[illegible]	[illegible]

১

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	Syed Imdad Hossain	Manager, GTCL Arongghata, KG	[illegible]@gmail.com 0170963[illegible]	[illegible]
১৭.	Engr. Nizam Uddin	Manager, SOCL 01711043578	[illegible]@gmail.com	[illegible]
১৮.	Abdullah Al Mamun	Asst. Teacher 01710027985	[illegible]@yahoo.com	[illegible]
১৯.	[illegible]	[illegible]	01713 4444[illegible]	
২০.	Mashuda Parvin	Manager [illegible] NWPGCL	[illegible] 01777[illegible]	[illegible] 21.10.17
২১.	Md. Jamal Uddin	AM (EHS) NWPGCL	[illegible]@gmail.com	[illegible] 21.10.17.
২২.	Md. HASMAT ALI	XEN NWPGCL	[illegible]	[illegible] 21.10.17
২৩.	[illegible] Alam Khan	General Secretary AL [illegible]		[illegible]
২৪.	Md. [illegible]	15 no Ward [illegible]	01712179692	[illegible]
২৫.	[illegible]	[illegible]	[illegible]	[illegible]
২৬.	[illegible]	[illegible]	01533847872	[illegible]
২৭.	[illegible]	[illegible]	[illegible]	[illegible]
২৮.	[illegible]	[illegible]	01616229992	[illegible]
২৯.	[illegible]	[illegible]	01319606447	[illegible]
৩০.	[illegible]	[illegible]	01926231008	[illegible]

২

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
০১.	[illegible]	[illegible]		[illegible]
০২.	[illegible]	[illegible]		[illegible]
০৩.	[illegible]	[illegible]		[illegible]
০৪.	[illegible]	[illegible]		[illegible]
০৫.	[illegible]	[illegible]		[illegible]
০৬.	[illegible]	[illegible]		[illegible]
০৭.	[illegible]	[illegible]		[illegible]
০৮.	[illegible]			
০৯.	[illegible]	[illegible]	01911710497	[illegible]
১০.	[illegible]	[illegible]	[illegible]	[illegible] 21.10.2017
১১.	[illegible]	[illegible]	01927406881	[illegible] 21.10.17
১২.	[illegible]	[illegible]	01782550353	Mukta
১৩.	[illegible]	[illegible]	[illegible]	Sobnam
১৪.	[illegible]	[illegible]	[illegible]	Putul
১৫.	[illegible]	[illegible]	[illegible]	Nupur

3

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	[illegible]	[illegible]	[illegible]	[illegible]
১৭.	[illegible]	[illegible]	[illegible]	[illegible]
১৮.	[illegible]	[illegible]	[illegible]	[illegible]
১৯.	[illegible]	[illegible]	[illegible]	[illegible]
২০.	[illegible]	[illegible]	[illegible]	[illegible]
২১.	[illegible]	[illegible]	01954443450	[illegible]
২২.	[illegible]	[illegible]	0171617000 38	[illegible]
২৩.	[illegible]	[illegible]	[illegible]	[illegible]
২৪.	[illegible]	[illegible]	01948157910	[illegible]
২৫.	[illegible]	[illegible]	—	[illegible]
২৬.	Yonjung Jung	ADB-HQ	[illegible]	[illegible]
২৭.	ZHAIJING MU	ADB	[illegible]	[illegible]
২৮.	SM Faruk Ahmed	BUSSINESS	0171500806	[illegible]
২৯.	[illegible]	[illegible]	01924390469	[illegible]
৩০.	[illegible]	[illegible]	[illegible]	[illegible]

4

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি সময়: সকাল

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	
৩১.	[illegible]	[illegible]	[illegible]	[illegible]
৩২.	[illegible]	Electrical [illegible] CEGIS	01710-564066	[illegible]
৩৩.	[illegible]	Advisor, CEGIS	[illegible]@cegisbd.com	[illegible] 21/10/17
৩৪.	Md. Hasan	AGM, IEB KLN.	[illegible]	[illegible]
৩৫.				

Annex 6

Photo documentation of Consultations

A. 12-13 November 2016


Consultation workshop


FGD with KNM School Management Committee and teachers


FGD with Imam and KNM mosque adherents

FGD with fisherfolks

B. 21 October 2017


Project Presentation by CEGIS and NWPGCL


Representatives from Khulna City Corporation




Q & A Portion

Annex 7
Handout in Bengali Given During Consultation, 21 October 2017

নর্থওয়েস্ট পাওয়ার জেনারেশন কোম্পানী কর্তৃক অত্র এলাকায় গৃহীত খুলনা ৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিক কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র এবং সংশ্লিষ্ট উপাদান সমূহের তথ্য, খুলনা

✓ সভার মূল উদ্দেশ্য

- আজকের সভার মূল উদ্দেশ্য হচ্ছে প্রস্তাবিত ২ x ৪০০ (৮০০) মেগাওয়াট গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প ও অত্র প্রকল্প সংশ্লিষ্ট উপাদান সমূহ স্থাপন হলে প্রকল্প সংলগ্ন এলাকায় কী ধরণের পরিবেশগত ও আর্থ-সামাজিক প্রভাব পড়তে পারে এ সম্বন্ধে এলাকার জনগোষ্ঠীর মতামত গ্রহণ করা।
- একই সাথে প্রকল্প নকশা ও নির্মাণ পর্যায়ে জনগণের প্রভাব নেওয়া যাতে প্রকল্প বাস্তবায়নে তাদের আকাঙ্ক্ষার প্রতিফলন ঘটে।

✓ প্রস্তাবিত প্রকল্প ও সংশ্লিষ্ট বিষয়াদি

- *বাংলাদেশ সরকার ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের লক্ষ্যে একটি মহাপরিকল্পনা, Power System Master Plan প্রণয়ন করে, যার মূল প্রতিপাদ্য বিষয় হচ্ছে:*
  - স্থানীয় যথাযথীকরণ যেমন: গ্যাস, এলএনজি, কয়লা, এইচএসডি, ফার্নেস অয়েল নবায়নযোগ্য স্থাপনি ইত্যাদি।
  - স্থানীয় উৎস সর্বোচ্চকরণ ও এর সর্বোত্তম ব্যবহার নিশ্চিত করণ।
  - স্থানীয় উৎসের ও সরবরাহের সুবিধাদির ভিত্তিতে বিদ্যুৎ প্রকল্প নির্বাচনে স্থান নির্ধারণ।
  - বিদ্যুতের ক্রমবর্ধমান চাহিদার উপর ভিত্তি করে উৎপাদন ক্ষমতা বৃদ্ধি করা, যা জাতীয় বিদ্যুৎ গ্রীডের মাধ্যমে নিরবিচ্ছিন্নভাবে বিদ্যুৎ সরবরাহ করতে পারবে।

- *রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্ল্যান, '২০১০ ও ২০১৬' এর আলোকে দেশের দক্ষিণে বিদ্যুৎ পৌঁছে দেয়ার লক্ষ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ (NWPGCL) খুলনা জেলায় গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প নির্মাণ করে ১০০০ মেগাওয়াটের অধিক বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে।*

✓ পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণ সংক্রান্ত তথ্য সংগ্রহ ও প্রয়োজনীয় পরীক্ষানিরীক্ষা

- *CEGIS এই প্রকল্পটির পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণে দায়িত্বপ্রাপ্ত হয়ে বিভিন্ন পর্যায়ে এলাকার জনগনের সাথে এই বিষয়ে আলাপ আলোচনা করে পরিবেশ ও আর্থ-সামাজিক প্রেক্ষাপটের বর্তমান অবস্থা বিশ্লেষণ করার চেষ্টা করেছে এবং পর্যবেক্ষণ করার জন্য সংশ্লিষ্ট অফিসগুলো থেকেও তথ্য সংগ্রহ করে, যেমন:*
  - কৃষি অফিস থেকে ফসল, ফসলী জমি ও সেচ সংক্রান্ত তথ্য।
  - মৎস্য অফিস থেকে মাছ ও মাছের আহরণ সংক্রান্ত তথ্য।
  - ইউনিয়ন পরিষদ থেকে সামাজিক ও অর্থনৈতিক বিষয়াদি সংক্রান্ত বিভিন্ন তথ্য।
  - বিভিন্ন প্রকার শিল্প থেকে নির্গত দূষণ সম্পর্কিত তথ্য সংগ্রহ।

- *প্রকল্প এলাকার বিভিন্ন বৈশিষ্ট সঠিকভাবে বিশ্লেষণ করার নিমিত্তে নিম্নলিখিত পরীক্ষা-নিরীক্ষা করা হয়:*
  - ভূ-তাত্ত্বিক জরিপ যার মাধ্যমে প্রকল্প এলাকার মাটি ভূ-পৃষ্ঠ পানি সম্বন্ধে ধারণা পাওয়া।
  - বন্যার পানির সর্বোচ্চ উচ্চতার বিষয়টি বিশ্লেষণ করে কতটুকু মাটি ভরাট করতে হবে তা জানা।
  - পানির গুণাগুণ যাচাই করার জন্য ভূ-পৃষ্ঠ ও ভূ-পৃষ্ঠ পানি পরীক্ষা-নিরীক্ষা করা হয়।
  - বায়ুর দূষণ মাত্রা যাচাই করার জন্য বায়ু পরীক্ষা-নিরীক্ষা করা হয়।
  - শব্দ দূষণ মাত্রা যাচাই করার জন্য শব্দ দূষণ যন্ত্র ব্যবহার করা এবং দূরত্ব থেকে ৫০০ মি. চারপাশে শব্দ দূষণ পরিমাপক যন্ত্রের মাধ্যমে শব্দের তীব্রতা মাপা হয়।

- *পরিবেশগত ও সামাজিক প্রভাব বিশ্লেষণের জন্য প্রকল্পকে কেন্দ্র করে চারপাশে ১০ কি.মি এলাকা পর্যবেক্ষণ করা হয়েছে*

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (পরিবেশগত প্রভাব বিশ্লেষণ)

- **৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিকবিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ**
  - বিভিন্ন সংবেদনশীল এলাকায় বায়ু দূষণের মাত্রা মাপা হয়েছে এবং বায়ু দূষণের ক্ষেত্রে ব্যাপকভাবে মাধ্যমে CO_2, SO_x, NO_x বিশ্লেষণ করে দেখা গেছে উল্লিখিত দূষণের মাত্রা বাংলাদেশ ও আন্তর্জাতিক প্রাধ্যতাযোগ্য সীমার নীচে আছে।
  - শব্দ দূষণের মাত্রা উল্লিখিত শব্দ দূষণ নিয়ন্ত্রন বিধি-২০০৬ এর প্রাধ্যতাযোগ্য সীমার নীচে থাকবে।
  - মেশিন চালুকালে ভূ-কম্পনের মাত্রা সহনশীল পর্যায়ে থাকবে।
  - প্রকল্প চালু করার সময় ফুলি টাওয়ার এর জন্য উৎকর নল থেকে একশীল ৯০,০০০ ঘন মিটার পানি উত্তোলন করা হবে এবং পরবর্তীতে প্রকল্প চালু অবস্থায় উৎকর নল থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তোলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
  - ভূ-পৃষ্ঠ পানিস্তরের মাত্রা বর্তমানে উল্লিখিত ইলিয়ার- ১৯৯৭ এর প্রাধ্যতাযোগ্য সীমার নীচে থাকবে।
  - বিদ্যুৎ কেন্দ্র থেকে নির্গতিত সকল তরল পদার্থ পরিশোধিত করে প্রাধ্যতাযোগ্য সীমার মধ্যে রাখতে হবে ফলে পরিবেশ বিপন্ন হবে।
  - বৃষ্টিপাতের পানির কোন সংকট হবে না এবং মাছ চাষের উপর কোন বিরুপ প্রভাব পড়বে না।
  - ২১৫ টি গাছের উপর প্রভাব পড়বে যা আইইসিএন এর লাল তালিকা বহির্ভূত।

- **গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ**
  - উল্লিখিত গ্যাস পাইপলাইন প্রকল্প বাস্তবায়নের ফলে বায়ু দূষণ, শব্দ দূষণ, মৃত্তী দূষণ, পানি দূষণ অথবা সংশ্লিষ্ট এলাকায় পানির কোন অভাব দেখা দেবে না। এছাড়া উক্ত প্রকল্পের কারণে কৃষি জমি ও মাছ চাষ প্রকল্পের কোন ক্ষতি হবে না। তবে ১৮.৫০ কিমি পাইপলাইনের জন্য কিছু গাছের উপর প্রভাব পড়বে যা বাংলাদেশ সরকার উল্লিখিত লিষ্টিভুক্ত বহির্ভূত। উদাহরণ, উক্ত প্রকল্পের কারণে কোন প্রানি বা সর্বত্রকারে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব পড়বে না।

- **ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ**
  - উল্লিখিত ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়নের ফলে বায়ু দূষণ, শব্দ দূষণ, মৃত্তী দূষণ, পানি দূষণ অথবা পানির কোন অভাব দেখা দেবে না। উক্ত ২৯ কিমি ২৩০ কেভি লাইন কোন প্রানি, কৃষি জমি এবং নদীসহ সার্বিকভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব ফেলবে না।

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (আর্থসামাজিক প্রভাব বিশ্লেষণ)

- গ্যাস ও তেল ভিত্তিক ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ প্রকল্প স্থাপনের জন্য খুলনা সরকারি সিটিকলিজি মিলের পরিত্যক্ত ৫০ একর জমি দেয়া হয়েছে। উক্ত এলাকায় পরিত্যক্ত মিলের ৩৫টি পরিবার স্থানান্তরিত হওয়ার কারণে অর্থনৈতিকভাবে প্রভাবিত হবে। অত্র জরিপে প্রকল্প এলাকায় কোন অধিবাসি ও ঘুকিপূর্ণ পরিবার নেই।
- অত্র প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প এলাকায় বর্তমানে অবস্থিত ০১ টি বাণক উচ্চ বিদ্যালয় ও ০১ টি কলিজা উচ্চ বিদ্যালয় স্থানান্তরিত করা হবে। ২১৫ টি গাছ অধিগ্রহণ হবে।
- গ্যাস ট্রান্সমিশন লাইন (১৮.৫০ কিমি) খুলনা বাস্তা সংলগ্ন সড়ক ও জনপদের জমির উপর স্থাপিত হবে। এ ক্ষেত্রে মূর্তি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে নিকটবর্তী পরিত্যক্ত জায়গায় স্থানান্তরিত করা হবে এবং ৫২৯ টি গাছ অধিগ্রহণ হবে। ২ কিমি লাইন লাইনের ক্ষেত্রে প্রস্তাব লাগের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ী নিকটবর্তী স্থানে স্থানান্তরিত হবে ও ৪০ টি গাছ অধিগ্রহণ হবে। উল্লেখ্য কোন স্থাপনা অধিগ্রহণ হবে না।
- ২৯ কিমি ওভারহেড ট্রান্সমিশন লাইন প্রকল্প কৃষি জমি, নদী এবং কিছু বাড়ী, সামাজিক প্রতিষ্ঠানের উপর দিয়ে যাবে তবে কোন প্রত্নতাত্ত্বিক এবং ঐতিহাসিক স্থাপনার উপর দিয়ে যাবে না। উল্লিখিত প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবার স্থায়ীভাবে অধিগ্রহণ হবে যার মধ্যে ০৫ টি পরিবারের ঘানকরাত্মীয় অধিগ্রহণ হবে এবং অধিগ্রহণের মধ্যে ০২ টি পরিবার ঘুকিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে পশু ও ০১ টি মাছের ঘের সার্বিকভাবে অধিগ্রহণ হবে।

- **বায়ু দূষণ মোকাবেলায় করণীয়:**

  - Advance Dry Low NOx Burner যা বায়ুর একরকম দূষণ (NOx)-কে নিয়ন্ত্রণ করবে।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা বায়ু দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - প্রধান ও বাইপাস চিমনীর উচ্চতা যথাক্রমে ন্যূনতম ৬০ মি. ও ৫০ মি. হতে হবে যাতে প্লান্ট নিঃসরিত ধোঁয়া আকাশে মিলিয়ে যায় এবং পরিবেশের উপর ক্ষতিকর প্রভাব না ফেলে।

- **পানি দূষণ মোকাবেলায় করণীয় :**

  - কুলিং টাওয়ারের কারণে কোন প্রকার গরম পানি নদীতে পড়বে না।
  - প্লান্ট হতে নির্গত পানি যথাযথ পরীক্ষা-নিরীক্ষার পর পুনঃব্যবহার করা হবে।তা পরিবেশের উপর কোন ক্ষতিকর প্রভাব ফেলবে না।
  - তেল ও গ্রীজ পানি থেকে আলাদা করণের জন্য সেন্ট্রিফিউগাল যন্ত্রের ব্যবহারের ব্যবস্থা রাখা হয়েছে। আলাদাকৃত তেল এলাকার ক্রেতাদের কাছে বিক্রি করা হবে।
  - বিদ্যুৎকেন্দ্র থেকে নিঃসরিত তরল আধুনিক বর্জ্য ব্যবস্থাপনার (ETP) মাধ্যমে পরিশুদ্ধ করা হবে। ফলে নদীর মাছ ও পানির তেমন কোন ক্ষতি হবে না।
  - প্রস্তাবিত বিদ্যুৎকেন্দ্রে পয়ঃনিস্কাশন ব্যবস্থাপনারও সুবিধা থাকবে।

- **পানি উত্তোলন সীমিতকরণ ব্যবস্থা:**

  - প্রকল্প চালু অবস্থায় ভৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তোলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
  - উপরন্তু, শর্ত অনুসারে প্রকল্প চালু রাখার জন্য কখনই ভূ-গর্ভস্থ পানি উত্তোলন করা হবে না।
  - উক্ত বিদ্যুৎ কেন্দ্রে বসবাসকৃত জনসাধারনের খাবার পানির জন্য খুলনা ওয়াসা কতৃক পাইপ লাইন দ্বারা সরবরাহকৃত পানি ব্যবহার করা হবে।

- **শব্দ দূষণ মোকাবেলায় করণীয়:**

  - আধুনিক প্রযুক্তি সম্বলিত মেশিনারী স্থাপন করা।
  - ঘূর্ণন মেশিনারীর জন্য শব্দ দূষণ প্রতিরোধী হুড বা ঢাকনার ব্যবস্থা করা।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা শব্দ দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - শব্দ দূষণ কমানোর জন্য প্রয়োজনীয় স্থানে স্তর ভিত্তিক দেশীয় জাতের গাছ লাগানো।
  - ঘূর্ণন মেশিনারীর ভিতরে যারা কাজ করবে তাদেরকে অবশ্যই পিপিই (PPE) যেমন: ইয়ার প্লাগ, মাফলার ইত্যাদি পরতে হবে।
  - ধোঁয়া বের হওয়ার পথে চিমনীতে সাইলেন্সার লাগানো।
  - শব্দ প্রশমনীয় দেয়াল নির্মাণ করা।

- **কম্পন মোকাবেলায় করণীয়:**

  - শীম (প্রতি ১/১০০০ ইঞ্চি) প্রযুক্তির ব্যবহার করা।

- **পরিবেশ ও জলজ প্রাণি ব্যবস্থাপনায় করণীয়:**

  - প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ কেন্দ্র হতে নিঃসৃত সকল তরল বর্জ্য ও পয়ঃনিস্কাশন যথাক্রমে ইটিপি (ETP) ও এসটিপি (STP) এর মাধ্যমে পরিশোধিত করে যথোপযুক্ত বাংলাদেশ বিধি ও আইএফসি (IFC) গাইডলাইনের গ্রহণযোগ্য সীমার মধ্যে রাখা হবে যাতে জলজিব সহ পরিবেশ ও জীববৈচিত্র দূষণের প্রভাব মুক্ত থাকে।

- গ্যাস লাইন ও OHT line এর ক্ষেত্রে প্রকল্প এলাকার কর্মচারীদের বাসস্থানের পয়ঃনিষ্কাশন পরিশোধনের মাধ্যমে বাংলাদেশ বিধির (ECR,1997) গ্রহণযোগ্য সীমার মধ্যে রাখা হবে।
- অত্র প্রকল্প চালু অবস্থায় EMP সংশ্লিষ্ট পর্যবেক্ষণ ব্যবস্থা নিয়মিত বলবৎ থাকবে এবং উক্ত পর্যবেক্ষণ এর আওতায় প্রকল্প এলাকার পরিবেশ ও জীববৈচিত্রের (জলজিব সহ) এর উপর নিরীক্ষা করা হবে এবং প্রয়োজনীয় প্রশমন পরিকল্পনা অনুযায়ী ব্যবস্থা নেয়া হবে।

✓ **আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা**

- ***৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - অত্র প্রকল্পটি বাস্তবায়নের জন্য উল্লিখিত খুলনা সরকারি নিউজপ্রিন্ট মিলের পরিত্যাক্ত ৫০ একর জমি সরকারি প্রথা অনুসারে নির্ধারিত মূল্য পরিশোধ সাপেক্ষে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লি: এর অনুকূলে বরাদ্দ দেয়া হয়েছে।
  - অত্র প্রস্তাবিত প্রকল্প এলাকায় উল্লিখিত ০২ টি বিদ্যালয় (০১ টি বালক ও ০১ টি বালিকা) পরিত্যাক্ত পেপার মিলের অবশিষ্ট (৩৭.৬০ একর) জমির উপর পুনর্নির্মিত হবে যা পাওয়ার প্লান্টের সীমানার বাইরে অবস্থিত। এবং উক্ত বিদ্যালয় দুটিতে উন্নয়নের পাশাপাশি ইমারতসহ প্রয়োজনীয় আধুনিক সুযোগ সুবিধা যথা: কম্পিউটার ল্যাব, বিজ্ঞানাগার, পাঠাগার, খেলার মাঠ, সুপেয় পানি,শৌচাগার, ইত্যাদির সুব্যবস্থা থাকবে।
  - উক্ত এলাকায় পরিত্যাক্ত মিলের ০৫টি স্থানান্তরিত পরিবারকে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লি: কতৃক ক্ষতিপূরণ দেয়া হবে।
  - উক্ত প্রকল্প এলাকা সংলগ্ন মসজিদ ও কবরস্থানের সংস্কার করা হবে এবং প্রকল্পসহ সর্বসাধারনের ব্যবহারের জন্য ব্যবস্থা থাকবে।

- ***গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত সড়ক ও জনপথের জমির উপর অনুমতি সাপেক্ষে স্থাপিত হবে। উক্ত প্রকল্পে মুড়ি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে অর্থনৈতিক ক্ষতির জন্য ক্ষতিপূরণ প্রদান করা হবে। এছাড়া ৩২৬ টি গাছের ক্ষতিপূরণ প্রদান করা হবে । উপরন্তু, ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ীকে অর্থনৈতিক ক্ষতিপূরণ ও ৪০ টি গাছের জন্য ক্ষতিপূরণ দেয়া হবে।

- ***ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - অত্র প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ৩৭ টি পরিবারকে ক্ষতিপূরণ দেয়া হবে যারা স্থায়ীভাবে ক্ষতিগ্রস্থ হবে এবং এদের মধ্যে ০২টি পরিবার ঝুকিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে শস্য ও ০১ টি মাছের ঘেরের সাময়িকভাবে ক্ষতির ক্ষতিপূরণ দেয়া হবে।

সারসংক্ষেপ

- ❖ প্রকল্পের পরিবেশগত প্রভাব প্রশমনের সুপারিশসমূহ যথাযথভাবে বাস্তবায়ন করা।
- ❖ প্রকল্পের আর্থ-সামাজিকসুপারিশসমূহ, সরকারি ও উন্নয়নযোগ্য উদাহরণ/অনুশীলন বাস্তবায়ন করা।
- ❖ যথাযথভাবে পরিবেশগত নিরীক্ষণ কার্যক্রম পরিচালনা করা এবং প্রয়োজনীয় পদক্ষেপ গ্রহন করা।
- ❖ আর্থ-সামাজিক বিষয় সংক্রান্ত অভিযোগ ও অসন্তুষ্ট লিপিবদ্ধ করা ও তা প্রশমনের ব্যবস্থা নেয়া।
- ❖ আমরা প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক বিষয়ের উপর আপনার সুচিন্তিত মতামত/বক্তব্য গ্রহণ করবো যা EIA প্রতিবেদনে লিপিবদ্ধ করা হবে।
- ❖ অত্র প্রকল্প চলাকালীন ইএমপি (EMP) সংশ্লিষ্ট বিষয়ের সার্বক্ষণিক পর্যবেক্ষণ ব্যবস্থা বলবৎ থাকবে এবং জলজিব সহ পরিবেশ ও জীববৈচিত্রের জন্য প্রয়োজনীয় টেকসই সংরক্ষণ পরিকল্পনা করা হবে।

Annex 8

Format of Environmental Monitoring Report

Environmental Monitoring Report

{Annual/Semestral} Report
{Month Year}

BAN: Rupsha 800 MW Combined Cycle Power Plant Project

Prepared by the North-West Power Generation Company Limited for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of {Day Month Year})

{The date of the currency equivalents must be within 2 months from the date on the cover.}

Currency unit	–	{currency name in lowercase (Symbol)}
{Symbol}1.00	=	${ }
$1.00	=	{Symbol_____}

ABBREVIATIONS

{AAA}	–	{spell out (capitalize only proper names)}
{BBB}	–	{spell out}
{CCC}	–	{spell out}

WEIGHTS AND MEASURES

{symbol 1 (full name 1)}	–	{Definition 1}
{symbol 2 (full name 2)}	–	{Definition 2}
{symbol 3 (full name 3)}	–	{Definition 3}

GLOSSARY

{Term 1}	–	{Definition 1}
{Term 2}	–	{Definition 2}
{Term 3}	–	{Definition 3}

NOTE

In this report, "$" refers to US dollars.

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Annex 9
Environmental Code of Practice

Introduction

These Environmental Code of Practices (ECPs) are established to address all potential and general construction-related impacts of Component 1 - Rupsha 800 MW CCP. The ECPs are only meant to provide guidelines for best operating practices and environmental management guidelines and are not an absolute thumb rule. Project authorities and contractors can modify and change the code of practice to better suite their organization and to better implement their environmental management system. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project. The list of ECPs prepared for Component 1 is given below.

ECP 1: Waste Management
ECP 2: Hazardous Goods Management
ECP 3: Water Resources Management
ECP 4: Drainage Management
ECP 5: Soil Quality Management
ECP 6: Erosion and Sediment Control
ECP 7: Top Soil Management
ECP 8: Topography and Landscaping
ECP 9: Air Quality Management
ECP 10: Noise and Vibration Management
ECP 11: Protection of Flora
ECP 12: Protection of Fauna
ECP 13: Protection of Fish and Aquatic Ecosystems
ECP 14: Road Transport and Road Traffic Management
ECP 15: Construction Camp Management
ECP 16: Cultural and Religious Issues
ECP 17: Worker Health and Safety
ECP 18: Construction and Operation Phase Security
ECP 19: Demolition of the Structure

Contractors will prepare site specific management plans, namely Construction Environmental Management Plan (CEMP), in compliance with guidelines of funding institutions and the Environmental Conservation Rules of 1997 of Bangladesh and based on the guidance given in the ECPs. The CEMP will form part of the contract documents and will be used as monitoring tool by NWPGCL for compliance. It is mandatory for the main contractors procured directly by NWPGCL to include these ECPs in their subcontracts. Violation of these requirements will be treated as non-compliance leading to corrections or otherwise imposing penalty on the contractors.

ECP 1: Waste Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
General Waste	Soil and water may be polluted due to improper management of wastes from the construction sites.	The Contractor shall • Develop site specific waste management plan for various waste streams (e.g., reusable waste,

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		flammable waste, construction debris, food waste etc.) prior to the commencement of construction works. • Dispose all construction related wastes in the designated disposal sites approved by the Project authority. • Minimize the production of waste materials via 3R (Reduce, Recycle and Reuse) approach. • Segregate all wastes, wherever practical. • Transport wastes in fully covered vehicles to prevent spilling waste along the route. • Train all personnel on waste management practices and procedures. • Provide refuse containers/ bins at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Clean and maintain construction sites • Provide and maintain appropriate facilities for temporary storage of all wastes before being transported for final disposal. • Avoid use of non-biodegradable plastic bag wherever possible.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices.	The Contractor shall • Store chemical wastes in a sealed container. • Label all chemical containers for easy recognition. • Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes/ chemicals appropriately in bunded areas away from water sources. • Maintain and document Material Safety Data Sheets (MSDS) for all hazardous materials/ chemicals on-site during construction period. • Construct concrete or other impermeable hard-stand to prevent

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		seepage of hazardous chemicals/ lube oils in case of any accidental spills. • Keep sufficient stock of absorbents for generally used chemicals or for petrochemicals (e.g., dirt, sawdust, etc.) within the storage area to contain accidental spills.

ECP 2: Hazardous Goods Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Hazardous goods and equipment.	Improper storage and handling of lubricants, chemicals, hazardous goods/materials on-site, wash down of plant and equipment, and potential spills may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and Hazardous Substance Management Plan. • Train the relevant construction personnel in spill control procedures. • Store dangerous goods in bunded areas on top of a sealed plastic sheet away from water sources. • Store all liquid fuels in fully bunded storage containers. • Store and use chemicals in accordance with the information provided in material safety data sheets (MSDS). • Make sure all containers, drums, and tanks that are used for storage are in good condition. • Check the containers regularly for leakage, dents or any other abnormalities. Any container, drum, or tank that is dented, cracked, or rusted should be notified to the supervisors immediately and replaced promptly. • Take all precautionary measures (e.g. hazard labeling, wearing of personal protective equipment (PPEs) etc.) when handling and storing fuels and lubricants, avoiding environmental pollution. • All machinery is to be stored away from any water body, drainage inlets or natural drainage area, where practical. • Transport waste of hazardous/ dangerous goods to an approved waste disposal facility.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		• Avoid washing of plant equipment and vehicle near the drainage inlets. The contractor shall construct a designated pit/bund away from waterways where washing activities may take place. • Keep stock of absorbent and containment material (e.g., absorbent matting, dirt, sawdust, etc.) where hazardous material are used and stored. The contractor shall also ensure the training of staffs of their proper use. • Chemical spills and washouts shall be cleaned up and collected immediately, where safety permits. Disposal of cleanup/ washout materials shall be made on an approved waste disposal facility. • Materials shall be transported by an approved / licensed transporter. • Provide appropriate PPE (protective clothing, safety boots, helmets, masks, gloves, goggles, etc.) to the construction personnel, depending on the materials being handled. • Use materials that are environment friendly and avoid materials that have the potential for contamination.

ECP 3: Water Resources Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Hazardous material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste, and accidental spillage.	The Contractor shall • Follow the management guidelines proposed in ECP 1: Waste Management and ECP 2: Hazardous Goods Management. • Minimize the generation of spoils, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). Steps should be taken to ensure these substances do not enter waterways or storm water systems.
Discharge from	Construction activities,	The Contractor shall

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
construction sites	sewerages from construction sites and work camps may affect the surface water quality. The construction works will modify groundcover and topography, changing the surface water drainage patterns of the area. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, and effect habitat of fish and other aquatic biology.	• Install temporary drainage system (channels and check dams) in areas required for sediment and erosion control and around storage areas for construction materials. • Install temporary sediment lagoons, where appropriate, to capture sediment-laden run-off from work site. • Divert runoff from undisturbed areas around the construction site. • Stockpile materials away from drainage lines. • Prevent all solid and liquid wastes entering waterways by collecting spoils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot. • Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. The contractor shall also ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas, not used for construction activities, with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove dust and sediment. • Water the loose material stockpiles, access roads and bare soils on a required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
Drinking water	Untreated surface water is not suitable for drinking	The Contractor Shall • Provide drinking water that meets

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	purposes due to presence of suspended solids and *E. coli*.	National and WHO Drinking Water standards.

ECP 4: Drainage Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities may harm environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare drainage management procedures. • Prepare a program to prevent standing waters, which the project proponent will verify in advance and confirm during implementation. • Provide alternative drainage for rainwater if the construction works/ earth-fillings cut the established drainage line. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. • Rehabilitate road drainage structures immediately if damaged. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. • Ensure wastewater quality conforms to National Standards, before being discharged into the recipient water bodies. • Ensure that there is no water stagnation at the construction sites and camps. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. • Protect natural slopes of drainage channels to ensure adequate storm water drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.
Ponding of	Health hazards due to	• Do not allow ponding of water

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
water	mosquito (vector) breeding.	especially near the waste storage areas and construction camps. • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals might contaminate the soils.	The Contractor shall • Strictly maintain the waste management plans proposed in **ECP 1: Waste Management** and **ECP 2: Hazardous Goods Management**. • Construct appropriate spill containment facilities for all fuel storage areas. • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. • Train personnel and implement safe work practices for minimizing the risk of spillage. • Identify the cause of contamination and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site. • Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils.	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible to erosion of top soils, which affects the growth of vegetation and causes ecological imbalance.	The Contractor shall • Prepare site specific erosion and sediment control measures and submit them for supervision consultant for approval. • Reinstate and protect cleared areas as

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		soon as possible. • Cover unused area of disturbed or exposed surfaces immediately with mulch /grass turf/ tree plantations.
Construction activities and material stockpiles	The impacts of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream and silt accumulation and (ii) destruction of aquatic environment by erosion and/or deposition of sediment damaging the spawning grounds of fish.	The Contractor shall • Relocate stockpiles away from drainage lines. • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds. • Remove debris from drainage paths and sediment control structures. • Cover the loose sediments of construction material and water them if required. • Divert natural runoff around construction areas prior to any site disturbance. • Install protective measures on site prior to construction, for example, sediment traps. • Install 'cut off drains' on large cut/fill batter slopes to control water runoff speed and hence erosion. • Observe the performance of drainage structures and erosion controls during rain and modify as required.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas, not used for construction activities, with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on a required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).

