

Chapter 3 Technical assistance for Environmental and Social Impact Assessment

This Chapter presents Environmental and Social Impact Assessment (EIA) and Resettlement Action Plan for all infrastructure development of FDIPP. Due to the complexity of the development of AEZ, 2 separate EIAs studies and 2 separate RAPs have been conducted in order to assess comprehensive impacts and to cover and identify all the project affected people (PAPs).

Thus, this chapter is sub-divided into to 4 sections; “3.1”, “3.2”, “3.3”, and “3.4”.

3.1: EIA 1 for the development of on-site and off-site (or peripheral) infrastructure.

3.2: RAP 1 for the development of the economic zone, including the power plant affected area.

3.3: EIA 2 for the construction of Gas Transmission Pipeline from Horipur to Dighiborabo as well as the power plant (including the sub-station and transmission system) which will be located at adjacent to AEZ premises. RAP for the affected people for the power plant is covered in 3.2 because the land acquisition is planned together with the economic zone.

3.4: RAP 2 for the construction of Gas Transmission Pipeline from Horipur to Dighiborabo.

In order to avoid unnecessary repetition / overlapping of information, some items have been omitted.

3.1 Environmental Impact Assessment (EIA 1) for On-site and peripheral infrastructure

3.1.1. Project Component

Table 3.1-1: Summary of Project

Summary of the project	
Location and district	Union: Satgram & Duptara, Upazila: Araihaazar, District: Narayanganj
Mouza	Panchrukhi, Panchgaon
Development area	218.84ha
Landuse	Farmland, double cropping
Site preparation	Embankment: 0.6- 2.6m (Avg.1.6m), Land elevation: Approx.6-m above MSL, Flood water level due to rivers of Shitalakhya and Meghna: Approx.7.52m (1/100), Elevation of land preparation: 8.0m.
Environmental and social conditions	Need resettlement of houses and people; No precious ecology and cultural heritages sites exist
Development Concept and Advantages	Development concept of the Project focuses a Multiple Export-oriented EZ but domestic-market oriented industries shall also be of interest to pursue. The EZ shall be developed as a competitive EZ against the similar facilities in the neighboring countries and equipped with a full line of the infrastructure of global standard, competitive business environment, highest investors satisfaction by One-stop-services (OSS), due consideration to environment and society, and low-cost operations.
Industries to be promoted	Agriculture/food processing industry, Plastic and Rubber Products, RMG/ apparels, Wooden Products, Knitting and Textile, Yarn, Spinning, Jute and Jute Goods Materials, Pharmaceutical and Healthcare Goods, Footwear and Leather Goods, Bi-cycle, Automobile/Motor cycle parts, Electrical and Electronics, Garments Accessories and Light Engineering industry (source: the previous survey)

Table 3.1-2: Project Components to be assessed: On-site infrastructure

On-site infrastructure	
Internal Roads	Inside the Economic Zone, a road starting at the gate and passing through the center of EZ will be the internal main road and will have four lanes. And the internal roads from the main road to each block will have 2 lanes. All internal roads will be planned to ensure width of 2.5m as the shoulders on their sidewalk sides so that accidents and trucks etc. parking while waiting will not obstruct traffic.
Power Distribution	On-site developer will prepare on-site power distribution plan. Interface between On-site and Off-site is external cable terminals at 11kV Switchgears in Substation in Off-site because jointing of 11kV cables in On-site area is not recommendable from electrical safety/maintenance point of view.
Water/Sewage Pipeline	Quantity of Water Supplied The predicted attracted industries are assumed to be mainly manufacturing industries that use relatively little water, assembling and sewing for example, and the basic unit of the quantity of water used is considered to be 35m³/day/ha for the total development area. And the total quantity is 7,000 m³/day for the initial 200 ha development. In fact, the area of factory use land will be about 145 ha, so it is about 45.74 m³/ day/ha. Supplying water to fire hydrants Assuming that one fire hydrant will cover an area with a radius of about 100m, fire hydrants will be installed at intervals of about 150m. Water supply facility The water storage tank scale will be equivalent to one day's requirement of 7,000 m³. An elevated water tank will ensure capacity for about 1 hour. The water supply facility will be close to N2 so that construction is possible from the first stage at a location where it is expected to supply water to the future expanded area. Araihasar water supply facility data is given below PVC Water-supply Pipes – 200 mm dia. - 2,300 m PVC Water-supply Pipes – 150 mm dia. - 9,400 m PVC Water-supply Pipes – 100 mm dia. - 2,400 m High pressure PVC Pipes, for hydrant – 100 mm dia.- 12,500 m Sewage Treatment Plant (On site infra.) General wastewater of each tenant factory (kitchen and toilet wastewater) is treated by the central processing facility in the EZ site. Industry wastewater from each tenant factory should be treated to an acceptable drainage level at each tenants's cost and responsibility.
Gas Distribution Pipeline	In the EZ, gas supply facility will be located adjoining the power station treatment facility. And use in the EZ is predicted to be general use rather than industrial use or power generation use, so gas will be supplied in 75mm diameter pipes.
Telecommunication line (Optical Fiber Cable) inside EZ	At Araihasar EZ, communication services will be provided by installing wire (optical fiber etc.) feed cables to provide services under contracts completed by each attracted enterprise with local service providers. The wires will be installed on electric power supply poles or in underground communication line use conduits following consultations with EZ management. The largest PSTN in Bangladesh is the Bangladesh Telecommunication Company

	Ltd (BTCL). Mobile phone operators, which in this region include Grameen Phone, Teletalk, Robi Axiata, Banglalink, supply internet communication and call services. As for IPTSP (Internet Protocol Telephony Service Provider), more than 40 companies supply internet communication services. They offer both high-speed internet communication services and IP call services.

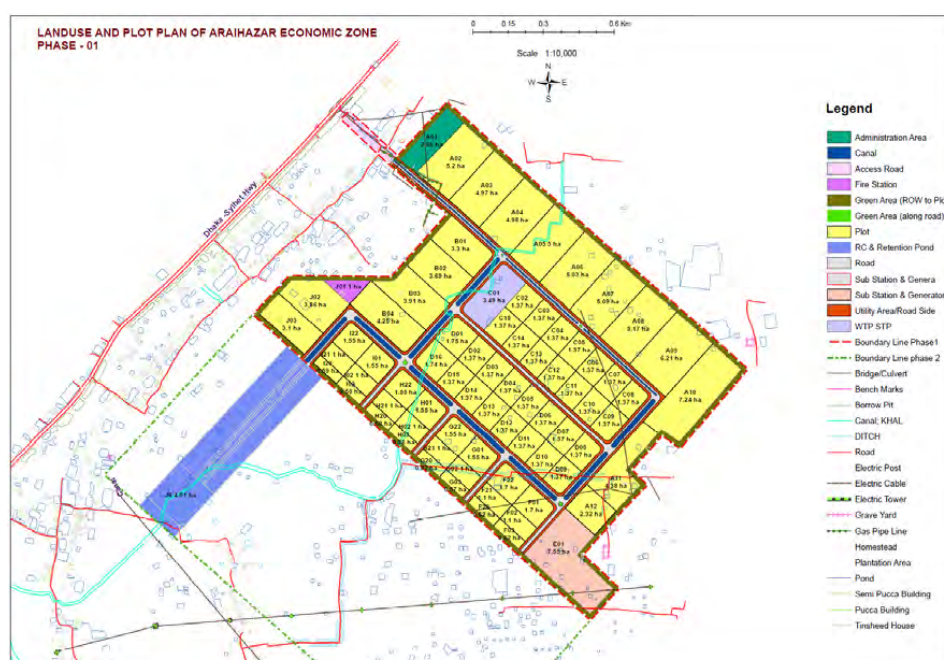
Table 3.1-3 Project Components to be assessed: Off-site infrastructure

Off-site infrastructure	
Land Filling Work	Approximately 9 million m³ dredged filling sand will be required. The site is 2.859 meter MSL. The proposed land will be developed up to the 6.5 m (8.0 m at highest area)MSL by dredged sand. Candidate dredging site is Meghna river. Loading points are expected to be around 45km from unloading point along Sitalakya river. From unloading point, the sand will be carried approximately 7 to 8 km to the EZ site by multiple pipelines using boosters.
Access Road	The access road is planned directly connecting from the national highway No.2 (Dhaka-Sylhet Expressway) to the Araihaazar EZ with approximate length of 400 m. Access roads are designed with two lanes on each side including a median strip, sidewalks and space for utilities (gas transmission, telecommunication, etc.). They also have space for parking areas for container trucks under entry permission procedure and commuting vehicles near the EZ entrance gate.
Canal/ Retention Pond	Rainwater drainage ditches will be located on both sides of internal roads and will drain rainwater to the canal located along the 60m main road. The flow rate to be carried downstream is the 50-year return period rainfall, and the concentration time from the furthest location for the completed 200ha plan is hypothesized to be 1 hour, and the rainfall intensity is calculated as about 100mm/hour. The planned flow rate is about 33.3m³/s. The flow capacity of the planned canal is, assuming the roughness coefficient is 0.035 and the water surface gradient is 0.02%, about 33.3m³/s when the water depth is 3.6m (if the canal bottom elevation is considered to be 2.5m, water surface elevation of 6.1m), and it can carry the planned flow rate. In the land use plan, the retention pond use land is planned as 18.55 ha. It will be located at the terminal of the canal, and it will have storage functions enabling it to perform the function, preventing the impact of the change of the runoff rate accompanying land preparation, and part of the pump drainage functions during flooding. If the water level outside the surrounding level is nearly 5m, discharge by natural flow will be difficult, so the gate of the surrounding level will be closed and the system switched over to pump drainage. The study of pump capacity assumed the scale able to withstand 115mm/3hours of the largest past rainfall of July 18, 2005.
Telecommunication line (Optical Fiber Cable) connecting from outside EZ	At Araihaazar EZ, communication services will be provided by installing wire (optical fiber etc.) underground from nearest telecommunication exchange(s) to the EZ. For the basic design of the optical fiber installation, along with JICA Study Team. BTCL will assist BEZA for basic design.

Table 3.1-4: Summary of General Land use

Land Use Plan (ha)	
Factory Lots	144.84
On-site Infrastructure	
Internal Road	10.76
Utilities: Power Distribution Water supply/Sewage line Gas Distribution, CETP/STP Telecommunication	14.28
Other infrastructure (administration, Fire station, Green area etc)	19.64
(On-site Infrastructure total)	44.68
Off-site Infrastructure	
Access Road	1.49
RC & Retention Pond w/PH	18.55
Telecommunication supply	Outside the EZ
Land Filling Work (Total) (including "Factory Lots", "On-site Infrastructure" "Off-site Infrastructure" except for Telecommunication supply)	218.84

Source: JICA Study Team



Source: JICA Study Team

Figure 3.1-1: Proposed Layout Plan of Araihaazar Economic Zone

Project Owner and Implementation Agency

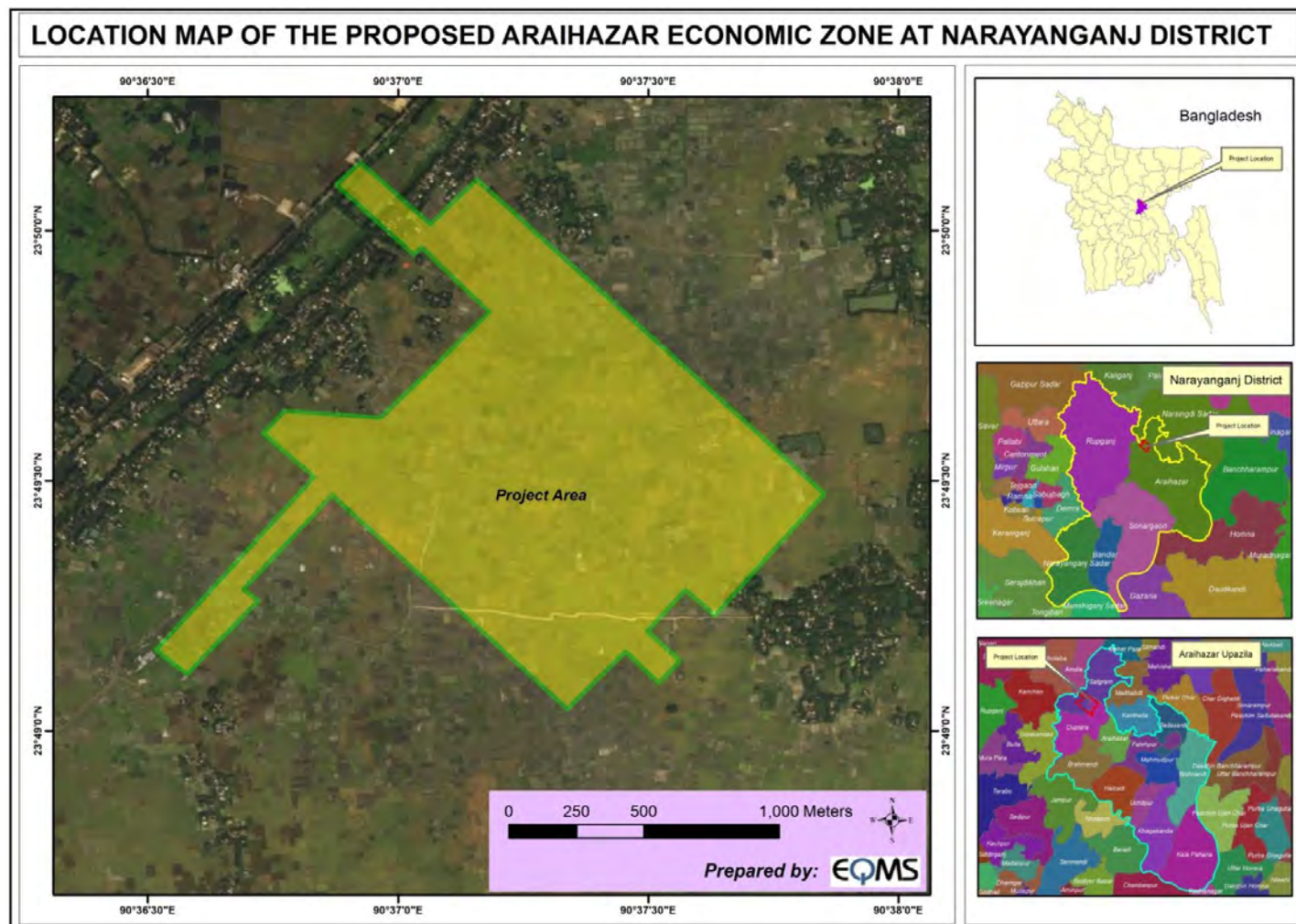
BEZA is responsible for total identification and promotion of all economic zones. BEZA identifies the location and develops the necessary off-site infrastructure to make a site accessible and buildable. Further, a developer is appointed by BEZA to develop the EZ as per the EZ Act, 2010.

Location of the Project

The proposed Araihaazar Economic Zone (AEZ) site is located at Mouza: Satgram, Shatgaon, Satgram & Duptara Union, under Araihaazar Upazila, Narayanganji District. The site is near to Dhaka-Sylhet Highway in the north direction, Shitalakhya River in east direction and Meghna River is in the South-East direction. The project area is mainly covers agricultural low land.

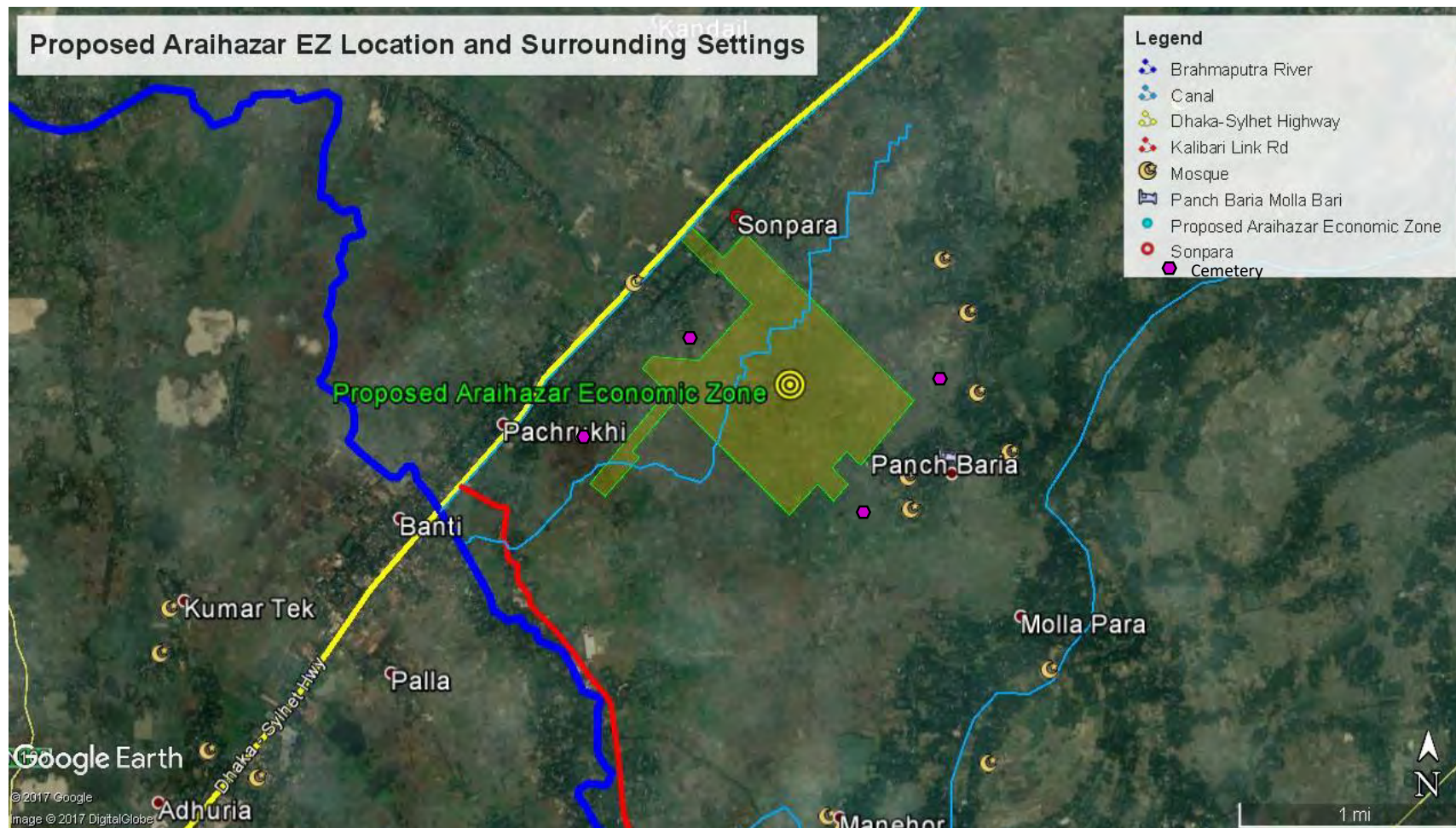
The location map of the proposed project site is presented in **Figure 3.1-2 & Figure 3.1-3** showing the geographical boundaries of the proposed Araihaazar Economic Zone and structures that have social importance, namely mosks and cemeteries.