ECP 7: Top Soil Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Land clearing	The top portion of soil is	The Contractor shall

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
and earth works	generally enriched with plant growth essential nutrient. Earth work might degrade the fertile top soil.	• Top soil removal from project site might not exceed 35 cm and store in stoke piles height not exceed 2 m. • The stockpiles should be done in slops of 2:1, so that, rate of surface runoff reduces and percolation rate increases. • Removed top soil should be stored outside of the core project facilities and drainage line. This soil mass should also be protected from erosion. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. • Construct diversion channels and silt fences around the top-soil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physic-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. • Prior to the re-spreading of topsoil, the ground surface should be ripped to assist the bunding of the soil layers, water penetration and re-vegetation.
Transport	Vehicular movement outside ROW or temporary access roads might affect the soil fertility of the agricultural lands.	• All kind of unnecessary vehicular movement should be restricted within the construction facility. • Limit equipment and vehicular movements to within the approved construction zone. • Planed construction for road alignment should be maintained from the beginning to minimize the loss of top soil. • Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural	The Contractor shall • Prepare landscaping and plantation plan and submit the plan to supervision consultant for approval.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	rainwater/flood water drainage as well as change the local landscape.	• Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water. • Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and better landscaping. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Air Quality Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Prepare air quality management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant approval. • Fit vehicles with suitable exhaust systems and emission control devices. Keep these devices in better working condition. • Function the vehicles in a fuel productive way. • Cover pulling vehicles conveying dusty materials moving outside the development site. • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. • Control the movement of construction traffic. • Water construction materials prior to loading and transport.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		• Service all vehicles regularly to minimize emissions. • Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit hardware with suitable fumes frameworks and discharge control devices. Keep up these devices in great working condition as per the details characterized by their makers to amplify ignition productivity and limit the contaminant discharges. Verification of support enlist should be required by the hardware providers and temporary workers/sub-contractors. Pay special consideration to manage emissions from fuel generators. • Machinery causing over the top contamination (e.g., unmistakable smoke) will be restricted from development destinations. • Service all equipment regularly to minimize emissions. • Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages, including unloading, collection, aggregate handling, cement application, circulation of trucks and machinery inside the installations.
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard, and also can affect the adjacent water bodies.	The Contractor shall • Water the material stockpiles, access roads and bare soils as needed basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. • Minimize the extent and period of exposure of the bare surfaces. • Restore disturbed areas as soon as practicable by grasses or trees. • Store the cement in silos and minimize

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust generation is minimized during such operations. • Use water as dust suppression in such way that will never produce any liquid waste stream. • Crushing of rock and aggregate materials shall be wet-crushed, or performed with particle emission control systems. • Not permit on burning of solid waste.

ECP 10: Noise and Vibration Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic.	The Contractor shall • Prepare a noise and vibration management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant/Owner's Engineer (OE) for approval. • Keep up all vehicles to keep it in great working condition as per produces support strategies. • Ensure all drivers will conform to the activity codes concerning most extreme speed restrain, driving hours, and so on. • Perform the loading and unloading of trucks, and handling operations minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately organize all noise generating activities to avoid noise pollution to local residents. • Utilize the calmest accessible hardware and gear in development work. • Maintain all equipment in order to keep them in good working order in accordance with manufactures maintenance procedures. Equipment

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic fenced in areas around generators to decrease noise levels. • Fit high productivity suppressors to fitting development hardware. • Avoid superfluous utilization of alerts, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify nearby landholders preceding normal noise events outside of light hours. • The operator should be educated about the construction equipments and technique to reduce noise level. • Employ best accessible work practice nearby to limit work related noise levels. • Install temporary noise control barriers where appropriate. • Notify affected people if major noisy activities will be undertaken, e.g. blasting. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and consider noise and vibration come about and modify development practices as required. Avoid undertaking the noisiest exercises, where conceivable, when working during the evening close to the neighborhoods.

ECP 11: Protection of Flora

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Vegetation clearance for site preparation	Clearance of vegetation for materials storing, labour shed construction and all kind of civil structures construction.	The Contractor shall • Prepare a plan of vegetation clearance supervised by experienced botanist. • Use comparatively barren places for storing/ labour shed to minimize vegetation damage. • Clear only the vegetation that needs to be cleared in accordance with the engineering plans and designs. These measures are applicable to both the

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		construction areas as well as to any associated activities such as sites for storing, labour movement and construction vehicle running. • Aware and train the workers regarding nature protection and the need of avoid vegetation damage during construction. • Implement proper plantation with native species after completion of construction works prior to engaging experienced plantation planner (Landscape ecologist).

ECP 12: Protection of Fauna

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction activities	Damage of wildlife habitat and relocation wildlife from the construction site due to vegetation damage and demolition of physical structures.	The Contractor shall • Survey faunal communities at first before site clearing and prepare a plan for protection of fauna supervised by experienced consultant. • Use comparatively barren places for storing/ labour shed to minimize vegetation damage. • Limit the construction works within the designated sites allocated to the contractors. • Check the site for trapped animals, rescue them by the help of a qualified person and release them in nearer protected area. • Appoint wildlife biologist and wildlife capture and relocation experts. • Demolish buildings one after another in order to save natural relocation of wildlife.
Night time lighting	Disturbance to nocturnal animals for excess lightening at the site.	The Contractor shall • Use lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution. • Avoid floodlights unless they are required. • Use motion sensitive lighting to minimize unneeded lighting. • Install light shades or plan the direction of lights to reduce light spilling outside

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		the construction area. • Avoid working in night time.
Excess level noise	Scaring wildlife like dolphins, birds and rodents due excess noise.	The Contractor shall • Use sound limiter with gas stacks. • Implement green belt with dense canopy plants surround the proposed power unit.

ECP 13: Protection of Fish and Aquatic Ecosystems

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Movement of vessels	Deterioration of aquatic habitat quality of nearby river channel due to disposal of waste like ballast and bilge water.	The contractor shall • Warn the vessel sailors about spillage in the river. • Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water. • Prepare an emergency oil spill containment plan (under the Hazardous Substances Management Plan).
Accidental discharge of hazardous effluents and hot water	Aquatic dolphins/fishes may be affected and habitat quality may deteriorate.	The Contractor shall • Follow mitigation measures proposed ECP 3: Water Resources Management and ECP 4: Drainage Management.

ECP 14: Road Transport and Road Traffic Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction vehicular traffic	Increased traffic may affect the safety of the road-users and obstruct their daily movement.	The Contractor shall • Prepare a traffic management plan and implement them strictly. • Ensure uninterrupted traffic movement during construction and shall include in the traffic plan: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc. • Provide signs at strategic locations of the roads complying with National

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		Traffic Regulations.
	Accidents and spillage of fuels and chemicals.	The Contractor shall • Restrict heavy vehicle movement, where practicable, to day time working hours only. • Restrict the transport of oversized loads. • Enforce on-site speed limit, especially close to the sensitive receptors, schools, health centers, etc.

ECP 15: Construction Camp Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Set-up of construction camps	Health, safety and security of workers might be affected due to the set-up of construction camps.	The Contractor shall • Prepare a construction camp management plan. • Set-up camps within the designated sites or at areas which are acceptable from environmental, cultural or social point of view and approved by the supervision consultant/OE or the Client. • Conduct consultation with communities including local government institutes bodies prior to set-up/ construction of the camp. • Submit a detailed layout plan to the project authorities for approval in order to develop the construction camp, which should include relative locations of all temporary buildings and facilities along with the location of access roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities. • Inform local authorities the setup of camp facilities so as to maintain effective surveillance over public health, social, and security matters.
Provision of construction camp facilities	Lack of basic facilities, such as housing, water supply, and sanitation facilities may lead to substandard living conditions and possible health hazards.	Contractor shall provide the following facilities in the campsites • Adequate housing for all workers. • Safe and reliable drinking water supply, conforming to national and

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		international (e.g. WHO) standards. • Hygienic sanitary facilities and sewerage system. • Separate toilet facilities for males and females. The minimum number of toilet facilities required is one toilet for every ten persons as per Labour Rules, 2015. • Treatment facilities for sewerage of toilet and domestic wastes. • Storm water drainage facilities. • Paved internal roads. • . • In-house community/ common entertainment facilities.
Disposal of waste	Waste run-off to nearby water sources, leading to pollution	The Contractor shall • Ensure solid wastes are properly collected and disposed of within the construction camps. • Ensure waste segregation at source. Wastes should be segregated on separate color-coded bins as per national waste management laws/ rules. • Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipment/vehicles needed.
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna.	The Contractor shall • Provide alternative fuels like natural gas or kerosene to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Conduct awareness campaigns to educate workers on preserving the protection of biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	Spreading of vector borne diseases such as, malaria, due to inadequate health and safety practices.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	Risk of spreading of sexually transmitted diseases (STD), such as HIV/AIDS.	clock. • Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. • Provide ambulance facility for the labours so that they can be transported to nearest hospitals in case of an emergency health hazard. • Conduct health screening of the laborers coming from outside areas. • Train all construction workers about basic sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide awareness on sexually transmitted diseases, such as HIV/ AIDS to all workers on a regular basis. • Provide and maintain adequate drainage facilities throughout the camps to minimize the spread of vector borne diseases. The contractor shall also regularly spray mosquito repellant during rainy season in offices, construction camps and yards. • Provide awareness drives and training on personal hygiene and waste disposal.
Security and Safety	Inadequate security and safety provision in construction camps may create security and safety problems of workforces and assets.	The Contractor shall • Provide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry into the camp area. • Maintain register to keep a track of entry and exit of people within the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of firefighting equipment suitable for the construction camps. • Display emergency contact numbers clearly and prominently at strategic places in camps.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		• Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Demolition of construction camps may lead to dust emission, elevated noise levels and possible health hazard.	The Contractor shall • Dismantle and remove all the established facilities from the site of the construction camp ensuring minimum dusts emission. Wet spray grounds to minimize dust emission. • Dismantle camps in phases instead of waiting for the entire work to be completed. • Provide prior notice to the laborers before demolishing their camps/units. • Maintain the noise levels within the national standards during demolition activities. • Hire different contractors to demolish different structures to promote recycling or reuse of demolished material. • Dispose excess debris at the designated waste disposal site. • Restore the site to its condition prior to commencement of the works.

ECP 16: Cultural and Religious Issues

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites leading to annoyances. Contractors lack of knowledge on cultural issues leading to social disturbances.	The Contractor shall • Avoid activities that may lead to the blocking of access to cultural and religious sites. • Avoid construction works during prayer time. • Avoid working in areas where there is any church/mosque/religious/ educational institutions and health centers close to the construction sites, if possible. Project proponent should issue warning to the people before commencing construction activities. • Establish a mechanism that allows local people to raise grievances arising from the construction process.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		• Provide compensations or relocate, whichever is best, if any grievances are raised by the community where any culturally important areas are to be demolished. • Take special care and use appropriate equipment when working next to a cultural/ religious center. • Stop work immediately and notify the site manager, if during construction, an archaeological or burial site is discovered. • Provide independent prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people. • Allow the workers to participate in praying during construction time, if there is a request. • Resolve cultural issues in consultation with local leaders and supervision consultants. • Inform the local authorities before commencement of civil works so as to maintain effective surveillance over public health, social, and security matters.

ECP 17: Worker Health and Safety

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction work at Plant site	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g., noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases, etc.), (ii)	The Contractor shall • Prepare an Occupational Health and Safety and Hazard and Risk Assessment plan. • Implement suitable safety standards for all workers and site visitors, with sufficient provisions to comply with international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; International Finance Corporation/World Bank Group Environmental, Health, and Safety General Guidelines') and contractor's

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	risk factors resulting from human behavior (e.g., STD, HIV/AIDS, etc.) and (iii) road accidents from construction traffic.	own safety standards, in addition to complying with national standards. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Conduct tool box meeting before starting any construction related work. Maintain a registry of the person present during the toolbox meeting. Anyone not participating in the tool box meeting will not be allowed to work. • Provide personal protective equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing the damaged ones. • Implement safety procedures including provision of training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Inform the local authorities before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.
	Child and pregnant labor.	The Contractor shall • Not hire children of less than 18 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims.	The Contractor shall • Ensure health care facilities and first aid facilities are readily available. • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.
Provision of construction camp facilities	Lack of basic facilities, such as housing, water supply, and sanitation facilities may lead to substandard living conditions and possible health hazards.	The Contractor shall provide facilities in the camp sites to improve health and hygienic conditions as mentioned in ECP 16: Construction Camp Management.
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce may make them susceptible to potential diseases.	The Contractor shall • Train all construction workers in basic sanitation and healthcare issues (e.g., protection against malaria and other vector borne diseases, transmission of sexually transmitted infections (STI) etc. • Train all construction workers in general health and safety practices and about specific hazards related to their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled workforces, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.

ECP 18: Construction and Operation Phase Security

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction work	Inadequate construction site security poses a significant risk to assets, construction materials and property. Theft/ vandalism of assets, materials and property may increase construction costs and may cause delays in project completion.	The Contractor shall: • Provide appropriate security personnel (i.e. security guards) to prevent unauthorized entry into the camp area. • Ensure all assets (i.e., tools, equipment, etc.) and construction materials at construction site are identified, recorded and tracked as closely as possible. All assets should be clearly labeled and marked. Keep records of tool serial numbers and check inventory on a regular basis. • All tools and equipment should have a check out/in system. If they are not in use, they should be securely stored in a proper place to prevent theft or loss. • Ensure that there is proper fencing around construction site perimeter. Fencing should be chain-link at least 2.4 m high and secured with a steel chain and lock. • The entire site should be fenced, if possible. If not, at least the construction trailer and equipment storage areas should be fenced. • Ensure construction site has controlled access points (one or two entry points at most), allowing for close monitoring of comings and goings from the site. • Workers should be easily identified and have credentials that indicate site access. • List of employees who have after hour access to the property should be available to the PMU and local authorities. • Ensure job site is properly lighted at night. Well-lit areas should include any office trailers and equipment storage trailers. Floodlights operated by sensors should also be installed where appropriate. • Pre-employment screening

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		investigations should be used to verify the applicants relating to their employment, education and criminal history background.
Operation Phase	Vandalism/damage (including use of explosives) of RMS, Gas Pipeline, Plant transfer station and storages.	• Routinely conduct patrols and inspections of transmission mains Plant area and facilities. • Monitor suspicious activity and notify local authorities and NWPGCL in event of any such occurrence/incident of vandalism or theft. • Ensure strategic infrastructure sites such as RMS, Gas Pipelines, and main Plant transfer stations, storages are secured and fenced with controlled access points. Fencing should be chain-link at least 2.4m high and secured with a steel chain and lock.

ECP 19: Demolition of Structures

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Demolition of structures	Rubbles and dust raised from the demolition/ decommissioning of structures may affect the surrounding environment (air, water resources, landscape, agricultural lands etc.), flora, fauna and health of the surrounding communities.	The Contractor shall: • Provide appropriate demolition/ decommissioning plan. • Inform nearby communities 5 days prior to the start of any demolition/ decommissioning activities. • Conduct thorough investigation of site and site history to identify potential risks and hazards to workers, local people and the environment. • Use of techniques to minimize compaction of soil. If necessary, soil should be carefully removed and stored for subsequent works. • Use dust control strategies (e.g. wet technique). • Set the route and time of movement of heavy trucks carrying demolition debris off site for disposal so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes). • Avoid building of access roads near

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		riparian zones. • Implement adequate site security • Recover, reuse and recycle salvaged materials, whenever possible. • Install and implement appropriate water management system as early as possible. Effectively stabilize altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids. • Incorporate existing habitat features into site design and protect them from any adverse change. • Preserve sites of archaeological or cultural interest where possible. If not, relocation should be considered where damage is unavoidable. • Implement management system that should aim to minimize disturbance to adjacent residential and recreational areas.

Annex 10

Fauna Rescue and Handling Procedures
Component 1 – 800 MW Rupsha CCPP

1.0 Introduction

1. The following outlines the actions and measures that will be undertaken in the event of an accidental encounter with a threatened fauna during the construction phase of Component 1. This chance find procedures will be finalized in consultation with among others, IUCN Bangladesh, Bangladesh Wildlife Advisory Board, Forest Department (DoF), and DoE to ensure compliance with applicable regulations.

2. These procedures will be included in the Construction Management Plan that will be required by Project Management Unit (PMU), NWPGCL from the EPC Contractor and will be an integral part of the bid documents. NWPGCL will ensure compliance of this ADB requirement. These procedures aim to identify and promote the protection and recording of threatened fauna that may be encountered during the site preparation and construction activities.

2.0 Scope

3. This will be applicable to construction activities by workers or personnel who may have the potential to encounter or contact with threatened species from the construction activities for Component 1.

3.0 Orientation of Workers

4. The EPC Contractor, with the assistance from relevant authorities of GoB such as DoE and DOF, will conduct an orientation of all workers, particularly those who will be involved in the site preparation for Component 1, on how to recognize and identify the potential threatened species that may be encountered including the appropriate actions to be done. The orientation will be done prior to construction works and during the regular toolbox talks/meetings.

5. Clear pictures of the threatened species, with sightings in the project site, including a brief description of their habitats will be posted at strategic locations within the construction site (about 50 acres or 20.23 hectares). This will help workers and staff in creating awareness and familiarity with the species. These pictures will be part of the references on-site to guide construction supervision staff. Local people recruited during pre-construction and construction phase may be familiar with these species and can provide assistance with their local knowledge and experience.

4.0 Procedures

6. The environmental staff (or consultant) of EPC Contractor together with the environmental staff of PMU, NWPGCL will be responsible for implementing these procedures. ADB will monitor compliance of NWPGCL.

7. Table 4.1 lists the species of conservation status according to IUCN Bangladesh 2015. The EPC Contractor will post the pictures of these species to assist the workers in identifying them.

Table 4: List of species of conservation status

English Name	Scientific Name	Bangladesh Wildlife (Preservation) Order 1973	IUCN Bangladesh Status (2015)	IUCN Global Status	Distribution	
					Project Site	Study area
Mammals						
Fishing Cat	*Prionailurus viverrinus*	Third Schedule[1] [1]Protected animals not to be hunted, killed, or captured	Endangered	Vulnerable	Temporary visitor but core habitat is within the study area outside project site	Yes
Smooth-coated Otter	*Lutrogale perspicillata*	Third Schedule	Vulnerable	Critically Endangered	No	Yes
Ganges River Dolphin	*Platanista gangetica*	Third Schedule	Vulnerable	Endangered	No	Yes
Small Indian Civet	*Viverricula indica*	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Jungle Cat	*Felis chaus*	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Birds						
Black headed Ibis	*Threskiornis melanocephalus*	---	Vulnerable	Near Threatened	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Reptiles						
Water Monitor	*Varanus salvator*	Third Schedule	Vulnerable	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Bengal Monitor	*Varanus bengalensis*	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Black Krait	*Bungarus niger*	---	Near Threatened	Not Assessed	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Monocled Cobra	*Naja kaouthia*	---	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Indian Cobra	*Naja naja*	---	Near Threatened	Not Assessed	Reported by Interviewee as	Yes

English Name	Scientific Name	Bangladesh Wildlife (Preservation) Order 1973	IUCN Bangladesh Status (2015)	IUCN Global Status	Distribution	
					Project Site	Study area
					temporarily found as visitor for hunting of preys	
Floral species						
West Indian Mahogany	*Swietenia mahagoni*	---	Not Assessed	Endangered	Cultivated species in Bangladesh and non-native in Bangladesh and also not listed in the IUCN Red list of Bangladesh	Yes

Source: CEGIS field survey from 29-30 October 2016 and secondary information from IUCN (2015)

8. In the event a threatened species is encountered or discovered during construction activities, the following steps will be done:

a) Stop the work within the vicinity of the species and immediately notify the environmental staff (or consultant) of the EPC Contractor and the construction supervision staff or site engineer.

b) The environmental staff will assess the impacts; identify the species, and the appropriate management measures such as relocation. The location where the species was encountered will be identified using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken.

c) The construction supervision staff will secure the approval of the environmental staff of PMU, NWPGCL (in consultation with relevant agencies of GoB) before resuming the construction works.

d) Construction works will resume as soon as the environmental staff (from EPC Contractor and PMU, NWPGCL) has done the following actions:

- Secured the approval/permit (if required)
- Corrective actions and/or management measures identified
- Complete the rescue event record/report to include: date and time the species was found, location, type of fauna (e.g., snake, fish, turtle, etc.) and species name, actions taken (e.g., treated by fauna specialist, fauna relocated and where, etc.)

9. The EPC Contractor will not be entitled for compensation due to work stoppage as a result of the encounter and the associated subsequent actions.

Final Report

Biodiversity Assessment for Rupsha800 MW Combined-Cycle Power Plant Project

IUCN Bangladesh Country Office February 2018

Final Report

Biodiversity Assessment for Rupsha 800 MW Combined-Cycle Power Plant Project

Submitted to

North-West Power Generation Company Limited (NWPGCL)

Prepared by

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Contents

Executive Summary

IUCN Bangladesh has been awarded a nine-month-long project entitled 'Biodiversity Assessment for Rupsha 800MW Combined-Cycle Power Plant' by North-West Power Generation Company Limited (NWPGCL) to be funded by Asian Development Bank (ADB). The project is designed to conduct dolphin and other related surveys on the project site and vicinity of this power plant to assess possible impacts of this project on aquatic biodiversity and to identify ways to mitigate these impacts. The survey will be conducted in a total of 30 km length along the Bhairab, Atai and Rupsha Rivers and their confluence in different seasons. As per contract the pre-monsoon, monsoon, post-monsoon and comprehensive survey reports were submitted to NWPGCL.

A total of seven surveys were conducted during pre-monsoon (one survey), monsoon (two surveys), post-monsoon (two surveys) and winter (two surveys). The survey period was May 2017 to January 2018. These results include data on dolphins, other animal presence, fish and fishing gears, fishing areas, physical and chemical water quality parameters, vegetation, plankton and watercrafts from the surveys. Water depth was also measured and pollution sources were also identified.

The survey results show a total of 284 sightings from four surveys (one pre-monsoon, two monsoon and first post-monsoon) of **Ganges River Dolphins**, with overall encounter rate is **1.18**/ **km** including 13.76% calves. The most important area determined from the surveys for dolphins is the confluence of Atai-Bhairab-Rupsha Rivers where feeding behavior was recorded and a large number of calves were seen.

Three surveys (second post-monsoon, first and second winter) were conducted using **the mark-recapture** method and the results of three surveys are used in this report. An average **47** and **34** dolphins were calculated for the project area by using the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' and the 'Huggins Conditional Likelihood Model', respectively.

In the second winter survey, a group of four Irrawaddy Dolphin was recorded from the project site opportunistically. This species is considered globally Endangered and nationally Near Threatened.

Critical Habitat Analysis was done following the IFC guidelines and using the dolphin number as **34** from the mark-recapture method. The results of the analysis indicate that the project site is not a Critical Habitat for Ganges River Dolphins under any criteria of the guidelines.

Long term continuous **monitoring** of the project area is needed to understand the effects of construction of the power plant especially in the important dolphin areas that were identified.

Other wildlife includes a total of 41 species of birds and four other wildlife species were recorded during the survey period.

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Watercrafts were also counted during the survey period. A total of 676 watercrafts comprised of mechanized and non- mechanized were recorded. The highest was mechanized boats with a total of 373. Rupsha River had the highest number of water vessels with a total of 253.

Fishing gears and fish species were counted during the surveys. A total of 19 types of fishing gears was identified along transects. A total of 50 fish species was also recorded based on direct field visit and questionnaire survey, out of which ten are nationally threatened. **Water depth** readings were recorded and presented in this report. The depth was measured in every 1 km using an echo sounder.

A total of 117 individuals of 29 species of **vegetations** were enumerated from six sample plots. *Syzygiumcumini L*. (Jam), *Areca catechu L*. (Supari), *Cocosnucifera L*. (Narkel), *LanneacoromandelicaMerr*. (Jial) and *Mangiferaindica L*. (Aam) are the five most abundant species in the study area.

Water quality parameters were tested to measure the concentration of different pollutants among the listed areas and illustrated the difference between two seasons. Furthermore, 15 genera of **phytoplankton** and two unknown genera of **zooplankton** were found in the study sites.

Additionally this report includes **the potential impact and mitigation** measures as well as some recommendations.

1. Introduction

An 800 MW combined-cycle power plant is proposed to be built in Khalishpur Thana, Khulna District along the Bhairab River by North-West Power Generation Company Limited (NWPGCL) and is funded by the Asian Development Bank (ADB). A draft Environmental Impact Assessment (EIA) prepared in December 2016 by the Center for Environmental and Geographic Information Services (CEGIS) showed the presence of the Ganges River Dolphin (*Platanista gangetica gangetica*) in the Bhairab River within the immediate vicinity of the proposed power plant site.

Dolphin survey at the Rupsha River, 22 October 2017. ©IUCN/ A.B.M. SarowarAlam

The Ganges River Dolphin is a freshwater dolphin which occurs in all connected rivers and tributaries of Ganges-Brahmaputra-Meghna river system, and Karnaphuli-Sangu river system.[1] In 2012, International Union for Conservation of Nature (IUCN) classified the Ganges River Dolphin as Endangered globally.[2] In Bangladesh, the species is considered as Vulnerable[3]. It is estimated that there are 225 individuals in Sundarbans and 125 in Karnaphuli-Sangu Rivers. There has been no study done on the species in the present study site that is in the Bhairab-Atai-Rupsha river system.

[1]Sinha, Ravindra and KurunthachalamKannan. Ganges River Dolphin: An Overview of Biology, Ecology, and Conservation Status in India. *Ambio.*2014, 43:1029-1046.Royal Swedish Academy of Sciences.
[2] Smith, B.D. and Braulik, G.T. 2012. *Platanistagangetica*. The IUCN Red List of Threatened Species 2012: e.T41758A17355810. http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T41

758A17355810.en. (Accessed 17 August 2017)
[3]Alom, Z.M.2015. (*Platanistagangetica).*In:*IUCN Bangladesh. Red List of Bangladesh*, Volume 2: Mammals, p. 107.

A land-based sighting survey was done in October 2016 in the confluence of the Bhairab and Atai Rivers close to the project site. The survey showed 33 surfing occurrences of the species, out of which 11 were at the confluence and the rest along the Bhairab River. Another line-transect survey was conducted in March 2017.
About 20 km stretch of the Bhairab River from the confluence of Bhairab-Madhumati Rivers (covering 10 km upstream) to the confluence of Bhairab-Atai Rivers until the Rupsha River at Khanjahan Ali Bridge (covering 10 km downstream) was covered. A total of 25 dolphins was recorded from different points of the survey.

The Safeguard Policy Statement 2009 (SPS 2009) of ADB sets out the requirements for environmental safeguard that applies to all the projects considered for financing. Under the SPS 2009, impacts and risks of projects are analyzed within the context of the project's area of influence.

The dolphin population in the proposed power plant project's area has the potential to be significantly impacted by the construction of the power plant. The impacts need to be adequately assessed and mitigated for in accordance with the biodiversity requirements of the SPS 2009. These include specific requirements for projects located within a critical habitat, and thus ensuring no net loss of biodiversity.

In June 2017, IUCN Bangladesh was awarded a nine-month-long project to conduct dolphin and other related surveys in the power plant project sites with the main aim to determine if the project site and vicinity is a critical habitat for dolphins and to identify the potential impact of the power plant on dolphins. A total of seven surveys were conducted from May 2017 to January 2018, where three surveys were done using Mark-recapture method. The results of all the surveys are presented in this report. Alsoincluded in this report are the literature review, survey methodology, Critical Habitat Analysis, important dolphin areas, impact and mitigation, and recommendations.

Surfing of a Irrawaddy Dolphin at the Atai River on 24 January 2018.©IUCN/ Sakib Ahmed

2. Literature Review

Smith *et al.* (1998) referred in a paper called "River Dolphins in Bangladesh: Conservation and the Effects of Water Development" that a vast survey was done in the upstream of the confluence of the Jamuna River and in some sections of downstream of Kushiyara River where 38-68 dolphins were seen in Jamuna river where the sighting rate was 0.13 sightings/km. Also 34-43 dolphins were found in Kushiyara River with a sighting rate 0.08 (sightings/km). The study also included that they found 2 or 3 dolphins during a short visit to Burhiganga River near Dhaka.

Smith *et al.* (2006) in another paper referred that a survey was done in mangrove channels of Sundarbans delta in Bangladesh. The title of the paper was "Abundance of Irrawaddy Dolphins (*Oecaella Brevirostris*) and Ganges River Dolphins (*Platanista Gangetica Gangetica*)" estimated using concurrent counts made by independent teams in waterways of the Sundarbans mangrove forest in Bangladesh". This paper shows that 451 individuals of Irrawaddy Dolphins and 225 individuals of Ganges River Dolphins were found in the survey area.

In addition, a paper named "Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh" written by Smith *et al.* (2009) mentioned that a survey was made in Sundarbans mangrove forest to identify the presence of Ganges River Dolphins and Irrawaddy Dolphins. During low water season survey 62 Ganges River Dolphins were found and the encounter rate was 15.1 individuals/100 km. 236 Irrawaddy Dolphins were detected and the encounter rate was 8.6 individuals/100 km. During high water season survey, 71 individuals of Ganges River Dolphins and 52 individuals of Irrawaddy Dolphins were seen and their encounter rate was 7.0 and 9.6 individuals/100 km respectively.

Smith *et al.* (2010) stated in the paper titled "Identification and channel characteristics of cetacean hotspots in waterways of the eastern Sundarbans mangrove forest, Bangladesh" that a survey was executed in the Eastern Sundarbans Mangrove forest. Six 5-km segments were selected for the survey. From the study it was found that the encounter rate of Ganges River Dolphins was 0.46 (sightings/survey) and the encounter rate of Irrawaddy Dolphins was 0.06 (sightings/survey).

Aziz *et al.* (2014) stated in the paper entitled "Biodiversity in the floodplain Ecosystem of Bera, Santhia and Sujanagar Upazilas of Pabna District in Bangladesh" that a survey was done in the 4 hotspots in the Padma-Jamuna River section. The study found that the estimated population of Ganges River dolphins was between 58-103.

Alom *et al.* (2014) mentioned in "Identification and Ecological Characteristics of Freshwater Dolphin 'Hotspots' in the Sundarbans, Bangladesh", that a survey was done in 6 hotspots and 6 non hotspot segments in the Eastern Sundarbans Reserved Forest. In the hotspot 334 Ganges River Dolphins including 67 calves, 41 Irrawaddy Dolphins and in non hotspot segments 62 Ganges River Dolphins including 18 calves and 17 Irrawaddy Dolphins were found. During dry, pre-monsoon, monsoon and post-monsoon seasons the encounter rate of Ganges River Dolphins in hotspot segments

was 3.0-4.0 individuals/survey and in non hotspot segments was 0.3-1.0 individuals/survey. The study highlighted that the encounter rate of Irrawaddy Dolphins was 0.4 individuals/survey in the hotspots and the encounter rate was 0.2 individuals /survey in the non hotspot segments.

3. Objectives of the Study

The study aims to determine if the stretch of the Bhairab River along the power plant project site and the adjoining rivers at the confluence are a critical habitat to the survival of the Ganges River Dolphins.The study will provide a baseline in understanding of the following:

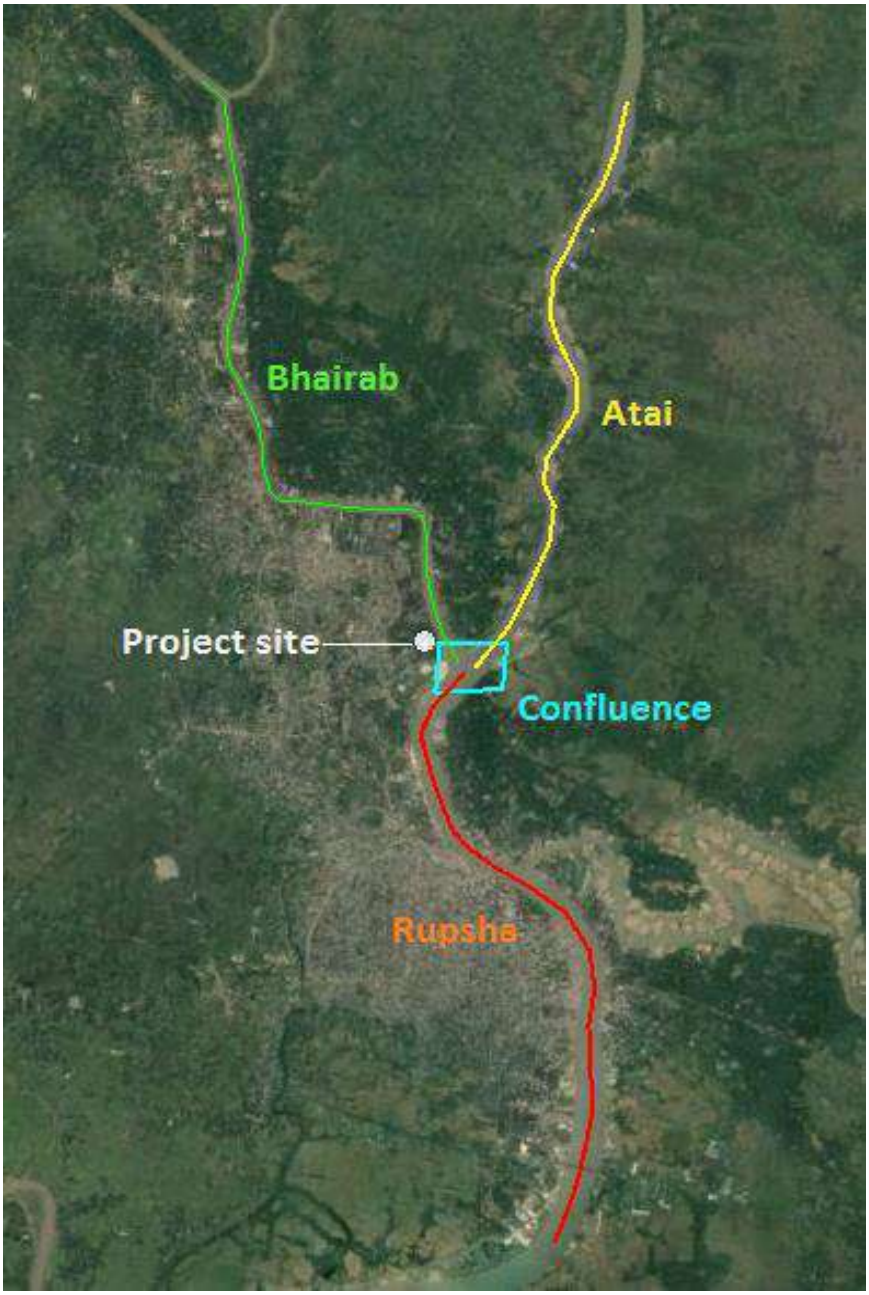
(i) Presence and persistence of Ganges River Dolphins within the 10 km upstream (the Bhairab and Atai Rivers total 20 km) and 10 km downstream (Rupsha River) of the proposed power plant site;
(ii) Ecological requirements of the Ganges River Dolphins prey, and the composition and status of fish and fishing activities co-existing with them;
(iii) Changes in the way the Ganges River Dolphins use the Bhairab, Atai and Rupsha Rivers according to season, water level, water flow, water quality, and nature and extent of human activities such as fishing and navigation; and
(iv) Potential impacts of construction and operation of the proposed power plant operations such as construction of jetty, heavy equipment transport, intake, discharge, etc. to Ganges River Dolphins.

A section of the confluence of the Bhairab, Atai and Rupsha Rivers on 31 May 2017.

4. Study Area

The area to be surveyed (Map 1) will cover the following transects:

- 10 km of the Rupsha River (downstream of the power plant site),
- 10 km of theBhairab River (upstream of the power plant site),
- Confluence of Bhairab-Atai-Rupsha Rivers, and
- 10 km of the Atai River (upstream from the confluence of station).



Map 1: Map of thearea to be surveyed under the present study.

5. Scope of Work

The following activities will be undertaken during the present survey project:

(i) **Dolphin survey**: Conduct dolphin surveys covering seasonal variations to determine habitat use, distribution, abundance, as well as record environmental conditions during the surveys (i.e. overcast, windy, glare);

(ii) **Other wildlife survey**: List species identified along the Bhairab, Atai and RupshaRivers according to its conservation status both from IUCN and national requirements including endemism/range restriction/migration/congregation, if any, and provide inputs to the determination of the presence of any critical habitat;

(iii) **Fish and fisheries resources survey**: Conduct surveys (once per season) on each section of the three rivers to describe and identify the fish and fisheries resources, fishing gears used by the fisher community, map the existing fishing areas, and record fishing practices including daily and seasonal variations;

A boat carrying fishing traps on the Bhairab River, 31 May 2017.

(iv) **Plankton and riparian vegetation survey**: Conduct survey for phytoplankton and zooplankton, and riparian vegetations along transect;

(v) **Watercraft survey**: Separately record the number and type of watercraft users including their movements/directions during the time dolphin surveys are conducted;

(vi) **Water quality analysis**: Conduct river water surveys/sampling and *insitu* water quality measurements (once per season) on each section of river to understand the physico-chemical characteristics of the Bhairab, Atai and RupshaRivers. Water quality parameters will include temperature, pH, salinity, dissolved oxygen, hardness, electrical conductivity, nitrates, phosphates, turbidity, suspended sediment, biological oxygen demand (BOD), chemical oxygen demand (COD), coliforms, and other relevant parameters include water depth and flow direction;

Fishing at the Bhairab River, 23 October 2017. ©IUCN/ A.B.M. Sarowar Alam

(vii) **Pollution mapping**: Identify/map existing sources of river water pollution and identify/map the presence of any meanders, eddies, and hydrogenological complexities;

(viii) **Impact assessment**: Assess potential impacts of proposed power plant activities during construction and operation, such as dredging, heavy equipment transport, withdrawal of river water, discharges, and construction of jetty and intake channel along the Bhairab, Atai and RupshaRivers on aquatic flora and fauna and provide inputs to the determination of whether critical habitat (if any) requirements are met; and

(ix) **Mitigation measure**: Identify mitigation measures and/or conservation management measures for species of conservation status. This may include mitigation measures as a part of the project design or offsets in the project area of influence or further afield to ensure the SPS 2009 requirement of no net loss of biodiversity is met.

6. Methodology and Workplan

This following sectionpresents the detailed methodology of the surveys that will be conducted. In addition, a detailed workplan is also provided showing the timeline of stipulated activities to be carried out during the project period.

6.1 Survey Methodology

6.1.1 Dolphin Survey

The dolphin survey is to be conducted in monsoon, post-monsoon and winter in the study area. A total of six surveys are to be conducted in July, September, October, November, December and February. A pre-monsoon survey has already been facilitated by NWPGCL following the same methodology. The dolphin surveys follow the standard methodology set by Smith *et al.*(2006and 2009)[4]. The first four surveys (pre-monsoon, first and second monsoon and first post-monsoon) were conducted by calculating encounter rate, and the last three surveys (second pre-monsoon, first and second winter) were conducted using Mark-recapture method.

To Analyze Encounter Rate

To conduct the survey, three transects are set (the Bhairab River Transect, the Atai River Transect and the Rupsha River Transect) and each transect is 10 km long. Three observers stand and actively search for dolphins along transects at all times and record sighting data. One observer is stationed on the port and one on starboard side of the vessel. These two observers search with handheld binoculars and naked eye from the beam to about 10˚ past the bow. The third observer stands in the centre and scans with the naked eye in about a 20˚ cone in front of the bow. This observer also keeps records in specialized data sheets. The observers are rotated through the three positions every half an hour. The height from the water level tothe observer is approximately 3 meters. The speed is set to 10 km/hour.

[4]Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B. and Mansur, R. 2006. Abundance of Irrawaddy dolphins (Orcaellabrevirostris) and Ganges river dolphins (*Platanistagangeticagangetica*) estimated using concurrent counts from independent teams in waterways of the Sundarbans mangrove forest in Bangladesh, *Marine Mammal Science* 22(3): 527-547.

Smith, B.D., Braulik, G., Strindberg, S., Mansur, R., Diyan, M.A.A. and Ahmed, B. (2009). Habitat selection of freshwater dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquatic Conservation: Marine and Freshwater Ecosystems, 19, pp. 209-225.

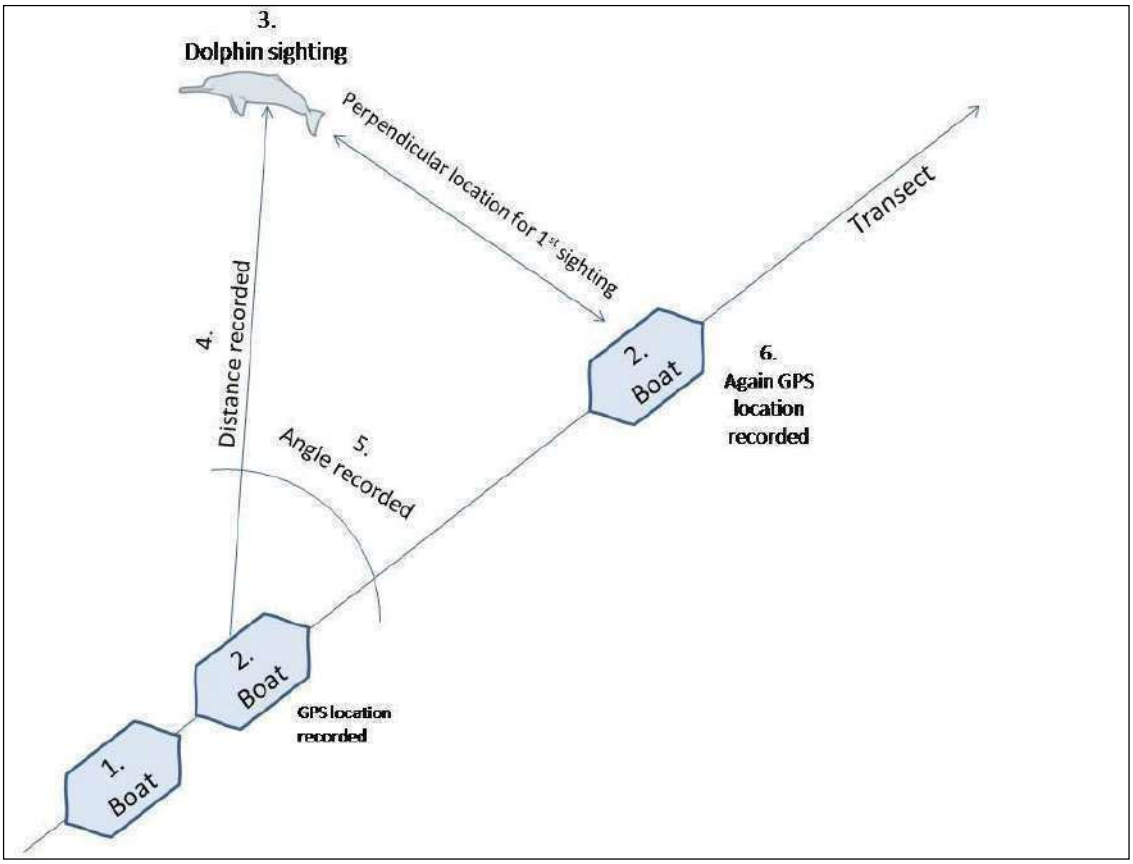


Illustration of the detailed methodology for dolphin survey described in Smith et al.(2006)

Once dolphins are spotted, the GPS coordinates of the exact spot where the animals were seen is recorded. The group size and the age class are then estimated.

To Calculate Population Number using Mark-recapture Method

The detailed methodology is in Appendix 2.

Along with this, weather conditions (wind, glare, and rain/fog) are recorded as well. These factors are given codes of 0, 1, or 2, where '0' corresponds to good (no effect on sighting conditions), '1' corresponds to fair (small effect on sighting conditions), and 2 corresponds to poor (large effect on sighting conditions) conditions, respectively.

6.1.2 Other Wildlife Survey

This survey will be done with the dolphin survey in July, September, October December and January. During the survey, the presence of other wildlife will be recorded along the transect by direct observation or call (for birds).The vessel will cover the transects at 10 km/hour and one observer will survey for other wildlife using binoculars and naked eyes. Furthermore, opportunistic encounters will be recorded as well. Locals will be interviewed for further information on the presence of other species in the area during the survey as well.

 A *fishing boat on the Rupsha River, 31 May 2017.*

6.1.3 Fish and Fishing Gear Survey

This survey will be done three times, in July, October, and November. Fishing communities and fishermen will be targeted for questionnaire surveys to gather information on fish species that are caught in various seasons and types of fishing gear used. Also, direct sampling will be done by visiting fishing boats and collecting data on fish species and fishing gears.

6.1.4 Riparian Vegetation Survey

For determining the riparian vegetation species diversity, quadrate method will be applied. This survey will be done in October. The size of each quadrate will be considered as 2 x 2 meter.The survey will be conducted 500m zone from the proposed power plant. The detailed methodology is in Appendix 11.

Different types of vegetation alongside the Atai River,31 May 2017.

6.1.5 Surface Water Quality Parameters

Water quality samples will be collected and analyzed during monsoon, post-monsoon and winter surveys. The surface water quality parameters are evaluated for physical, chemical, and biological characteristics of aquatic systems in relation to ecological conditions, and designated uses. Before the samples are collected for evaluation, the total area is mapped and ten stations are selected based on the concentration of pollution sources and confluences.

Sample Collection Seasons: Samples will be collected during monsoon, post-monsoon and winter seasons from 10 selected stations to assess the real concentration of different types of pollutants and their spatial distribution.

Sources of pollution at the Rupsha River, 31 May 2017.

Selecting Sample Sites: The first round of water samples will be collected from ten different locations along the entire river course. Spatial information of all sample sites will be collected using a handy GPS to prepare GIS maps. Quality of the river water will be assessed by comparing the selected parameters with the industrial water standard prepared by the Department of Environment (MoEF,1997)[5]. Location information of all the pollution sources as well as water sample collection points should be collected using GPS to develop pollution GIS maps.

Field Measurements: The field parameters, such as water temperature, pH, dissolved oxygen, and specific conductance will be measured using multi-probe instruments. For

[5]MoEF(1997). *The Environment Conservation Rules*. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh.

each sampling trip, field measurements and observations will be recorded in a field data logbook or on a field data sheet.

For each visit to a specific station where field measurements and samples will be collected, the following information are needed to be noted:

- Station ID,
- Sampling date, location,
- Sampling depth,
- Sampling time, and
- Samplecollector's name.

All measured field parameters and their respective values and observationswill be recorded.

Brick field on the bank of the Atai River, 31 May 2017.

Field physicochemical parameters include part or all of the following:

- Dissolved oxygen,
- Temperature,
- Specific conductance,
- pH, and
- Salinity.

General Observation: It is always important to record field observations to aid in the interpretation of water quality information. Some common observations will be noted:

1) *Water appearance:* General observations on water might include colour or an unusual amount of suspended matter, debris, or foam.

2) *Unusual odours*: Examples include hydrogen sulphide, mustiness, sewage, petroleum, chemicals, or chlorine.

3) *Observations related to water quality*: If the water quality conditions are exceptionally poor, note that standards are not met in the observations—for example; dissolved oxygen is below minimum criteria. Uses may include swimming, wading, boating, fishing, irrigation pumps, or navigation. This type of information may be used in evaluating compliance with standards.

Collecting Samples: The 250 ml plastic bottles were washed properly and rinsed with 1-2 ml 2% industrial HCl. The bottles will be rinsed again with sampled water and will be properly labelled. Aeration during sampling will be avoided as much as possible. The water samples will be carefully transported to the laboratory and will be preserved for physical and chemical analyses. Water samples (including bacteriological) are generally collected before field measurements are taken.

Water samples to be collected at the same location for both bacteriological and chemical analysis. Water samples to be collected at the *centroid* of flow. The *centroid* is defined as the midpoint of that portion of the river width which contains 50 percent of the total flow. For river samples, the centroid of flow must be accessible for sampling physicochemical parameters, either by wading, from a bridge, or from a boat. If the water depth at the sampling point is less than 0.5 m, collect samples at a depth equal to one-third of the water depth measured from the water surface. If the water depth is greater than 0.5 m, collect samples at a depth of 0.3 m below the surface.

Sample containers should be new, unused, clean polyethylene containers or glass jars or used laboratory cleaned containers. Prior to sample collection, collectors should rinse containers three times with ambient water and discard water away from the sample location. However, new, unused containers or those cleaned in a laboratory may be used without rinsing.

Collection of Water Samples.

Collecting Water-Chemistry Samples: Examples of routine (baseline) conventional parameters include total suspended solids (TSS), chloride, sulfate, total nitrate, total phosphate (TP), total organic carbon (TOC), and chlorophyll a. Laboratory measured total dissolved solids (TDS) and orthophosphate (OP) are not routine parameters. Both laboratory analyzed TDS and field-filtered OP may be sampled and analyzed as needed for specific purposes.

Sample Preservation:
Ice: Samples must be placed on ice immediately after collection. Place all samples that require cooling only on ice before preserving other samples with acid. Sufficient ice will be needed to lower sample temperature to < 6ºC but not to the freezing point. Sample temperature must be maintained at < 6ºC until delivery to the laboratory. Take care at all times during collection, handling, and transport to prevent exposure of the sample to direct sunlight.

Acid: Label samples requiring preservation with sulphuric acid (H2SO4) in a way that lets the laboratory know that acid has been added. For example, put an X on the container cap to signify that acid was used for preservation, or label container "2 mL H_2SO_4 added." Add approximately 2 mL of 1:1, analytical reagent grade H_2SO_4 to each litre of sample to be analyzed for ammonia, total Kjeldahl nitrogen, total phosphorus, and total organic carbon. This amount is adequate to reduce the pH to less than 2. Maintain the temperature at < 6ºC until arrival at the laboratory. Preservation with acid must occur in the field within 15 minutes of collection. Samples must be cooled to < 6ºC, but should never be frozen.

Surfing of a Ganges River Dolphin at confluence of the Rupsha, Bhairab and Atai Rivers, 23 October 2017.

Water sample for anion and cation analysis: At each sampling point, water will be collected in two different bottles. One will be acidified properly for heavy metal analysis and the other non-acidified water sample was preserved for anion.

Physical properties such as color, odor and temperature, and chemical properties such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand and total dissolved solids are important quality parameters of water. The pH will be determined by digital pH meter (HANNA Instrument 211, Microprocessor pH). Total dissolved solids and electrical conductivity will be determined by digital TDS meter and EC meter (HM digital). Temperature will be determined by Thermometer. Dissolved oxygen will be determined by Winkler's Iodometric method, and biological oxygen demand (BOD) and alkalinity will be determined by titrimetric method as described by Huq and Alam (2005)[6].

There are lots of organic materials in river water. In order to assess BOD and chemical oxygen demand (COD), the organic materials in the river water will needed to be oxidized by oxidizing agent like sulphuric acid, potassium dichromate. Later, titrimetric method will be used after digestion (150°C for 2 hours) and cooling the samples properly. Alkalinity will be measured and reported in terms of CaCO3 equivalent. Analysis of water samples for Cation will be done using AAS machine and the anion using IC machine.

6.1.6 Biological Parameters

Collecting and Analyzing Biological Samples: The indicator organisms used for determining support of the recreation use are *Escherichiacoli* in freshwater and *Enterococcus* in marine waters and some saline inland waters. Baseline bacteriological samples should be collected at all monitoring sites under all flow conditions. To maximize the processing time for the laboratory, bacteriological samples will be collectedlast at a site. In streams and rivers, care should be takento find an undisturbed location if other work, like flow or sediment collection, will be done at the site. When collecting samples from a bucket of water (bridge site), the bacteriological sample should be collected before other samples. Water into the bacteriological-sample container will be poured. water-sample containers should never be immersed in the bucket; doing so could introduce contamination.

Sample Collection: Few important measures to be undertaken while collecting samples. They are as follows:

Clean hands: Bacteria samples are the easiest to contaminate. Take steps to help eliminate possible contamination by using either an alcohol-based hand sanitizer that contains at least 60 percent alcohol prior to sample collection or wearing disposable latex gloves when collecting a sample.

Never pre-rinse the sample container: When submerging the sample container, take care to avoid contamination by surface scum. The surface film is enriched with particles and bacteria not representative of the water mass.

*

[6]Huq, S. and Alam, M. (2005).*A Handbook on Analyses of Soil, Plant and Water*. BACER-DU, University of Dhaka, Bangladesh.

Leave sufficient headspace: The lab needs to mix the sample prior to processing to redistribute bacteria in the sample. Fill the sample container to the top. This allows the lab to process the sample according to their procedures.

Flowing streams: Dip the open sample container to a depth of 0.3 m, or roughly half the depth in very shallow streams. Avoid contact with the sediment. With the open end facing upstream, push the mouth of the bag upstream at this depth until full. Always hold the mouth of the sample container upstream of the sampler, the sampling apparatus, and any disturbed sediments.

Abandoned cargo vessels on the Atai River,31 May 2017.

Sample Labeling: Each sample will be labeled with the sample number, date, and time collected.

Sample Preservation: Place samples on ice immediately after collection. No more than one bacteria sample per gallon of cooler capacity may be placed inside the cooler; these should be evenly spaced inside the cooler and completely covered with wet ice. Cool the samples as quickly as possible to < 6ºC but do not allow the samples to freeze.

Sample Holding Time: Holding time is defined as the amount of time between collection and the initiation of analysis. Plan sample collection so that samples are set up within the required holding time. Do not report samples that are not prepared within the time limit or are reported from the laboratory as exceeding the holding time. Laboratories are required to process bacteriological samples within eight hours of sample collection whenever possible. The 8-hour holding time includes 6 for transporting and 2 for processing. Field personnel should submit samples to the lab within 6 hours when possible. When transport conditions cause delays in sample preparation longer than 8 hours, the holding time may be extended up to 48 hours for *E. coli*. However, any extension should be minimized.

Foggy condition in the Atai River which affects dolphin sighting on 31 May 2017.

Collecting and Analyzing Phytoplankton and Zooplankton: To identify and quantify phytoplankton and zooplankton in the river water, concentrated one litrewater sample will be collected in plastic bottles by concentrating 20 litres of water into one litre. The water samples will be immediately preserved by adding formalin so that concentration becomes 8%. Water samples will be immediately transported to laboratory and will beworked out to enumerate both phytoplankton and zooplankton.

In the laboratory, water will be taken out with the help of 1 ml pipette and then one drop of it will be spread onto a Sedgewick/Rafter chamber. A cover slip will be placed on the slide. Finally, the slide will be observed under microscope to get results about the abundance of targeted species (Zeiss microscope with digital camera, Nikon).

6.1.7 Water Depth

Water depth will be measured in pre-monsoon, monsoon, post-monsoon and winter periods. It will be measured during the dolphin survey. The water depth is measured by an echo-sounder every 1 km on the transects during high and low tides.

An eddy observed where highest depth recorded at the AtaiRiver, 31 May 2017.

6.1.8 Watercraft Survey

Survey for watercrafts and other water transports will be done in monsoon, post-monsoon and winter months in July, October and November, respectively. This survey coincides with three dolphin surveys and will be done simultaneously. The vehicles are categorized as cargo (C), non-cargo (NC), mechanized (M), and non-mechanized (NM).

Motorized cargo vessel carrying sand on the Bhairab River, 31 May 2017.

6.1.9 Pollution Mapping

Sources that will be identified during collection of water samples will be used to produce GIS-based maps, which will show the pollution sources. Along with this, the results from the water samples analysis will be used to produce GIS maps.

Existing power plant by the Bhairab River,31 May 2017.

6.1.10 Assess Potential Impacts and Identify Mitigation Measure

Using the results of the surveys, criteria for determining critical habitat will be analyzed as per IFC Guidance Notes[7]and through various literature reviews, and potential impacts and mitigation measures will be shared.

A portion of fishing area in the Atai River, 31 May 2017.

[7]International Finance Corporation, http://www.ifc.org/wps/wcm/connect/e280ef804a0256609709ffd1a5d13d27/GN_English_2012_Full-Document.pdf?MOD=AJPERES.

6.2 Workplan

The workplan below provides the timeline when each of the activity will be done during the project period (June 2017-February 2018)

Workplan for Biodiversity Assessment																																						
Season	Monsoon																Post-monsoon								Winter														
Month	June				July				August				September				October				November				December				January				February						
Action / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36			
Study team formation, background information collection and mapping																																						
Dolphin Survey																																						
Fish/Fisheries/Fishing Gears/Vegetation																																						
Watercraft																																						
Water quality Parameters Collection and analysis																																						
Mapping																																						
Other Species Survey																																						
Data analysis																																						
Report preparation and Submission																																						
Submission of pre-monsoon and monsoon survey Report												X																										
Submission of post monsoon report(1)																		X																				
Submission of post monsoon report(2)																					X																	
Submission of winter survey report																												X										
Final Report																																			X			

7. Surveys

The surveys include dolphins, other wildlife, watercrafts, water depth, eddies, fish species, fishing areas, fishing gears, vegetation, and surface water quality parameters and biological parameters.

Post-monsoon survey Dolphin survey 09 November 2017

8. Survey Findings

8.1 Dolphin Survey

A total of 284 sightings of Ganges River Dolphins were recorded during pre-monsoon, monsoon and first post-monsoon surveys (May-October 2017) (Map 1 and Figure 1). The overall encounter rate is 1.18/ km (Table 1).Calculation is in Appendix 1.

In the second winter survey, a group of Irrawaddy Dolphin consisting of four individuals was recorded from Atai river opportunistically. The species is considered globally Endangered and nationally Near Threatened.

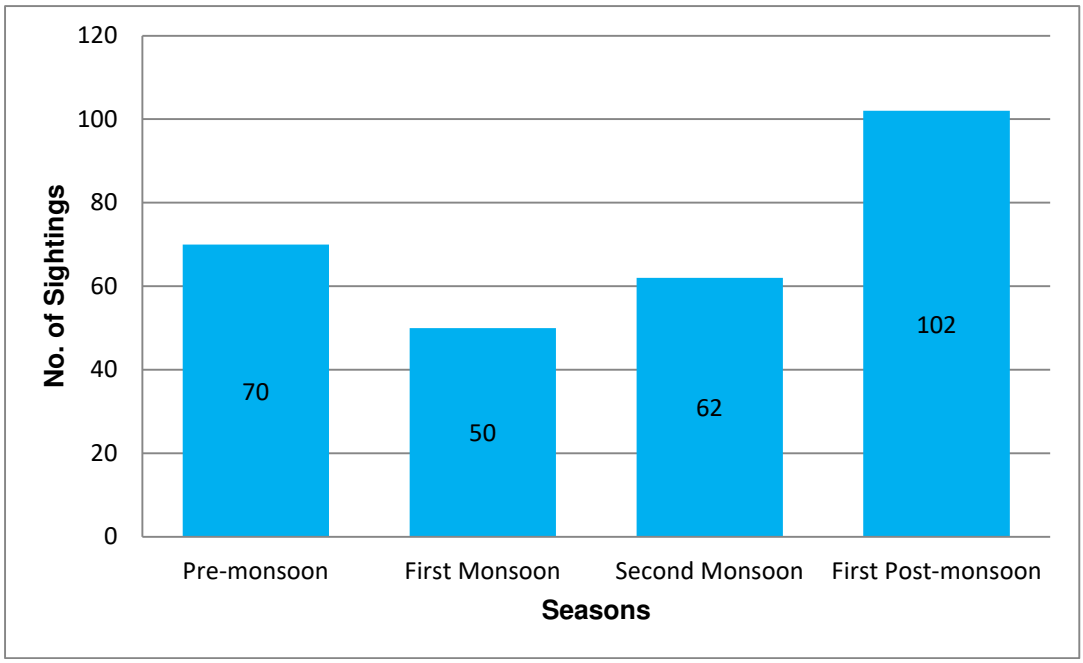


Figure 1. Graph showing seasonal variation of dolphin sightings during the survey period.

Table1. Table showing encounter rates of dolphins in all surveyed seasons and tides.

Survey season	Encounter rate (High Tide)	Encounter Rate (Low Tide)	Encounter Rate (Average)
Pre-monsoon survey	1.40	0.93	1.16
First monsoon survey	1.33	0.33	0.83
Second monsoon survey	1.03	1.03	1.03
First post-monsoon survey	1.23	2.16	1.70
Total	4.99	4.45	4.72
Average	**1.24**	**1.11**	**1.18**

Three surveys were conducted using the mark-recapture method (Details in Section 6.1.1) and the result of three surveys is used in this report.

An average of **47** and **34** dolphins were calculated for the project area by using the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' and the 'Huggins Conditional Likelihood Model', respectively (Table 2 and 4).

The 'Chapman's modified Lincoln-Petersen Estimator' revealed that the sum of groups detected by both the groups($n_p + n_s$)was always greater than the corrected number of groups(G_c).

$$n_p + n_s > G_c$$

$$G_c = (n_{p+1})(n_{s+1})/(m_{ps} + 1) - 1$$

Where, "n_p"is the number of groups detected by the primary observer team and "n_s" for the secondary observer team. Also, $m_{ps}$is the total number of group detected by both teams

The correction factor 1.26, 1.18 and 1.69 were used for the groups missed by primary and secondary observer team during the second post-monsoon, first winter and second winter respectively. This number was then multiplied with the mean group size to calculate the dolphin abundance in the survey area (A_d). The upper (19) and lower range (8) of dolphin abundance (Table 2)at the 95% confidence interval then calculate using

$$A_d \pm \sqrt{VAR(A_d)}\ .$$

Table2: Estimated dolphin population using Chapman's Modified Lincoln-Petersen model

Model	**Dolphin population**		
	Second post-monsoon survey	First winter survey	Second winter survey
Chapman's Modified Lincoln-Petersen model	28 ~ 58	41 ~ 51	38 ~ 64
No. of Dolphin (Mean)	43	46	52
Average	47		

'Huggins Conditional Likelihood Model' has the advantage of incorporating covariates directly into the modeling process by maintaining the link between individual mark-recapture records (here, five occasions were considered) and their respective covariate values (three covariates: group size, channel width, and sighting conditions). So, considering the maximum likelihood Huggins Model, average **34** dolphins were estimated for the study area.

Apparently, the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' is relative less rigorous and straight forward, as it does not consider the variables. Both the models were done to compare the results.

Although, the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' showed a little over-abundance than the Huggins Conditional Likelihood Model', we rely more on the probabilistic 'Huggins Conditional Likelihood Model' for estimating dolphin population and Critical Habitat analysis.

Table 3: The number of Ganges River Dolphin detected by the primary and secondary observer teams during search effort in second post-monsoon, first winter and second winter, the number of corrected groups and their associated co-efficient of variations from the Chapman's modified Lincoln-Petersen mark-recapture estimator.

Second post-monsoon survey					
Ganges River Dolphin	Number of Sighting (Primar	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)

	y Team, n_p)				
Group Size (1)	8	11	7	13	0.069
Group Size (2-3)	8	5	4	10	0.112
Group Size(>3)	2	1	1	2	0
First winter survey					
Ganges River Dolphin	Number of Sighting (Primary Team, n_p)	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)
Group Size (1)	11	7	6	13	0.087
Group Size (2-3)	5	7	4	9	0.113
Group Size(>3)	3	2	2	3	0
Second winter survey					
Ganges River Dolphin	Number of Sighting (Primary Team, n_p)	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)
Group Size (1)	7	7	5	10	0.104
Group Size (2-3)	6	8	4	12	0.158
Group Size(>3)	2	2	1	4	0.247

The 'Huggins Conditional Likelihood Model', in the MARK software, ran to derive the probabilities under closed capture condition. The Horvitz-Thomson estimator was used to calculate the abundance, it was considered that, capture probability equals to recapture probability ($p = c$), total Dolphin Abundance ($\tilde{N}$) = M_{t+1}.

Nine different models with different number of parameters simulated (built-in models in the MARK software) and compared with the selected model having the lowest AIC value. The likelihood ratio test revealed that the chosen model performs better than other compared models considering both the number of parameters and the AIC value (Appendix 6,7,8).

According to the model result, an average **34** (Table 4) dolphin found in the mark-recapture (closed abundance) analysis. The detailed results, parameters, covariates are summarized in Appendix 3,4,5.