It's been found through the topographic survey that there are several mosks and cemeteries around the project site. Access to one of cemeteries will be affected by the project but alternative access road will be constructed and the access will be secured during and after the project.



Source: Google Earth-image has been partially modified by JICA Study Team.

Figure 3.1-2: Location Map of Araihasar Economic Zone



Source: Google Earth-image has been partially modified by JICA Study Team.

Figure 3.1-3: Proposed Araihaazar EZ location and surrounding settings; mosks, cemetery.

Particulars	• Details
Location	Site is located at Union: Satgram & Duptara, Upazila: Araihaazar, District: Narayanganj
Mouza	Panchrukhi & Panchgaon
Nearby Villages	West- Banti, Kumartek North- Kandail, Prabashi palli South-Manehor East- Tekpara, Noagaon
Project Area	218.84 ha
Road Access	Adjacent Dhaka-Sylhet Highway
River Access	Approx. 1.5 km from Brahmaputra River Approx. 5.5 km from Shitalakhya River Approx. 9 km from Meghna River 31.5 km from Narayanganj River Port & 115 km from Chadpur River Port,

3.1.2. Current Natural and Social Environmental Condition

(1) Meteorology and Climate

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

Our study area, Araihaazar, falls in the south central climatic sub zone of Bangladesh (**Figure 3.1-4**). This sub climatic zone experiences abundant rainfall (more than 1900 mm) and moderate temperature. Eighty percent (80%) of the rain falls during the monsoon season. Hails storms and Nor'westers (thunder storm) are also observed in this area. However, in order to investigate the climatic condition of the study area Araihaazar, data from different secondary sources have been collected.

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

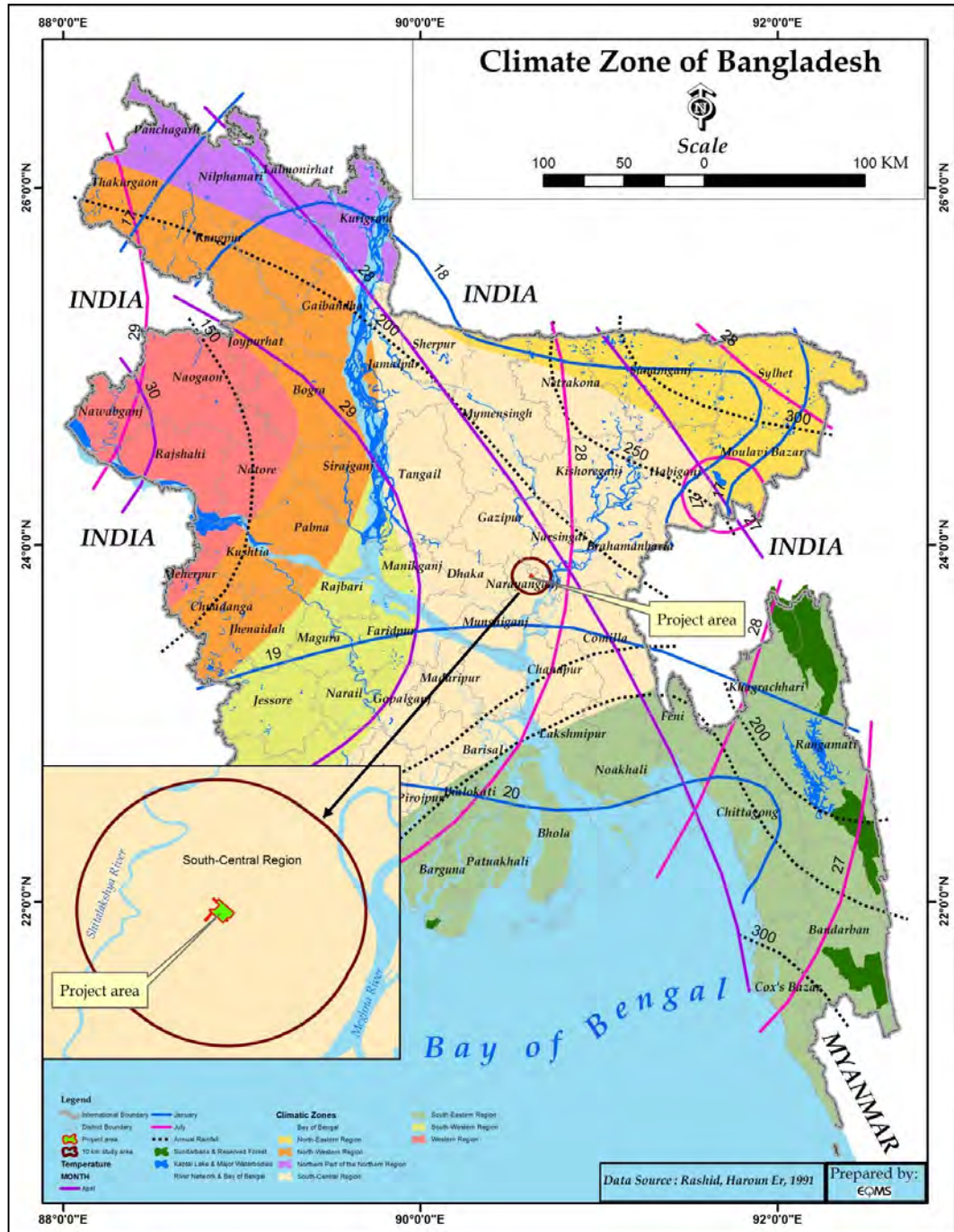
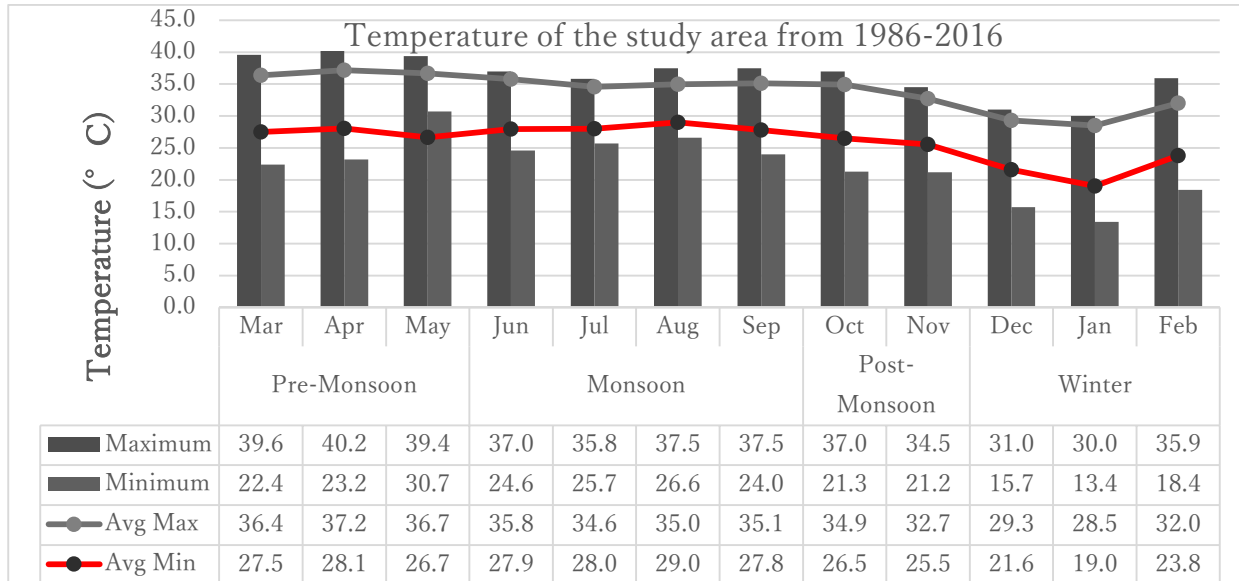


Figure 3.1-4: Climate Region Map of Bangladesh

Temperature

The maximum, minimum and average temperatures recorded at the Dhaka weather station are presented below in **Figure 3.1-5**.

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

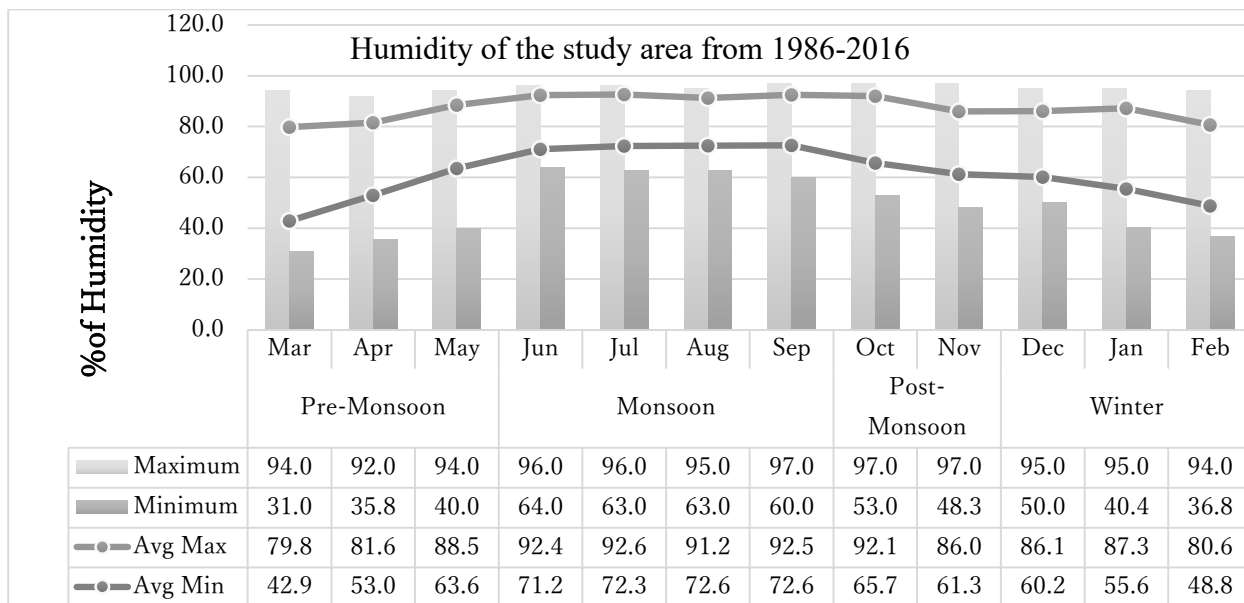


Source: Bangladesh Meteorological Department, Dhaka

Figure 3.1-5: Monthly Maximum, Minimum and Average Temperatures (1986-2016) of Dhaka Weather Station

Humidity

Due to the heavy rainfall and high air temperature, the humidity levels in Bangladesh remains high. Analyzing meteorological data, we found that, during the pre-monsoon period, the humidity level remained at its lowest point. In our study area, February is the driest month with an average minimum of around 49% humidity. However, humidity increases to maximum in the monsoon period. The average maximum humidity ranges from 94% to 97%, whereas the minimum average ranges from 31% to 64%. The monthly maximum, maximum average, and minimum, and minimum averages of the last 30 years (1986-2016) registered at the Dhaka weather station are shown in the **Figure 3.1-6**.

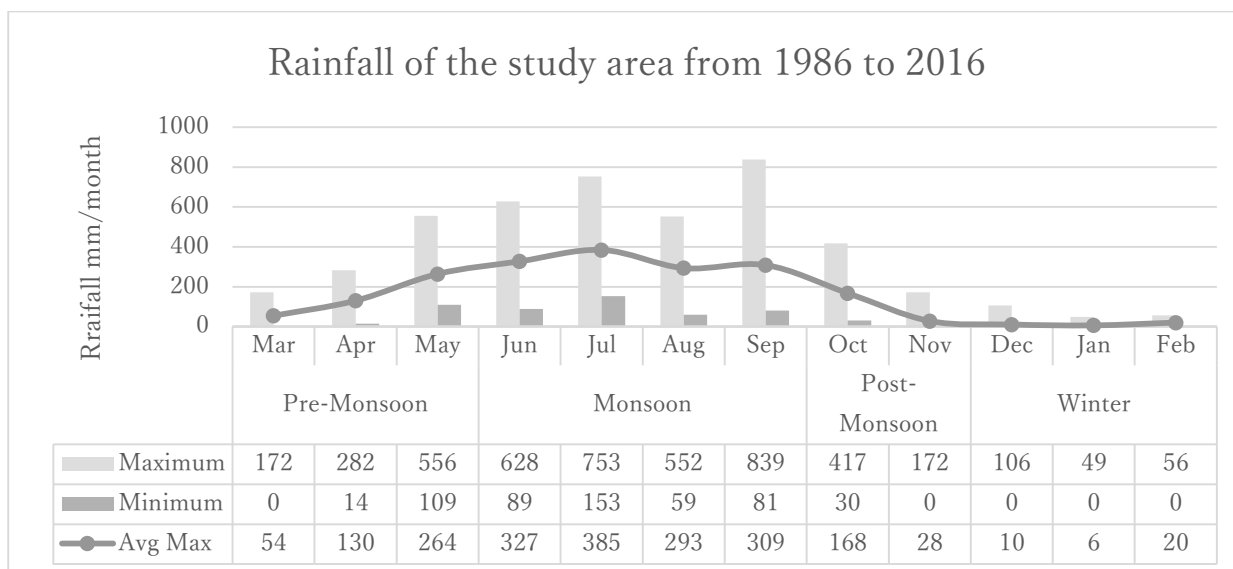


Source: Bangladesh Meteorological Department, Dhaka

Figure 3.1-6: Monthly Maximum, Minimum and Average Humidity (1984-2014) registered at Dhaka Weather Station

Rainfall

About 80% of the rainfall occurs during the six monsoon months (May to October) with June and July getting the maximum average rainfall. Minimum rains are reported during the months of November to February whereas the average showering occurs in March, April, and November. The meteorological data of the last 30 years from the Dhaka meteorological station shows that the annual average of total rainfall recorded as 1,994.6 mm/year. According to the analysis of the historical data, the monthly average of total rainfall occurs in July at 1,049 mm whereas the monthly minimum rainfall is recorded during the winter season. The monthly maximum, minimum and average rainfall data of the last 30 years (1986-2016) registered at the Dhaka weather station is shown in the **Figure 3.1-7**.



Source: Bangladesh Meteorological Department, Dhaka

Figure 3.1-7: Monthly Maximum, Minimum and Average Rainfall (1986-2016) of Dhaka Weather Station

(2) Topography, Geography, Land Use

Topography

The EZ site is a naturally depressed area, which remains submerged during monsoon and dry in winter. The land use of the project site is agricultural land. Area is classified as a Jamuna (Young Brahmaputra) Floodplain. A river network is present close to the site floods during any monsoon. A physiographic map of Bangladesh is depicted in **Figure 3.1-8**. The Araihaazar candidate site is flat agricultural land (paddy field) with an elevation of MSL + 2.5 m, and is submerged in the rainy season. Small water channels a few meters lower than the surrounding agricultural ground elevation exist. The Canal has been used for transportation of agricultural products and fertilizers by small boat. The area on the north-western side of the candidate site, along National Road N2 and along the southwestern side of the river are MSL +4 ~ +5.5 m higher than the agricultural land with scattered village roads, houses, and water ponds. The pavement elevation of the National Highway N2 is higher than local land. It has dropped from MSL +10 m at the southwestern side of the bridge to about MSL +7 m at the north-eastern side. Rainwater inside the EZ candidate site flows from the northeast to the southwest and drains into the southwestern side of the river, connecting to the Meghna River. The elevation of the candidate site is lower than past flood levels of surrounding large rivers such as the Meghna River and the Shitalakshya River. Hence, it is necessary to ensure surface water diversion around the candidate site after site formation. A contour map of 10 km radius area is shown in **Figure 3.1-9**. A 10 km radius area is shown in **Figure 3.1-10**.