Table 4:Estimated dolphin population using Huggins conditional likelihood model

Huggins conditional likelihood model	**Dolphin population**		
	Second post-monsoon survey	First winter survey	Second winter survey
Lowest AIC Value	123.8927	96.589	106.726
Dolphin number	35	35	32
Average	**34**		

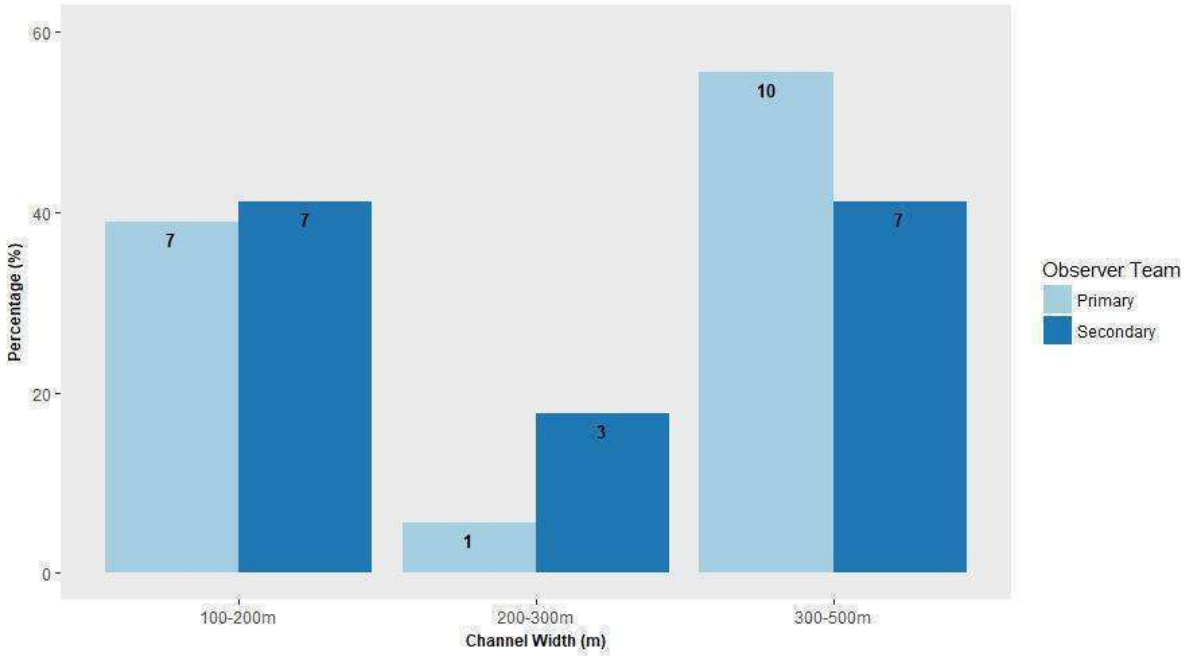


Figure 2. Channel width (m) measured by primary and secondary team during post-monsoon survey

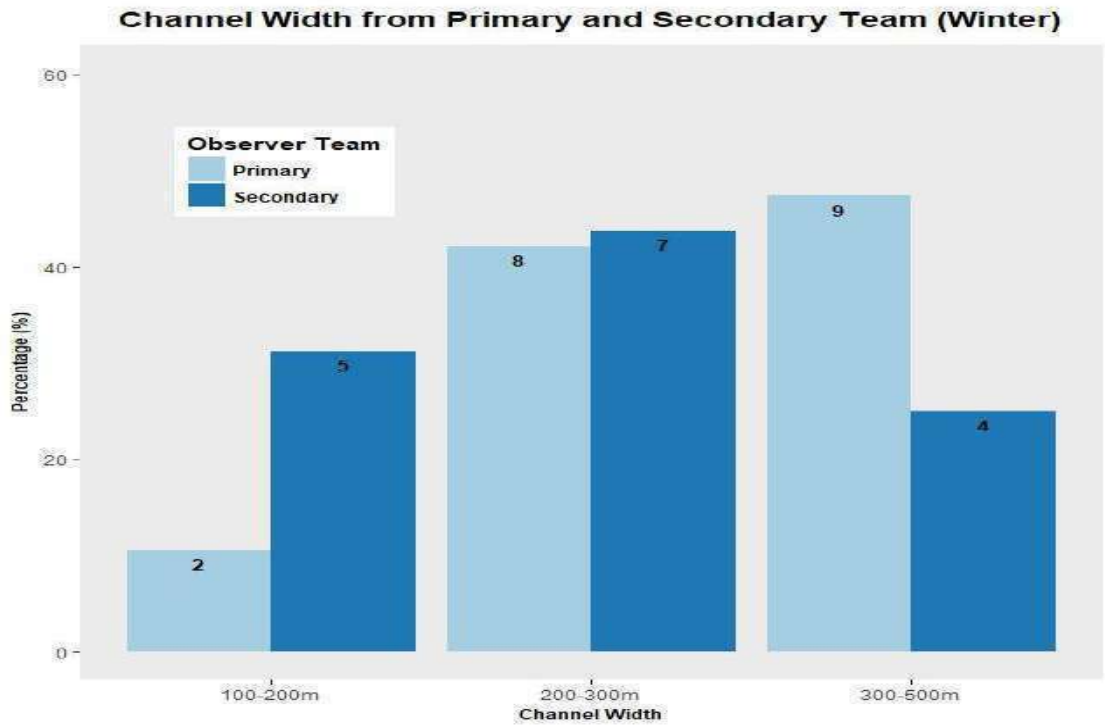


Figure 3. Channel width (m) measured by primary and secondary team during first winter survey

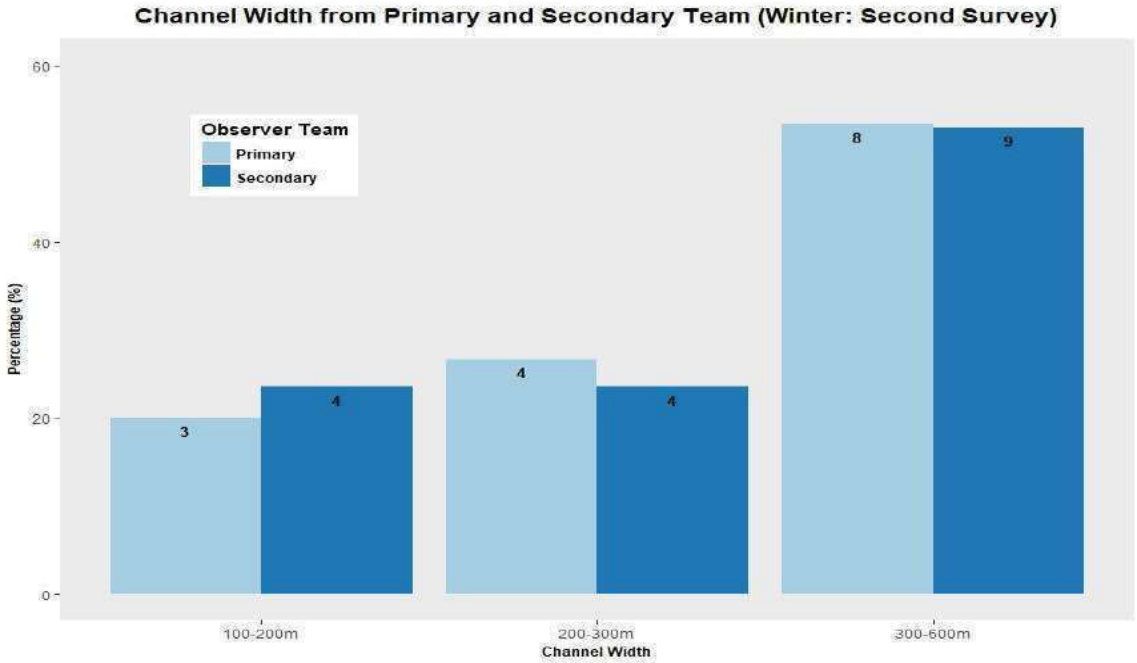


Figure 4.Channel width (m) measured by primary and secondary team during second winter survey

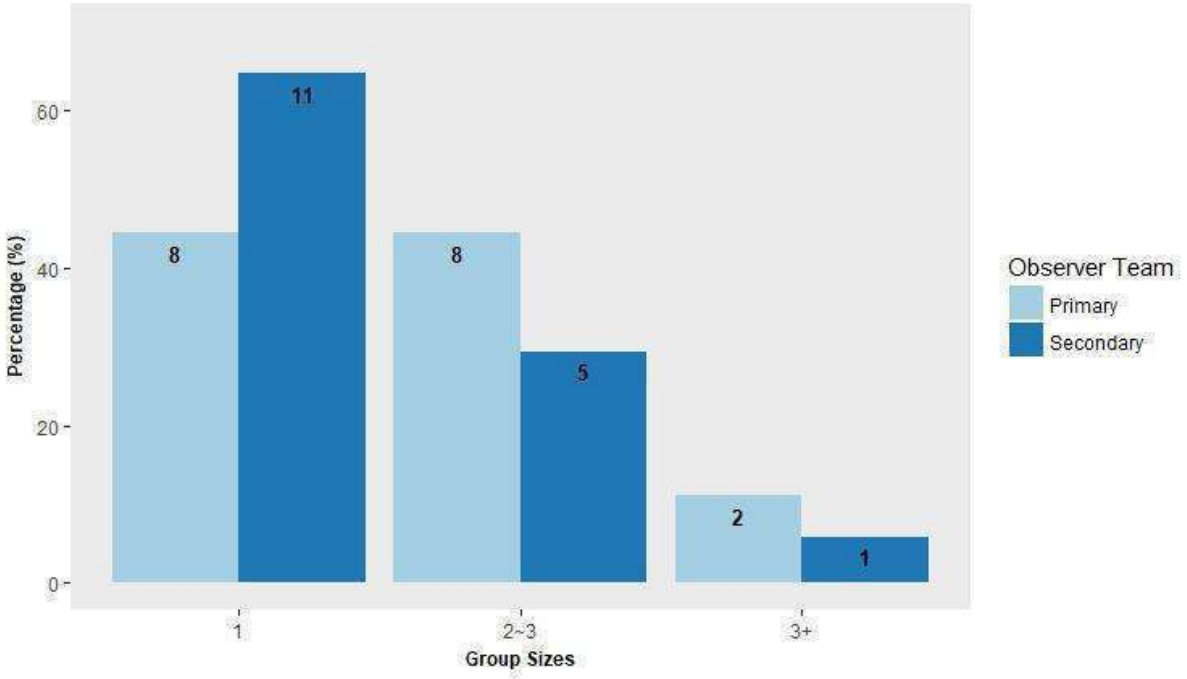


Figure 5. Group sizes recorded by the primary and secondary team during second post-monsoon survey

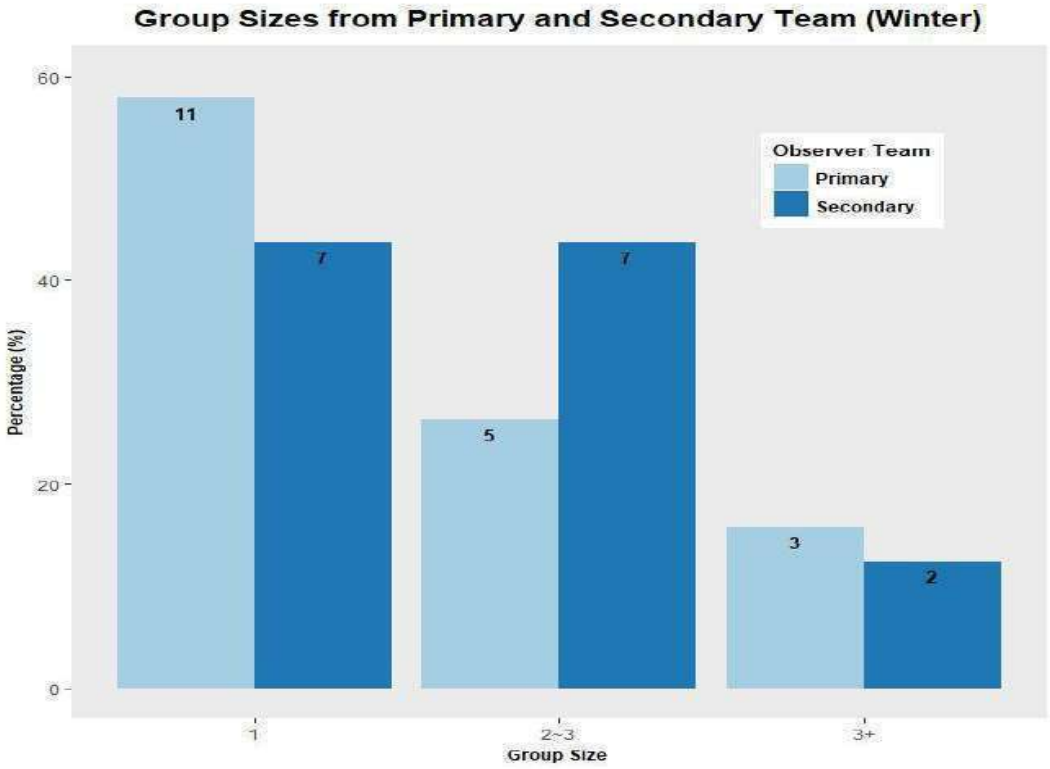


Figure 6. Group sizes recorded by the primary and secondary team during second post-monsoon survey

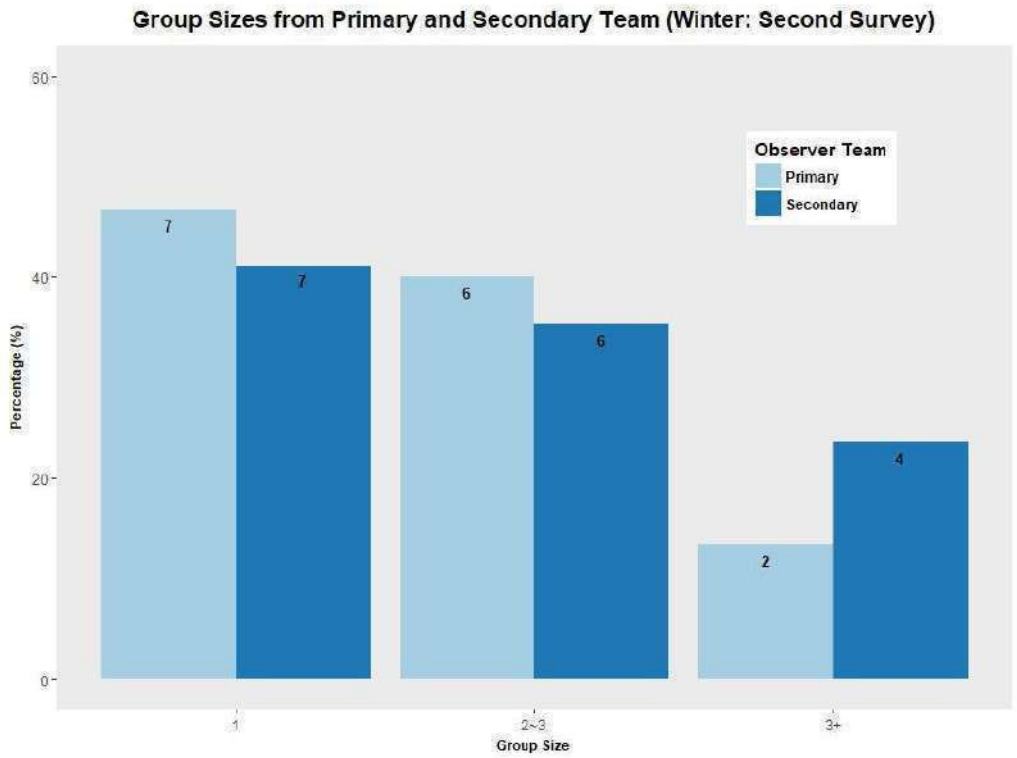


Figure 7. Group sizes recorded by the primary and secondary team during second post-monsoon survey

Important Dolphin Area

From all the surveys, specific areas within the total area have been identified with high concentration of dolphin sighting including calves. The areas can be considered as important dolphin areas based on the number of sightings and considering the channel width and other parameters (Map 3 and Table 5).The most important area is the confluence of Atai-Bhairb-Rupsha Rivers which is c.500m from the project site.

From the surveys, it was understood that the dolphin population in the area is <7.5% of the total known national population. So, the entire 30 km area should be considered as an important area.

Table 5. Details of important dolphin areas

Rank	Name of important dolphin site	Location in Map	Sighting number in pre-monsoon, monsoon and post monsoon surveys
1	Confluence of the Bhairab-Atai-Rupsha	Confluence	75
2	Atai river	Atai	59
3	Near Rupsha bridge	Rupsha 2	47
4	Bhairab-Madhumati Confluence	Bhairab 1	27
5	JelkhanaGhat confluence	Rupsha 1	20
6	Near Daulatapur	Bhairab 2	17

Critical Habitat Analysis

According to the International Finance Corporation (IFC) Guidelines, critical habitats are 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. Critical habitat is defined by the following criteria;

-Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
-Criterion 2: Endemic and/or restricted-range species
-Criterion 3: Migratory and/or congregatory species
-Criterion 4: Highly threatened and/or unique ecosystems
-Criterion 5: Key evolutionary processes

Critical Habitat Analysis for Dolphins

Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species

Criterion 1 states that any species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species shall be considered as part of Criterion 1.

There are two tiers with sub-criteria under Criterion 1.

From the surveys following mark-recapture method conducted for the Ganges River Dolphin in the project area. The probabilistic 'Huggins Conditional Likelihood Model' was relied upon for estimating dolphin population and Critical Habitat analysis.

Table 6: Details of Ganges River Dolphins

Species Name	Global Status	National Status	Global Population	National Population	Population in Project Site	% of Global Population	% of National Population
Ganges River Dolphin	Endangered	Vulnerable	<5000	Unknown (225 in Sundarbans, 125 in Karnaphuli River, 38–58 in Jamuna River and 34–43 in nine groups in Kushiyara River)	34	<0.68%	<7.5%

Source: Braulik and Smith (2017), IUCN Bangladesh (2015), Smith *et al.*(1998)

Under the Tier 1 sub-criteria of Criterion 1, the project site cannot be declared as Critical Habitat as percentage of dolphins found in the project site is not ≥ 10 percent

of the global population and the habitat cannot be considered as a discrete management unit. The project site holds less than 0.68% (Table 6) of the global population of the species. Furthermore, the project area is not one of 10 or fewer global discrete management site for this species.

The project site cannot be declared as Critical Habitat under Tier 2 sub-criteria of Criterion 1, as it does not support an regionally important concentration of this species (in comparison to densities of the species elsewhere in Bangladesh and beyond). There is also no other reason to consider the area of significant importance to the species.

Finally, the loss of this habitat will not significantly impact the long-term survivability of the species owing to its small population at the project site compared to global population.

The habitat does not contain nationally important concentration of CR or EN species, as the species is considered nationally Vulnerable.

Lastly, the species is nationally Vulnerable and globally Endangered. If the species was considered as nationally CR or EN, the area would have been considered Critical Habitat under Tier 2 sub-criteria of Criterion 1.

Criterion 2: Endemic and/or restricted-range species

The project site cannot be considered as Critical Habitat under Criterion 2, as there was no record of any endemic or restricted-range species from the surveys.

Criterion 3: Migratory and/or congregatory species

The project site cannot be considered as Critical Habitat under Tier 1 of Criterion 3 as no migratory or congregatory species were recorded whose ≥ 95% population relies on this habitat.

The project site cannot be considered as Critical Habitat under Tier 2 of Criterion 3, as the project site were fulfill the standers of Tier 2.

Criterion 4: Highly threatened and/or unique ecosystems

The project site cannot be considered as Critical Habitat under Criterion 5, as it cannot be considered as a highly threatened and/or unique ecosystem under the given standards.

Criterion 5: Key evolutionary processes

The project site cannot be considered as Critical Habitat under Criterion 5, as area does not fulfill the standards set under criterion.

Critical Habitat for Fish and Other Wildlife

A total of 6 species of fish were found to be included in the recently published National IUCN Redlist (2015). These six fish species have EN status as per the National RedList, but the global status of these 6 species are: four Least concerned (LC) and two Near threatened (NT)(Detail Appendix 10). The data collected on these species is inadequate to analyze the species abundance as well as Critical Habitat. Due to the unavailability of the data, the Critical Habitat analysis was done using the national/regional range of these species as a proxy. When considering the range of the species, the project site cannot be considered as critical habitat for these species. Details in the Table 6a.

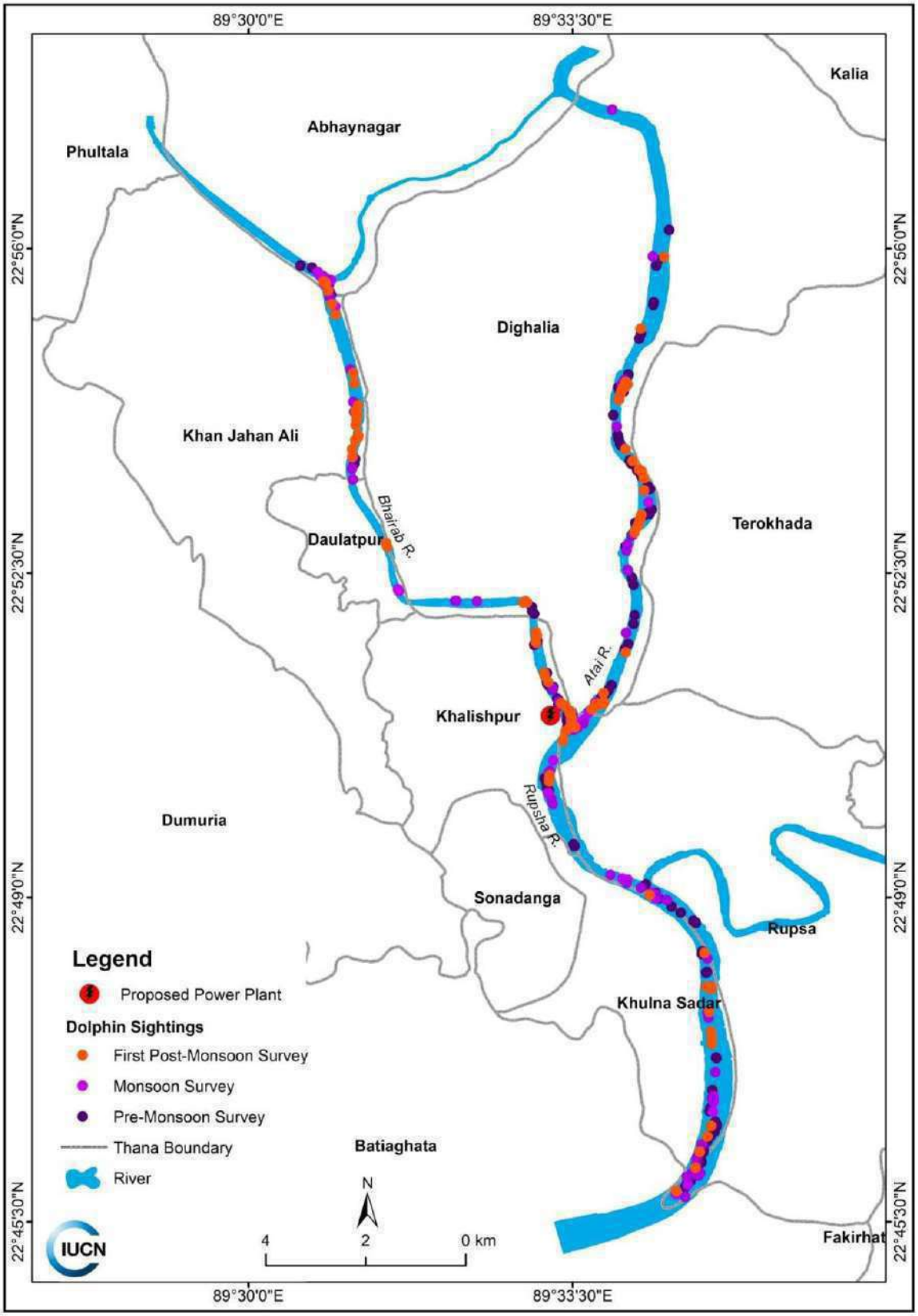
Regarding Smooth-coated Otter, we have no direct evidence/sighting during field survey period. Due to the unavailability of the data, the Critical Habitat analysis was done using the national/regional range of these species as a proxy. When considering the range of the species, the project site cannot be considered as critical habitat for these species.

Regarding Irrawaddy Dolphin, only one sighting of a group consisting of four individuals was recorded. This sighting was only during the second winter survey. There was no other sightings from previous six surveys. Although the species is globally Endangered, and nationally Near Threatened, the population in the project area is not large enough to fall under any criterion of Critical Habitat. The national population of this species is around 6000 individuals (IUCN 2015).

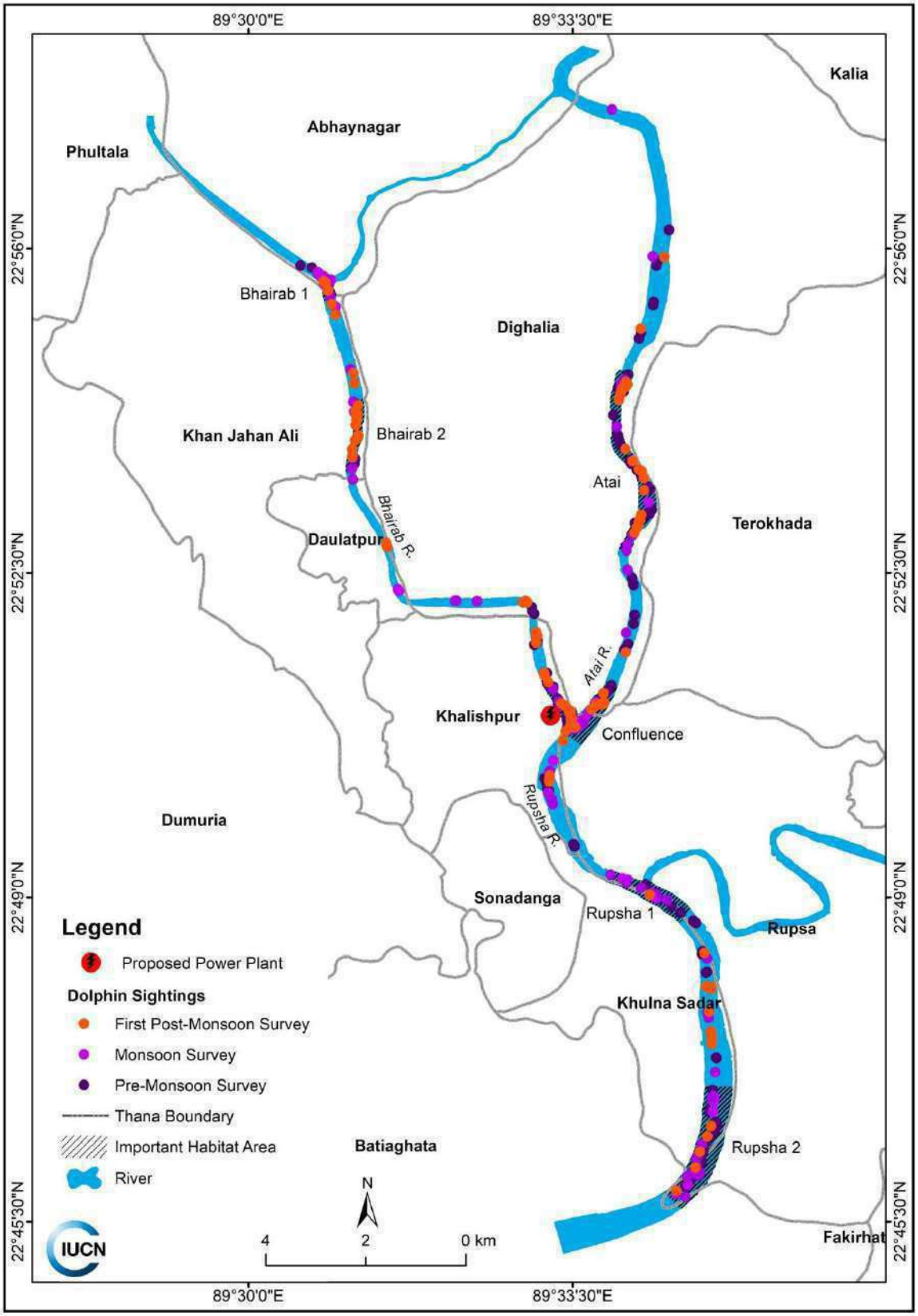
Table.6a. Species distribution range in Bangladesh

Species Name	**Distribution range in Bangladesh (IUCN 2015 Redlist)**	**Remarks**
Smooth-coated Otters(*Lutrogale perspicillata)*	This species is mainly found in hilly areas of northeast, southeast coastal region with the largest population is in Sundarbans. The total extent of occurrence is 1,34,973 km^2	Although the species is considered as CR nationally, it still has a large area of occupancy, and thus cannot be considered for the Critical Habitat assessment. Furthermore, there have no direct evidence/sighting during field survey period. Interviews of local people were held and only one person had claimed(out of 6 interview surveys) that the species was sometimes found in the area
Fish		
Tire-track Spinyeel (*Mastacembelus armatus)*	Found in rivers, canals, beels, ponds, and inundated fields throughout Bangladesh. The total extent of occurrence is 2,17,468 km^2	Although the species is considered EN nationally, the species has a fairly large area of occupancy and found throughout Bangladesh. Considering

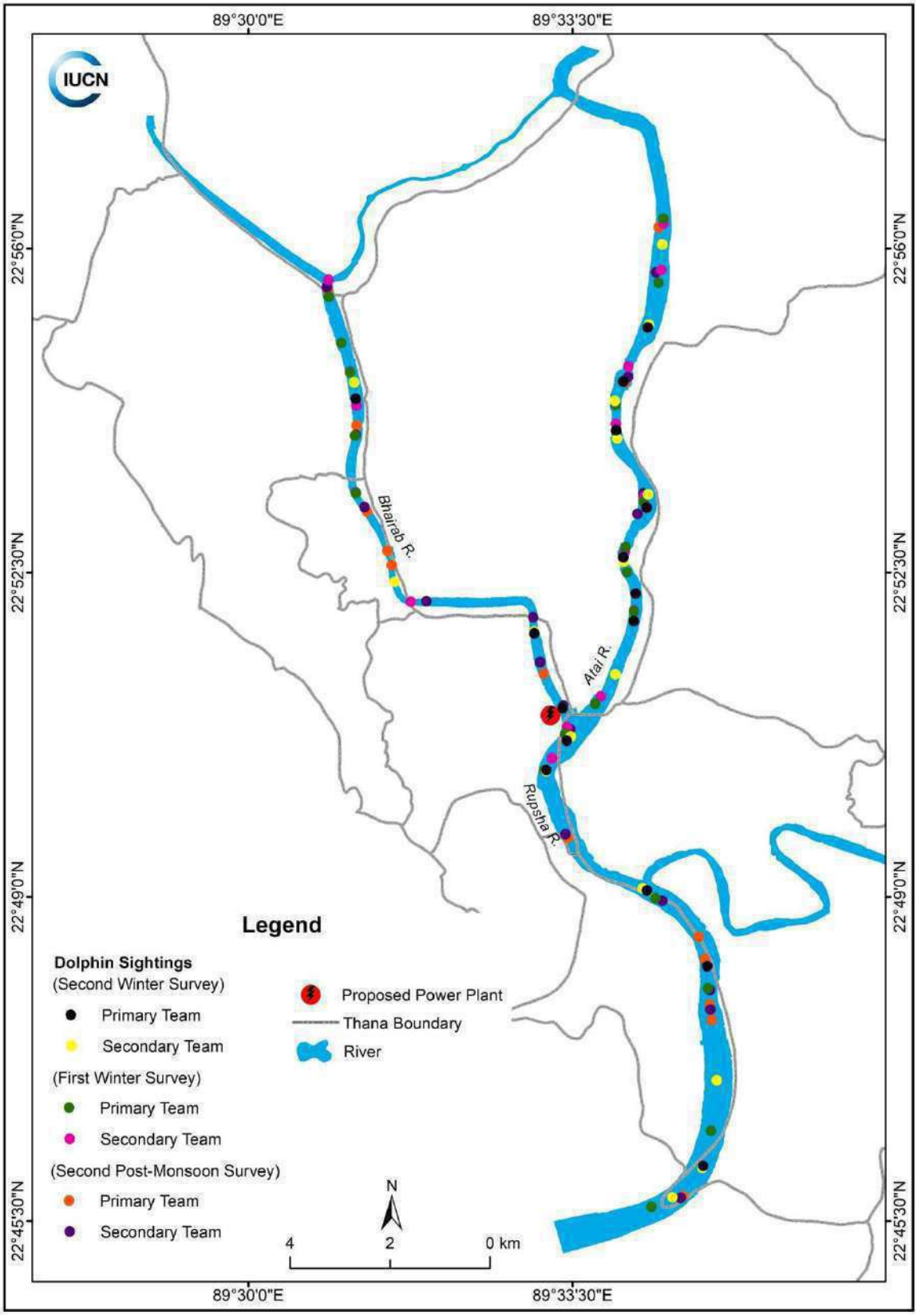
		the range of this species, the area cannot be considered CH for this species.
Humped Featherback (*Chitala chitala)*	Considered as a widely distributed species in rivers, beels, haors, reservoirs, canals and ponds. The total extent of occurrence is 1,31,403 $km^{2.}$	The species is recorded through interview survey (2 out 3 surveys) and there was no direct evidence of the project site. Furthermore, the species is widely distributed through out the country and considering the range and area of occupancy, this species, the area cannot be considered CH for this species.
Giant Snakehead (*Channa marulius)*	The Padma, Padma distributaries, Borulia haor (Nikli, Kishorganj), Mahananda, Choto Jamuna, Ichanoi Beel (Gaibandha), Dogger Beel (Chandpur), Titas, larger haors in Greater Sylhet and Mymensingh Districts, beels and larger water bodies in Dhaka, Manikganj and Tangail Districts. The total extent of occurrence is 70254 $km^{2.}$	The species is recorded through interview survey (1 out 3 surveys) and there was no direct evidence of the project site. According to the national distribution, this species is not found in or near the project area.
Pabda catfish (*Ompok pabda)*	The species is widely distributed throughout Bangladesh and reported from Padma, Jamuna, Meghna, Surma, Kushira, Manu Ichamati, Banglali, Turag, Baral, Choto Jamuna, Mahananda, Muhuri, Barnai and Titas Rivers Feni Reserviour, Tanguar Haor, Hakaluki Haor, Chalan Beel and Medha Beel. The total extent of occurrence is 1,21,601$km^{2.}$.	The species has a large EOO and found throughout Bangladesh. Considering the range of this species, the area cannot be considered CH for this species.



Map2. Map showing dolphin sightings of pre-monsoon, monsoon and first post-monsoon surveys along the three transects



Map 3. Map showing important dolphin areas in the project area.



Map4. Map showing dolphin groups observed by primary and secondary team in the second post-monsoon and winter survey along the transect

8.2 Other Wildlife

Other wildlife includes a total of 41 species of birds among which are 8 are migratory species and four other species (Water Monitor, Indian Flying Fox, Smooth-coated Otters and Irrawaddy Dolphin) were recorded during the survey period. The highest number of species recorded was from monsoon (28 species) followed by post-monsoon (26 species), winter (17 species) and pre-monsoon (11 species). The highest number counted was of Little Cormorant with 241individuals. Details are in Appendix 9.

8.3 Watercraft Survey

Watercrafts were also counted during the survey period. A total of 676 watercrafts comprised of mechanized and non- mechanized were recorded. The highest was mechanized boats with a total of 373 from all surveys. Rupsha River had the highest number of water vessels with a total of 253, followed by Atai River with 225 and Bhairab River with 198. The details of water vessels are given in (Table 7).

Table 7. Table showing number water vessels recorded during the surveys.

Survey season		**Non-Cargo**		
	Cargo	**Mechanized**	**Non-mechanized**	**Total**
Pre-monsoon survey	11	32	19	62
First monsoon survey	20	53	62	135
Second monsoon survey	8	71	15	94
First post-monsoon survey	40	90	42	172
Second post-monsoon survey	19	30	9	58
First winter survey	06	52	11	69
Second winter survey	32	45	9	86
Total	**136**	**373**	**167**	**676**

8.4 Water Depth

Water depth was measured along transects every 1km intervals using an echo-sounder. Table 8 presents the details of the water depth surveys.

Table 8. Table showing the water depth recorded during the surveys.

Transect	**Tide**	**Pre-monsoon**		**Monsoon (1st& 2nd monsoon average)**		**Post-monsoon**	
		Max	**Min**	**Max**	**Min**	**Max**	**Min**
Rupsha	High	34.4	3	22.75	8.8	30.8	8.2
	Low	23.9	10	27.1	8.8	29.3	11.9
Bhairab	High	20.1	6.6	12.65	6.45	13.5	5.2
	Low	17.3	6.3	12.95	5.65	19.5	5.9
Atai	High	30.4	18.7	32.1	8.65	27.6	6.8
	Low	24.3	6.6	43.9	9.8	34.6	10

8.5 Eddy

Eddies were recorded in five surveys in the project areas. The number of eddies found in each rivers in high and low tides in the surveys is presented in Table 9.

Table 9. Table showing number of eddies in each river during five surveys

Transect	Tide	Pre-monsoon	First monsoon	Second monsoon	First post-monsoon	Second post-monsoon
Rupsha	High	0	0	0	0	0
	Low	0	1	0	0	0
Bhairab	High	0	0	0	0	0
	Low	0	0	0	2	0
Atai	High	0	0	0	0	0
	Low	4	3	4	6	5

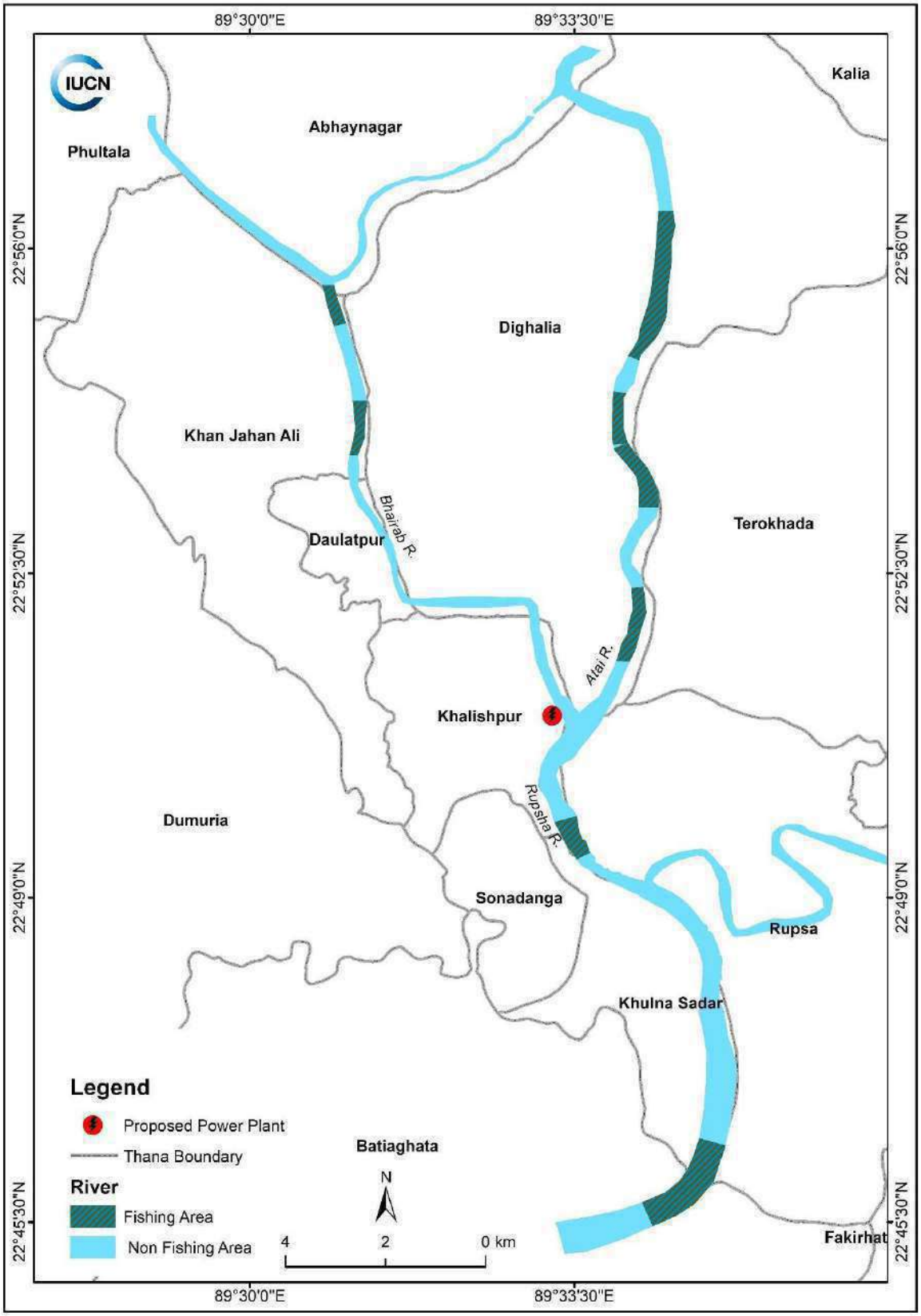
8.6 Fishing Gear and Fishing Area

Fishing at Atai River, 09 November 2017. ©IUCN/ A B M SarowarAlam.

A total of 19 types of fishing gears were recorded in the three seasons that were surveyed. Table 10shows types of gears used in the project areas. Fishermen catch fish in the rivers by using different types of fishing gears as mentioned below. Among these, small-mesh drifting gill net (jatkailishjal), monofilament gill net (current jal), set bag net (bheundi jal) and long shore net (charpatajal) are widely and illegally used for fishing. The mesh size of small-mesh drifting gill net and monofilament gill net is very small. The hand set bag net and long shore net are zero mesh size net. These net are used to catch eggs, spawn and larvae of all the fish species along with adult fish. Fishing areas were identified and a map was prepared. Map 5 shows the identified fishing areas of the three transects.

Table 10. Table showing the types of fishing gears recorded from the surveys.

S.N	Gear Type	Local Name	Operational Fishermen	Monsoon	Post-monsoon	Winter
1	Big-mesh drifting gill net	Ilishjal	2 or 3	√	√	√
2	Small-mesh drifting gill net	Jatkailishjal	2	√	√	√
3	Medium–mesh drifting gill net	Faksha/Poajal/Phasajal	2 or 3	√	√	√
4	Monofilament gill net	Current jal	2	√	√	√
5	Long shore net	Charpatajal	2	√	√	√
6	Creek net	Khalpatajal	2	√	—	—
7	Set bag net	Behundi/Bhadajal	2 or 3	—	√	√
8	Drag net	Moijal	1	√	—	√
9	Hand push net	Thelajal	1	√	—	—
10	Post-larvae seine net	Parse ponarjal	2 or 4	√	√	—
11	Large lift net	Vesaljal	2 or 3	√	—	√
12	Small lift net	Saine/Khotjal	1	√	√	√
13	Cast net	Jhaki/Kheplajal	1	√	√	√
14	Drag net	Pangaserponarjal	2 or 3	√	—	√
15	Gill net	Pangaserjal	2 or 3	√	√	√
16	Long line with many hooks	Doriborshi/Donborshi/Tanaborshi	2	√	√	—
17	Hook and rod	Chhipborshi	1	√	—	—
18	Hand fishhook	Hath borshi	1	—	√	—
19	Box trap	Chai	1 or 2	—	—	√



Map 5. Map showing important fishing areas in the project areas.

8.7 Fish Survey

A total of 50 species of fishes were identified during the surveys. Among them 6 species are nationally Endangered (*Mastacembelusarmatus, Chitalachitala, Channamarulis, Ompokpabda, Pangasiuspangasius, Rita rita*), 4 species are nationally Vulnerable (*Sperataaor, Wallagoattu, Gudusiachapra, Notopterusnotopterus*), 7 species are nationally Near Threatened (*Hemibagrusmenoda, Labeogonius, Mystuscavasius, Plotosuscanius, Pseudambassisbaculis, Nandusnandus, Cirrhinuscirrhosus*).

Out of 50, 39 species of fishes were sighted by using the method of direct sighting and 11 species of fishes were recorded by using the method of questionnaire surveys. 22 species was recorded in the Monsoon, 45 species in the Post-monsoon and 36 species in the winter. Details of fish species are in Appendix 11.

Fishermen at Bhairab River, 09November 2017. ©IUCN/ Sultan Ahmed

8.8 Vegetation Survey

A total of 117 individuals of 29 species were counted from six sample plots(methodology in Appendix 7). *Syzygiumcumini L.* (Jam), *Areca catechu L.* (Supari), *Cocosnucifera L.* (Narkel), *LanneacoromandelicaMerr.* (Jial) and *Mangiferaindica L.* (Aam) are the five most abundant species in the study area (Table 11). All the identified species are listed in Table 12.

Table 11**.** Ranking of five most abundant species in the study area

Species rank	Species name	Tree/ha
1	*Syzygiumcumini L.*(Jam)	317
2	*Areca catechu L.* (Supari)	233
3	*Cocosnucifera L.* (Narkel)	200
4	*LanneacoromandelicaMerr.* (Jial)	167
5	*Mangiferaindica L.* (Aam)	133

Cocosnucifera L. (Narkel), *Mangiferaindica L.* (Aam), *Swieteniamahagoni (L.) Jacq.* (Mehgoni), *FicushispidaL.f.* (Dumur) and *Leucaenaleucocephala (Lam.) de Wit* (Ipilipil) are the five high frequency species in the study area. Natural regeneration is higher and frequently available in the study area. The natural regeneration is occurred by the mother tree available here. The regeneration is higher in the newsprint mill area because of fewer disturbances by the human.

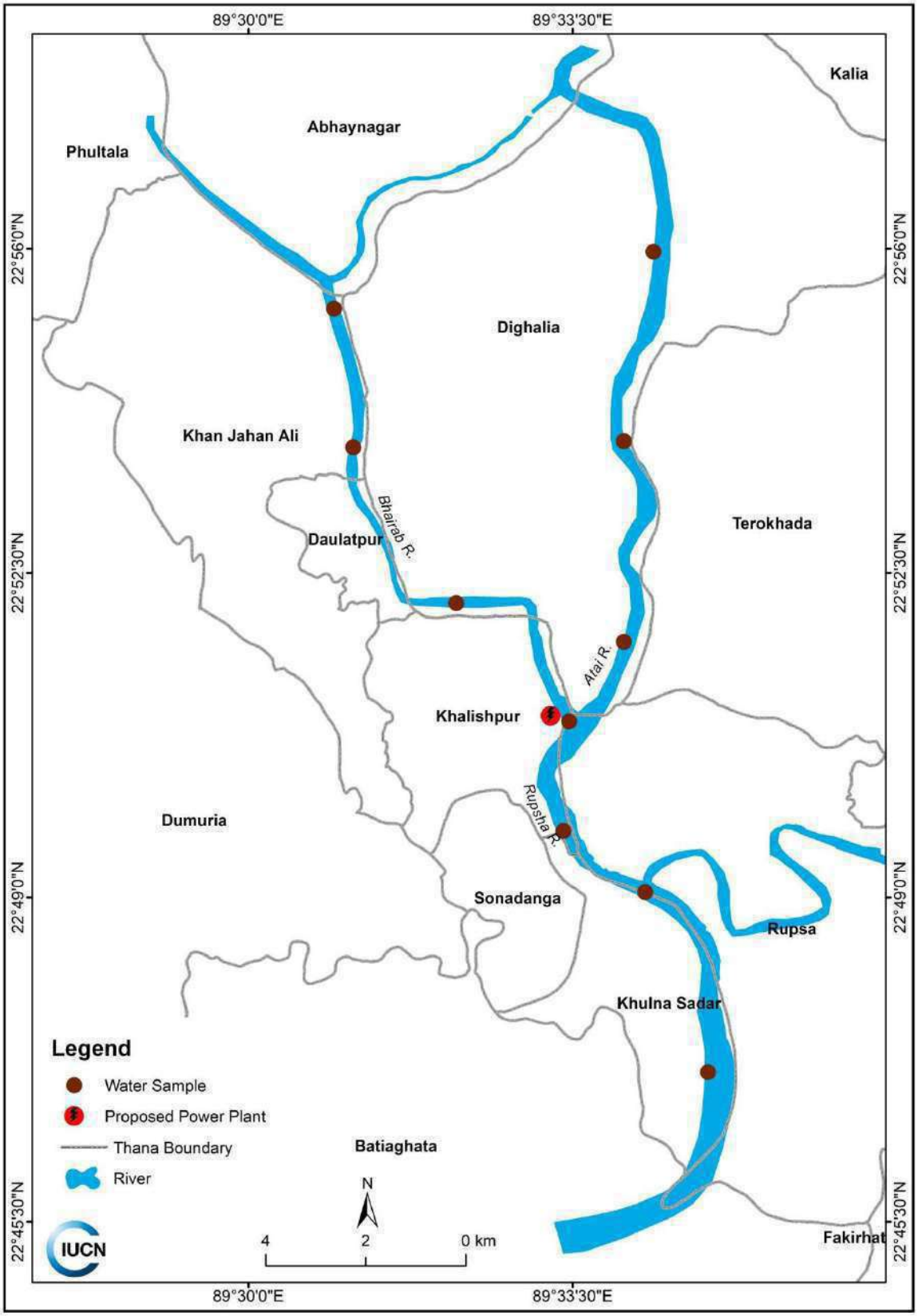
Table 12.List of identified species in the study site

Sl. No.	Scientific Name	Family
1	*Cocos nucifera*	Palme
2	*Mangifera indica*	Anacardicaea
3	*Swietenia mahagoni*	Annonaceae
4	*Ficus hispida*	Moraceae
5	*Leucaena leucocephala*	Leguminoceae
6	*Phoenix sylvestris*	Palmae
7	*Albizia saman*	Leguminoceae
8	*Dalbergia sissoo*	Leguminoceae
9	*Phyllanthus emblica*	Euphobiaceae
10	*Spondias pinnata*	Anacardiaceae
11	*Terminalia arjuna*	Combretaceae
12	*Ziziphus mauritiana*	Rhamnaceae
13	*Aegle marmelos*	Rutaceae
14	*Punica granatum*	Lythraceae
15	*Polyalthia longifolia*	Meliceae
16	*Terminalia chebula*	Combretaceae
17	*Syzygium cumini*	Annonaceae
18	*Lannea coromandelica*	Anacardiaceae
19	*Trema orientalis*	Ulmaceae
20	*Ficus racemosa*	Moraceae
21	*Limonia acidissima*	Rutaceae
22	*Citrus aurantiifolia*	Rutaceae
23	*Artocarpus heterophyllus*	Myrtaceae
24	*Azadirachta indica*	Meliaceae
25	*Elaeis guineensis*	Arecaceae
26	*Psidium guajava*	Myrtaceae
27	*Moringa oleifera*	Moringaceae
28	*Areca catechu*	Palme
29	*Borassus flabellifer*	Palmae

8.9 Water Sample Collection

Water samples collected from the middle of the Rupsha, Bhairab and Atai River based on pollution sources (Map 6). Samples collected from the same location as it was in the monsoon survey. Table 13shows location, GPS coordinates and major infrastructures on the river bank. Samples were collected in first winter survey, but the data is being analyzed and is not included here.

Confluence of Bhairab-Rupsha-Atai River, 22 October 2017,©IUCN/ Sultan Ahmed



Map6. Map showing water sample collection points along transects

Table 13.Water sample collection along the transects with GPS coordinates and major infrastructure on the river bank.

Stations	GPS Co-ordinates		Major infrastructures in the River bank
	Latitude	Longitude	
Station 1 (Rupsha)	22°47.115' N	89°34.958' E	Khulna shipyard, Seven ring cement industry, Fish processing zone
Station 2 (Rupsha)	22°49.060' N	89°34.281' E	Jelkhanaghat, Purobi Salt Factory
Station 3 (Rupsha)	22°49.719' N	89°33.400' E	5 no. fishery ghat, goods load and unload zone
Station 4 (Confluence)	22°50.898' N	89°33.459' E	Brick field, Khalishpurghat, Power plant
Station 5 (Bhairab)	22°52.174' N	89°32.243' E	Padma, Meghna and Jamuna petroleum industry, Jute mill
Station 6 (Bhairab)	22°53.857' N	89°31.130' E	CSD ghat, F.R. jute mil
Station 7 (Bhairab)	22°55.352' N	89°30.921' E	Sheikh cement industry, Brick field
Station 8 (Atai)	22°55.968' N	89°34.370' E	Human settlements
Station 9 (Atai)	22°53.924' N	89°34.051' E	Human settlements, Brick field
Station 10 (Atai)	22°51.758' N	89°34.052' E	Brick field, human settlements

8.10 Water Quality Test Result

Physio-Chemical Parameters

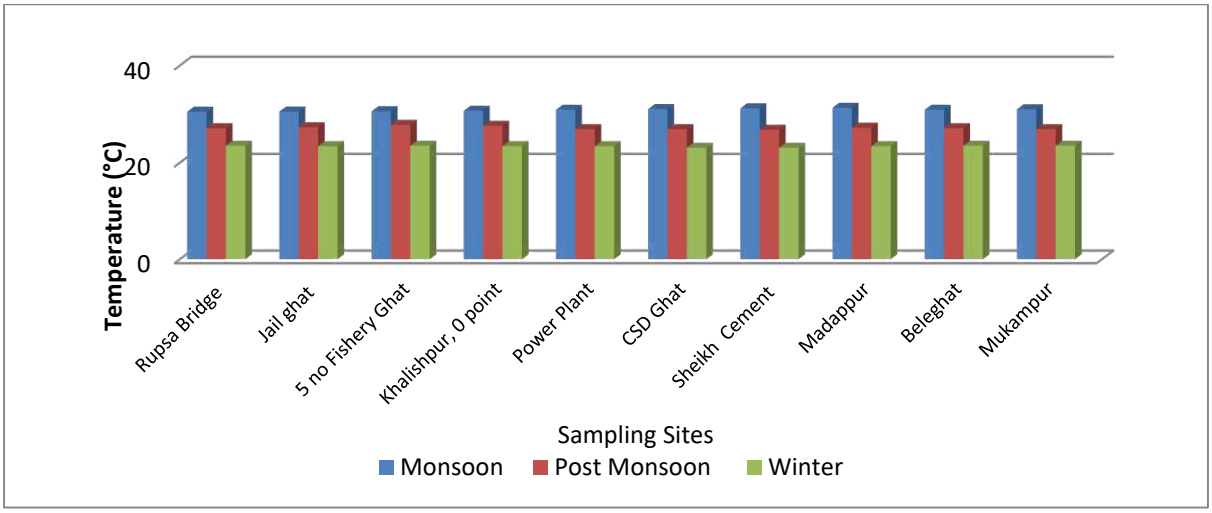


Figure 8. Temperature at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 8illustrates the temperature difference during thethree different time periods i.e. monsoon,post-monsoon and winter season of different river points of the study area. The highest temperature difference was found in Madappur point. The mean

temperature value in monsoon,post-monsoon and winter season was 30.87°C, 27.17°C and 23.38°C, respectively. However, the temperature was found within the permissible limit for both monsoon and post-monsoon season.

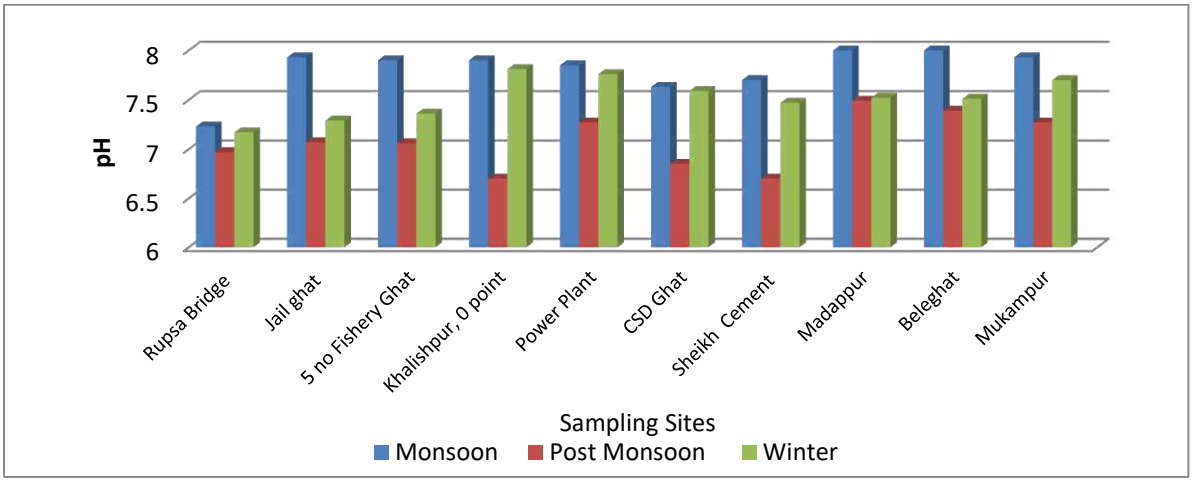


Figure 9. pH at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 9illustrates the pH values during monsoon, post-monsoon and winter season at different sample points of survey area. The pH value did not cross the standard value for Bangladesh in all three seasons. The average pH value was found a bit higher in monsoon season (mean value 7.8) than that of both post-monsoon season (mean value 7.07) and winter season (mean value 7.52). The maximum pH value in monsoon and post-monsoon seasons was found in Madappur Point. But in case of winter season, the maximum pH value (7.81) was found in Khalishpur Zero Point. The mean pH value in monsoon, post-monsoon and winter season was 7.807, 7.077 and 7.518 respectively. The cause of such may be related to the effluent water discharge from the cement factory. The standard pH value of surface water ranges from 6.5-8.5 (ECR, 1997).

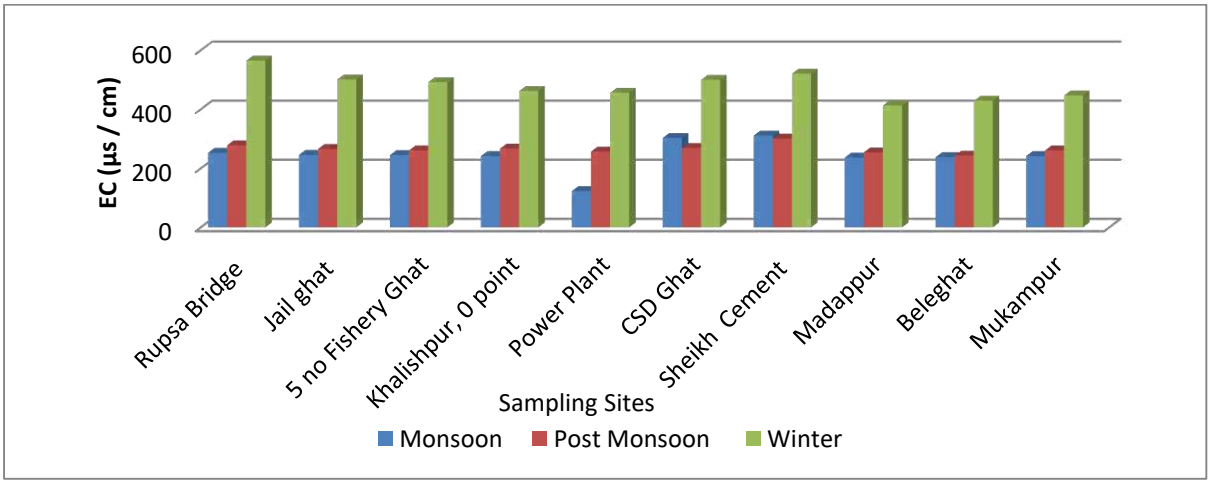


Figure 10. Electrical conductivity at the sample sites of the project area in monsoon, post-monsoon and winter/dry season surveys.

Figure 10 illustrates the EC values during dry, post-monsoon and monsoon season at different sample sites of project area. The EC value was found very high in dry season than that of the monsoon and post-monsoon season. Highest value of electrical conductivity (565) was found in Rupsha Bridge point. The mean EC value in monsoon, post-monsoon and dry season was 243.8, 265.7 and 478.6, respectively. However, in all other sample points, the EC value was below the standard EC value of river water for Bangladesh.

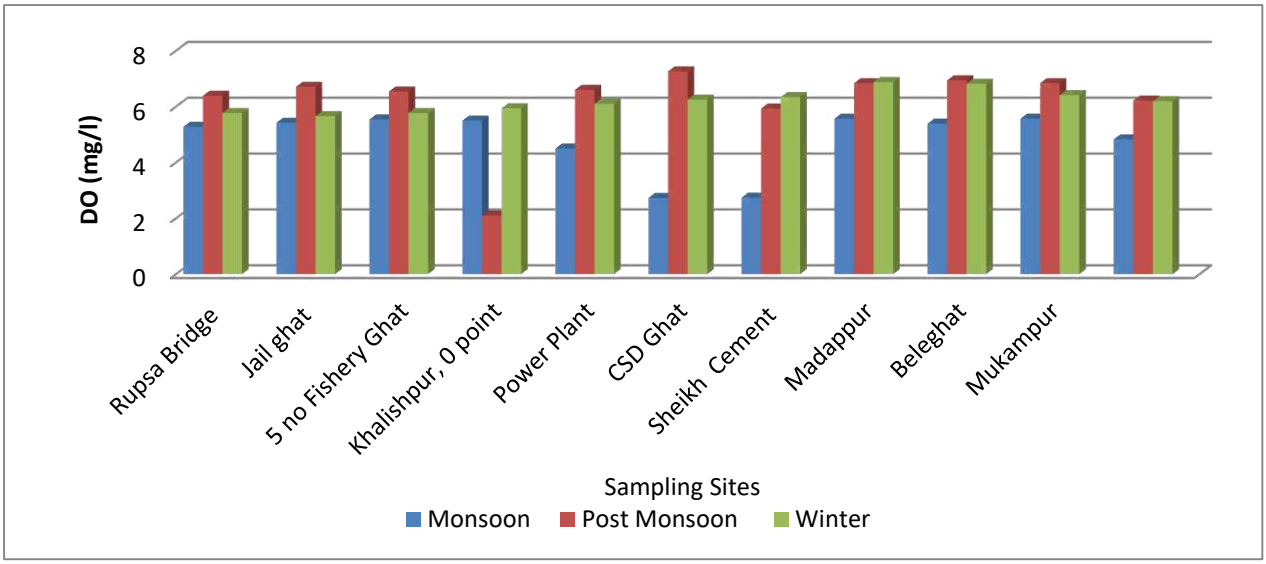


Figure 11. Dissolved oxygen at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 11 illustrates the DO values during dry, post-monsoon and monsoon survey at different sample sites of the study area. As we know, the level of Do required for survival of aquatic life is between 5 to 6 mg/l and DO level below 1.0 mg/l will not support any aquatic species. DO in the sampled water was found satisfactory during monsoon season. However, this concentration increases for all sample location in both post-monsoon and dry seasons with a maximum concentration at CSD Ghat (i.e. 7.26) in post-monsoon season and at Madappur point (i.e. 6.88) in dry season. The average concentration of DO in post-monsoon season was 6.22 mg/l whereas it was 4.8 mg/l in monsoon season and 6.19 mg/l in dry season. Therefore, it can be said that the concentration of Dissolved Oxygen (DO) was found higher in post-monsoon season and winter season and thus indicates water pollution at moderate level in the sampled river water.

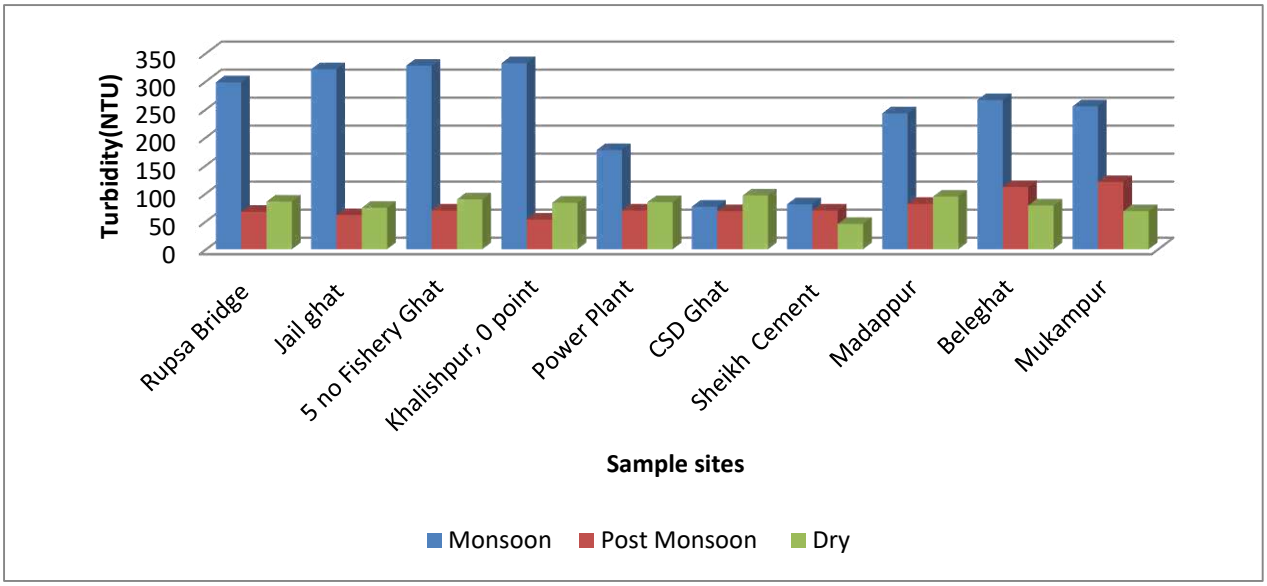


Figure 12. Turbidity at the sample sites of the project area in area in monsoon, post-monsoon and winter/dryseason surveys.

Figure 12 illustrates the turbidity values during dry, post-monsoon and monsoon surveys at different sample sites of project area. Though in dry and post-monsoon season turbidity was found almost steady at all sampled locations, it varied widely in the monsoon season with highest concentration at Khalishpur (327 NTU). The mean Turbidity value in monsoon, post-monsoon and winter season was 237.62 NTU, 76.8 NTU and 79.62 NTU, respectively.