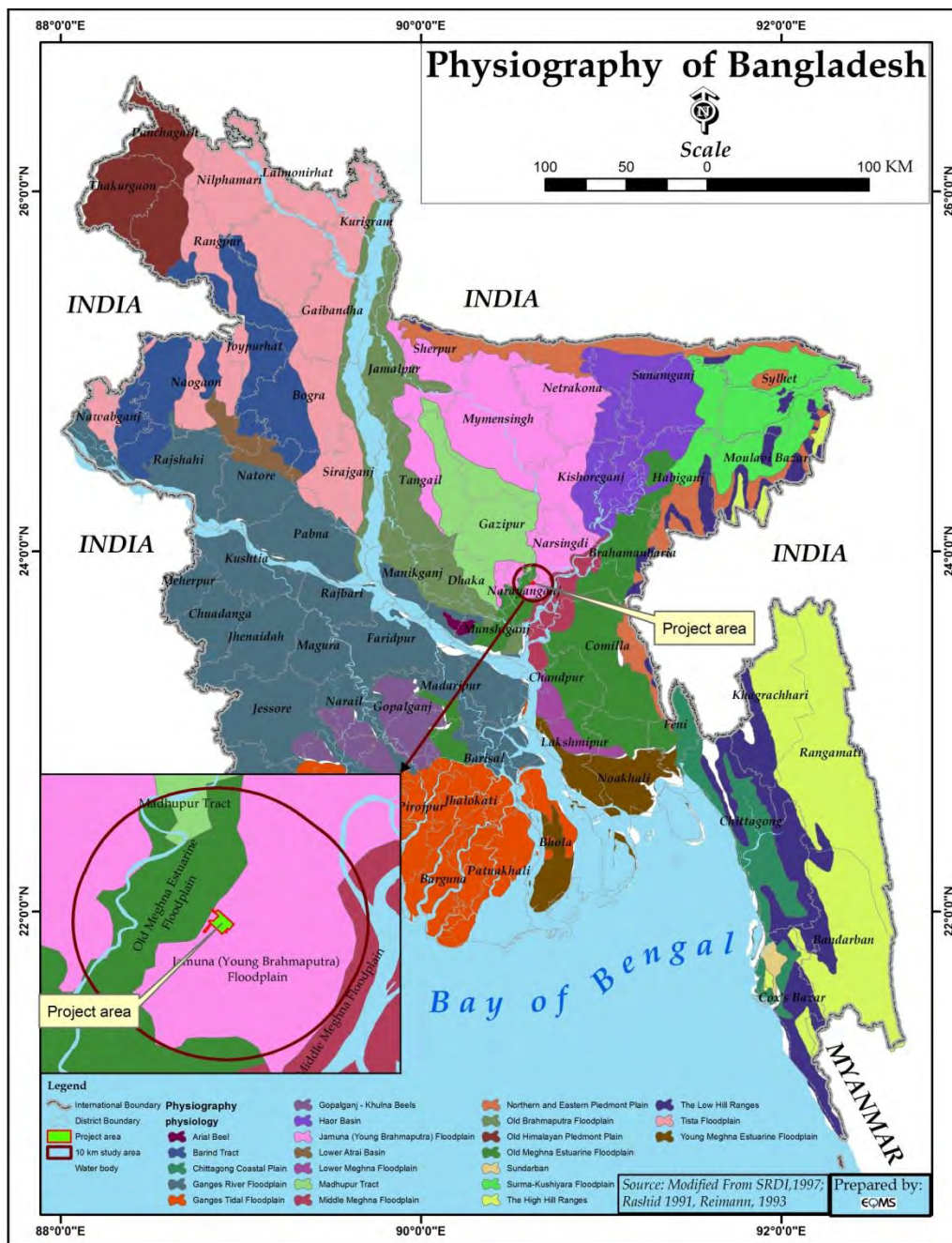


Figure 3.1-8: Physiographic Map of Bangladesh

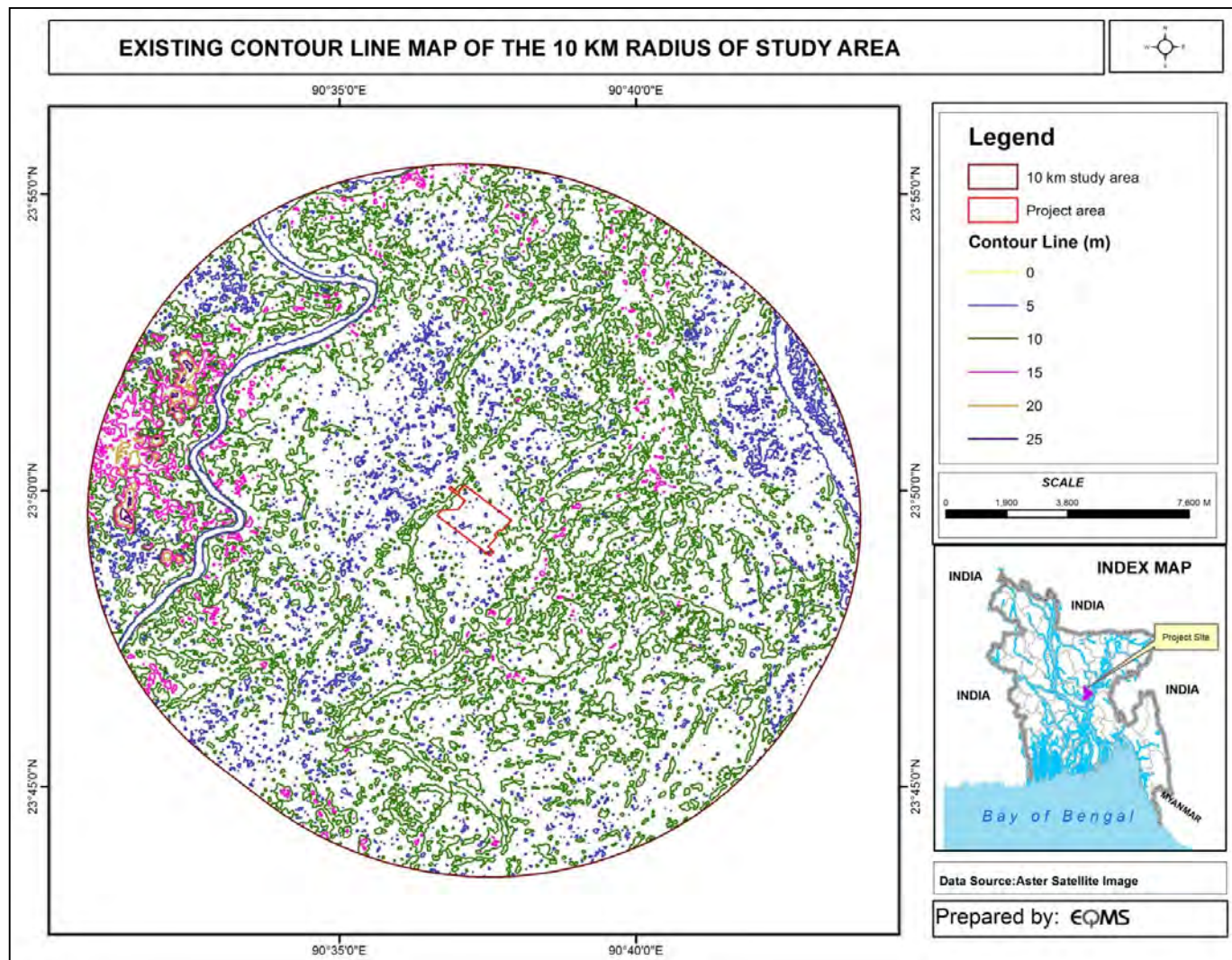


Figure 3.1-9: Contour Map of the 10 km radius of Study Area

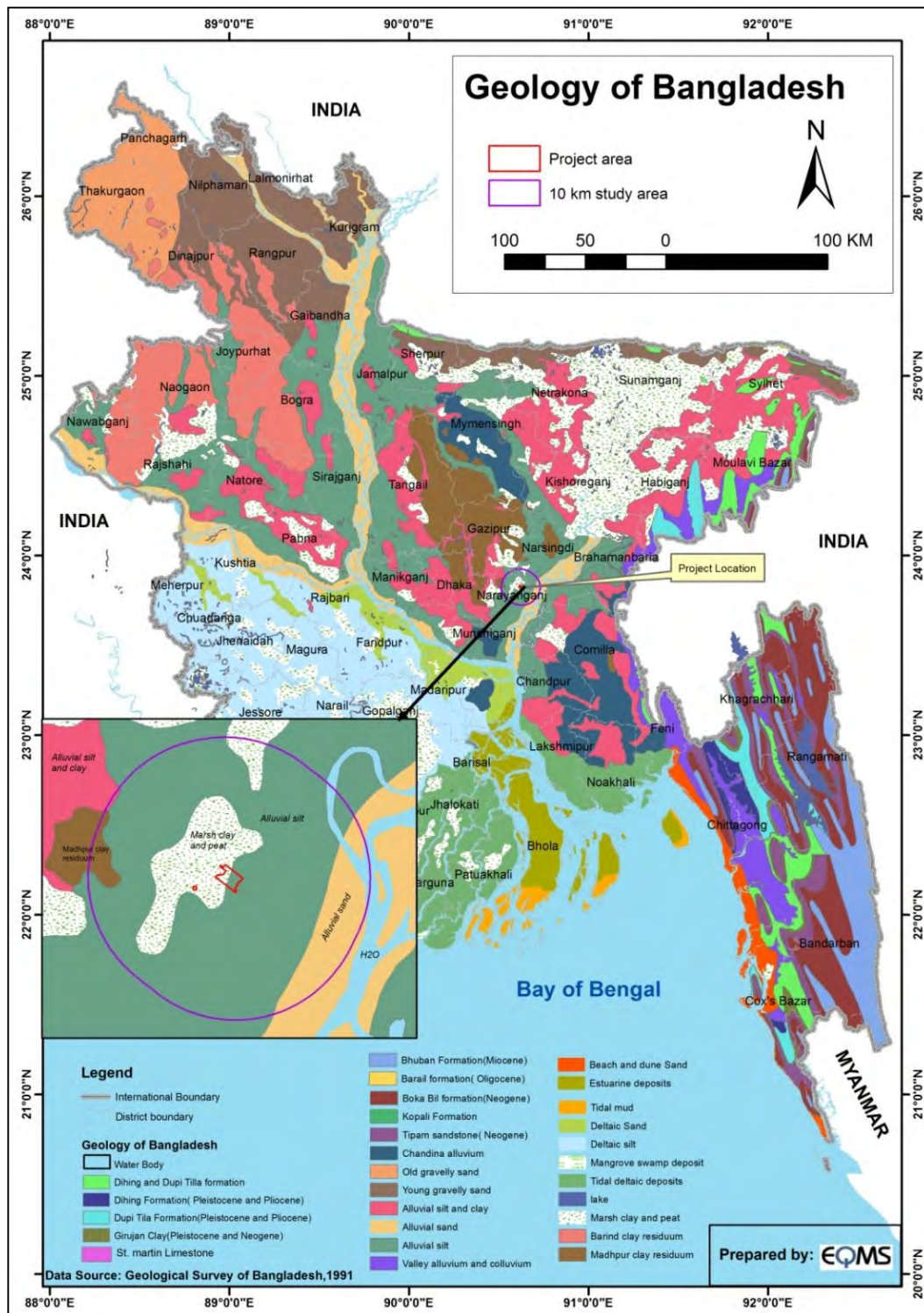


Figure 3.1-11: Geology of Bangladesh

Land Use

Predominant land use of the Satgram union area is agriculture followed by settlement and water body. Recommended land zoning of this area is agriculture increasing industrial and commercial zone. A detailed land use pattern of the Araihaazar union is shown in **Table 3.1-5**.

Table 3.1-5: Union wise Present Land Use Information and Identified Land Zoning of Arai hazar Upazila

Union	Present Land Use (%)	Recommended Land Zoning
Bishnandi	Agriculture=46, Fallow/ChanceCrop=1, Area UnderDevelopment=1, Road=1, Settlement=17, Water Bodies=34	Agriculture-Charand MeghnaRiver Zone
Brahmandi	Agriculture=64, IndustrialArea=1, Road=2, Settlement=29, Water Bodies=4	AgricultureIndustrial andCommercialZone
Duptara*	Agriculture=68, IndustrialArea=1, Road=1, Settlement=24, Water Bodies=6	AgricultureIndustrial andCommercialZone
Fatehpur	Agriculture=58, Road=2, Settlement=33, Urban=1, Water Bodies=6	AgricultureIndustrial andCommercialZone
Haizadi	Agriculture=74, Road=1, Settlement=21, Water Bodies=4	Agriculture Zone
Kalapaharia	Agriculture=56, Settlement=9, Water Bodies=35	Agriculture-Charand MeghnaRiver Zone
Khagakand	Agriculture=49, Road=1, Settlement=16, Water Bodies=34	Agriculture-Charand MeghnaRiver Zone
Mahmudpur	Agriculture=49, Road=1, Settlement=16, Water Bodies=34	Agriculture-Charand MeghnaRiver Zone
Satgram*	Agriculture=76, IndustrialArea=1, Road=1, Settlement=18, Water Bodies=4	AgricultureIndustrial andCommercialZone
Uchitpur	Agriculture=73, Road=1, Settlement=20, Water Bodies=6	Agriculture Zone
Arai hazar Paurashava	Agriculture=55, IndustrialArea=1, BrickField=1, Road=2, Settlement=37, Urban=1, Water Bodies=3	Paurashava area
Gopaldi Paurashava	Agriculture=58, IndustrialArea=3, Road=1, Settlement=32, Water Bodies=6	Paurashava area
Satgram(Part)	IndustrialArea (Economic Zone)	Arai hazarEconomic Zone
Duptara(Part)		

Source: National Land Zoning Report, Arai hazar Upazila, December 2016

*Project site located in this union

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

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

The evaluation of the existing environmental status of the study area has considered 0-10 km. This revealed that the land use/land cover consists mainly of Agricultural land, residential area, settlement

with homestead vegetation and water bodies. **Table 3.1-6** shows the existing land use composition around 10 km of the project study area. **Figure 3.1-12** gives the Land use/Land cover map and shows the land use pattern within 10 km of the study area.

Table 3.1-6: Existing Land use Composition around 10 km of the Project Area

Land use Category	Area in Acres	Percentage (%)
Commercial	87.16	0.09
Agricultural land	62250.19	66.21
Industrial	542.23	0.58
Water	6605.07	7.03
Public	79.29	0.08
Residential	19259.53	20.48
Mixed area	1575.87	1.68
Brick Field	859.05	0.914
Roads	427.89	0.46
Built Up area	2332.45	2.48
Total		100.0

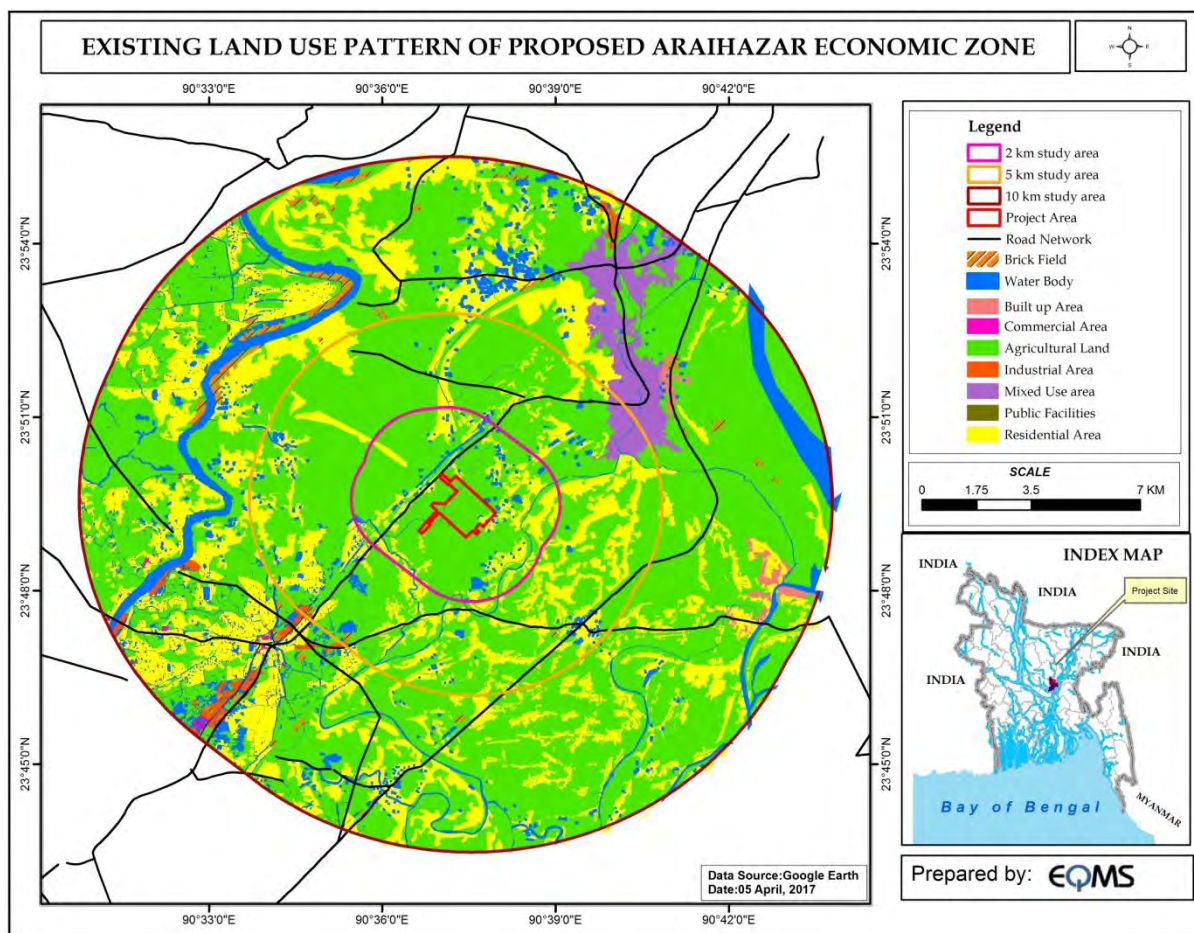


Figure 3.1-12: Land use/Land Cover Map for 10 km Study Area

Protected Area

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

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

National Park (NP)

It is a reserved land, usually declared and owned by a national government, protected from most human development and pollution. No NP exists at or near the proposed project site.

Game reserve (GR)

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

Wildlife Sanctuary (WS)

An area assures that the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment, where these require specific human manipulation for their perpetuation. The nearest protected area is “Bhawal National Park” (see the yellow star in the map below), located at 35km from the project site, and the project will have no impact .

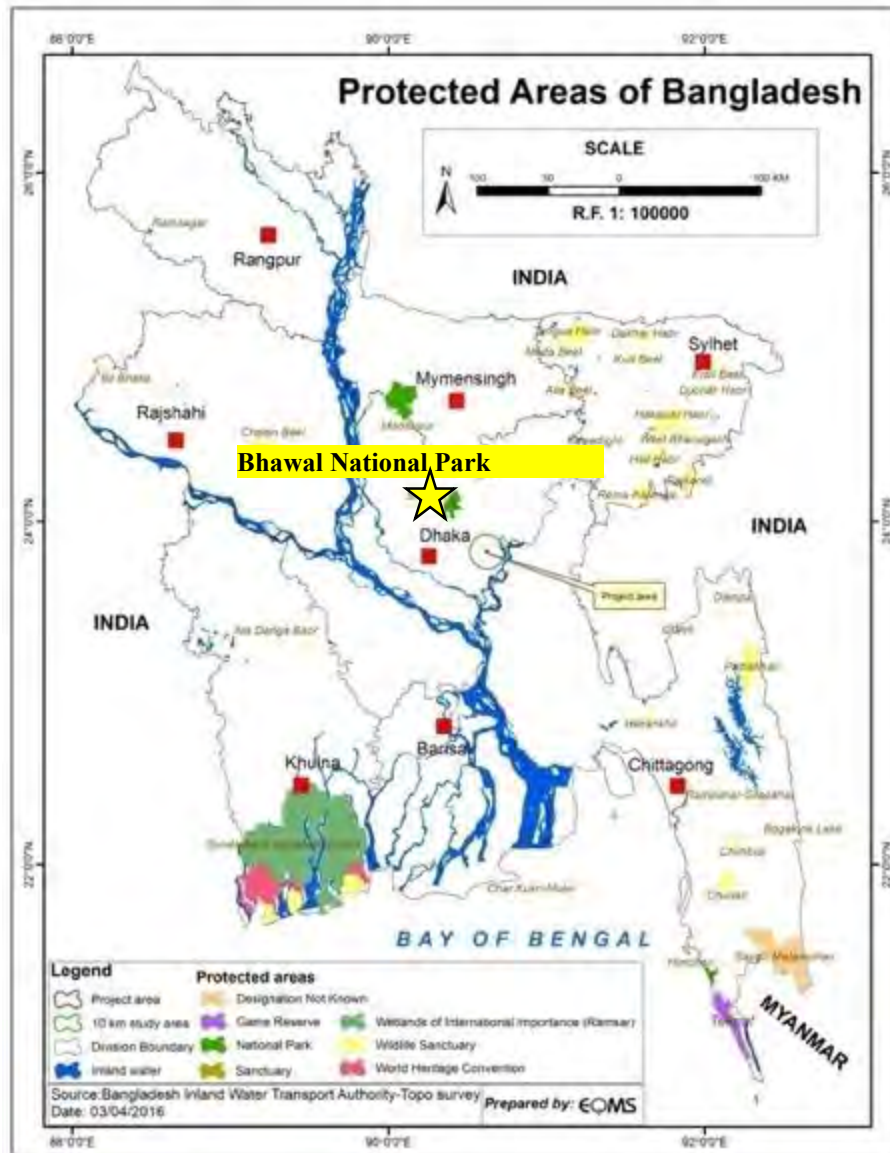


Figure 3.1-13: Protected Areas of Bangladesh

Ecologically Critical Area (ECA)

Ecologically the Government of Bangladesh under the Bangladesh Environment Conservation Act, 1995, defines a Critical Area (ECA) where an ecosystem has been considered to be threatened and reaching a critical state endangerment. In 2009, the Bangladesh Government declared the four rivers, such as Buriganga, Sitalakhaya, Turag and Balu around Dhaka city as ECAs. The Gazette notification to this effect imposes restrictions on a number of activities in these rivers and their associated riparian environs. These include all types of hunting, collection of all types of aquatic species living in the rivers, all activities that could result in the destruction of floral or faunal habitats, all activities that

could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste. The nearest ECA to the project site is “Ghulshan Baridhara Lake” located in Dhaka city (indicated with an yellow star in figure 3.1-14). The distance from the project site is approximately 20km and no impact is expected.