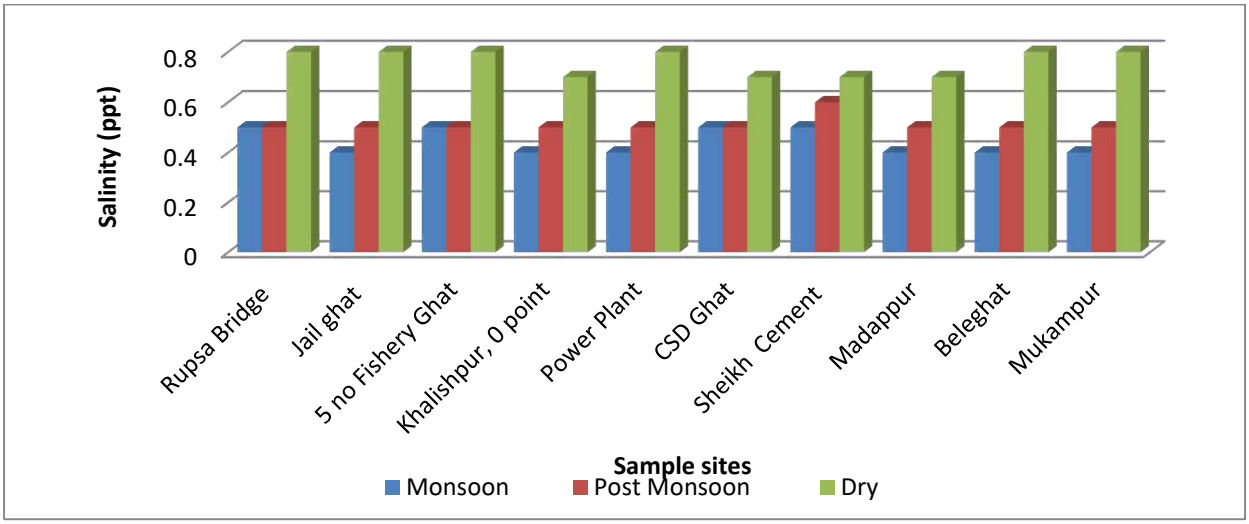


Figure 13. Salinity at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 13 illustrates the difference in salinity during dry, post-monsoon and monsoon season at different sample sites of the project areas. The salinity concentration in the river water was found higher in winter season, whereas slightly higher in post-

monsoon season than in monsoon season. The mean salinity concentration in monsoon, post-monsoon and dry season was found 0.44, 0.51 and 0.76, respectively.

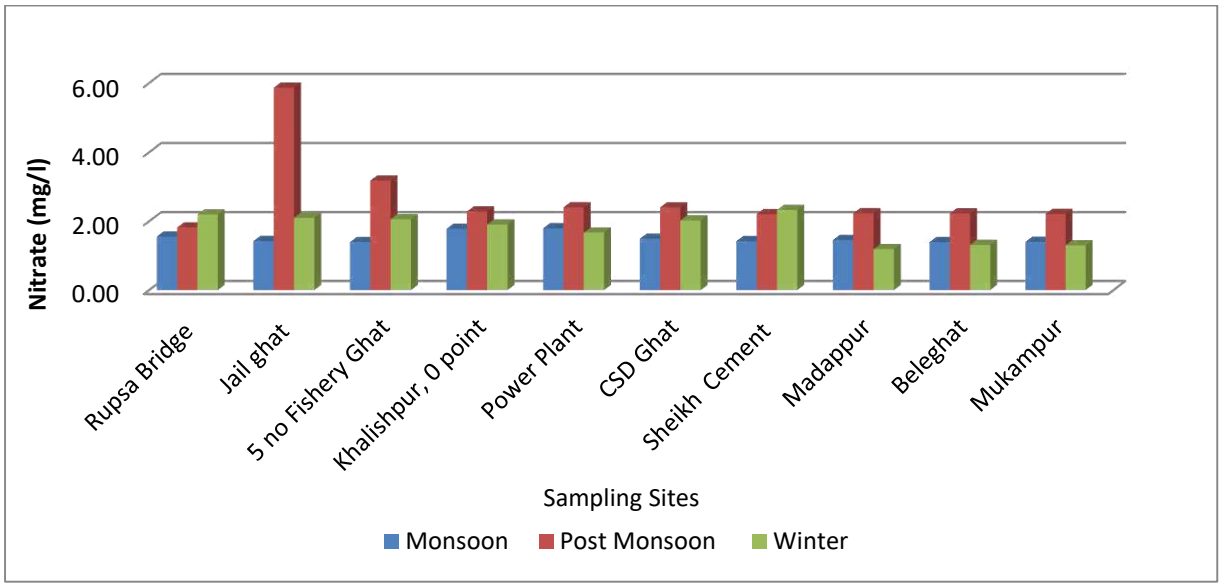


Figure 14. Nitrate value at the sample sites of the project area in area in monsoon, post-monsoon and winter season surveys.

Figure 14 illustrates the nitrate values during dry, post-monsoon and monsoon surveys at different sample sites of the project areas. Nitrate concentration of sample water ranges from lowest of 1.40 mg/l to a maximum 1.80 mg/l in the monsoon, from a lowest of 1.82 mg/l to a maximum of 5.87 mg/l in post-monsoon and from a lowest of 1.19 mg/l to a maximum of 2.20 mg/l in winter season. The standard nitrate value is 10 mg/l. The post-monsoon season nitrate concentration was found a little bit higher than that of the monsoon and dry season (2.68, 1.51 and 1.81 mg/l, respectively). This small amount of nitrate was probably coming from the adjacent agricultural land. However, the highest concentration of nitrogen was found in Jail Ghat (5.87 mg/l) and the probable cause might be the obvious direct discharge of agricultural waste into the river.

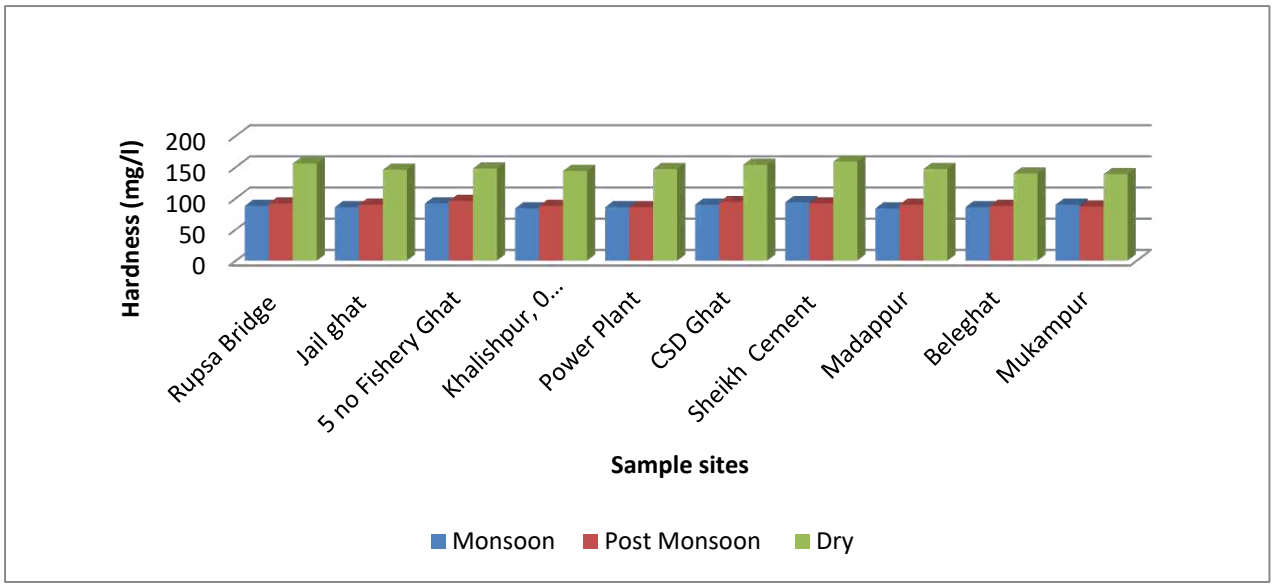


Figure 15. Hardness at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 15 illustrates the hardness value during winter, post-monsoon and monsoon season at different sample sites of project area. Significant difference in hardness of the river water was found between post-monsoon and monsoon season with dry season. The mean Hardness value in monsoon, post-monsoon and dry season was found 88, 90.3 and 148, respectively. Highest value of Hardness (i.e. 159 mg/l) was found in Sheikh Cement point at winter season.

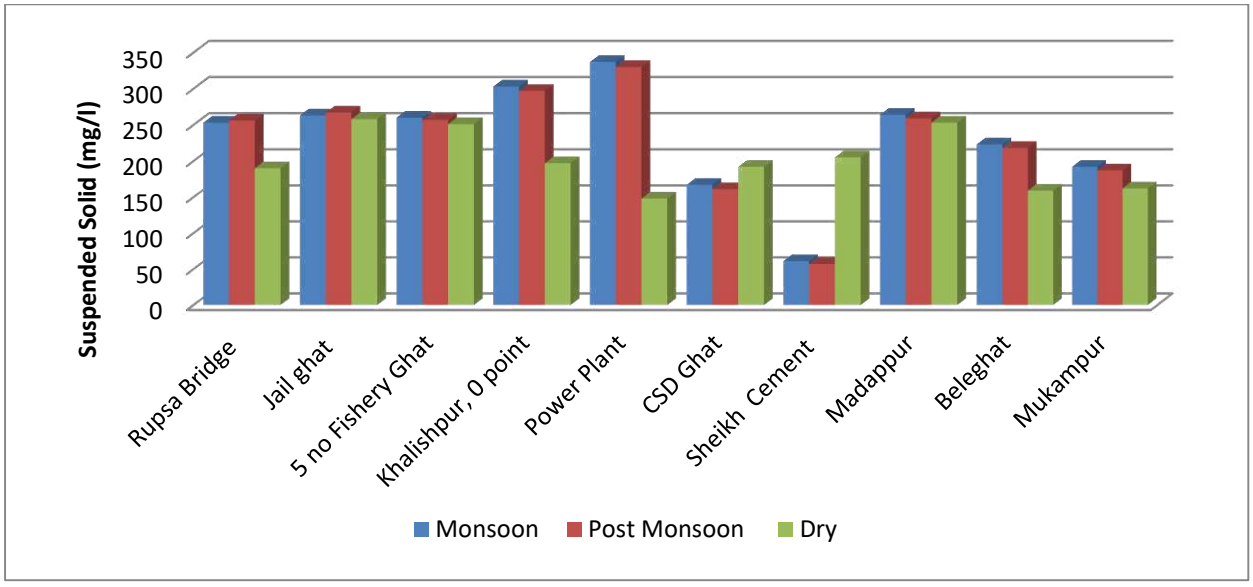


Figure16. Suspended solid at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 16 illustrates the suspended solid values during post-monsoon and monsoon season at sample sites of project area. Concentration of suspended solid was found higher than the standard value (150 mg/l) at all sample sites, irrespective of the season. However, no significant seasonal difference was found in concentration of the suspended solid. The average suspended solids in post-monsoon and monsoon season was 228.9mg/l and 232.3 mg/l, respectively.

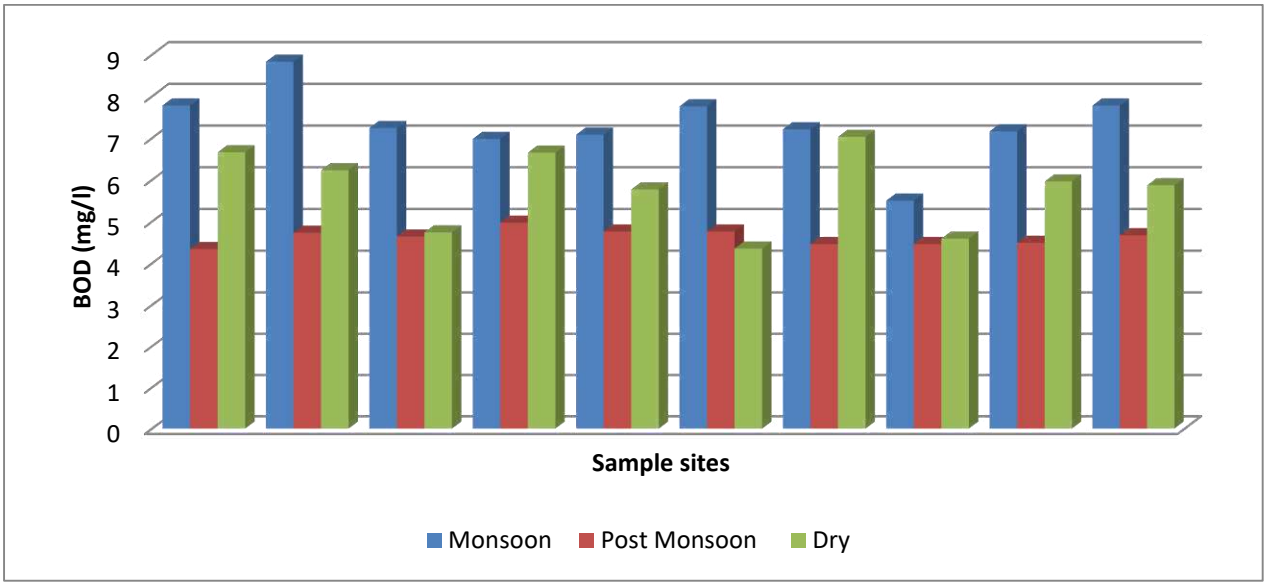


Figure 17. Biological Oxygen Demand at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 17 illustrates the BOD values during winter, post-monsoon and monsoon season at different sampled sites of the project area. The standard limit of BOD concentration in surface water is 50mg/l. None of the water samples collected in the dry, post-monsoon and monsoon season crossed the standard value for BOD. However, it is observed from the data that the BOD level in monsoon season decreases compared to other seasons. The average BOD level was 7.33, 4.62 and 5.8 mg/l of monsoon, post-monsoon and dry season, respectively. The maximum difference in BOD concentration was found in Jail Ghat location (8.83 mg/l). However, the overall BOD concentration in the river water was found satisfactory and it was well below the standard limit for surface water quality.

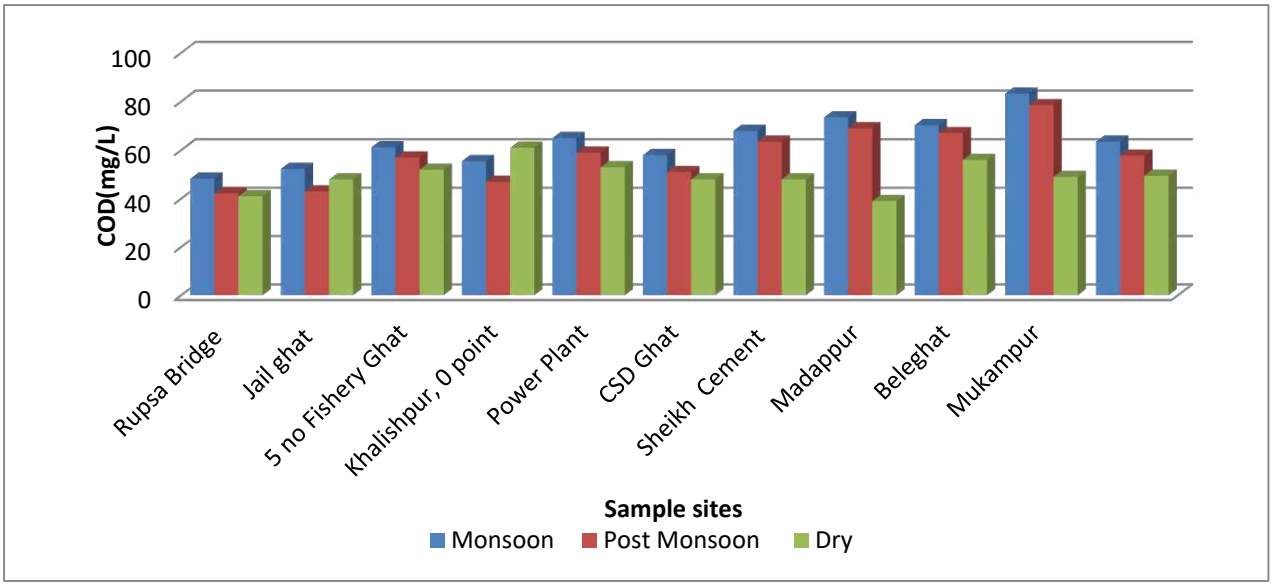


Figure 18. Chemical Oxygen Demand at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 18 illustrates the difference in COD value during dry, post-monsoon and monsoon season at the sample sites of project area. Average COD of the collected water samples for winter, post-monsoon and monsoon season was found to be 49.5 mg/l, 57.53 mg/l and 63.53mg/l, respectively; which is much lower than the national average of 200 mg/l.

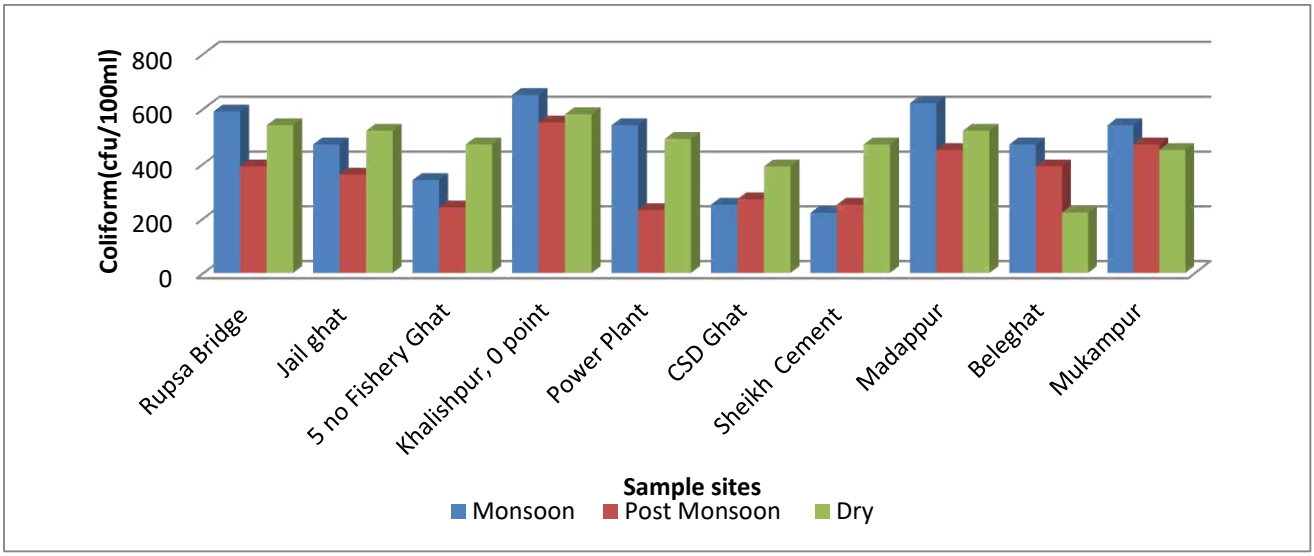


Figure19. Coliform at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 19 illustrates the total coliform value during winter, post-monsoon and monsoon season at the sample sites of project area. Average coliform concentration was found to be higher in the monsoon season (469 cfu/100 ml) which is close to the concentration of winter season (465.1 cfu/100 ml). The minimum average coliform concentration was in post monsoon season (360 cfu.100 ml).

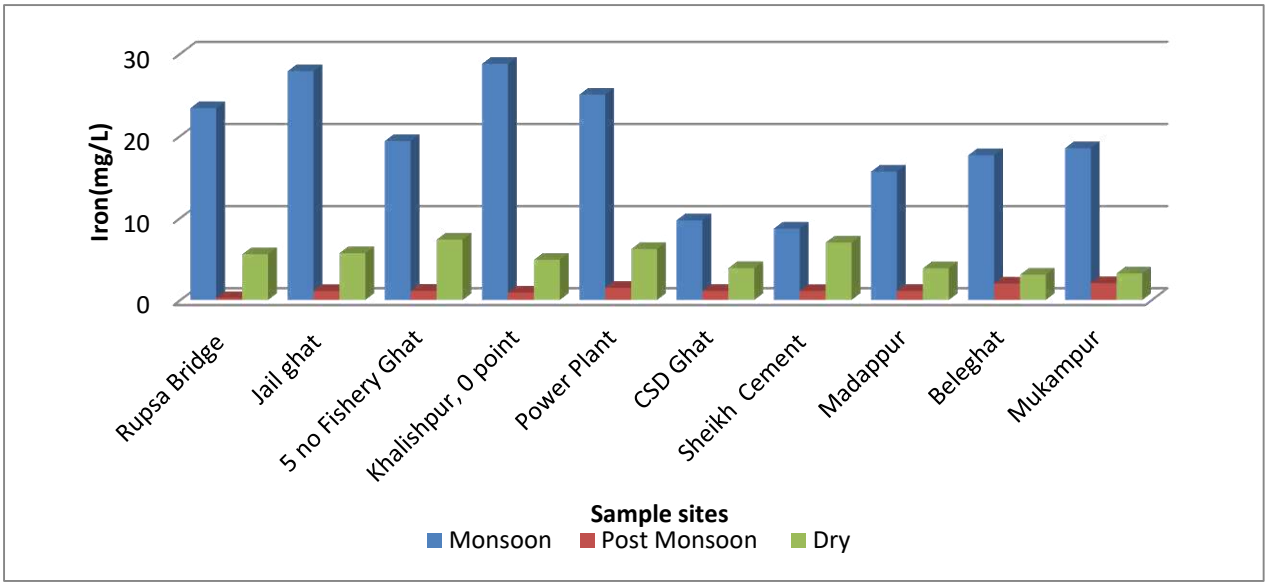


Figure 20. Salinity at the sample sites of the project area in area in monsoon, post-monsoon and winter or dry season surveys.

Figure 20 illustrates the iron value during winter, post-monsoon and monsoon season at the sample sites of the project areas. Average concentration of iron in the collected water sample in monsoon season was much higher than that of the post-monsoon and dry season concentration (average 19.44 mg/l, 1.219 mg/l and 5.08 mg/l, respectively). Flood water brings lot of sediments and minerals from the upstream region and this might be the reason for high concentration of iron in the river water during monsoon season.

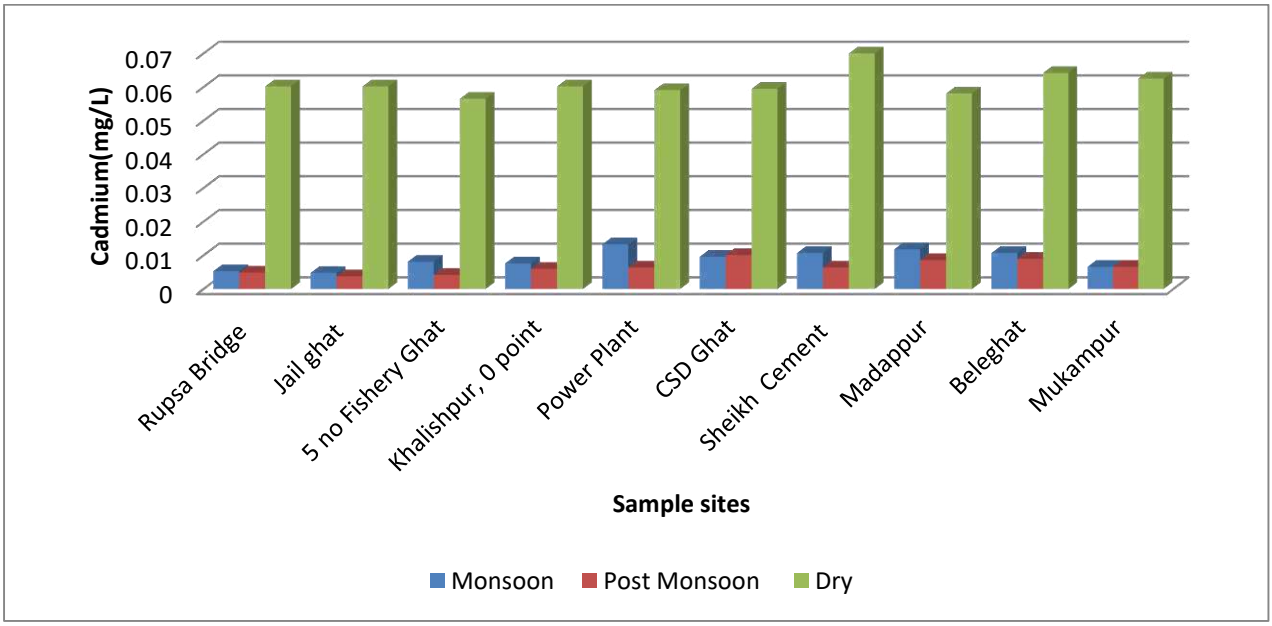


Figure 21. Cadmium at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 21 illustrates the Cadmium values during dry, post-monsoon and monsoon season at sample sites of the project area.Average Cadmium concentration was found to be very high in the dry season (0.06mg/l) which is little over the surface water quality standard for Bangladesh of 0.05 mg/l. Although elevated iron concentration was found in some water samples, however in general, concentration of cadmium in the river water did not exceed relevant quality standard during monsoon (0.009 mg/l) and post-monsoon season (0.007 mg/l), beyond which it becomes a threat to freshwater life. The highest cadmium concentration (i.e. 0.0642 mg/l) was found in the Beleghat point.

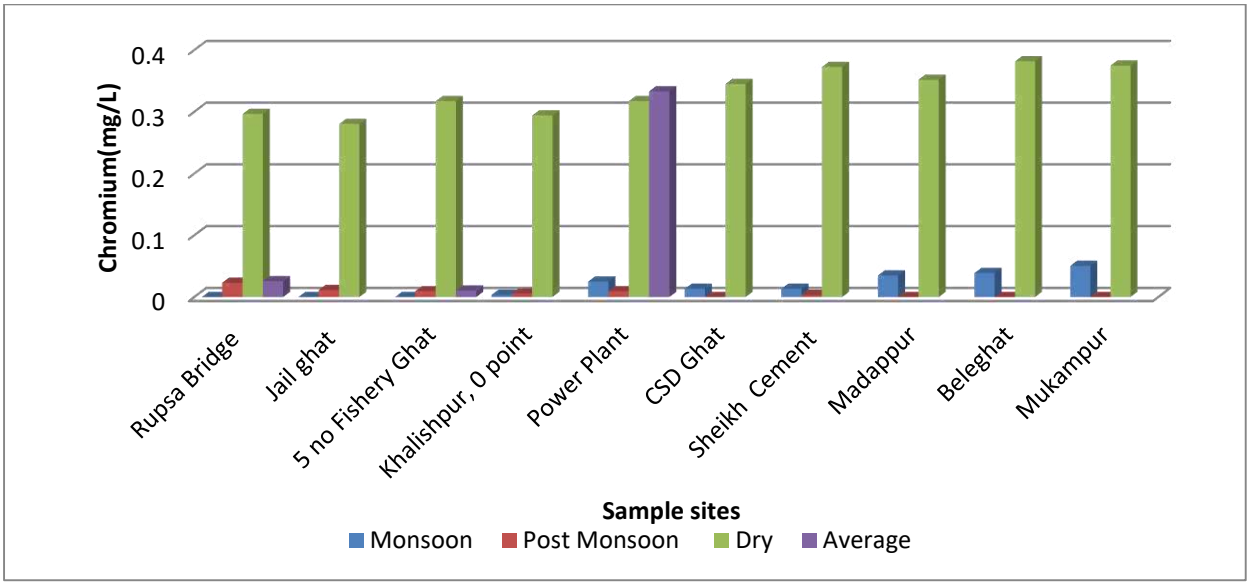


Figure 22. Chromium at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry period surveys.

Figure 22 illustrates the Chromium values during winter, post-monsoon and monsoon season at sample sites of the project area. Average Chromium concentration was found to be very high in the dry season (0.33 mg/l) than that of the monsoon (0.026 mg/l) and post-monsoon (0.01 mg/l) season, which is much below than the national standard of 0.5 mg/l.

8.11 Biological Parameters

A total of 15 genera of phytoplankton and two unknown genera of zooplankton were found in the 6 study sites. Among the plankton, *Oscillatoria* and *Melosira* were found in all 6 study sites indicating that these two genera are common in the study area. On the other hand, *Nostoc*, *Pediastrum,Cymbella* and *Volvox* were found only in single site indicating that these genera are less common in the study area. Maximum number of genera (10) were found in 5 No. Fishery ghat, Rupsha and minimum number of genera (4) were found in the site of Rupshabridge, Rupsha. *Microsystis* sp. is considered as indicator of water pollution. This genus was found more abundantly in 5 No. Fishery ghat, Rupsha than other sites indicating that water of this site might be polluted.

Table 14**.** Abundance (individuals/litre water) of plankton in the study sites

Sl. No	**Name of organisms**	**Family**	**Rupsa bridge, Rupsa**	**Jail ghat, Rupsa**	**5 no. fishery ghat, Rupsa**	**Khalispur, Confluence**	**Power plant, Bairab**	**CSD ghat, Bairab**
1	*Oscillatoria* sp.	Oscillatoriaceae	8.8×10^4	1.84×10^5	1.2×10^5	1.36×10^5	4.0×10^4	6.4×10^4
2	*Melosira* sp.	Melosiraceae	1.12×10^5	1.04×10^5	1.2×10^5	1.12×10^5	1.44×10^5	1.28×10^4
3	*Gloeocapsa* sp.	Microcystaceae	1.6×10^4	-	-	-	-	-
4	*Closterium* sp.	Desmidiaceae	8.0×10^3	8.0×10^3	8.0×10^3	-	3.2×10^4	-
5	*Microsystis* sp.	Microcystaceae	-	8.0×10^3	1.6×10^4	1.6×10^4	8.0×10^3	8.0×10^3
7	*Navicula* sp.	Naviculaceae	-	8.0×10^3	8.0×10^3	-	-	8.0×10^3
8	*Anabaena* sp.	Nostocaceae	-	1.6×10^4	-	-	-	-
9	*Synedra* sp.	Fragilariaceae	-	-	8.0×10^3	1.6×10^4	8.0×10^3	8.0×10^3
10	*Gyrosigma* sp.	Naviculaceae	-	-	-	8.0×10^3	-	-
11	*Nostoc* sp.	Nostocaceae	-	-	8.0×10^3	-	-	-
12	*Pediastrum* sp.	Hydrodictyaceae	-	-	8.0×10^3	-	-	-
13	*Cymbella* sp.	Cymbellaceae	-	-	-	-	8.0×10^3	-
14	*Scenedesmus* sp.	Scenedesmaceae	-	-	8.0×10^3	-	-	8.0×10^3
15	*Volvox* sp.	Volvocaceae	-	-	-	-	-	1.6×10^4
16	Zooplankton (unknown)		-	-	-	-	1.6×10^4	1.6×10^4
17	Unknown		-	-	2.4×10^4	8.0×10^3		

'-' organism not found

9. Impact and Mitigation

On the basis of literature review and analysis of the survey results, the potential impacts and mitigation for different phases of the power plant is given below.