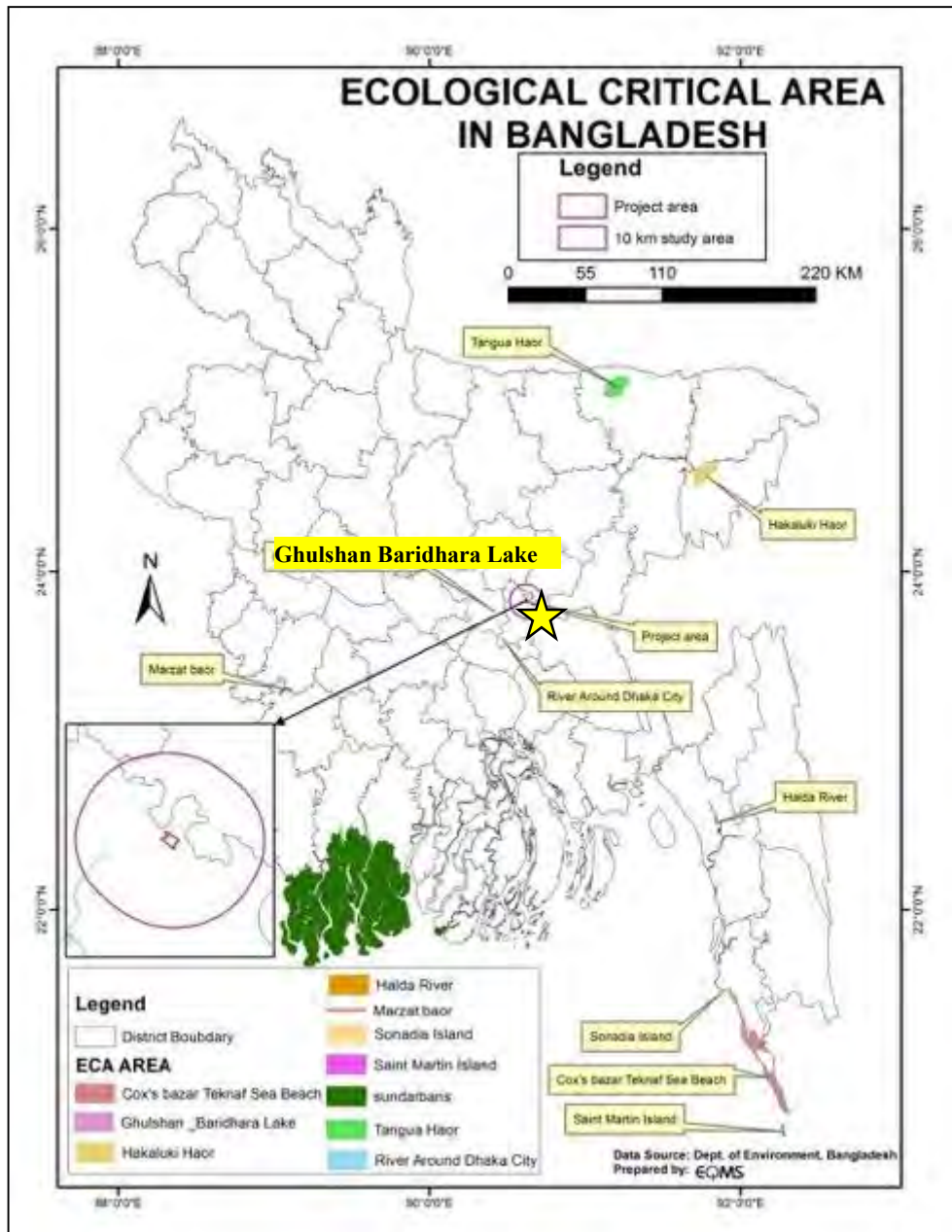


Figure 3.1-14: Ecological Critical Area in Bangladesh

Cultural Heritage

Nothing found in the development area would be affected by the development. No impact or impacts are negligible, no further study required.

An environmental impact is defined as any change to an existing condition of the environment. Findings of the assessment are presented according to site preparation, construction and operation

3.1.3. Environmental Legislation

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

- Identification of national legal obligations in relation to the interventions which will be required to review under the EIA study of the proposed economic zone;

To address the environmental and social risks of any proposed project and its associated components; to protect and conserve the environment from any adverse impacts, the GoB has specified regulations, policies and guidelines. The activities of the proposed economic zone project fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore, we need to conduct EIA studies to obtain site and environmental clearance from the DoE.

phases. The impacts will be determined as significant, positive or negative, direct or indirect, long term or short term.

The EIA study, based on the screening and scoping of IEE study, review of proposed civil works, review of similar environmental assessment reports, baseline monitoring and stakeholder consultations, has identified 30 major environmental and social concerns that are expected from the project. The impacts are broadly classified into following 4 rating during preconstruction, construction and operation stage:

- Environmental Pollution
- Natural Environment
- Social Environment
- Others

Project impacts to key 30 items caused by the project both tentatively during construction and permanently during operation phase is given below;

- Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the proposed project interventions;

(1) Environment Conservation Act, 1995 (subsequent amendments in 2000 and 2002)

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

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

(2) Environment Conservation Rule, 1997 (subsequent amendments in 2002 and 2003)

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

- The National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load;
- Procedure for obtaining environmental clearance;
- Requirements for undertaking IEE and EIA's as well as formulating EMP's according to categories of industries/development projects/activities; and
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.
- Depending upon the location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories: Green, Orange A, Orange B and Red respectively as nil, minor, medium and severe impacts on important environmental components (IECs).

(3) International Treaties

Bangladesh has signed most international treaties, conventions and protocols on environmental protection. **Table 3.1-7** shows relevant international treaties, conventions and protocols signed by Bangladesh.

Table 3.1-7: Relevant International treaties, conventions and protocols signed by Bangladesh

Treaty or Convention	In	Brief Description	Responsible Agency
International Convention for Protection of Birds, Paris	1950	Protection of birds in wild state	Department of Environment/ Department of Fisheries
International Plant Protection Convention, Rome	1951	To secure coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products.	Department of Environment
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, Brussels	1969	Civil liability on oil pollution damage from ships	Department of Environment/ Ministry of Shipping
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar	1971	Protection of wetlands	Department of Environment/ Department of Fisheries
Convention Concerning the Protection of the World Cultural and natural Heritage, Paris	1972	Protection of major cultural and natural monuments	Department of Archaeology
Convention on International Trade in Endangered Species of Wild Fauna and flora (CITES), Washington	1973	Ban and restrictions on international trade in endangered species of wild fauna and flora	Department of Environment/ Department of Fisheries
Convention Concerning the Prevention and Control of Occupational Hazards caused by Carcinogenic Substances and Agents, Geneva	1979	Conservation of migratory species of wild animals	Department of Environment/ Department of Fisheries
Convention Concerning the Protection of	1974	Protect workers against	Ministry of Health and

Treaty or Convention	In	Brief Description	Responsible Agency
Workers Against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration, Geneva		occupational exposure to carcinogenic substances and agents	Family Welfare
Convention on the Conservation of Migratory Species of Wild Animals, Bonn	1977	Protect workers against occupational hazards in the working environment	Ministry of Health and Family Welfare
Convention Concerning Occupational Safety and Health and the Working Environment, Geneva	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	Ministry of Health and Family Welfare
Convention Concerning Occupational Health Services, Geneva	1985	To promote a safe and healthy working environment	Ministry of Health and Family Welfare
Vienna Convention for the Protection of the Ozone Layer, Vienna	1985	Protection of ozone layer	Department of Environment/Ministry of Environment and Forest
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, Basel	1989	Safe methods for transport of dangerous goods by road, railway and inland vessels	Ministry of Communication
International Convention on Oil Pollution Preparedness, Response and Cooperation, London	1990	Legal framework and preparedness for control of oil pollution	Department of Environment/ Ministry of Shipping
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London	1990	Control of global emissions that deplete ozone layer	Department of Environment/ Ministry of Environment and Forest
United Nations Framework Convention on Climate Change (UNFCCC), New York	1992	Regulation of greenhouse gases emissions	Department of Environment/Ministry of Environment and Forest
Convention on Biological Diversity (CBD), Rio De Janeiro	1992	Conservation of bio-diversity, sustainable use of its components and access to genetic resources	Department of Environment/ Ministry of Environment and Forest
Kyoto Protocol to the United Nations Framework Convention on Climate Change, Kyoto	1997	International treaty on climate change and emission of greenhouse gases	Department of Environment/ Ministry of Environment and Forest
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal	2000	Biological safety in transport and use of genetically modified organisms	Department of Environment/ Ministry of Environment and Forest
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	2010	Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	Minister for Environment and Forests of Bangladesh
Paris Climate Agreement	2015	Climate Change	Minister for Environment and Forests of Bangladesh

(4) Environmental Clearance from DoE, Bangladesh

Bangladesh has very simple administrative framework regarding environmental aspect. It has strong interface between local government and federal Government. Department of Environment is responsible for a grant of environmental clearance to a project. In addition, there are other ministries to deal with specific areas of importance to the country like Forests, Water. According to the Section 12 of the Environment Conservation Act 1995 no project will be established or undertaken without obtaining permission, in the manner prescribed by the Environment Conservation Rules 1997, an Environmental Clearance Certificate from the Director General.

Therefore, every development projects/industries which are specified under the Schedule–1 of the Environment Conservation Rules 1997 require obtaining site and environmental clearance from the Department of Environment. According to the Rule 7 (1) of the Environment Conservation Rules 1997; for the purpose of issuance of Environmental Clearance Certificate (ECC), every project, in consideration of their site and impact on the environment and will be classified into the four categories, i.e. green, orange A, orange B and red. Development of on-site facilities for economic zone will fall under the Red category.

Thus, EIA study is required to be carried out for the project. The present EIA study has been conducted for the proposed project complying with the approved TOR issued vide Memo No. 22.02.0000.018.72.003.17/334 dated 21st June 2017. Focused group and stakeholder consultation has also been conducted to discuss the environmental issues associated with the project. Proceedings of stakeholder consultations have also been included in the report. A schematic representation of the various steps involved in obtaining the Environment Clearance certificate from DoE for Red category projects is given in below.

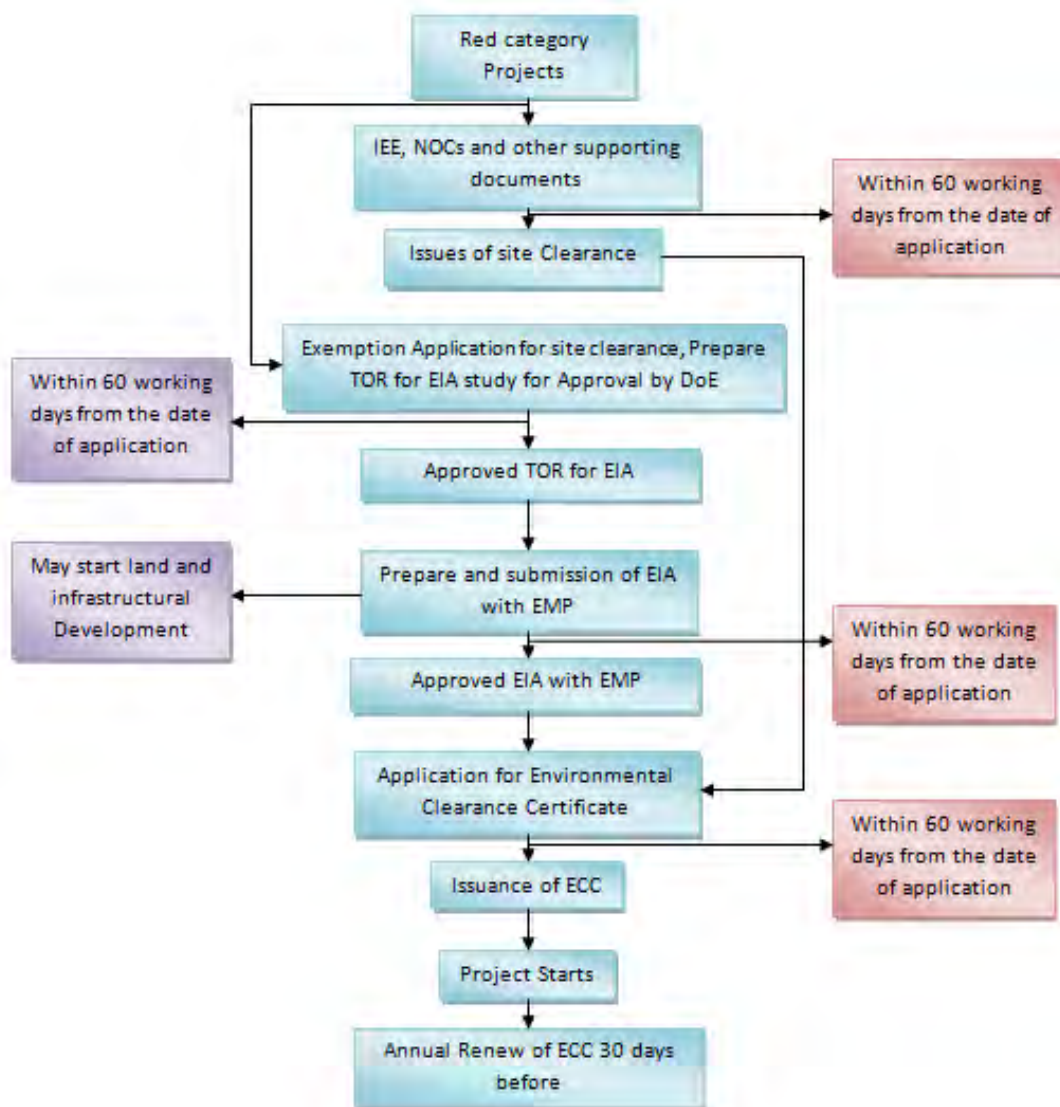


Figure 3.1-15: Steps for Obtaining Environment Clearance from DoE

3.1.4. Alternative Analysis

In order to consider the project area and the shape of the Economic Zone, two alternatives were compared comprehensively from the viewpoint of technical aspect, economical aspect, safety, and social and environmental consideration.

As a result of the alternative study shown in Table 3.1-8, Araihaazar EZ was selected as the priority option because it has advantages from the viewpoint of technical aspect, economical aspect, safety, and environmental/social consideration as follows:

- Technical aspect: higher ground elevation
- Economic aspect: less construction cost
- Safety: less traffic volume during construction
- Environment/social consideration: less scale disruption of nature and less number of project-affected households (PAHs)

Table3.1-8: Result of Alternative Study

	Araihazar Economic Zone	Nayanpur Economic Zone
Location Map		
Area	218.84 ha	233 ha
Location & District	20 km from Dhaka in direct distance, Araihaazar Upazila, Narayanganj District	50 km from Dhaka in direct distance, Sreepur Upazila, Gazipur District
Highway access	Along Dhaka-Sylhet Highway	1.2 km Dhaka from Mymensingh Highway(National Highway No.3)
Distance from dhaka	26.0km from Dhaka in road distance(37 minutes)	60.9 km from Dhaka in road distance (1 hour 51 minutes)
Infrastructures	132kV/33kV substation, 2.5 km from site. BEZA stated that Petrobangla has agreed for provision of 100MMCFD of Gas to the EZ from Madhobdi TBS (VS-14). However, TITAS suggests that 6 km long pipeline and 12-inch dia. Pipe could be sufficient and more feasible cost wise for the EZ	4 km away from 132kV/33kVsubstation (Sreepur Sub-Sta.1), 3.4km from site. 12 inches gas pipeline along National Highway No. 3, 1.5km east away from site.
Land use	Farmland, double cropping	Farmland, single cropping
Site preparation	Embankment: 0.6- 2.6m (Avg.1.6m), Land elevation: Approx.6-8m above MSL, Flood water level due to rivers of Shitalakhya and Meghna: Approx.7.52m (1/100), Elevation of land preparation: 8.0m	Embankment: 0.5- 2.5m(avg. 1.5m),Land elevation: Approx. 14-16mabove MSL, Flooding: Not affected by Padma and Meghna Rivers, Avg. height of elevation: 16.5mabove MSL considering rain water gradient, Borrow pit in Barmi Bazar 17kmeast away from site
Natural environment	Rice paddy(Low risk for erosion and water logging)	Rice paddy (Low risk for erosion and water logging)
Environment /Social Consideration	- Since the traffic volumes resulting from the earthwork transportation during the construction phase are estimated to be smaller than in Nayanpur EZ, exhaust gas from the vehicular traffic will be less than in Nayanpur EZ. - According to the project description, the modification in the creek is not expected. Therefore, the negative impact on natural environment is forecasted as less than Nayanpur EZ. - Around 11 structures might be resettled in the Araihaazar EZ area, which is less than in	- Since the traffic volumes resulting from the earthwork transportation during the construction phase are estimated to be larger than in Araihaazar EZ, exhaust gas from the vehicle traffic will be more than in Araihaazar EZ. - According to the project description, the modification in the creek is expected. Therefore, the negative impact on natural environment, Flora/Fauna and Ecosystem is expected. - More households will be resettled than

	Araihazar Economic Zone	Nayanpur Economic Zone
	Nayanpur EZ area. Therefore, the social impact will be lesser than that of Nayanpur EZ.	Araihazar EZ area. Therefore, the social impact will be greater than that of Araihazar EZ.
Flood Water Level	The result of the 100-year rough probability calculation shows that the water level is 7.21 m at Araihazar.	The result of the 100-year rough probability calculation shows that the water level is 10.72 m at Nayanpur.
Nearest River	Shitalakhya River, Brahmaputra River and Meghna River	Turag River and Shitalakhya River
Safety	As transportation of soil for land reclamation is basically done inside the project site, the risk of traffic accident occurring outside of the project site is not increased.	Since it is necessary to transport the soil for land reclamation from outside of the project site, the risk of traffic accident is increased.
Annual average revenue from fields such as rice paddies and farmlands (Tk/acre/year)	Approx. 50,000Tk/acre/year	Approx. 80,000Tk/acre/year
Economic Aspect	- Since earthwork volume is smaller than Nayanpur EZ, construction cost is estimated to be less and construction period is estimated to be shorter than in Nayanpur EZ. - Since the number of PAHs will be less than in Nayanpur EZ as stated in the environmental/social consideration below, the compensation for resettlement will be reduced.	- Since earthwork volume is larger than in Araihazar EZ, construction cost is estimated to be higher and construction period is estimated to be longer than in Araihazar EZ. - Since the number of PAHs will be more than Araihazar EZ as stated in the environment/social consideration below, the compensation for resettlement will be increased.
Evaluation	Compared with Nayanpur EZ, Araihazar EZ has advantages from the viewpoint of technical aspect, economical aspect, safety aspect, and environmental/social consideration. Therefore, Araihazar EZ is chosen as the preferred option.	