Pre-construction Phase				
Parameter	Source	Overall Impact	Impact on dolphins	Mitigation
Ambient Air quality	Dust and gases generated from demolition works and transportation of the debris	The emitted dust from the demolishing areas will disperse to the ambient environment. The particulate matters inhaled by the human may cause respiratory problem. Moreover, the dust will fall over the leaves of the vegetation and water bodies, including rivers, near to the project site causing pollution and may affect aquatic ecosystem.	These emitted dust particles may include nitrogen, mercury compounds which may deposit on the river and accelerate etrophication. It will result in excess algae blooms which depletes oxygen levels and kills aquatic life. It will hamper the food chain and deplete fish stock which in turn will affect prey population of dolphins.	-Avoid the demolition works in the evening especially during the dry season or watering to the possible sources of fugitive emission. -Regular water spraying on the adjacent vegetation, roads andunpaved groundespecially during dry season to avoid dust. -The transportations carrying debris should be moved as soon as possible to avoid accumulation and being blown by wind. -Impact and compliance monitoring should be done as per the recommended guideline at all the sensitive locations.
Ambient Noise quality	Demolishing buildings and other structures using heavy machineries. Heavy movement of traffic and machineries.	Loud noise will affect the behavior of Ganges River Dolphins and other the nocturnal animals. Generation of impulse noise will harm the community people.	Dolphins rely on echolocation for detecting prey, communication and navigation. Noise pollution may cause trouble for them to hunt, navigate and communicate.	-The procedure of demolition should be conducted as per the guidelines. -Noise level must not exceed a set threshold. -The machines/ equipment/ vehicles

	During transportation by ships			should be turned off when not in use. -All sound-reducing devices and restrictions should be properly maintained throughout the demolition period. -Limit the hours of demolition works. -Use rubber-tired equipment rather than track equipment -Reduce the use of large cargo water vessels for the transportation of materials. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site. -Keep loading and staging areas on site within the perimeter protected by the recommended temporary noise barrier and away from the noise-sensitive sidesofsite.
Loss of vegetation	Dispersion of the dust particles during destruction of building Chop down of terrestrial vegetation	The normal photosynthesis and the transpiration process of plant will be affected due to dust particle Chop down of terrestrial	There are no direct impact	In the significant portion of the proposed power plant area green belt should be developed which will ultimately makeup the loss of carbon dioxide sequestration due to clearing of

		vegetation will reduce carbon sequestration of about 6880.480046 for 30 acres of land cover and will ultimately impact biological process and food chain as well Removal of enormous terrestrial vegetation may cause damage of habitats like mammals, reptiles etc. which may create pressure on other species.		existing vegetation and also conserve the visiting animals of the project studyarea and also beyond that area.
Water quality	Discharge of oil or other pollutants during material transportation by ship. Backfilling, food waste, plastic, papers, metal or plastic binders, solid wastes from other sources.	During pre-construction, backfilling soil and other solid wastes may leach into the surrounding water bodies which degrades the water quality, affects the fish habitats and other aquatic life.	Breathing organs of invertebrates, fish, dolphins can be clogged. Primary and secondary production of fish habitat can be reduced which will affect dolphin prey.	-For any discharge from the project site and vessels, GOB and IFC guidelines should be followed -Proper waste disposal management plan should be implemented.
Construction Phase				
Parameter	**Source**	**Overall Impact**	**Impact on dolphins**	**Mitigation**
Ambient air quality	Dust resulting from construction work and transportation of raw materials. Exhaust gas from	Operation of construction equipment and vehicles may generate PM, CO, CO_2, NOx, SOx, etc. As a result, engineers and	Emitted dust particles include nitrogen, mercury compounds which can be deposited from the plant site to water bodies. When excess mercury deposits in river it may turn into methyl	-Watering access road andconstruction site, especiallyin the dry season -Using cover sheets on trucks and open cargo water vessels

	construction machinery and vehicles used for mobilization of equipment. Air pollution arising from incineration of construction.	workers might suffer from lung diseases including shortness of breath, coughing, wheezing; chest pain; loss of appetite; tiredness due to the prolonged inhalation of dusts by the site. Particulate matter, dust will fall on the leaves, vegetation and water bodies near to the project site. Gasses in air may mix with rain and fall on waterbodies causing contamination.	mercury that affects aquatic plants, microorganisms and fish species. As a result, the food chain is affected which might have an impact on the dolphins.	for the transportation raw materials. -Regular maintenance and management of all the construction machinery andvehicles -Prohibit open burning -Impact and compliance monitoring should be done as per the recommended guideline at the sensitive location. -Reduce the use of large cargo water vessels for the transportation of materials. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site.
Ambient noise quality	Construction machinery such as pumps, generators, compressors ,pile drivers, rock drills etc. Vehicles transporting equipments and workers	Communities settled beside proposed project will be effected. Noise pollution will directly cause health hazards to the nearby residents and construction workers on the site. Loud noise will affect the behavior of Ganges River Dolphins and other the nocturnal animals.	Dolphins use echolocation for communication, navigation and finding prey. Noise pollution will effect dolphin populations, interrupt their normal behavior, way of movement, hunting behavior and driving them away from the important areas.	-Optimizing construction schedule work during daytime, especially piling work. -Using low-noise/ low vibration equipment as much as possible. -Reduce the use of large cargo water vessels for the transportation of materials.

				-Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site. -Roadways should be used for transportation of materialand equipments. -Route-setting and speed limit for water vessels -The machines/ equipment/ vehicles should be turned off when not in use. -Using of appropriate safety equippments (eg. ear plugs) during construction work. -Temporary noise barriers are infeasible, portable noise panels -Keep loading and staging areas on site within the perimeter protected by the recommended temporary noise barrier and away from the noise-sensitive sides of the site.
Ambient water quality	Run-off water from construction area containing pollutants. Domestic	Disposal of such harmful substances into the river water have temporary and permanent impact on fisheries.	Oil spillage from water vessels may contains heavy metals such as mercury, copper and selenium which have negative	-All the vessels must follow the inland water transport regulations of GOB as applicable -During any kind of discharges from the

	wastewater from workers. Inappropriate disposal of waste. Leakage oil and chemical materials from construction activity.	Discharge of wastewater increase the turbidity of the river which clogs breathing organ of fish habitats and leads to death.	effects on the health of dolphin population. Bio-accumulation of many of these chemicals may have adverse effects on dolphins. Prey population of dolphins might be effected.	project site and from the vessels or construction equipment during construction period, GOB and IFC guidelines should be strictly followed. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site to avoid spillage.
Waste disposal	Large amount of construction waste from construction site/transport vehicles including waste water, unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from labor sheds, packaging materials, used home appliances, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc	Indiscriminate dumping of waste may affect surrounding aquatic species and may also lead to the spread of various diseases.	Waste containing chemicals may create imbalances in riverine ecosystems. As a result fish and aquatic plants may die, bacteria may flourish and cause disease and disrupt in the food chain which may result in decrease in prey population or adverse health effects on dolphins. Toxic algae outbreaks may cause by these imbalances that may reduce oxygen in the water, driving dolphins away from important areas. Also debris, including plastic, tarps, nets and other non-degradable objects dumped in water might trap or choke dolphins, especially young animals.	-For any discharge from the project site and vessels, GOB and IFC guidelines should be followed -Conduct separate waste collection and promote recycling and reuse. -Appropriate disposal of non-recyclable waste according to rules -Wastes generated from the construction site should be stored in appropriate bins/skips, well-covered and later buried in an approved landfill site. -All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal.

				-Proper waste disposal management plan should be implemented.
Operational Phase				
Parameter	Source	Overall Impact	Impact on dolphins	Mitigation
Ambient air quality	Oxides of Nitrogen (NOx), Oxides of Sulfur (SOx), Carbon Monoxide (CO), particulate matters may be emitted from stacks and chimneys of power plant.	Emission of exhaust gas from the stack may contribute elevated ground level concentration of CO, CO_2, NOx, particulate matter etc. at the down wind direction. The emission of SOx, NOx and PM may have significant impact on vegetation and other species. NOx, SOx, CO and PM can be washed into the river through rain. Particulate matter, dust will fall on the leaves, vegetation and water bodies near to the project site.	Emitted dust particles from the plant site include nitrogen, mercury compounds which can be deposited into the water bodies causes eutrophication and kills aquatic life. When excess mercury deposits in river it may turn into methyl mercury that affects aquatic plants, microorganisms and fish species. As a result, the whole food chain is affected and can adversely effect dolphin and dolphin prey.	-Power plant should adopt inbuilt pollution control measures like Low-NOx burner, Wet injection process etc -Cleaner fuel should be used to run the power plant -Emission from the stacks must belimited to the IFC, 2008 standard for thermal power plant. -All measures for limiting the emission of SOx, NOx and PM should be within the GOB standards and IFC guidelines -On the other hand, significant portion of greenbelt in and around the project area should be developed to improve the vegetation coverage and enhance the capacity of carbonsinking.
Ambient water quality	Thermal effluents from cooling system. Wastewater from plant process.	Discharge of wastewater, effluents and accidental spillage of oil and chemical materials into river and open water reduces the productivity of fish habitats.	Oil spillage from water vehicle contains heavy metals such as mercury, copper and selenium might have direct harmful effects on dolphins.	-Thermal effluents should be discharged far from the intake point of cooling water to reduce the impact on surrounding area. -No waste water should be

	Leakages of oil and chemical materials. Abstraction of river water. Collection of fresh water.	Water intake from the river would entrap fish, crustaceans and other aquatic organisms. Predator-prey relationship might be affected due to spread of invasive species through ballast water. Direct discharge of hot water into the river might have harmful effects on fish population.	Effects on fish population will also have adverse effects on prey of dolphins. Water extraction from river particularly during dry season for cooling and makeup process of power plant may affect aquatic ecosystem, aquatic species including dolphin and their prey.	discharged to the river without treatment. Installation of waste water treatment system by neutralization, settling and oil separation so any wastewater produced complies with wastewater standards and IFC and GOB guidelines. -Storage of oil and chemical materials in appropriate tanks with retaining walland method to prevent permeation into ground and leaching into the river. -Temporary water reservoir can be built for water storage rather than direct abstraction from river. -Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intakevelocities should be as low as possible
Ambient Noise quality	Noise from steam turbines generators, and pumps, etc. Transportation of power plant equipment	Hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from the plant.	Transportation of power plant equipment, other materials may affects habitat quality of aquatic species due to creation of underwater noise. As dolphins rely on echolocation for detecting prey,	-Installation of low noise/low vibration type equipment -Adequate enclosure ofequipment to reduce noise -All the vessels must follow the standard of IMO, MARPOL during transportation

			communication and navigation. Noise pollution threats their survival.	of materials up to the port of delivery of foreign imported machinery and equipment. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site to avoid spillage.
Waste disposal	Waste water, waste oil, sludge and other untreated effluent. Solid waste generated from the workers living within the region such as cans, bottles and food. Hydrazine added in boiler water.	Hydrazine is a known carcinogen and a mutagen which is added in the boiler water in power plant. Workers may be exposed to hydrazine from the boiler blow down. Generation of waste may affect the fish habitats and surrounding aquatic species	Wastes may leach into nearby canal and river, affecting aquatic life. Toxic algae outbreaks may take place and reduce oxygen in the water, driving dolphins from important areas. Also debris, including plastic bags, tarps and other non-degradable objects dumped along shorelines and in coastal areas will trap or choke dolphins, especially young animals	-Waste management program consisting of -reduction, reuse, and recycling of materials -Systematic collection and protected storage -Waste disposal should be at appropriate location -Installation of wastewater treatment system by neutralization, settling and oil separation so any wastewater produced complies with wastewater standards and IFC guidelines -Hazardous waste should be treated under the related regulations.

*Source:1)DRAFT REPORT ON ENVIRONMENTALIMPACT ASSESSMENTRUPSHA 800 MW COMBINED CYCLE POWER PLANTVOLUME – I (BOOK 1 OF 2)
2) Report onEnvironmental Impact AssessmentofConstruction of Matarbari 600X2 MW Coal FiredPower Plant and Associated FacilitiesVolume 1 and 2
3)Whalesorg. (2017). *WDC, Whale and Dolphin Conservation*. Retrieved 14 December, 2017, from http://uk.whales.org/issues/pollution

10. Recommendations

From the field surveys, analysis and the results, recommendations are provided below:

- Regular long-term monitoring of dolphins following the current methodology and other wildlife should be continued during construction phase. This is important to know whether there are any effects on the dolphin population in the area. The results of the surveys that are presented in this report will act as a baseline. Long-term monitoring will also show the effectiveness of mitigation measures implemented. Regular monitoring will also help to propose conservation measures if there is a decrease in dolphin population.

- Important dolphin areas have been identified from the surveys (Map 2), where there is high concentration of dolphins, including calves. It should be ensured that these areas are disturbed as less as possible by following the mitigation measures as well as close monitoring.

- As stated in the mitigation section, it is not recommended that large cargo water vessels/Berge carrying heavy equipments for Rupsha 800 MW CCPP Project should move through the important dolphin areas. The movement of high number of large cargo water vessels will create a lot of noise. As dolphins use echolocation (a process where an animal uses calls for navigation, communication and hunting), loud noises will disrupt their normal behaviour, causing adverse effects to the dolphin population. If there is movement of large cargo vessels, specific routes will have to be identified in the areas, during specific time of the day so that disturbance is limited.

- It is recommended that the large cargo water vessels be docked in a more suitable place away from the important dolphin areas, and the materials be transported via roads to the construction sites, where applicable.

- No waste or chemicals can be discharged during O&M of Rupsha 800 MW CCPP into the river without treatment and following standard guidelines from the project site or transport vehicles.

- Mitigation measures stated in section 4 (Impact and Mitigation) should be followed to ensure that the adverse effects are mitigated and the dolphins are not harmed.

Appendix 1: Dolphin individuals recorded during the survey period

Survey season	Number of Sighting	Area (low and high tide) (km)	Encounter Rate/km in each survey
Pre-monsoon survey	70	60	1.17
First monsoon survey	50	60	0.833
Second monsoon survey	62	60	1.03
First post-monsoon survey	102	60	1.70
Total	**285**	**240**	**4.18**
Average Encounter Rate	**1.18** (the total area will be 30kmx8=240km and Encounter rate will be 284/240=1.18)		

Appendix 2: Dolphin survey methodology

Teams	1. A primary observer team will be stationed on the upper deck (approximately 4.4 m above the waterline) 2. A secondary observer team will be stationed on the lower deck (c.2.3 m above the waterline) 3. The two independent observer teams will not be in visual contact and observers will be instructed to avoid alerting the other team about dolphin sightings. (Note: this will maintain the independence of results.)
Observer position	1. Three observers will stand watch at all times while "on-effort" (i.e., actively searching for dolphins along the transect line and recording effort and sighting data) 2. One will be stationed on each the port and starboard sides, searching with handheld binoculars and naked eye from the beam to about 10^0 past the bow 3. One in the centre searching by naked eye in about a 20^0 cone in front of the bow 4. The centre observer will also serve as the data recorder. Both primary and secondary teams will be comprised of the same structure.
Observer rotation	1. Observer will be rotated through the three different positions every 30 min followed by at least an hour of rest before switching teams. 2. Each team will have 3 observers. There will be a back up team who will switch positions during rotation every 30 mins.
Transect and Boat Speed	1. Transect will start from the lower part of Rupsha river and finish at upper part of Bhairab river. We will cover a total 20 km in favor of the tide. We will then move into Atairiver where we will not be in favor of the tide.

	Then we will cover the last 10 km of Atairiver. The boat speed will be controlled accordingly. 2. Boat speed will be on average 10 km/hour.
Survey Equipment	• Handheld 7 x 43 binoculars • Laser Range Finder (will be used if less than 500m) • Handheld GPS (GARMIN GPSmap62s) • Double decked boat will be used in the survey.
Sighting conditions	Every 30 min, at the location of dolphin sightings, or when there will be a significant change in sighting conditions we will record our position with a Global Positioning System and information on sighting conditions, human activities, channel width, and the distance cover along the transect line.
Channel width	Channel width will be recorded according to the sum of distance measurements to the right and left banks using a laser range finder, if less than 500 m, or the sum of estimates will be made by naked eye, if greater. We can also use satellite image to measure the channel width according to the GPS coordinates if both options are not feasible.
Sighting condition codes	Wind, glare, or rain/fog conditions will be given codes of 0, 1, or 2 corresponding to good, fair and poor respectively.
Dolphins data record	1. Species; 2. Time; 3. Radial distance to the first dolphin sighted; 4. the location of the estimated position (GPS) where the dolphins located when first observed; and 5. Group size (according to best, high and low)Specialized data sheet is attached.
Model Use	The following models will be used for analysis and estimation of population size. 1. A stratified Lincoln-Petersen model 2. Huggins conditional likelihood model 3. Horvitz-Thomson Estimator (to obtain the abundance)

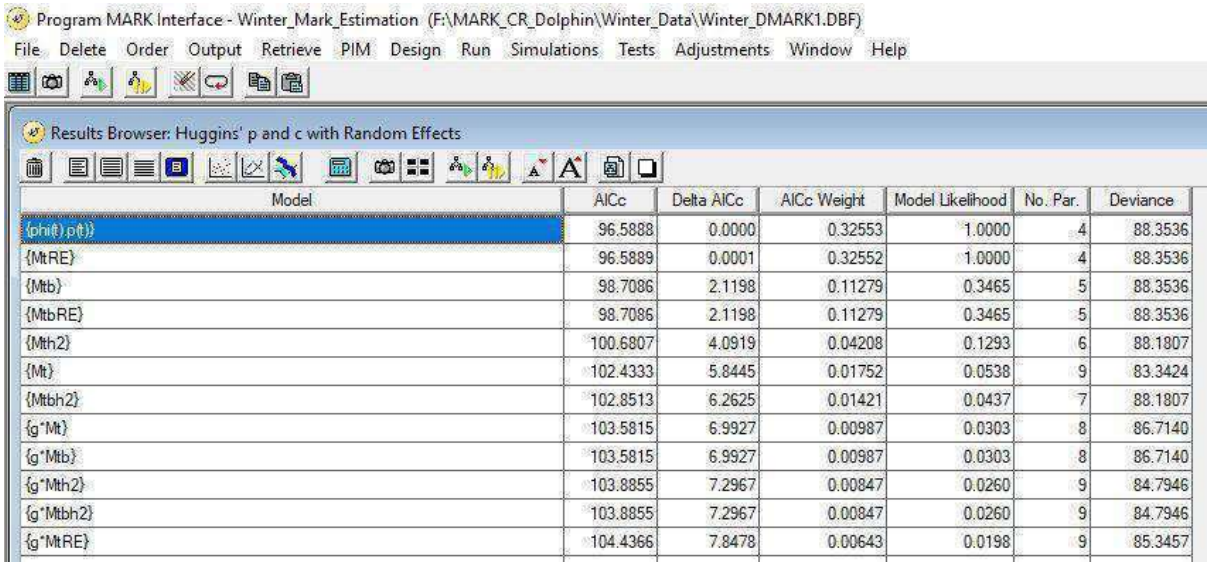
Smith et al, 1994; Smith 2000; Smith *et al.* 2006

Appendix 3:The chosen model (highlighted in blue) and the results from other compared models in the MARK software (second post-monsoon survey)

Results Browser: Huggins' p and c with Random Effects

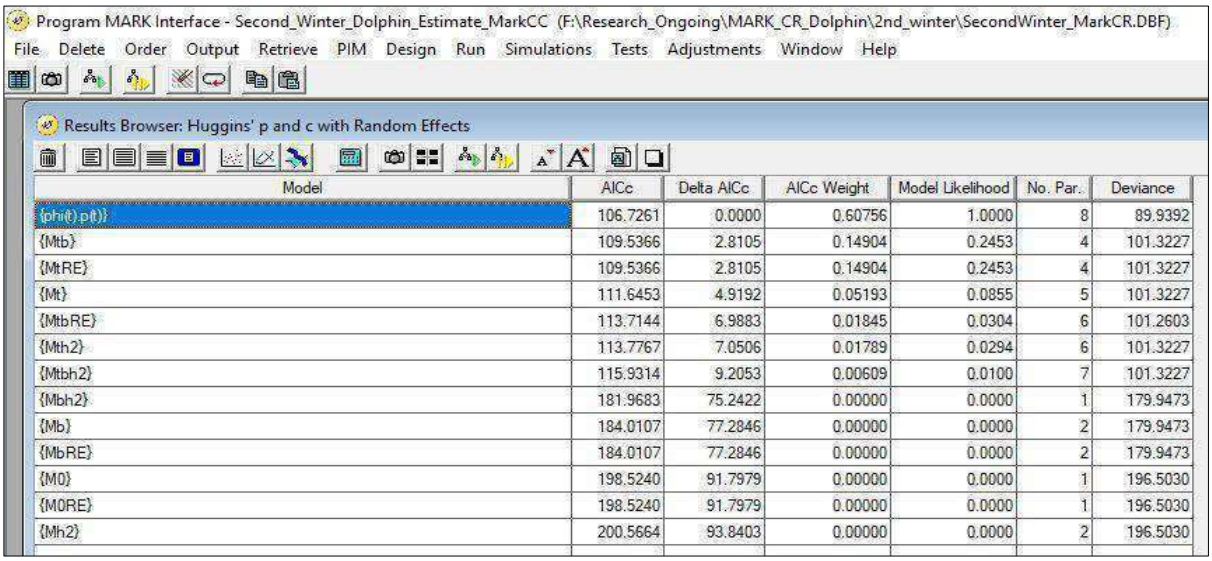
Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{Phi(t),p(t)}	123.8927	0.0000	0.99408	1.0000	6	111.3927
{Mt}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mtb}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mtbh2}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mth2}	138.6738	14.7811	0.00061	0.0006	5	128.3188
{Mbh2}	157.2414	33.3487	0.00000	0.0000	1	155.2183
{Mb}	159.2880	35.3953	0.00000	0.0000	2	155.2183
{M0}	174.3360	50.4433	0.00000	0.0000	1	172.3129
{M0RE}	174.3360	50.4433	0.00000	0.0000	1	172.3129
{Mh2}	176.3826	52.4899	0.00000	0.0000	2	172.3129

Appendix 4. The chosen model (highlighted in blue) and the results from other compared models in the MARK software (first winter survey)



Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{phi(t),p(t)}	96.5888	0.0000	0.32553	1.0000	4	88.3536
{MtRE}	96.5889	0.0001	0.32552	1.0000	4	88.3536
{Mtb}	98.7086	2.1198	0.11279	0.3465	5	88.3536
{MtbRE}	98.7086	2.1198	0.11279	0.3465	5	88.3536
{Mth2}	100.6807	4.0919	0.04208	0.1293	6	88.1807
{Mt}	102.4333	5.8445	0.01752	0.0538	9	83.3424
{Mtbh2}	102.8513	6.2625	0.01421	0.0437	7	88.1807
{g*Mt}	103.5815	6.9927	0.00987	0.0303	8	86.7140
{g*Mtb}	103.5815	6.9927	0.00987	0.0303	8	86.7140
{g*Mth2}	103.8855	7.2967	0.00847	0.0260	9	84.7946
{g*Mtbh2}	103.8855	7.2967	0.00847	0.0260	9	84.7946
{g*MtRE}	104.4366	7.8478	0.00643	0.0198	9	85.3457

Appendix 5. The chosen model (highlighted in blue) and the results from other compared models in the MARK software (second winter survey)



Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{phi(t),p(t)}	106.7261	0.0000	0.60756	1.0000	8	89.9392
{Mtb}	109.5366	2.8105	0.14904	0.2453	4	101.3227
{MtRE}	109.5366	2.8105	0.14904	0.2453	4	101.3227
{Mt}	111.6453	4.9192	0.05193	0.0855	5	101.3227
{MtbRE}	113.7144	6.9883	0.01845	0.0304	6	101.2603
{Mth2}	113.7767	7.0506	0.01789	0.0294	6	101.3227
{Mtbh2}	115.9314	9.2053	0.00609	0.0100	7	101.3227
{Mbh2}	181.9683	75.2422	0.00000	0.0000	1	179.9473
{Mb}	184.0107	77.2846	0.00000	0.0000	2	179.9473
{MbRE}	184.0107	77.2846	0.00000	0.0000	2	179.9473
{M0}	198.5240	91.7979	0.00000	0.0000	1	196.5030
{M0RE}	198.5240	91.7979	0.00000	0.0000	1	196.5030
{Mh2}	200.5664	93.8403	0.00000	0.0000	2	196.5030

Appendix 6: Mark-recapture Analysis (Second post-monsoon)

Program MARK - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017 13-Dec-2017 15:51:36 Page 001
- -

This version was compiled by GCC version 5.3.0 using the options:
-cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
-U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2

```
   -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
   -ffpe-summary=invalid,zero,overflow,underflow -fno-unsafe-math-optimizations
   -frounding-math -fsignaling-nans -fopenmp.

  This problem will use 4 of 4 possible threads.

 INPUT --- proc title Dolphin_Estimation;

    CPU Time in seconds for last procedure was 0.00

INPUT --- procchmatrix occasions=5 groups=2 etype=Huggins mixtures=2
 INPUT --- Nodes=101 icovar=3 ICMeansNoHisthist=300;

 INPUT ---    glabel(1)=Primary;

 INPUT ---    glabel(2)=Secondary;

 INPUT ---    time interval 1 1 1 1;

 INPUT ---       icovariatesGSizeCWidthSCon;

     Number of unique encounter histories read was 35.

     Number of individual covariates read was 3.
     Time interval lengths are all equal to 1.

     Data type number is 12
     Data type is Huggins' p and c

    CPU Time in seconds for last procedure was 0.00

Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36    Page  002
Dolphin_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  INPUT --- proc estimate link=Logitvarest=2ndPart ;
 INPUT --- model={Phi(t).p(t)};
 INPUT ---    group=1 p rows=1 cols=5 Square Time=1;
 INPUT ---    group=2 p rows=1 cols=5 Square Time=6;
 INPUT ---    group=1 c rows=1 cols=4 Square Time=11;
 INPUT ---    group=2 c rows=1 cols=4 Square Time=15;
 INPUT ---    design matrix constraints=18 covariates=18 identity;
 INPUT ---      blabel(1)=p;
 INPUT ---      blabel(2)=p;
 INPUT ---      blabel(3)=p;
 INPUT ---      blabel(4)=p;
 INPUT ---      blabel(5)=p;
 INPUT ---      blabel(6)=p;
 INPUT ---      blabel(7)=p;
 INPUT ---      blabel(8)=p;
 INPUT ---      blabel(9)=p;
 INPUT ---      blabel(10)=p;
 INPUT ---      blabel(11)=c;
 INPUT ---      blabel(12)=c;
 INPUT ---      blabel(13)=c;
 INPUT ---      blabel(14)=c;
 INPUT ---      blabel(15)=c;
```

```
 INPUT ---      blabel(16)=c;
 INPUT ---      blabel(17)=c;
 INPUT ---      blabel(18)=c;
 INPUT ---      rlabel(1)=p;
 INPUT ---      rlabel(2)=p;
 INPUT ---      rlabel(3)=p;
 INPUT ---      rlabel(4)=p;
 INPUT ---      rlabel(5)=p;
 INPUT ---      rlabel(6)=p;
 INPUT ---      rlabel(7)=p;
 INPUT ---      rlabel(8)=p;
 INPUT ---      rlabel(9)=p;
 INPUT ---      rlabel(10)=p;
 INPUT ---      rlabel(11)=c;
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36    Page  003
Dolphin_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 INPUT ---      rlabel(12)=c;
 INPUT ---      rlabel(13)=c;
 INPUT ---      rlabel(14)=c;
 INPUT ---      rlabel(15)=c;
 INPUT ---      rlabel(16)=c;
 INPUT ---      rlabel(17)=c;
 INPUT ---      rlabel(18)=c;
 INPUT ---      dlabel(1)=Grp 1 N;
 INPUT ---      dlabel(2)=Grp 2 N;

 Link Function Used is LOGIT

 Variance Estimation Procedure Used is 2ndPart

M(t+1):
    18    17

 -2logL(saturated) = -0.0000000
 Effective Sample Size = 175

 Number of function evaluations was 43 for 18 parameters.
 Time for numerical optimization was 0.03 seconds.
 -2logL {Phi(t).p(t)} = 111.39272
 Penalty {Phi(t).p(t)} = -0.0000000
 Gradient {Phi(t).p(t)}:
  0.000000     0.000000     0.000000     0.000000     0.000000
  0.000000     0.000000     0.000000     0.000000     0.000000
  0.000000    0.6308189E-06  0.000000     0.000000    0.9427072E-06
  0.000000     0.000000     0.000000
 S Vector {Phi(t).p(t)}:
  4.235293     3.999999     3.611111     3.111111     1.764706
  1.764706    0.8827028E-07 0.8051994E-07 0.6681132E-07 0.6681059E-07
 0.6523502E-07 0.6315005E-07 0.4948998E-07 0.2262376E-07 0.1477314E-07
 0.4738380E-08 0.4026128E-08 0.1484434E-08
 Time to compute number of parameters was 0.09 seconds.
   Threshold =  0.3800000E-06     Condition index =  0.3504914E-09     New Threshold =  0.6297919E-08
 New Guessimate of Estimated Parameters {Phi(t).p(t)} = 13
 Conditioned S Vector {Phi(t).p(t)}:
```

1.000000 0.9444446 0.8526237 0.7345681 0.4166669
0.4166668 0.2084160E-07 0.1901166E-07 0.1577490E-07 0.1577473E-07
0.1540272E-07 0.1491043E-07 0.1168514E-07 0.5341724E-08 0.3488104E-08
0.1118784E-08 0.9506140E-09 0.3504914E-09
Number of Estimated Parameters {Phi(t).p(t)} = 6
DEVIANCE {Phi(t).p(t)} = 111.39272
DEVIANCE Degrees of Freedom {Phi(t).p(t)} = 29
c-hat {Phi(t).p(t)} = 3.8411282
AIC {Phi(t).p(t)} = 123.39272
AICc {Phi(t).p(t)} = 123.89272
BIC {Phi(t).p(t)} = 142.38143
Pearson Chisquare {Phi(t).p(t)} = 245.89617

LOGIT Link Function Parameters of {Phi(t).p(t)}

			95% Confidence Interval	
Parameter	Beta	Standard Error	Lower	Upper
1:p	19.442761	1698.6670	-3309.9446	3348.8301
2:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
3:p	-3.9814670	0.0000000	-3.9814670	-3.9814670
4:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
5:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
6:p	23.996232	0.1625529E-004	23.996200	23.996264
7:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
8:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
9:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
10:p	-3.7437833	0.0000000	-3.7437833	-3.7437833
11:c	0.9555113	0.5262348	-0.0759090	1.9869316
12:c	1.2527629	0.5669467	0.1415473	2.3639785
13:c	-0.6931474	0.5000000	-1.6731474	0.2868527
14:c	20.731936	7970.8080	-15602.052	15643.516
15:c	2.0149031	0.7527727	0.5394686	3.4903375
16:c	-0.1177833	0.4859127	-1.0701723	0.8346057
17:c	2.0149028	0.7527726	0.5394685	3.4903372
18:c	25.140963	0.0000000	25.140963	25.140963

Real Function Parameters of {Phi(t).p(t)}

			95% Confidence Interval	
Parameter	Estimate	Standard Error	Lower	Upper
1:p	1.0000000	0.6112579E-005	0.9999880	1.0000120
2:p	0.0183158	0.0000000	0.0183158	0.0183158
3:p	0.0183165	0.0000000	0.0183165	0.0183165
4:p	0.0183158	0.0000000	0.0183158	0.0183158
5:p	0.0183158	0.0000000	0.0183158	0.0183158
6:p	1.0000000	0.6159766E-015	1.0000000	1.0000000
7:p	0.0231177	0.0000000	0.0231177	0.0231177
8:p	0.0231177	0.0000000	0.0231177	0.0231177
9:p	0.0231177	0.0000000	0.0231177	0.0231177
10:p	0.0231173	0.0000000	0.0231173	0.0231173

```
 11:c                0.7222222      0.1055718      0.4810319      0.8794181
 12:c                0.7777778      0.0979908      0.5353279      0.9140389
 13:c                0.3333333      0.1111111      0.1580050      0.5712255
 14:c                1.0000000      0.7902001E-005 0.9999845      1.0000155
 15:c                0.8823529      0.0781425      0.6316888      0.9704116
 16:c                0.4705882      0.1210578      0.2553703      0.6973279
 17:c                0.8823529      0.0781425      0.6316888      0.9704116
 18:c                1.0000000      0.0000000      1.0000000      1.0000000
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36    Page  005
Dolphin_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                Estimates of Derived Parameters
             Population Estimates of {Phi(t).p(t)}
                                  95% Confidence Interval
   Group     N-hat       Standard Error     Lower          Upper
---------  --------------  --------------  --------------  --------------
     1    18.000000      0.2640368E-003  18.000000      18.000184
     2    17.000000      0.2422045E-004  17.000000      17.000005

 Attempted ordering of parameters by estimatibility:
  16 13 11 12 17 15  9 10  3  5  2  4  8  7 14  6  1 18
 Beta number 18 is a singular value.

    CPU Time in seconds for last procedure was 0.14

  INPUT --- proc stop;

    CPU Time in minutes for this job was 0.00

    Time Start = 15:51:36.679   Time End = 15:51:36.810

    Wall Clock Time in minutes for this job was 0.00


        E X E C U T I O N   S U C C E S S F
```

Appendix 7: Mark-recapture Analysis (First Winter)

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   17-Jan-2018 18:17:28    Page  001
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   This version was compiled by GCC version 5.3.0 using the options:
     -cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
     -U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2
     -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
     -ffpe-summary=invalid,zero,overflow,underflow -fno-unsafe-math-optimizations
     -frounding-math -fsignaling-nans -fopenmp.

   This problem will use 4 of 4 possible threads.


  INPUT --- proc title Winter_Mark_Estimation;
```

CPU Time in seconds for last procedure was 0.00

INPUT --- proc chmatrix occasions=5 groups=2 etype=Huggins mixtures=2
INPUT --- Nodes=101 icovar=3 ICMeansNoHisthist=300;

INPUT --- glabel(1)=Primary;

INPUT --- glabel(2)=Secondary;

INPUT --- time interval 1 1 1 1;

INPUT --- icovariatesGSizeCWidthSiteCon;

Number of unique encounter histories read was 35.

Number of individual covariates read was 3.
Time interval lengths are all equal to 1.

Data type number is 12
Data type is Huggins' p and c

CPU Time in seconds for last procedure was 0.00

- -

```
 INPUT --- proc estimate link=Logit varest=2ndPart ;


 INPUT --- model={phi(t).p(t)};

 INPUT ---    group=1 p rows=1 cols=5 Square Time=1;

 INPUT ---    group=2 p rows=1 cols=5 Square Time=6;

 INPUT ---    group=1 c rows=1 cols=4 Square Time=11;

 INPUT ---    group=2 c rows=1 cols=4 Square Time=15;

 INPUT ---    design matrix constraints=18 covariates=5;
 INPUT ---          1 1 0 0 0;
 INPUT ---          1 0 1 0 0;
 INPUT ---          1 0 0 1 0;
 INPUT ---          1 0 0 0 1;
 INPUT ---          1 0 0 0 0;
 INPUT ---          1 1 0 0 0;
 INPUT ---          1 0 1 0 0;
 INPUT ---          1 0 0 1 0;
 INPUT ---          1 0 0 0 1;
 INPUT ---          1 0 0 0 0;
 INPUT ---          1 0 1 0 0;
 INPUT ---          1 0 0 1 0;
 INPUT ---          1 0 0 0 1;
 INPUT ---          1 0 0 0 0;
 INPUT ---          1 0 1 0 0;
 INPUT ---          1 0 0 1 0;
 INPUT ---          1 0 0 0 1;
 INPUT ---          1 0 0 0 0;
 INPUT ---       blabel(1)=p Intercept;
 INPUT ---       blabel(2)=p Occasion 1;
 INPUT ---       blabel(3)=p Occasion 2;
 INPUT ---       blabel(4)=p Occasion 3;
 INPUT ---       blabel(5)=p Occasion 4;
 INPUT ---       rlabel(1)=p;
 INPUT ---       rlabel(2)=p;
 INPUT ---       rlabel(3)=p;
 INPUT ---       rlabel(4)=p;
 INPUT ---       rlabel(5)=p;
 INPUT ---       rlabel(6)=p;
```

- -

INPUT --- rlabel(7)=p;
INPUT --- rlabel(8)=p;
INPUT --- rlabel(9)=p;
INPUT --- rlabel(10)=p;
INPUT --- rlabel(11)=c;
INPUT --- rlabel(12)=c;
INPUT --- rlabel(13)=c;
INPUT --- rlabel(14)=c;
INPUT --- rlabel(15)=c;
INPUT --- rlabel(16)=c;
INPUT --- rlabel(17)=c;
INPUT --- rlabel(18)=c;

Link Function Used is LOGIT

Variance Estimation Procedure Used is 2ndPart

M(t+1):
19 16

-2logL(saturated) = -0.0000000
Effective Sample Size = 175

Number of function evaluations was 38 for 5 parameters.
Time for numerical optimization was 0.02 seconds.
-2logL {phi(t).p(t)} = 88.353555
Penalty {phi(t).p(t)} = -0.0000000
Gradient {phi(t).p(t)}:
0.2110236E-05 0.000000 0.000000 -0.8625427E-06 0.000000
S Vector {phi(t).p(t)}:
15.53201 3.661730 2.180378 0.5687458 0.2314120E-07
Time to compute number of parameters was 0.01 seconds.
Threshold = 0.1200000E-06 Condition index = 0.1489904E-08 New Threshold = 0.5174529E-07
New Guessimate of Estimated Parameters {phi(t).p(t)} = 4
Conditioned S Vector {phi(t).p(t)}:
1.000000 0.2357538 0.1403797 0.3661767E-01 0.1489904E-08
Number of Estimated Parameters {phi(t).p(t)} = 4
DEVIANCE {phi(t).p(t)} = 88.353555
DEVIANCE Degrees of Freedom {phi(t).p(t)} = 31
c-hat {phi(t).p(t)} = 2.8501147
AIC {phi(t).p(t)} = 96.353555
AICc {phi(t).p(t)} = 96.588849
BIC {phi(t).p(t)} = 109.01270
Pearson Chisquare {phi(t).p(t)} = 480.92057

LOGIT Link Function Parameters of {phi(t).p(t)}

Parameter	Beta	Standard Error	95% Confidence Interval Lower	Upper
1:p Intercept	2.3671248	0.6038076	1.1836620	3.5505877

2:p Occasion 1 19.296656 6573.6576 -12865.072 12903.666
3:p Occasion 2 -.1529803E-005 0.8539126 -1.6736703 1.6736672

4:p Occasion 3 -3.9426613 0.7521522 -5.4168797 -2.4684429
5:p Occasion 4 0.4362349 0.9459841 -1.4178938 2.2903637

Real Function Parameters of {phi(t).p(t)}

Parameter	Estimate	Standard Error	95% Confidence Interval Lower	Upper
1:p	1.0000000	0.2566531E-005	0.9999950	1.0000050
2:p	0.9142857	0.0473188	0.7656054	0.9720933
3:p	0.1714286	0.0637049	0.0791035	0.3325925
4:p	0.9428571	0.0392347	0.7983560	0.9856658
5:p	0.9142858	0.0473187	0.7656056	0.9720934
6:p	1.0000000	0.2566531E-005	0.9999950	1.0000050
7:p	0.9142857	0.0473188	0.7656054	0.9720933
8:p	0.1714286	0.0637049	0.0791035	0.3325925
9:p	0.9428571	0.0392347	0.7983560	0.9856658
10:p	0.9142858	0.0473187	0.7656056	0.9720934
11:c	0.9142857	0.0473188	0.7656054	0.9720933
12:c	0.1714286	0.0637049	0.0791035	0.3325925
13:c	0.9428571	0.0392347	0.7983560	0.9856658
14:c	0.9142858	0.0473187	0.7656056	0.9720934
15:c	0.9142857	0.0473188	0.7656054	0.9720933
16:c	0.1714286	0.0637049	0.0791035	0.3325925
17:c	0.9428571	0.0392347	0.7983560	0.9856658
18:c	0.9142858	0.0473187	0.7656056	0.9720934

Estimates of Derived Parameters
Population Estimates of {phi(t).p(t)}

Group	N-hat	Standard Error	95% Confidence Interval Lower	Upper
1	19.000000	0.1606274E-005	19.000000	19.000000
2	16.000000	0.1474608E-005	16.000000	16.000000

Attempted ordering of parameters by estimatibility:
1 4 3 5 2
Beta number 2 is a singular value.

CPU Time in seconds for last procedure was 0.02

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   17-Jan-2018 18:17:28    Page  005
Winter_Mark_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  INPUT --- proc stop;
    CPU Time in minutes for this job was 0.00
    Time Start = 18:17:28.166   Time End = 18:17:28.197
    Wall Clock Time in minutes for this job was 0.00

        E X E C U T I O N   S U C C E S S F U L
```

Appendix 8: Mark-recapture Analysis (Second winter)

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017    2-Feb-2018 18:27:34    Page  001
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   This version was compiled by GCC version 5.3.0 using the options:
     -cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
     -U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2
     -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
     -ffpe-summary=invalid,zero,overflow,underflow -fno-unsafe-math-optimizations
     -frounding-math -fsignaling-nans -fopenmp.

   This problem will use 4 of 4 possible threads.

  INPUT --- proc title Second_Winter_Dolphin_Estimate_MarkCC;

    CPU Time in seconds for last procedure was 0.00

  INPUT --- proc chmatrix occasions=6 groups=2 etype=HugFullHet
  INPUT --- mixtures=2 Nodes=101 icovar=3 ICMeansNoHisthist=300;

  INPUT ---    glabel(1)=PrimaryTeam;

  INPUT ---    glabel(2)=SecondaryTeam;

  INPUT ---    time interval 1 1 1 1 1;

  INPUT ---       icovariatesGroupSizeChWidthSCon;

      Number of unique encounter histories read was 32.

      Number of individual covariates read was 3.
      Time interval lengths are all equal to 1.

      Data type number is 26
      Data type is Huggins' Heterogeneity pi, p, and c

     CPU Time in seconds for last procedure was 0.01

Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017    2-Feb-2018 18:27:34    Page  002
Second_Winter_Dolphin_Estimate_MarkCC
```

- -

```
INPUT --- proc estimate link=Logit varest=2ndPart ;

INPUT --- model={phi(t).p(t)};

INPUT ---   group=1 pi rows=1 cols=1 Square Constant=1;

INPUT ---   group=2 pi rows=1 cols=1 Square Constant=2;

INPUT ---   group=1 p rows=2 cols=6 Square;
INPUT ---            3  4  5  6  7  8;
INPUT ---            9 10 11 12 13 14;

INPUT ---   group=2 p rows=2 cols=6 Square;
INPUT ---           15 16 17 18 19 20;
INPUT ---           21 22 23 24 25 26;

INPUT ---   group=1 c rows=2 cols=5 Square;
INPUT ---           27 28 29 30 31;
INPUT ---           32 33 34 35 36;

INPUT ---   group=2 c rows=2 cols=5 Square;
INPUT ---           37 38 39 40 41;
INPUT ---           42 43 44 45 46;

INPUT ---   design matrix constraints=46 covariates=46 identity;
INPUT ---     blabel(1)=pi;
INPUT ---     blabel(2)=pi;
INPUT ---     blabel(3)=p;
INPUT ---     blabel(4)=p;
INPUT ---     blabel(5)=p;
INPUT ---     blabel(6)=p;
INPUT ---     blabel(7)=p;
INPUT ---     blabel(8)=p;
INPUT ---     blabel(9)=p;
INPUT ---     blabel(10)=p;
INPUT ---     blabel(11)=p;
INPUT ---     blabel(12)=p;
INPUT ---     blabel(13)=p;
INPUT ---     blabel(14)=p;
INPUT ---     blabel(15)=p;
INPUT ---     blabel(16)=p;
INPUT ---     blabel(17)=p;
```

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INPUT --- blabel(18)=p;
INPUT --- blabel(19)=p;
INPUT --- blabel(20)=p;
INPUT --- blabel(21)=p;
INPUT --- blabel(22)=p;
INPUT --- blabel(23)=p;
INPUT --- blabel(24)=p;
INPUT --- blabel(25)=p;
INPUT --- blabel(26)=p;
INPUT --- blabel(27)=c;
INPUT --- blabel(28)=c;
INPUT --- blabel(29)=c;
INPUT --- blabel(30)=c;
INPUT --- blabel(31)=c;
INPUT --- blabel(32)=c;
INPUT --- blabel(33)=c;
INPUT --- blabel(34)=c;
INPUT --- blabel(35)=c;
INPUT --- blabel(36)=c;
INPUT --- blabel(37)=c;
INPUT --- blabel(38)=c;
INPUT --- blabel(39)=c;
INPUT --- blabel(40)=c;
INPUT --- blabel(41)=c;
INPUT --- blabel(42)=c;
INPUT --- blabel(43)=c;
INPUT --- blabel(44)=c;
INPUT --- blabel(45)=c;
INPUT --- blabel(46)=c;
INPUT --- rlabel(1)=pi;
INPUT --- rlabel(2)=pi;
INPUT --- rlabel(3)=p;
INPUT --- rlabel(4)=p;
INPUT --- rlabel(5)=p;
INPUT --- rlabel(6)=p;
INPUT --- rlabel(7)=p;
INPUT --- rlabel(8)=p;
INPUT --- rlabel(9)=p;
INPUT --- rlabel(10)=p;
INPUT --- rlabel(11)=p;
INPUT --- rlabel(12)=p;
INPUT --- rlabel(13)=p;
INPUT --- rlabel(14)=p;
INPUT --- rlabel(15)=p;
INPUT --- rlabel(16)=p;

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INPUT --- rlabel(17)=p;
INPUT --- rlabel(18)=p;
INPUT --- rlabel(19)=p;
INPUT --- rlabel(20)=p;
INPUT --- rlabel(21)=p;
INPUT --- rlabel(22)=p;
INPUT --- rlabel(23)=p;
INPUT --- rlabel(24)=p;
INPUT --- rlabel(25)=p;
INPUT --- rlabel(26)=p;
INPUT --- rlabel(27)=c;
INPUT --- rlabel(28)=c;
INPUT --- rlabel(29)=c;
INPUT --- rlabel(30)=c;
INPUT --- rlabel(31)=c;
INPUT --- rlabel(32)=c;
INPUT --- rlabel(33)=c;
INPUT --- rlabel(34)=c;
INPUT --- rlabel(35)=c;
INPUT --- rlabel(36)=c;
INPUT --- rlabel(37)=c;
INPUT --- rlabel(38)=c;
INPUT --- rlabel(39)=c;
INPUT --- rlabel(40)=c;
INPUT --- rlabel(41)=c;
INPUT --- rlabel(42)=c;
INPUT --- rlabel(43)=c;
INPUT --- rlabel(44)=c;
INPUT --- rlabel(45)=c;
INPUT --- rlabel(46)=c;
INPUT --- dlabel(1)=Grp 1 N;
INPUT --- dlabel(2)=Grp 2 N;

Link Function Used is LOGIT

Variance Estimation Procedure Used is 2ndPart

M(t+1):
15 17

-2logL(saturated) = -0.0000000
Effective Sample Size = 192

Number of function evaluations was 43 for 46 parameters.
Time for numerical optimization was 0.16 seconds.

- -

-2logL {phi(t).p(t)} = 89.939240
Penalty {phi(t).p(t)} = -0.0000000
Gradient {phi(t).p(t)}:
-0.2969045E-05 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 -0.2842165E-05 0.000000
0.000000 0.1933445E-05-0.1050808E-05 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.7533742E-06 0.5593844E-06-0.3766871E-06 0.1678153E-05
0.000000
S Vector {phi(t).p(t)}:
3.076923 2.470588 2.470588 1.733332 1.692307
0.9411769 0.9411764 0.5000003 0.1405864E-05 0.7240347E-06
0.7130144E-06 0.4434888E-06 0.3585167E-06 0.3235718E-06 0.3178967E-06
0.3178892E-06 0.3178892E-06 0.3074423E-06 0.1496835E-06 0.1314289E-06
0.1202430E-06 0.1172966E-06 0.1171686E-06 0.6247524E-07 0.6063276E-07
0.5458477E-07 0.5458477E-07 0.5458291E-07 0.2283143E-07 0.1573467E-07
0.1169571E-08 0.1153389E-08 0.8287850E-09 0.5064499E-09 0.5064497E-09
0.4531770E-09 0.4268930E-09 0.3780729E-09 0.2005165E-09 0.1179552E-09
0.1072146E-09 0.1064020E-09 0.7240969E-10 0.3993209E-10 0.3381622E-10
0.2674458E-10
Time to compute number of parameters was 0.36 seconds.
Threshold = 0.9400000E-06 Condition index = 0.8691988E-11 New Threshold = 0.1813906E-09
New Guessimate of Estimated Parameters {phi(t).p(t)} = 33
Conditioned S Vector {phi(t).p(t)}:
1.000000 0.8029410 0.8029409 0.5633329 0.5499997
0.3058825 0.3058823 0.1625001 0.4569059E-06 0.2353113E-06
0.2317297E-06 0.1441338E-06 0.1165179E-06 0.1051608E-06 0.1033164E-06
0.1033140E-06 0.1033140E-06 0.9991875E-07 0.4864714E-07 0.4271439E-07
0.3907897E-07 0.3812139E-07 0.3807978E-07 0.2030445E-07 0.1970564E-07
0.1774005E-07 0.1774005E-07 0.1773944E-07 0.7420213E-08 0.5113768E-08
0.3801105E-09 0.3748514E-09 0.2693551E-09 0.1645962E-09 0.1645961E-09
0.1472825E-09 0.1387402E-09 0.1228737E-09 0.6516784E-10 0.3833543E-10
0.3484475E-10 0.3458064E-10 0.2353315E-10 0.1297793E-10 0.1099027E-10
0.8691988E-11
Number of Estimated Parameters {phi(t).p(t)} = 8
DEVIANCE {phi(t).p(t)} = 89.939240
DEVIANCE Degrees of Freedom {phi(t).p(t)} = 24
c-hat {phi(t).p(t)} = 3.7474683
AIC {phi(t).p(t)} = 105.93924
AICc {phi(t).p(t)} = 106.72612
BIC {phi(t).p(t)} = 131.99920
Pearson Chisquare {phi(t).p(t)} = 174.23540

LOGIT Link Function Parameters of {phi(t).p(t)}

Parameter	Beta	Standard Error	95% Confidence Interval Lower	Upper

1:pi	-1.8718031	0.7595548	-3.3605305	-0.3830757
2:pi	-41.092522	0.1341568E-005	-41.092525	-41.092519
3:p	56.564278	0.0000000	56.564278	56.564278

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4:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
5:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
6:p	-1.5512644	0.0000000	-1.5512644	-1.5512644
7:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
8:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
9:p	28.474750	94.454163	-156.65541	213.60491
10:p	-0.7411186	0.0000000	-0.7411186	-0.7411186
11:p	-0.7411377	0.0000000	-0.7411377	-0.7411377
12:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
13:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
14:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
15:p	-27.652989	7.5940723	-42.537371	-12.768607
16:p	0.0571189	0.0000000	0.0571189	0.0571189
17:p	0.0571511	0.0000000	0.0571511	0.0571511
18:p	0.0571511	0.0000000	0.0571511	0.0571511
19:p	0.0571636	0.0000000	0.0571636	0.0571636
20:p	0.0571636	0.0000000	0.0571636	0.0571636
21:p	20.772807	7968.5714	-15597.627	15639.173
22:p	-0.4750927	1133.1592	-2221.4671	2220.5169
23:p	-0.4750927	1022.7672	-2005.0988	2004.1486
24:p	-0.4750927	1068.5058	-2094.7466	2093.7964
25:p	-0.4750249	1326.3821	-2600.1839	2599.2339
26:p	-0.4750249	1520.2949	-2980.2530	2979.3030
27:c	79.441290	0.0000000	79.441290	79.441290
28:c	-69.045743	0.0000000	-69.045743	-69.045743
29:c	-.2238521E-005	1.4142132	-2.7718602	2.7718557
30:c	-98.251477	0.0000000	-98.251477	-98.251477
31:c	56.783687	0.0000000	56.783687	56.783687
32:c	0.4700039	0.5700877	-0.6473680	1.5873757
33:c	-1.7047485	0.7687063	-3.2114128	-0.1980842
34:c	93.323316	0.0000000	93.323316	93.323316
35:c	59.560680	0.1258984E-005	59.560677	59.560682
36:c	28.347807	0.0000000	28.347807	28.347807
37:c	-25.485731	0.0000000	-25.485731	-25.485731
38:c	16.428773	0.0000000	16.428773	16.428773
39:c	-25.485724	0.0000000	-25.485724	-25.485724
40:c	-19.821643	0.0000000	-19.821643	-19.821643
41:c	-27.848325	0.0000000	-27.848325	-27.848325
42:c	2.7725888	1.0307764	0.7522670	4.7929107
43:c	-1.5404451	0.6362090	-2.7874148	-0.2934754
44:c	2.7725883	1.0307762	0.7522669	4.7929097
45:c	1.5404454	0.6362091	0.2934756	2.7874152
46:c	20.497756	6618.0719	-12950.923	12991.919

Real Function Parameters of {phi(t).p(t)}

Parameter	Estimate	Standard Error	95% Confidence Interval Lower	Upper
1:pi	0.1333332	0.0877707	0.0335520	0.4053853
2:pi	0.1424769E-017	0.1911424E-023	0.1424765E-017	0.1424773E-017
3:p	1.0000000	0.0000000	1.0000000	1.0000000
4:p	0.1749131	0.0000000	0.1749131	0.1749131
5:p	0.1749131	0.0000000	0.1749131	0.1749131
6:p	0.1749037	0.0000000	0.1749037	0.1749037
7:p	0.1749131	0.0000000	0.1749131	0.1749131
8:p	0.1749131	0.0000000	0.1749131	0.1749131
9:p	1.0000000	0.4062477E-010	1.0000000	1.0000000
10:p	0.3227596	0.0000000	0.3227596	0.3227596
11:p	0.3227554	0.0000000	0.3227554	0.3227554
12:p	0.3227191	0.0000000	0.3227191	0.3227191
13:p	0.3227191	0.0000000	0.3227191	0.3227191
14:p	0.3227191	0.0000000	0.3227191	0.3227191
15:p	0.9782720E-012	0.7429068E-011	-.1358270E-010	0.1553925E-010
16:p	0.5142758	0.0000000	0.5142758	0.5142758
17:p	0.5142839	0.0000000	0.5142839	0.5142839
18:p	0.5142839	0.0000000	0.5142839	0.5142839
19:p	0.5142870	0.0000000	0.5142870	0.5142870
20:p	0.5142870	0.0000000	0.5142870	0.5142870
21:p	1.0000000	0.7583419E-005	0.9999851	1.0000149
22:p	0.3834116	267.88691	0.6131017E-304	1.0000000
23:p	0.3834116	241.78946	0.6131017E-304	1.0000000
24:p	0.3834116	252.60241	0.6131017E-304	1.0000000
25:p	0.3834276	313.57115	0.6131433E-304	1.0000000
26:p	0.3834276	359.41424	0.6131433E-304	1.0000000
27:c	1.0000000	0.0000000	1.0000000	1.0000000
28:c	0.1032321E-029	0.0000000	0.1032321E-029	0.1032321E-029
29:c	0.4999994	0.3535533	0.0588639	0.9411359
30:c	0.2137597E-042	0.0000000	0.2137597E-042	0.2137597E-042
31:c	1.0000000	0.0000000	1.0000000	1.0000000
32:c	0.6153847	0.1349320	0.3435829	0.8302466
33:c	0.1538461	0.1000682	0.0387385	0.4506402
34:c	1.0000000	0.0000000	1.0000000	1.0000000
35:c	1.0000000	0.0000000	1.0000000	1.0000000
36:c	1.0000000	0.0000000	1.0000000	1.0000000
37:c	0.8544520E-011	0.0000000	0.8544520E-011	0.8544520E-011
38:c	0.9999999	0.0000000	0.9999999	0.9999999
39:c	0.8544579E-011	0.0000000	0.8544579E-011	0.8544579E-011

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40:c	0.2463597E-008	0.0000000	0.2463597E-008	0.2463597E-008
41:c	0.8046855E-012	0.0000000	0.8046855E-012	0.8046855E-012
42:c	0.9411765	0.0570672	0.6796725	0.9917798
43:c	0.1764706	0.0924594	0.0580081	0.4271533
44:c	0.9411764	0.0570672	0.6796725	0.9917798
45:c	0.8235295	0.0924594	0.5728468	0.9419920
46:c	1.0000000	0.8292185E-005	0.9999837	1.0000163

Estimates of Derived Parameters
Population Estimates of {phi(t).p(t)}

Group	N-hat	Standard Error	95% Confidence Interval Lower	Upper
1	15.000000	0.8922051E-006	15.000000	15.000000
2	17.000000	0.3970944E-004	17.000000	17.000010

Attempted ordering of parameters by estimatibility:
32 43 45 1 33 44 42 29 24 23 22 25 26 16 18 17 20 19 14 11 12 10 13 7 8
5 4 6 46 21 38 36 40 39 37 9 15 41 2 3 31 35 28 34 27 30
Beta number 30 is a singular value.

CPU Time in seconds for last procedure was 0.53

- -

INPUT --- proc stop;

CPU Time in minutes for this job was 0.01

Time Start = 18:27:34.419 Time End = 18:27:34.925

Wall Clock Time in minutes for this job was 0.01

E X E C U T I O N S U C C E S S F U L

Appendix 9: Other wildlife recorded during the survey period

Other Animal presence			Pre-monsoon (No. of individuals)	Monsoon (No. of individuals)	Post-monsoon (No. of individuals)	Winter (Number of individuals)	National Status (IUCN Red List 2015)	Migratory/ Resident
Sl. No.	Common Name	Scientific Name						
1	Collared King Fisher	*Todiramphus chloris*	3	2			LC	R
2	White Throated King Fisher	*Halcyon smyrnensis*	4					R
3	Pied Kingfisher	*Ceryle rudis*	1	3	2	4	LC	R
4	Brahminy Kite	*Haliastur Indus*	3	17	12	2	LC	R
5	Yellow Bittern	*Ixobrychus sinensis*	1					R
6	Asian Pied Starling	*Sturnus contra*	8	9	29	2	LC	R
7	Black Kite	*Milvus migrans*	6	37	57	23	LC	R
8	Common Kingfisher	*Alcedo atthis*	3		1		LC	R
9	Greater Coucal	*Centropus sinensis*	1				LC	R
10	House Crow	*Corvus splendens*	1	65	90	55	LC	R
11	Little Cormorant	*Microcarbo niger*	16	175	50	2	LC	R
12	Jungle Crow	*Corvus levaillantii*		18	3	7	LC	R
13	Spotted Dove	*Spilopelia chinensis*		5	2	3	LC	R
14	Indian Pond Heron	*Ardeola grayii*		12	4		LC	R
15	Little Egret	*Egretta garzetta*		9	50	2	LC	R
16	Red Vented Bulbul	*Pycnonotus cafer*		9	10	1	LC	R
17	House Swift	*Apus nipalensis*		7	30		LC	R
18	Common Myna	*Acridotheres tristis*		6	2		LC	R
19	Black Drongo	*Dicrurus macrocercus*		6	6	2	LC	R
20	Sand Martin	*Riparia riparia*		6				M
21	White Wagtail	*Motacilla alba*		3	2	1	LC	M
22	Common Sandpiper	*Actitis hypoleucos*		3	18	8	LC	M

23	Palm Swift	*Cypsiurus balasiensis*		30		3	LC	R
24	Striated Heron	*Buto ridesstriata*		2			LC	R
25	Common Bittern	*Ixobrychus cinnamomeus*		2			LC	R
26	Magpie Robin	*Copsychus saularis*		1	9		LC	R
27	Chestnut Tailed Starling	*Sturnia malabarica*		2			LC	R
28	Cattle Egret	*Bubulcus ibis*		4			LC	R
29	Stork Billed Kingfisher	*Pelargopsis capensis*		1			LC	R
30	Barn Swallows	*Hirundo rustica*		7		2	LC	M
31	Gray Headed Lapwing	*Vanellus cinereus*		2			LC	R
32	Black Capped Kingfisher	*Halcyon pileata*		1				R
33	Wood sandpiper	*Tringa glareola*			1		LC	M
34	Brown headed gull	*Larus brunnicephalus*			2		LC	M
35	Baya weaver	*Ploceus philippinus*			20		LC	R
36	Black headed ibis	*Threskiornis melanocephalus*			50		VU	M
37	RufousTreepie	*Dendrocitta vagabunda*			1		LC	R
38	Rock pigeon	*Columba livia*			5		LC	R
39	Black Hooded Oriole	*Oriolus xanthornus*			1	1	LC	R
40	Great Cormorant	*Phalacrocorax carbo*			5		LC	M
41	Little Grebe	*Tachybaptus ruficollis*				1	LC	R
Total			47	444	462	119		

Appendix 10. A list of identified fish species recorded during the survey period

S. N	Common Name	Scientific Name	Monsoon	Post-monsoon	Winter	IUCN 2015 (National Status)	IUCN (Global Status)
1	Long-whiskered Catfish	*Sperata aor**	X	Ar, Rr	X	VU	LC
2	Tengara catfish	*Mystus tengara*	X	Ar, Rr	X	LC	LC
3	Fresh Water Goby	*Glossogobius giuris*	Ar	Ar	Br, Ar, Rr	LC	LC
4	Tire-track Spinyeel	*Mastacembelus armatus*	X	Ar	Ar, Rr	EN	LC
5	Bata Labeo	*Labeo bata*	Ar	Ar	Br, Ar, Rr	LC	LC
6	Sind Danio	*Devario devario*	X	Br, Ar, Rr	X	LC	LC
7	Barramundi	*Lates calcarifer*	Ar, Rr	Ar, Rr	X	NO+	
8	Freshwater shark	*Wallago attu*	Ar	Ar	X	VU	NT
9	Chola Barb	*Puntius chola*	X	Ar, Rr	Ar, Rr	LC	LC
10	Indian river shad	*Gudusia chapra*	X	Br, Ar, Rr	Br, Ar, Rr	VU	LC
11	Moonsoon River Prawn	*Macrobrachium malcomsonii*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	
12	Lanceolate goby	*Pseudapocryptes elongates*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
13	Humped Featherback	*Chitala chitala**	X	Ar, Rr	Ar, Rr	EN	NT
14	Grey Featherback	*Notopterus notopterus*	X	Ar	X	VU	LC
15	Giant Snakehead	*Channa marulius**	X	X	Ar	EN	LC
16	Menoda Catfish	*Hemibagrus menoda*	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
17	Kuria labeo	*Labeo gonius*	Ar, Rr	Ar, Rr	X	NT	LC
18	Giant Freshwater Shrimp	*Macrobrachium rosenbergii*	Br, Ar	Br, Ar, Rr	Br, Ar, Rr	LC	LC
19	Gangetic Mystus	*Mystus cavasius*	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
20	River Shad	*Tenualosa ilisha*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
21	Ganges River-sprat	*Corica soborna*	Br	Br	Br, Ar	LC	LC
22	Gangetic Ailia	*Ailia coila*	X	Br	Br, Ar	LC	NT
23	Canine Catfish Eel	*Plotosus canius**	X	Rr		NT	
24	Silver Needle Fish	*Xenentodon cancila*	X	Ar	Ar, Rr	LC	LC

25	Himalayan Glassy Perchlet	*Pseudambassis baculis*	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
26	Banded gourami	*Trichogaster fasciata*	X	Ar, Rr	Ar, Rr	LC	LC
27	Catla	*Catla catla**	X	Ar, Rr	Ar, Rr	LC	LC
28	Climbing Perch	*Anabas testudineus**	X	X	Ar	LC	DD
29	Rubicundus Eelgoby	*Odontamblyopus rubicundus*	X	Br, Ar, Rr	Br, Ar, Rr	LC	-
30	Mottled Nandus	*Nandus nandus*	Ar, Rr	Ar, Rr	Ar	NT	LC
31	Mrigal Carp	*Cirrhinus cirrhosus*	Rr	Ar, Rr	Ar, Rr	NT	VU
32	Mola Carplet	*Amblypharyngodon mola*	X	Ar, Rr	X	LC	LC
33	Glass barb	*Pethia guganio*	X	Br, Ar, Rr	X	LC	LC
34	Pabda catfish	*Ompok pabda*	X	X	Br, Ar	EN	NT
35	Bar-tailed Flathead	*Platycephalus indicus*	X	Ar	X	LC	DD
36	Pungas Catfish	*Pangasius pangasius*	Ar, Rr	Ar, Rr	Ar, Rr	EN	LC
37	Goldspot Mullet	*Liza parsia*	Rr	Ar, Rr	Rr	LC	
38	Gangetic Hairfin Anchovy	*Setipinna phasa*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
39	Spotted Snakehead	*Channa punctatus*	X	Ar	X	LC	
40	Striped Dwarf Catfish	*Mystus vittatus*	X	Br, Ar, Rr	X	LC	LC
41	Pama Croaker	*Otolithoides pama*	Ar, Rr	Ar, Rr	Br, Ar, Rr	LC	
42	Ocellated pufferfish	*Tetraodon cutcutia*	X	Ar	Ar, Rr	LC	LC
43	Rita	*Rita rita**	X	Ar, Rr	Ar, Rr	EN	LC
44	Rohu	*Labeo rohita*	Ar, Rr	Ar, Rr	Ar, Rr	LC	LC
45	Silond catfish	*Silonia silondia*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
46	Stinging Catfish	*Heteropneustes fossilis**	X	X	Ar, Rr	LC	LC
47	Snakehead Murrel	*Channa striatus**	X	Ar, Rr	Ar, Rr	LC	
48	Silver carp	*Hypophthalmichthys molitrix**	X	X	Ar, Rr		DD
49	Paradise Threadfin	*Polynemous paradiseus*	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	-
50	Flathead Sillago	*Sillaginopsis panijus**	X	Ar, Rr	X	LC	-

Status code: LC-Least Concern, VU-Vulnerable, EN-Endangered, NT-Near Threatened, DD- Data Deficient, NO-Not Threatened,'+'= IUCN List 2000

N.B.: 'Br' = Present in the Bhairab River, 'Ar' = Present in the Atai River, 'Rr' = Present in the Rupsha River' X' = Absent in the River&'*' = Questionnaire survey

Appendix 11: Vegetation Survey Methodology

Sampling design and sample size
A total of 6 plots were selected in 500 m zone from the proposed power plant. The plots are equal in size (10m x 10m).

Data collection
Every individual of woody species as well as the number of herbs and shrubs was counted. The number of seedling and sapling that is regenerated naturally was recorded.

Data analysis
Density, Relative Density, Frequency and Relative Frequency is calculated by following equations.

$$1.\ \text{Density (stem/ha)} = \frac{\text{Total no. of individuals of one species in all the plots}}{\text{Plot area} \times \text{Total no. of plots studied}}$$

$$2.\ \text{Relative density (\%)} = \frac{\text{Total no. of individuals of one species in all the plots}}{\text{Total no. of plots studied}} \times 100$$

$$3.\ \text{Frequency (\%)} = \frac{\text{Total no. of plots in which the species occurs}}{\text{Total no. of plots studied}} \times 100$$

$$4.\ \text{Relative frequency (\%)} = \frac{\text{Frequency of one species}}{\text{Sum of frequency of all species}} \times 100$$