Comparison with the case in which the Project is not implemented

This scenario should be based on the current condition of the project and without the development of Economic Zone. The study of the scenario is shown in **Table 3.1-9** below. As a result of this study, it is judged that the implementation of the Project should be undertaken because of some advantages in terms of effective urban development and economic development of the country and region including infrastructure development around the candidate Economic Zone. In addition, anticipated negative impacts could be avoided or minimized by taking the appropriate countermeasures.

Table 3.1-9: Study of the case with the case in which the Project is not implemented

Aspect	Condition Without the Project	Condition With the Project
Technical Aspect	Random development might be implemented without any plan for overall area development. Then, the future development plan might be restricted after disorderly development	Candidate Economic Zone would be developed efficiently in accordance with the planned area development plan.

Aspect		Condition Without the Project	Condition With the Project
Economical Aspect	Employment	Job opportunity would not increase from the current situation	Job opportunities would increase for local residents
	Farmer/Share Cropper/Day labor	No need to change their occupation	Farmer's will be compensated project proponent and they will alter by other profession
	Infrastructures	Economic development of the entire area would be limited.	A series of infrastructure development project (water supply, telecommunication and access road) would be beneficiary and cost-effectiveness for Candidate Economic Zone development.
	Annual revenue from Paddy land	Annual revenue will be increased from paddy land because of no development project	Annual revenue will be decreased from paddy land but it will be limited
	National Economy	Contribution of national economic development of the entire area would be limited.	Because of high industrial development and thousand job holders will contribute on national economic growth.
Environment/Social Consideration	Resettlement	Involuntary resettlement would not occur.	Impact on social aspect such as involuntary resettlement would occur.
	Environment	Impact on natural environment that might be caused by the development of candidate Economic Zone will not occur.	Impact on natural environment and pollution caused by the construction work and operation of candidate Economic Zone would occur.
	Social	Impact on social environment that might be caused by the development of candidate Economic Zone will not occur.	Impact on social environment (road accident, social conflict, Community health and safety) caused by the construction work and operation of candidate Economic Zone might occur.

3.1.5. Scoping and Terms of Reference (TOR) for the Environmental Impact Assessment

(1) Scoping

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

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

Results of the scoping for environmental and social impact assessment for over all project are shown in Table 3.1-10.

Scoping was conducted toward the development project of Araihaazar Economic Zone. These impacts were evaluated in each of the three phases separately, namely: pre-construction, construction phase and operation phase.

Table 3.1-10: Scoping Matrix of the economic zone

Field	No	Impacts	Rating		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	B-	PC: It is estimated that minimum of 6 to 7-meter land filling must be practiced. Clearance of the site will involve removal of wild vegetation, land leveling, & filling activities. These activities will lead to dust generation. CO: Impact on air quality due to operation of construction machineries and circulation of construction vehicles is expected. OP: Impact on air quality due to increase of vehicle traffic during industrial operation. Emission would be generated from the industrial operation.
	2	Water pollution	A-	B-	CO: Impact on water quality from muddy water flowing to the river due to land reclamation work is expected. OP: Impact on water quality of the surrounding water bodies is expected due to wastewater discharge from the EZ.
	3	Waste	B-	A-	PC/CO: General construction waste is expected and typically managed by the appointed contractors. OP: Industrial waste is expected. Appropriate waste management by law and regulation is the responsibility of the tenant factory/facilities, which shall be approved by DOE for their own EIAs.
	4	Soil pollution	B-	B-	PC/CO: Project site and surrounding area would be contaminated by dredged soil. Development of the structures and construction of the access road may disturb the soil profile of the area. Land will be filled and compacted after filling. Also sand will be required for construction of access road and administration building which will be sources from nearby markets or other part of the country. Storage of raw material, fuel and construction debris may contaminate the soil. OP: Soil contamination would occur due to the improper operation of the EZ industries.
	5	Noise and vibrations	A-	B-	PC/CO: Increase of noise and vibration levels due to construction machineries operation, particularly by the sand compaction and traveling of construction vehicle would temporarily occur. OP: An increase in noise and vibration levels due to the circulation of vehicular traffic and operation of the industries would occur.
	6	Ground subsidence	D	C	CO: Construction activities will not attract significant water use and will be negligible. OP: Even though the projected amount of ground water consumed in the EZ 2.5 million m³/ year, the ground water will be taken from deep wells (260m to 300m) so that it will very unlikely to cause ground subsidence nor impact on surrounding wells used by residents. However, depending on the ground water resource capacity and EZ water extraction, unknown subsidence could occur.
	7	Offensive odors	D	D	Construction works that generate odors are not expected.
	8	Sediment quality	B-	B-	PC: During the land development, earth filling material may washout to canal and increase the sediment concentration in and around the EZ. Dredging activity along the meghna river may damage the sediment condition. CO: Development of the structures and construction may disturb the bottom sediment profile of the water bodies. OP: Bottom sediment of the surrounding water bodies would be

Field	No	Impacts	Rating		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
Natural environment					deteriorated by wastewater generated from the industries.
	9	Protected areas	D	D	Since no natural preservation area and national parks exist in and around the Economic Zone, impact on protected areas is not expected.
	10	Ecosystems	B-	B-	PC/CO: Extensive use of vehicle horns and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Many species of flora and fauna would frighten easily by vehicle horns and may become distressed. Dredging related activities may disturb river creature and vegetation along Meghna and Sitalakya river. OP: Post development of the economic zone & setting up of industries, there could produce some impacts to the ecosystem of the area. Industrial development will involve generation of emissions, kinds of effluent, and increased vehicular movements. These all together may have overall negative impact on the eco-system of the site and the nearby areas as certain specific air pollutants will impact the existing vegetation and avifauna in the area.
	11	Hydrology	A-	B-	CO: surface water movement would be significantly changed due to the construction of the retaining walls above the existing ground level. OP: without EZ drainage retaining systems, excess drainage water from the EZ could flood the surrounding area.
	12	Topography and geology	A-	D	CO: Due to the significant sand reclamation from the surrounding river beds, erosion of the river bank could occur without proper sand dredging. OP: No dredging or land filling work during operation phase and no impacts are expected
Social environment	13	Involuntary resettlement	A-	D	PC: Land acquisition will be required and some scale of involuntary resettlement is expected. OP: Involuntary resettlement is not expected.
	14	Vulnerable group	C	C	PC/CO: Vulnerable people in the project area would be affected. On the other hand, job opportunity and commercial opportunity would increase. OP: Vulnerable people would not be able to receive the benefits of the Project. On the other hand, job opportunity as workers of the industries and commercial opportunity would increase.
	15	Indigenous and ethnic people	D	D	CO: no indigenous/ethnic people live in the project affected area. OP: no impacts are expected
	16	Local economies, such as employment, livelihood, etc.	A-	A+	PC/CO: PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. On the other hand, increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. OP: Impact on the livelihood of relocated households is expected. On the other hand, an increase of job opportunity as workers of the industries or commercial opportunity targeting workers is expected.
	17	Land use and utilization of local resources	B-	C	PC: Total land of the project site is seasonally agricultural land. During the monsoon season the proposed land is submerged by the Dhawrakhali canal water which is connected to the river. In the pre-construction phase, the temporary storage and stockyard are built up on the agricultural lands, and then the crop production will be obstructed in those areas. Crops will also be damaged when the equipment and heavy vehicles will pass through agricultural fields of the proposed project areas. CO: The 218.84 ha of agricultural land will be altered by the industrial zone. As a result, the annual agricultural production rate of that upazila will diminish. In the project site, land is single cropped agricultural land so the impact on agriculture

Field	No	Impacts	Rating		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
					activities/resources is anticipated to have a low significant impact from the project development. OP: Industrial activities in and around the EZ may affect agricultural activities in the surrounding area.
	18	Water usage	C	C	CO: Since Araihaazar EZ sites do not have existing public water supply facilities, it is necessary to utilize the nearby rivers or wells as water sources. Ground water will be used during the construction phase. The ground water will be taken from deep wells (260m to 300m) so that it will not influence the surrounding environment or water supply. OP: Thousands of employees and workers will use and consume water and generate wastewater from the office and the residential building.
	19	Existing social infrastructures and services	B-	B-	PC/CO: <u>Impact to Relocated PAHs of the Project</u> Accessibility of PAHs to social Infrastructure/service would be affected more or less due to the relocation. On the other hand, the proposed relocation site will be arranged with basic social infrastructure as a part of the assistance by the project <u>Impact to Local People in the local Community of the project area</u> Accessibility of social infrastructure/service will be affected due to the increase of construction vehicles. The traffic volume should be controlled by the construction contractor to avoid serious traffic congestion. OP: Accessibility to social infrastructure would be limited by the existence of the industries.
	20	Social institutions such as social infrastructure and local decision-making institutions	B-	B-	PC/CO: <u>Impact to Relocated PAHs of the Project</u> Accessibility of PAHs to social Infrastructure/service would be affected more or less due to the relocation. On the other hand, the proposed relocation site will be arranged with basic social infrastructures as a part of the assistance by the project <u>Impact to Local People in the local Community of the project area</u> Accessibility of social infrastructure/service will be affected due to the increase of construction vehicles. The traffic volume should be controlled by the construction contractor to avoid serious traffic congestion. OP: Accessibility to social infrastructure would be limited by the existence of the industries.
	21	Misdistribution of benefits and damages	A-	D	PC: Only land owner and property owners and affected labors will be eligible for the compensation and rehabilitation. CO: Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors. OP: No activity or little activity will cause misdistribution of benefits and damages.
	22	Local conflicts of interest	D	D	CO: Due to an increase in employment opportunity during construction; construction workers may experience some conflicts between communities. OP: Misdistribution of benefits and damages would occur since there are PAHs who lose their income source, while there are people who would get job opportunity as workers of the industries. But, more than 10,000 people will be involved directly in this Economic zone.
	23	Cultural	D	D	Nothing found in the development area would be affected by the development.

Field	No	Impacts	Rating		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
		heritage			N/A
	24	Landscape	D	D	PC/CO: The landscape will change by the construction work of Araihaazar Economic Zone. Moreover, 218.84 ha of agricultural land will be cleared and altered to industrial area as the part of Economic Zone development. But All construction activities for administration building, land filling & boundary wall will be carried out within the economic zone site and will not cause any impact on landscape and scenic beauty. A green buffer of 10 m (minimum three rows of trees) will be developed all around the project site which will enhance the scenic beauty of the area. OP: No scenic area in and around the site will exist, no impact is expected on the landscape.
	25	Gender	B-	B-	PC/CO: Female laborers may be discriminated in wage at construction site. OP: Female laborers may be discriminated in wage during tenant operational period
	26	Children's rights	B-	B-	PC/CO: Due to the relocation, children's education would be temporarily disrupted. OP: There are 11 affected households who have school-going children's. They must relocate to other places and these children's educational opportunities will be temporarily disrupted due to the relocation. On the other hand, children would be indirectly influenced by the improvement of social infrastructure in the region as a result of the Project.
	27	Infectious diseases	B-	B-	CO: There is a possibility to increase the risks of infectious diseases due to an influx of construction workers into the Project area. OP: There is a possibility to increase the risks of infectious diseases due to influx of workers of the industries and the semi-urbanization of the Project area and its surrounding area.
	28	Working conditions, including occupational safety	B-	B-	PC/CO: There would be a possibility to occur accidents and incidents during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapors, liquids are the major hazards which are harmful to workers health OP: During the operation phase each industry will start their operation, accidents or incidents are expected to occur more or less during the operation phase.
Others	29	Accidents	A-	B-	CO: Construction accidents and road accidents around the project site are expected due to the construction activities. OP: Road accidents would be increased due to industrial vehicles and commuter busses and motor bikes.
	30	Transboundary impact and climate change	D	B-	CO: Few impacts are expected. OP: Emissions of GHGs would be generated from vehicle traffic and industrial operations.

Source: JICA Study Team

Rating:

A: Significant impact (+: positive impacts, -: negative impacts)

B: Some impact (+: positive impacts, -: negative impacts)

C: Existence, degree and scope of impact are not clear thus more investigation required

D: No impact is expected.

(2) Term of References for EIA

In order to fulfill the requirements of the JICA Environmental Guidelines and advisory instructions given by JICA Environmental and Social Consideration Advisory Committee, the JICA Study Team prepared a term of reference (TOR) for identified uncertain impacts summarized for the JICA EIA study and RAP study. A summary of the additional survey items and their survey methodologies is presented in Table 3.1-11

Table 3.1-11: Methods of Survey and Impact Assessment (TOR)

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
Environmental pollution	1	Air pollution	The existing ambient air quality of the study area monitored at Four (4) locations during the monitoring period (September & October 2017). The monitoring parameters included Particulate Matter (SPM, PM ₁₀ and PM _{2.5}), Sulphur Dioxide (SO ₂), Oxides of Nitrogen (NO _x), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours and rest of the parameters monitored on 24-hourly basis during the duration of the study.	Industrial emissions and movement of vehicular access
	2	Water pollution	Water sampling and analysis undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Samples were taken from a selected surface water body's source representing different parts of the study area. 3 Water sampling and analysis was undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area.	Estimated industry types of the EZ studied in the previous study
	3	Waste	Review and summary of the previous survey	study Estimated industry types of the EZ
	4	Soil pollution	The soil sampling strategy was designing to assess the existing soil quality over the study area. The analysis results of physio-chemical parameters (metal content), pH level of samples are studied.	Estimated industry types of the EZ
	5	Noise and vibrations	Noise levels recorded at ten (10) locations in the study area during the monitoring period. Noise levels recorded in the form of sound pressure levels with the help of a digital sound level meter.	Increased traffic movement and industrial operations
	6	Ground subsidence	Deep well boring survey and pump up test	Estimated industry types and their water consumption
	8	Sediment quality	Sampling and laboratory test shown in the result of Baseline.	Estimated industry types of the EZ and treated waste water from CETP
Natural environment	10	Ecosystems	Field survey	2ndary data/studies for sensitivity of the observed species
	11	Hydrology	Review and summary of the JICA previous study	Previous study
	12	Topography and geology	Secondary data collection	Review and summary

Social environment	13	Involuntary resettlement	RAP study	Comparison of the survey results and proposed entitlement matrix and stakeholder meetings, Estimated industry types of the EZ and their expected jobs
	14	Vulnerable group	RAP study and Focus group discussion	
	16	Local economies, such as employment, livelihood, etc.	Socio-economic census surveys for affected people will be conducted to identify income and livelihood of PAPs including sharecroppers and fishermen.	
	17	Land use and utilization of local resources	Field survey, inventory of loss, census survey	
	18	Water usage	Field survey, inventory of loss, census and socioeconomic survey	
	19	Existing social infrastructures and services	Field survey, inventory of loss, census and socioeconomic survey	
	21	Misdistribution of benefits and damages	Field survey, inventory of loss, census and socioeconomic survey	
	22	Local conflicts of interest	RAP	
	25	Gender	RAP	
	26	Children's rights	census and socioeconomic survey	
	27	Infectious diseases	Secondary data (EZ development monitoring studies)	Secondary data
Others	28	Working conditions including occupational safety	Secondary data (EZ development monitoring studies)	Secondary data
	29	Accidents	Secondary data (EZ development monitoring studies)	Secondary data

Source: JICA Study Team

3.1.6. Result of Assessment

(1) Air Quality

Ambient Air Quality

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

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

Methodology of Air Quality Monitoring

The wet season ambient air quality of the study area monitored at Four (4) locations during the monitoring period (September& October 2017) and dry season ambient air quality of the study area monitored at Four (4) locations during the monitoring period (March 2018). The monitoring parameters included Particulate Matter (SPM, PM₁₀ and PM_{2.5}), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours with the remaining parameters monitored on a 24-hourly basis during the study period.

Selection of sampling locations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality-monitoring network. The ambient air quality monitoring locations (**Figure 3.1-16**) are based on the following aspects covered in the field survey plan developed prior to the fieldwork:

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

The particulate and gaseous samples collected during the monitoring have been analysed as per the procedures specified in **Table 3.1-12**. The geographical locations and setting of the ambient air quality monitoring locations has been presenting in Table 3.1-13.

Table 3.1-12: Methodology for Analysis of Ambient Air Quality

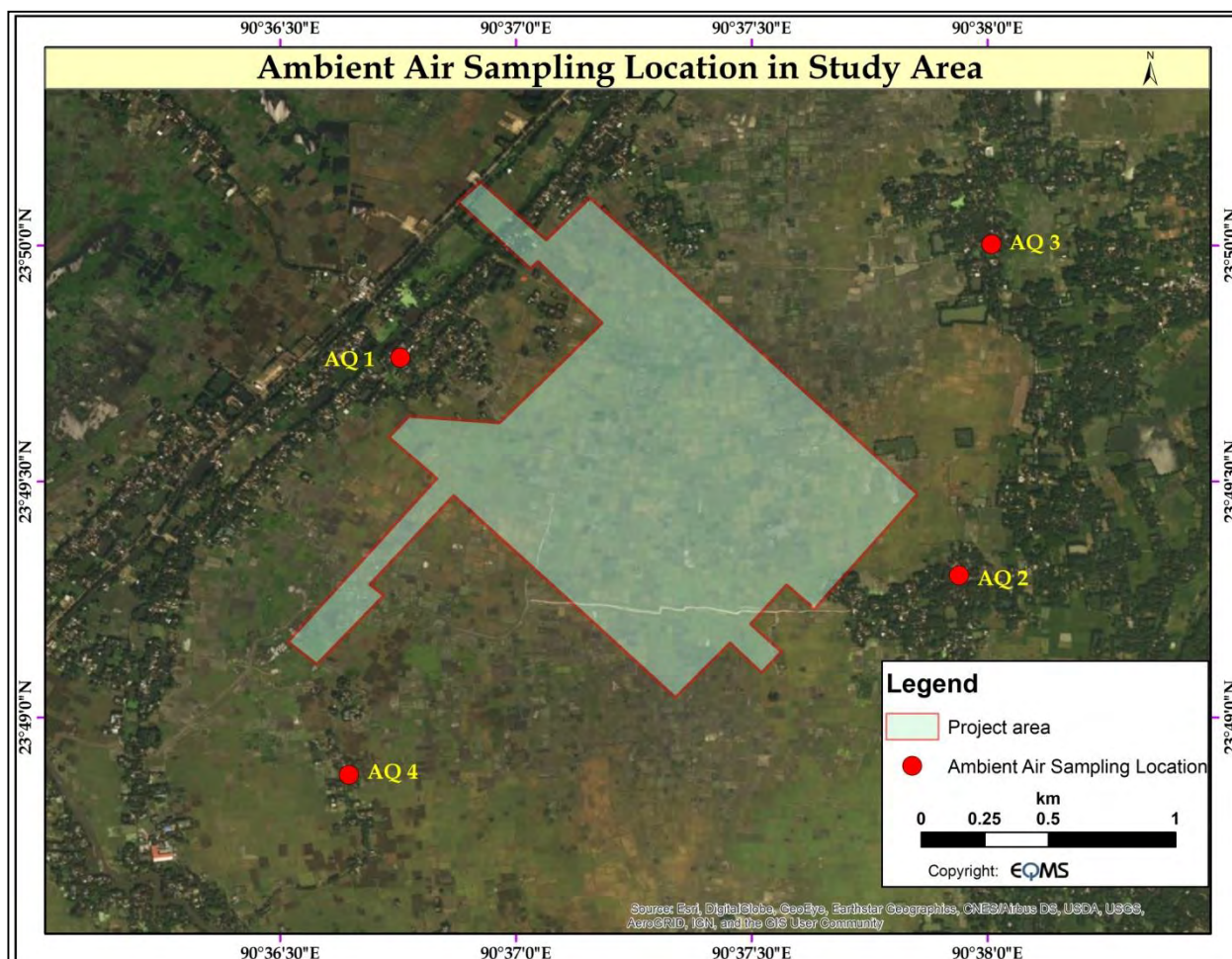
Sl.	Parameter	Analysis procedure
	SPM	Gravimetric method
	PM10	Gravimetric method
	PM2.5	Gravimetric method
	SO ₂	Colorimetric method at 560nm using spectrophotometer readings (West-Gaeke method)
	NO _x	Colorimetric method at 540 nm using spectrophotometer readings (Jacob and Hochheiser method)
	CO	Digital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

Table 3.1-13: Ambient Air Quality Sampling Locations

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1	In front of Nurul Haque House; Vill: Maizpara, Union: Satgram, Upazila: Arai hazar	AQ1	23°49'45.8"N 90°36'45.3"E	Rural
2	In front of Panchbaria Boro bari; Vill: Panchbaria, Union: Duptara, Upazila: Arai hazar	AQ2	23°49'18.1"N 90°37'56.4"E	Rural
3	In front of Tekpara govt. primary school; Vill: Tekpara, Union: Satgram, Upazila: Arai hazar	AQ3	23°50'00.4"N 90°38'00.5"E	Rural

4	In front of Rahim sekh house; Vill: Shingrati, Union: Duptara,Upazila: Araihazar	AQ4	23°48'52.59"N 90°36'38.57"E	Rural

Air Quality Monitoring Pictures



Source: Google Earth-image has been partially modified by JICA Study Team.

Figure 3.1-16: Air Quality Monitoring Locations

Ambient Air Quality in the Study Area

The monitored ambient air qualities are summarized in **Table 3.1-14**.

Table 3.1-14: Ambient Air Quality in the Study Area

SL.	Sampling Code	Station	Ambient air pollution concentration					
			PM _{2.5}	PM ₁₀	SPM	SO ₂	NOx	CO
			µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	ppm
1.	AQ1	Wet	46.6	105.2	152.1	8.4	27.5	2
		Dry	52.1	116.6	167.4	10.1	30.2	2.5
2.	AQ2	Wet	27.8	83.6	120.3	5.3	17.8	0.25
		Dry	34.5	87.6	134.7	6.3	19.4	0.50
3.	AQ3	Wet	32.8	92.4	135.5	6.8	20.1	1
		Dry	41.7	98.5	150.2	7.2	22.4	1
4.	AQ4	Wet	25.3	78.3	109.4	4.2	14.3	0.23
		Dry	31.6	84.2	123.8	5.7	16.6	0.50
Duration (hours)			24	24	8	24	24	8
Weather Condition			Sunny					
Bangladesh Standard (according to Environmental Conservation Rules' 1997 and subsequent amendment in 2005)			65	150	200	365	65	9
IFC EHS Guideline (2007)			75 (24 hr) 35 (year)	150 (24 hr) 70 (year)	-	500(10 min) 125 (24 hr)	200 (1 hr) 40 (year)	-
Method of analysis			Gravimetric	Gravimetri c	Gravimetri c	West- Geake	Jacob and Hochh eiser	Indic ator tube

Note:

* CO concentrations and standards are 8-hourly only.

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

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

Analysis and Discussion of Result

PM_{2.5}	Particulate matter is the dust found in the air. Particulate matter is the term for tiny particles found in the air. These particles can include dust, dirt, smoke, and liquid droplets. The 24-hourly wet season average PM _{2.5} concentration in ambient air in the study area was recorded in the range of 25.3µg/m ³ – 46.6µg/m ³ . In addition, dry season average PM _{2.5} concentration was recorded in the range of 31.6µg/m ³ – 52.1µg/m ³ . All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM _{2.5} in Bangladesh as well as IFC EHS Guidelines (2007).
PM₁₀	The 24-hourly wet season average PM ₁₀ concentration in ambient air in the study area was recorded in the range of 78.3µg/m ³ –105.2µg/m ³ . In addition, dry season average PM ₁₀ concentration was recorded in the range of 84.2µg/m ³ – 116.6µg/m ³ . All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM _{2.5} in Bangladesh.
SPM	The 24-hourly average SPM concentration in ambient air in the study area was recorded in the range of 109.4µg/m³–152.1µg/m³. In addition, dry season average SPM concentration was recorded in the range of 123.8µg/m³ – 167.4µg/m³. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh as well as IFC EHS Guidelines (2007). During the monitoring period, the maximum SPM concentration was reported from project area as 167.4µg/m³. SPM level of the four locations were reported below the National Ambient Air Quality Standards of Bangladesh as well as IFC EHS Guidelines (2007)
SO₂	The 24-hourly average SO₂ concentration was recorded in the range of 4.2µg/m³– 8.4µg/m³. In addition, dry season average SO₂ concentration was recorded in the range of 5.7µg/m³ – 10.1µg/m³. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh as well as IFC EHS Guidelines (2007). During the monitoring period, the maximum SO₂ concentration was reported at project site as 10.1µg/m³. SO₂ concentrations at all the monitoring locations were reported well below 365µg/m³, which is National Ambient Air Quality Standard (NAAQS) for SO₂ in Bangladesh as well as IFC EHS Guidelines (2007).
NO_x	The 24-hourly average NO _x concentration was recorded in the range of 14.3µg/m ³ – 27.5µg/m ³ . In addition, dry season average NO _x concentration was recorded in the range of 16.6µg/m ³ – 30.2µg/m ³ . All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM _{2.5} in Bangladesh as well as IFC EHS Guidelines (2007) .
CO	The 8-hourly CO concentration was recorded at AQ1, AQ2, AQ3 and AQ4 below 2ppm for both wet and dry season. CO concentrations were reported low at all the monitoring locations while comparing with the Bangladesh Standards (9ppm).

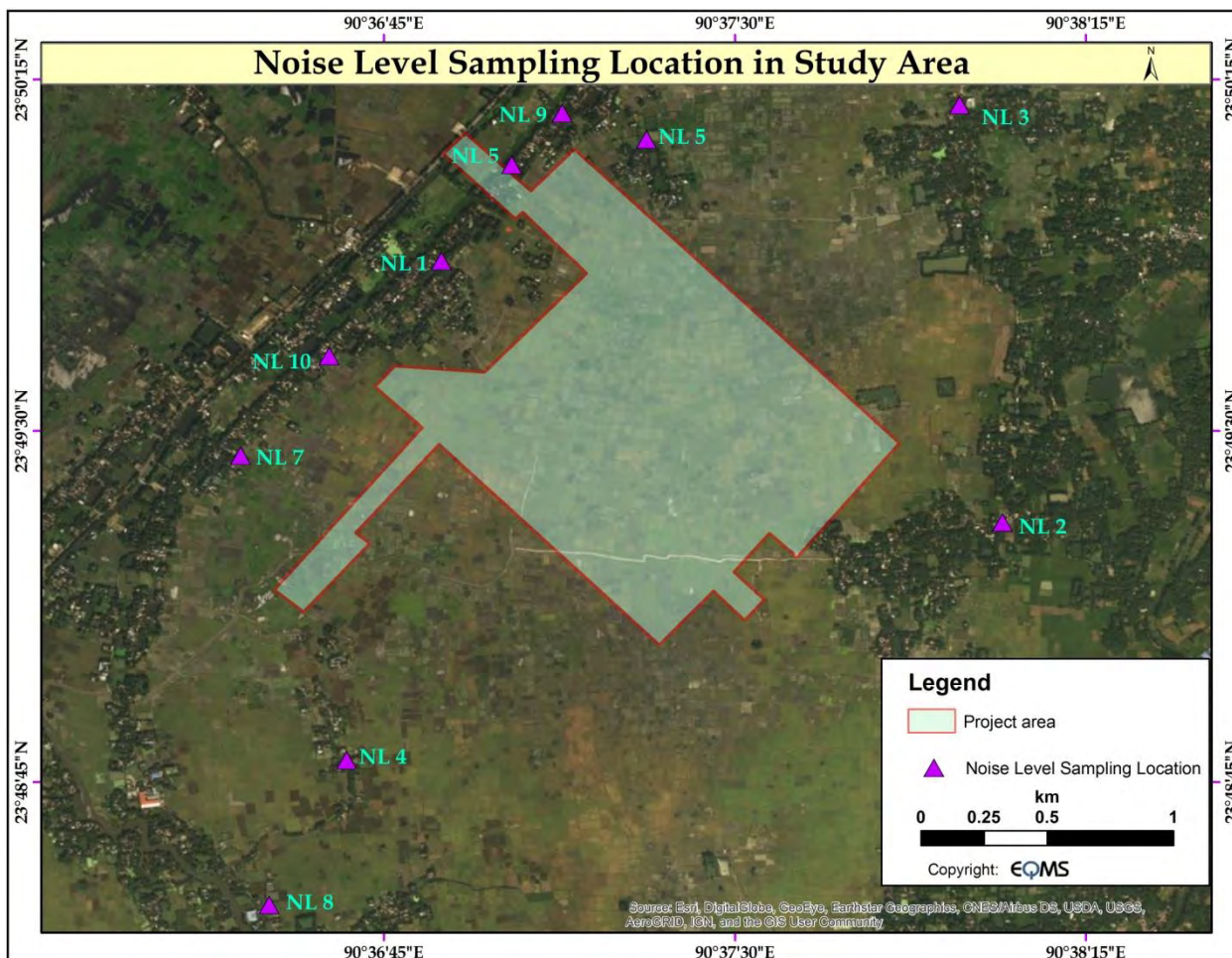
(2) Noise Quality

Ambient Noise Levels

Noise levels were recorded at ten (10) locations in the study area both wet and dry season during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are shown in **Table 3.1-15**. The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations were chosen in such a way that a representative data could be record all over the block. The sound level recorded in form of A-weighted equivalent continuous sound pressure level (Leq) values with the use of A-weighting filters in the noise-measuring instrument.

Table 3.1-15: Details of Ambient Noise Monitoring Locations

Sl.	Location	Location Code	Geographic location	Location setting
	In front of Abdul Barez House; Vill: Maizpara, Union: Satgram	NL1	23°49'51.9"N 90°36'52.4"E	Residential
	In front of Danis Market; Vill: Panchbaria, Union: Duptara	NL2	23°49'18.2"N 90°38'04.5"E	Commercial
	In front of Israil House; Vill: Tekpara, Union: Satgram, Upazila: Arai-hajar	NL3	23°50'11.8"N 90°37'58.8"E	Residential
	In front of Arju mia house; Vill: Shingrati, Union: Duptara	NL4	23°48'47.6"N 90°36'40.0"E	Residential
	In front of Sonpara bonder Bari Jame Mosque; Vill: Sonpara, Union: Satgram	NL5	23°50'07.4"N 90°37'18.7"E	Silent
	In front of Sonpara govt. primary school; Vill: Sonpara, Union: Satgram	NL6	23°50'04.1"N 90°37'01.4"E	Silent
	In front of Naziruddin community clinic; Vill: Panchrukhi, Union: Satgram	NL7	23°49'26.8"N 90°36'26.6"E	Silent
	In front of Methila group; Vill: Shingrati, Union: Duptara	NL8	23°48'28.9"N 90°36'30.3"E	Industrial
	In front of Rafiq molla house; Vill: Sonpara, Union: Satgram,	NL9	23°50'10.8"N 90°37'07.9"E	Residential
10.	In front of Nurul hoque house; Vill: Panchrukhi, Union: Satgram,	NL10	23°49'39.6"N 90°36'38.0"E	Residential



Source: Google Earth-image has been partially modified by JICA Study Team.

Figure 3.1-17: Noise Monitoring Locations

Noise Level Monitoring Pictures



Recorded noise level is presented in the following table.

Table 3.1-16: Noise Level Parameter in and Around the Proposed Site

Location	Noise level (dB(A)) Wet Season				Noise level (dB(A)) Dry Season				Applicable standard (dB(A))*		IFC Guideline (2007)		EHS Location setting
	L _{eq} (day)	L _{eq} (night)	L _{max}	L _{min}	L _{eq} (day)	L _{eq} (night)	L _{max}	L _{min}	Day	Night	Day	Night	
NL1	54	44.5	72	43.3	50.9	44.1	65.2	42	55	45	55	45	Residential
NL2	63.8	59.9	70.1	58.7	61.3	56.9	72	53.4	70	60	70	70	Commercial
NL3	62.6	47.5	72	44.2	57.3	46.7	57.2	43.1	55	45	55	45	Residential
NL4	54.5	44.3	75.7	43.1	49.4	44.2	61	43.5	55	45	55	45	Residential
NL5	49.2	39.8	70.4	39.4	46.8	43.1	63.5	42.4	50	40	55	45	Silent
NL6	55.3	43.8	76.6	39.6	53.2	41.2	70.3	48.2	50	40	55	45	Silent
NL7	63.5	57.4	84.8	56.5	61.5	55.3	68.9	52.3	50	40	55	45	Silent
NL8	65.9	60.5	78	57	58.2	57.2	63.1	54.9	75	70	70	70	Industrial
NL9	54.6	44.9	81.7	42.6	51.1	44.0	60.3	43.6	55	45	55	45	Residential
NL10	52.2	44.6	71.7	43.4	55.4	43.7	63.4	41.1	55	45	55	45	Residential

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

This table summarizes the measured ambient noise levels at each monitoring location. The noise level at some locations within the study area was well within the standard limit of ECR'97 (subsequent amendment in 2006) except NL3, NL6 & NL7. The noise monitoring location NL3 is falls into residential area but a textile mill (Sifat Textile) enhance huge sound day to night. As a result, this location noise level found very high. The noise monitoring location NL6 is falls into silent zone but it is too close to Dhaka-sylhet highway and 95 m far from Kazi kabir textile limited and NL7 also falls under silent zone but it's noise level found also high because of a textile mill called Shuchona Textile. The project area falls into residentialarea according to the Bangladesh Environmental Quality Standard ECR'97 categorization.

(3) Water Quality

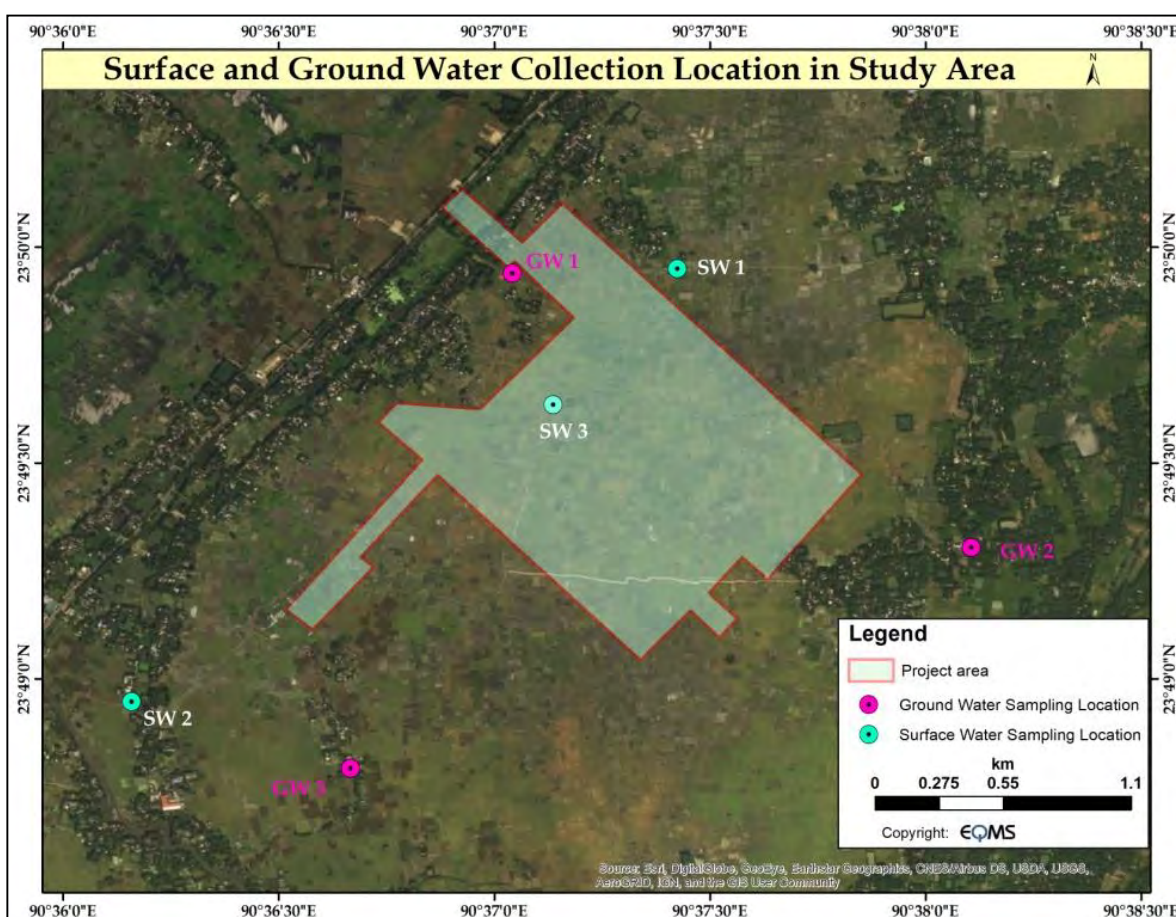
Surface Water Quality

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

The surface water samples were collected from the Dhawrakhali canal to the project area. Surface water sampling locations were selected to obtain a representative water sample from various zones within the study area. Two (2) samples of surface water (SW1 & SW2) were collected from the canal at wet season. Three (3) samples of surface water (SW1, SW2 & SW3) were collected from the canal at dry season. Detail of the sampling location provided in Table 3.1-17 and Figure 3.1-18.

Table 3.1-17: Details of Surface Water Sampling Locations

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
	Dhawrakhali Khal (Up-stream) Village: Tekpara	SW1	23°49'57.01"N 90°37'25.47"E	Canal
	Dhawrakhali Khal (Down-stream); Village: Panchrukhi	SW2	23°48'56.8"N 90°36'09.5"E	Canal
	Dhawrakhali Khal, Village: Panchrukhi	SW3	23°49'38.29"N 90°37'8.79"E	Canal



Source: Google Earth-image has been partially modified by JICA Study Team.

Figure 3.1-18: Surface Water & Ground Water Sample Collection Locations

The samples were analyzed for parameters covering Bacteriological and physico-chemical characteristics which include certain heavy metals and trace elements.

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

The samples were analyzed as per standard procedures/methods given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in **Table 3.1-18**.

Table 3.1-18: Methods for Water Analysis

Sl.	Parameter	Test method (APHA)
1.	Temperature (°C)	Digital thermometer
2.	TDS (mg/l)	Digital TDS meter
3.	EC (µmhos/cm)	Digital EC meter
4.	DO (mg/l)	Digital DO meter
5.	pH	Digital pH meter
6.	Biochemical Oxygen Demand (BOD)	5 days incubation
7.	Chemical Oxygen Demand (COD)	CRM
8.	Chloride	Titrimetic
9.	Hardness	Titrimetic
10.	Iron (Fe)	AAS
11.	Manganese (Mn)	AAS
12.	Sulphate	UVS
13.	Total Suspended Solid (TSS)	Gravity Multimeter
14.	Turbidity	Turbidity Meter
15.	Alkalinity	Titrimetic
16.	Calcium	CRM
17.	Coliform (Faecal)	MFM
18.	Coliform (Total)	MFM

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

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

The surface water quality compared with the Bangladesh ECR standard for best practice based classification criteria. **Table 3.1-19** shows the analysis results. Some of the water analysis parameters discussed below in detail:

A certain quantity of surface water was collected from upstream and downstream areas of the Dhawrakhali Canal. The surface water quality of Dhawrakhali canal is acceptable in the monsoon season. However, in the dry season the water become polluted because of untreated water discharge from dyeing industries. The concentration level of BOD is above the Bangladesh Standard for both SW2 & SW3. DO found low at SW3 in dry season as per Bangladesh Standard and Turbidity level also low as per WHO standard. In addition, the concentration level of chloride and hard particles in the water is shown in the table below to be clearly published Bangladesh Standard.

Table 3.1-19: Surface Water Quality Analysis

Characteristics	Unit	Concentration Present					WHO	Bangladesh Standard*					
		SW1		SW2		SW3		Source of drinking water for supply only after disinfecting	of Water usable for recreational activity	Source of drinking water for supply after conventional treatment	of Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
		Wet	Dry	Wet	Dry	Dry							
Temperature	°C	29.0	27.2	28.6	28.2	27.0	-	-	-	-	-	-	-
BOD	mg/L	6	9	2	17	23	-	2 or less	3 or less	3 or less	6 or less	10 or less	10 or less
COD	mg/L	24	32	8	56	88	-	-	-	-	-	-	-
EC	µS/cm	190	630	150	650	560	(2,000 by EPA)	-	-	-	-	-	-
DO	mg/L	6.62	6.28	6.19	6.04	2.26	-	6 or above	5 of more	6 or more	5 or more	5 or more	5 or more
pH	-	7.21	7.70	6.82	7.8	7.52	9.2	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
TDS	ppt	0.09	0.32	0.08	0.33	0.35	1500	-	-	-	-	-	-
Chloride	mg/L	22	73	19	76	81	250.0	-	-	-	-	-	-
Hardness	mg/L	85	265	75	275	270	500	-	-	-	-	-	-
Iron (Fe)	mg/L	0.54	0.12	0.25	0.05	0.30	0.3	-	-	-	-	-	-
Manganese (Mn)	mg/L	0.03	0.03	0.04	0.04	0.03	0.1	-	-	-	-	-	-
Sulphate	mg/L	1	5	0	4	1	400	-	-	-	-	-	-
Total Suspended Solid (TSS)	mg/L	14	22	13	14	20	-	-	-	-	-	-	-
Turbidity	NTU	7.2	21.2	4.6	2.2	6	5>	-	-	-	-	-	-

Characteristics	Unit	Concentration Present					WHO	Bangladesh Standard*						
		SW1		SW2		SW3		Source of drinking water for supply only after disinfecting	of Water usable for recreational activity	Source of drinking water for supply after conventional treatment	of Water usable by fisheries	Water usable by various process and cooling industries	Water usable by	Water usable for irrigation
		Wet	Dry	Wet	Dry	Dry								
Alkalinity	mg/L	-	185	-	183	243	-	-						
Calcium	mg/L	-	298	-	268	256	-	-						
Coliform (Faecal)	mg/L	-	25	-	34	16	-	-						
Coliform (Total)/100	mg/L	-	53	-	55	23	-	50 or less	200 or less	5000 or less	-	5000 less	or	1000 or less

(Source: Laboratory Analysis, DPHE and JST laboratory)

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

Ground Water Quality

Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area. Samples were taken from representative selected groundwater sources representing different parts of the study area.

The groundwater sampling locations were selected to obtain a representative water sample from various zones within the study area. The samples were collected from existing tube wells (hand-tube wells being use by the villagers). A total Three (3) ground water samples were collected **Table 3.1-20**. Detail of the sampling location provided in and depicted in **Figure 3.1-18**.

Table 3.1-20: Details of Ground Water Sampling Locations

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram, Upazila: Araiuhajar	GW1	23°49'56.5"N 90°37'02.6"E	Tube well
	In front of Bacchu mia House, Vill: Sonpara, Union: Satgram, Upazila: Araiuhajar	GW2	23°49'18.2"N 90°38'06.5"E	Tube well
	In front of Arju mia Sentu House, Vill: Shingrati, Union: Duptara, Upazila: Araiuhajar	GW3	23°48'47.6"N 90°36'40.0"E	Tube well

The samples analyzed for parameters covering Bacteriological and physio-chemical characteristics included certain heavy metals and trace elements.

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

The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in **Table 3.1-21**.

Table 3.1-21: Methods for Water Analysis

Sl.	Parameter	Test method (APHA)
1.	Temperature (°C)	Digital thermometer
2.	TDS (mg/l)	Digital TDS meter
3.	EC (μmhos/cm)	Digital EC meter
4.	DO (mg/l)	Digital DO meter
5.	pH	Digital pH meter
6.	Arsenic (As)	AAS
7.	Calcium (Ca)	AAS
8.	Chemical Oxygen Demand (COD)	CRM
9.	Chloride	Titrimetic
10.	Coliform (Faecal)	MFM
11.	Coliform (Total)	MFM
12.	Fluoride	UVS
13.	Iron (Fe)	AAS

Sl.	Parameter	Test method (APHA)
14.	Lead (Pb)	AAS
15.	Manganese (Mn)	AAS
16.	Phosphate	UVS
17.	Sulphate	UVS
18.	Total Suspended Solid (TSS)	Gravity Multimeter
19.	Turbidity	Turbidity Meter

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

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

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

In September 2017, the JICA Study Team collected groundwater samples from tube wells in and around the project area. The result of the groundwater field samples and the GoB standards for potable water (ECR, 1997) is shown in Table 3.1-22..

The concentration levels of Manganese (Mn) of tube well found above the standard set by the DOE, GoB for drinking water. But the levels of pH, TDS, As, Ca, COD, Chloride, Fluoride, Fe, Pb, Phosphate, Sulphate, TSS and turbidity were found to be within the limit set by the DOE, GoB for drinking water. The average depths of deep tube wells for drinking water are at least 600-700 feet. After consultation with the DPHE officer of Araihasar, JICA Study Team found the concentration level of Iron and Arsenic become higher when the tube wells depth reaches below the 600 feet. According to the overall water quality data, practically good quality and quantity of ground water is available in and around the project site.

In March 2018, JICA Study Team collected dry season groundwater samples from tube wells in and around the project area. The concentration level of Total Coliform for GW1 & GW2 found below the drinking water standards set by the DOE, GoB and Manganese level also high for GW2 & GW3 sampling locations and TSS level found above the standard set by the DOE, GoB for drinking water.

Table 3.1-22: Ground Water Quality Analysis Result

Sl.	Parameters	Unit	Sampling code						Bangladesh Standard	WHO
			GW1		GW2		GW3			
			Wet	Dry	Wet	Dry	Wet	Dry		
	Temperature	°C	27.1	27.3	27.0	26.0	27.4	27.4	20-30 °C	-
	EC	µS/cm	560	540	840	1130	520	510	-	(2,000 by EPA)
	pH	-	6.64	7.80	6.71	7.42	6.92	7.25	6.5-8.5	9.2
	DO	mg/L	6.88	7.80	6.23	7.01	6.38	7.61	6	-
	TDS	ppt	0.28	0.28	0.42	0.57	0.26	0.26	-	1500
	Arsenic (As)	mg/L	0.002	0.001	0.002	0.001	0.002	0.001	0.05 mg/l	0.05
	Calcium (Ca)	mg/L	39	303	15	268	33	287	75	200.0
	COD	mg/L	4	4	4	4	4	4	4.0	-
	Chloride	mg/L	37	45	152	150	62	52	150-600	250.0
	Coliform (Faecal)	N/100ml	0	2	0	0	0	0	0	0
	Coliform (Total)	N/100ml	0	6	0	3	0	0	0	0
	Fluoride	mg/L	0.028	0.67	0.027	1.72	0.025	0.44	1.0	1.5
	Iron (Fe)	mg/L	0.26	0.42	0.06	0.19	0.57	0.36	0.3-1	0.3
	Lead (Pb)	mg/L	0.009	0.021	0.001	0.001	0.001	0.001	0.05	0.01
	Manganese (Mn)	mg/L	0.06	0.10	0.28	0.46	0.12	0.11	0.1	0.1
	Phosphate	mg/L	0.089	0.32	0.18	0.43	0.19	0.37	6.0	-
	Sulphate	mg/L	1	4	3	5	1	6	400	400
	Total Suspended Solid (TSS)	mg/L	2	15	3	12	5	13	10	-
	Turbidity	NTU	0.70	3.9	6.4	3.1	4.5	4.2	10	5>
	BOD	mg/L	-	1	-	1	-	1	0.2	-

Source: Laboratory Analysis, DPHE and JST laboratory

Water Quality of Sitalakhya and Meghna River (Dredging work)

Apart from the proposed EZ site, water quality analysis of two rivers; Sitalakhya (Unloading site for dredged sand) and Meghna river (loading site of dredged sand) were analysed. The water quality of the Sitalakhya River is not favorable for the aquatic ecosystem due to the industrial effluent discharge into the river. The dissolve oxygen level of Sitalakhya River is low in both dry and wet season as well as biological oxygen demand is quite high due to the pollution concentration. On the other hand, water quality of Meghna River is quite good for aquatic ecosystem. The water quality of Sitalakhya and Meghna River is shown in the following Table 3.1-23.

Table 3.1-23: Sitalakhya and Meghna River Water Quality

Location		Confluence of Balu and Sitalakhya River		Upstream of Meghna Industrial Area	
Date of Sampling		22.01.2016 (Dry Season)	19.03.2016 (Early Summer)	23.01.2016 (Dry Season)	18.03.2016 (Early Summer)
GPS		23°43'18.1"N 90°30'00.3"E		23°38'0.7N 90°37'19.2"E	
Parameter	Unit	Result	Result	Result	Result
pH	-	7.25	7.3	6.82	6.6
Total Dissolved Solids (TDS)	mg/l	410	658	86	150
Cadmium (Cd)	mg/l	<0.001	<0.001	<0.001	<0.001
Lead (Pb)	mg/l	<0.005	<0.005	0.01	<0.005
Total Chromium (Cr)	mg/l	<0.01	<0.01	<0.01	<0.01
Total Suspended Solid (TSS)	mg/l	84.6	57	3.9	11.4
Temperature	mg/l	21.1	27.8	19.9	26.0
Dissolved Oxygen (DO)	mg/l	4.2	2.2	5.9	6.2
Biochemical Oxygen Demand (BOD)	mg/l	34	12.4	<2.0	<2.0
Chemical Oxygen Demand (COD)	mg/l	106	79.7	<4.0	<4.0
Oil and Grease	mg/l	<1.4	4.9	<1.4	<1.4
Faecal Coliform	MPN/100 ml	Present	Present	Absent	Present
Total Coliform	MPN/100 ml	140	1600	1.8	1600

Source: Cumulative Environmental Impact Assessment Study for Siddhirganj Power Hub, Environmental Resource Management (March 2016)

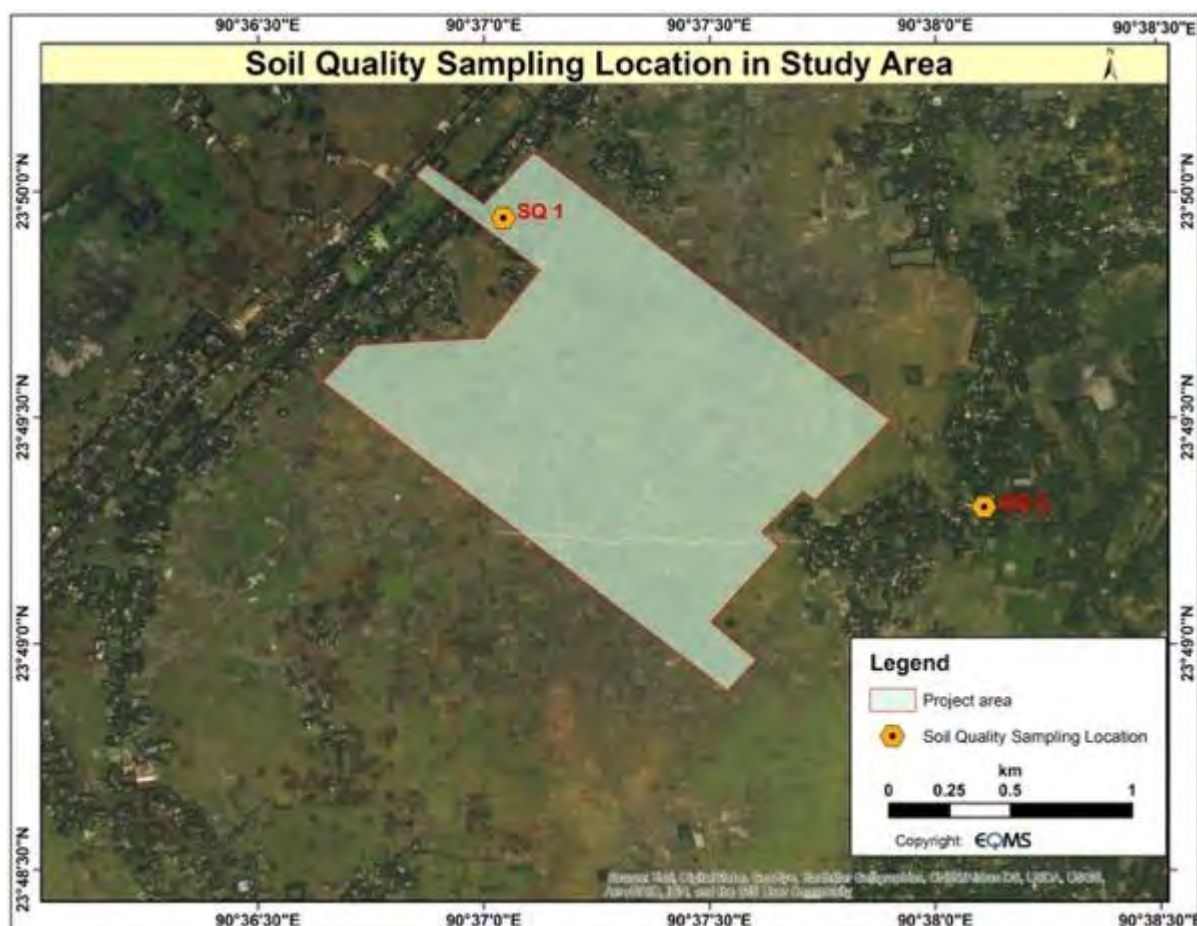
(4) Sediment Quality (Soil quality)

The soil sampling strategy was designed to assess the existing soil quality over the study area. Two soil samples were collected from the study area during rainy (wet) season, and Thress samples during dry season. The details of the rainy season sampling locations were presented in **Table 3.1-24**, Figure 3.1-19 and Table 3.1-25.

. A composite sampling technique was used for soil sampling from each location.

Table 3.1-24: Location of Soil Samples (Wet season)

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
1	Project Site; Vill: Sonpara, Union: Satgram, Upazila: Araihaazar	SQ1	23°49'56.5"N 90°37'02.6"E	Project area
2	Vill: Tekpara, Union: Satgram, Upazila: Araihaazar	SQ2	23°49'18.2"N 90°38'06.5"E	Land

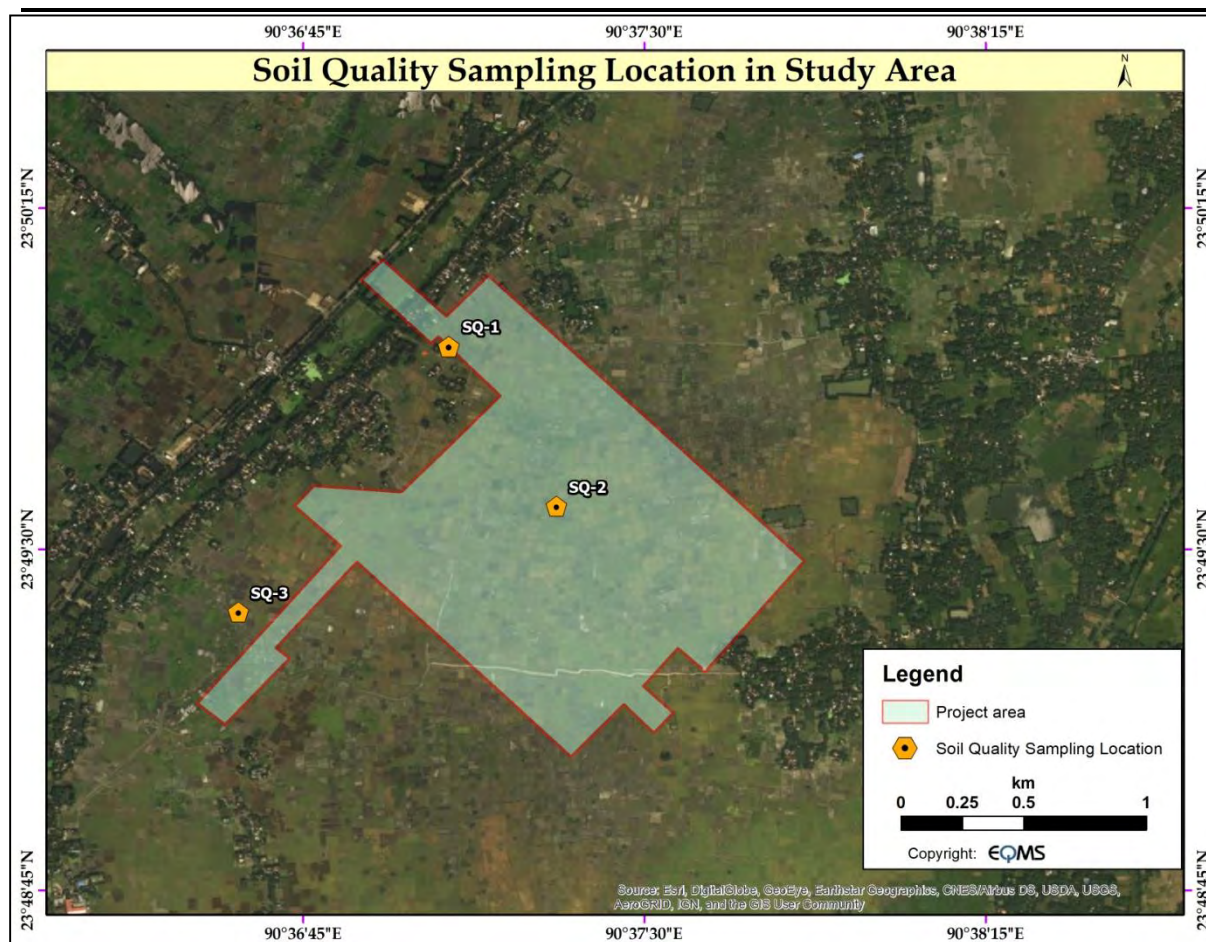


Source: Google Earth-image has been partially modified by JICA Study Team

Figure 3.1-19: Soil Sampling Location Map (Wet season)

Table 3.1-25: Location of Soil Samples (Dry season)

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



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

Figure 3.1-20: Soil Sampling Location Map (Dry season)

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

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



Figure 3.1-21 Soil Sample Collection Pictures

Analysis Results and Discussions

The analysis results of physio-chemical parameters of samples are presented in **Table 3.1-26**.

Table 3.1-26: Soil Quality (Wet season) Results

Parameters	Unit	Soil Quality	Soil Quality	USEPA
Sample Code		SQ1	SQ2	Guideline*
pH	-	5.7	6.2	
Manganese	(µg/g or ppm)	5.40	15.00	-
Copper	(µg/g or ppm)	6.02	1.40	149
Iron	(µg/g or ppm)	138.60	99.40	-
Zinc	(µg/g or ppm)	1.00	0.86	459
Lead	(µg/g or ppm)	36.50	25.37	128

Source: Laboratory analysis, SRDI

Table 3.1-27: Soil Quality (Dry season) Results

Location	Soil Quality					USEPA
Sample Code	-	SQ1	SQ2	SQ3		Guideline*
Parameter	Unit	Result	Result	Result		-
Grain Size Distribution	Sand	14	15	13		-
	Silt	66	58	51		-
	Clay	20	27	36		-
Textural Class	-	Silt loam	Silty loam	clay	Silty loam	clay -
pH	-	6.9	6.9	6.9		-
Organic Content	%	2.89	1.83	2.35		-
Potassium	meq/100g soil	0.09	0.12	0.14		-
Calcium	meq/100g soil	11.42	12.83	13.16		-

Location		Soil Quality			USEPA Guideline*
Sodium	meq/100g soil	0.38	0.50	0.44	-
Phosphorous	µg/g	0.85	1.01	1.30	-
Copper	mg/kg	1.79	7.46	5.21	149
Iron	µg/g	32.31	70.80	8.80	-
Manganese	µg/g	4.12	6.48	10.14	-
Zinc	mg/kg	0.84	1.34	1.24	459
Lead	mg/kg	0.02	0.143	0.06	128
Cadmium	mg/kg	11.31	25.00	27.62	4.98
Chromium	mg/kg	23.82	30.35	29.50	111
Chloride	ppm	35.50	35.50	35.50	-

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

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

Physical characteristics of soil

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

pH level of soil

The pH of the soil samples from the site was found to be neutral as per the standard soil classification given in **Table 3.1-28**. As per laboratory analysis, SQ1 is moderately acidic and SQ2 is slightly acidic.

Table 3.1-28: Standard pH level of soil

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

Metals in soil

Iron, Copper, Zinc, Lead and Manganese were detected in the soil sample.

The Environmental Conservation Rules (ECR), 1997 does not have soil quality standard. So, the soil quality in the study area was compared with the heavy metal content standard of USEPA office of solid waste and emergency response, hazardous waste land treatment (

Table 3.1-29).

Table 3.1-29: Heavy Metal Contents of the Natural Soil

Element	Symbol	Common Range (ppm or mg/kg)	Average Concentration (ppm or mg/kg)
Manganese	Mn	200-3000	600
Copper	Cu	2-100	30
Lead	Pb	2-200	10
Zinc	Zn	100-300	50

Source: USEPA office of solid waste and emergency response, hazardous waste land treatment, SW-874 (April 1983, page 273)

Both baseline soil qualities have observed to be well below the threshold limit compared with the USEPA standard of heavy metal content in soil.

Sediment quality of loading and unloading site of dredging work

Sediments samples were collected from the loading and unloading point of Meghna and Sitalakhya Rivers. The sediment quality of Meghna and Sitalakhya Rivers were analyzed and the result are summarized in table 3.1-30. International guidelines are taken since there is no standard for sediment pollution in Bangladesh. As shown in the table, contamination by heavy metals, copper, Zinc, Lead, Cadmium, and Chromium are within guidelines and considered as no polluted.

table 3.1-30: Results of Sediment Quality of Sitalakhya and Meghna River

Location		Unloading Point (Near Bazar)	Point Atlapur	Loading Point (Upstream of Meghna Industrial Area)	USEPA Guideline*
GPS		23°52'34.20"N 90°34'44.25"E23		23°37'57.14"N 90°37'26.94"E	-
Sample Code	-	SD1		SD2	-
Parameter	Unit	Result		Result	-
Grain Size Distribution	Sand	%	12	19	-
	Silt		17	68	-
	Clay		17	13	-
Textural Class	-	Silt Loam		Silt Loam	-
pH	-	6.9		6.6	-
Organic Content	%	1.14		1.14	-

Potassium	meq/100g soil	0.19	0.41	-
Calcium	meq/100g soil	14.15	10.27	-
Sodium	meq/100g soil	0.24	3.78	-
Phosphorous	µg/g	2.06	4.31	-
Copper	mg/kg	5.58	4.98	149
Iron	µg/g	211.40	231.72	-
Manganese	µg/g	47.40	100.52	-
Zinc	mg/kg	1.90	1.59	459
Lead	mg/kg	16.03	13.24	128
Cadmium	mg/kg	0.025	0.025	4.98
Chromium	mg/kg	31.78	27.70	111
Chloride	ppm	35.50	497.00	-

*Consensus-based freshwater sediment quality guidelines, US EPA, 2000

(5) Ecology

IUCN has classified Bangladesh into 25 Bio-ecological Zones in the context of physiographic and biological diversity. The survey area covers three distinct Bio-ecological zones; they are the Brahmaputra-Jamuna Floodplain (Bio-Ecological Zone 4c), Madhupur Sal Tract (Bio-ecological Zone 3) and Major Rivers (Bio-Ecological Zone 11). The Project site falls under Brahmaputra-Jamuna Floodplain (Bio-Ecological Zone 4c) Zone. Details of the Bio-ecological zone within the study area are described below. (Source: Bio-ecological zones of Bangladesh, 2002, IUCN).

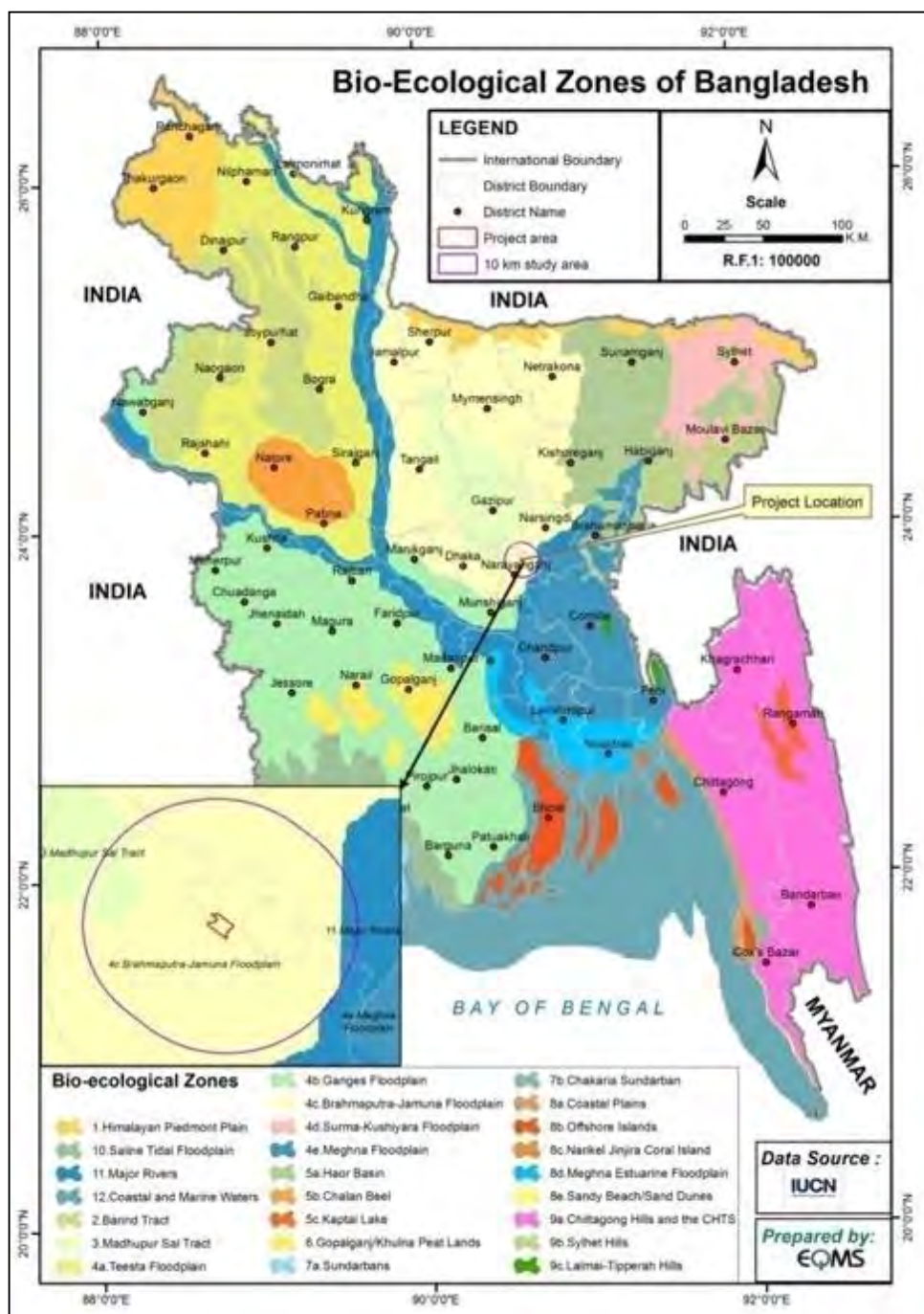


Figure 3.1-22: Bio-ecological zones of the study area

Bio-ecological zone (4c)

Brahmaputra-Jamuna Floodplain

Location	23° 37'-26°38' N and 89° 37'-91°00'E
Relevant adm hq	Sherpur, Jamlpur, Tamgail, Mymensingh, Kisoreganj, Narsighdi, Dhaka
Physiography	Old Brahmaputra floodplain and Young Brahmaputra floodplain
Soil	Non-calcareous gray floodplain soils; Non-calcareous dark grey

	floodplains soils.
Rainfall	2030-3300 mm.
Temperature	Maximum 34°C, Minimum 11°C
Floodindg depth	H-MH, MH-H, MH-L
Land Use	Rabi-Aus-T.aman(2a); Boro-Fallow-T.aman(4a), Boro-Fallow-Fallow(9)

Ecology to be concerned by dredging work

Plankton

According to the plankton analysis by department of Zoology, University of Dhaka under the Environmental and Social Impact Assessment of Bangladesh Regional Waterway Transport Project 1, Plankton was present both Sitalakhya and Meghna Rivers water. Plankton was analyzed for both dry and post monsoon season. Plankton's were found more during the dry season compare to the post monsoon season. Plankton analysis result of Sitalakhya and Meghna River is shown in the following table 3.1-31.

table 3.1-31: Plankton Analysis Result of Sitalakhya and Meghna River

Location	GPS	Result (Plankton/L)	
		24.02.2016 (Dry Season)	01.10.2015 (Post-Monsoon Season)
Sitalakhya River, Araihasar, Narayanganj	23°32.934'N 90°34.660'E	Blue Green Algae- 74.2 Rotifers- 43.4 Nauplii- 12.6 Copepoda- 2.8	Blue Green Algae- 35 Protozoa- 6 Rotifers- 25
Meghna River, Gazaria, Munshiganj	23°44.653'N 90°43.408'E	Blue Green Algae- 83.7 Rotifers- 29.7 Nauplii- 9.45 Copepoda- 2.7 Protozoans- 2.7	Blue Green Algae- 10 Green Algae- 19 Diatoms- 3 Protozoans- 10 Rotifers- 6

Source: Environmental and Social Impact Assessment of Bangladesh Regional Waterway Transport Project 1, prepared by: Institute of Water Modeling (May 2016)

Benthos

Benthos was found both dry and post monsoon season sediment samples of Sitalakhya and Meghna River. Benthos analysis result of Sitalakhya and Meghna River is presented in the Table 3.1-32.

Table 3.1-32: Benthos Analysis Result of Sitalakhya and Meghna River

Location	GPS	Result (Number)	
		15.01.2016 (Dry Season)	01.10.2015 (Post-Monsoon Season)
Sitalakhya River, Araihasar, Narayanganj	23°32.934'N 90°34.660'E	Bivalve- 1 Gastropods- 16 Arachnids- 2	Polychaetes- 17 Oligochaetes- 2 Bivalves- 15
Meghna River, Gazaria,	23°44.653'N	Naididae worm- 1	Oligochaetes- 5

Munshiganj	90°43.408'E	Bivalve- 1 Gastropoda- 6 Mollusca broken part- 3	Polychaetes- 2 Bavalves- 2 Gastropodes- 20

Source: Environmental and Social Impact Assessment of Bangladesh Regional Waterway Transport Project 1, prepared by: Institute of Water Modeling (May 2016)

Dolphin

Ganges River Dolphin (*Platanista gangetica*) or Shushuk (Local Name) is an endangered species as per IUCN global red list (Smith *et al.* 2012), is on the CITES (CITES 2013) and is also listed in CMS (CMS 2012). In Bangladesh, habitat fragmentation by barrages, excessive water abstraction and river pollution are the major threats for this species (Smith and Smith 1998, Smith *et al.* 1998, Sinha 2006, and Alam and Sarker 2012). Hence, they are classified as a vulnerable species in the country (IUCN Bangladesh 2015) and are placed in the First Schedule of Bangladesh Wildlife (Conservation & Security) Acts, 2012.

Ganges river dolphin lives exclusively in freshwater river system (Ahmed 2009, Culik, 2011, Khan 1985, 1987, Smith *et al.* 2009) and the estuaries where salinity level is low. It occurs in all connected rivers and tributaries of Ganges-Brahmaputra-Meghna system, and Karnaphuli-Sangu river system in southern Bangladesh. Kasua and Haque (1972) mentioned that the area from upper Meghna to south of Gualanda is a goldmine for the Dolphins. It is also reported that, many river dolphins were observed while breeding season at the merging point of Kushiara River and Monu River, some 200km upstream from Meghna Bridge, where river is meandering and water quality is turbid with many fishes and strong flow and is one of the major habitats for them.

To review this study about the presence of Ganges River Dolphin within the study area of Meghna river, a field visit was carried out on April 15th to 17th, 2018 which consist consultation and FGD with local fishermen, fish seller and resident people of different chars of Meghna River. Focus Group Discussion (FGD) with local people helps to get information about the dolphin's availability in the study area. According to them the shushuk are randomly seen within the bank of various chars namely Chalivanga, Nolchar, Forazi Kandi, Ram Prasader Char, Dengur Kandi, Nuner Tek, Kodaler Tek, Mohisher Char which are adjacent of the study location. Furthermore, they used to observe dolphin daily when this animal perform a dive within the water. Moreover, the fishermen who goes for fishing with big fishing net, they often got dolphin in their net. Sightings of dolphins become too high during the period of May–June (Joishtho). In addition, people also described that, the population of dolphin about 5 years ago was too high along these area from the recent period. Dolphin populations are declining in recent time due to modification of river flows, alterations in sediment and nutrient fluxes, habitat destruction, river pollution from urbanization and agriculture, boat traffic, dredging, illegal hunting, and over exploitative fisheries are making threaten the habitats of this species.



Consultation with Fishermen



Consultation with Fish seller



Figure 3.1-23: Dolphin Population Study at the Study Area

Impact on Dolphin

As per discussion with fisherman and local people, the Ganges River Dolphin is found in the proposed dredging site and surrounding area. The dredging activity will increase the turbidity and noise level that would be effect on River Dolphin.

Potential impacts of noise on dolphins include mortality, hearing damage, masking of communication and other biologically important sounds, and behavioral responses. Mortality only occurs in the immediate vicinity of very high-energy noise sources, such as blasting, and is unlikely to occur for the considered pump noise. Noise and disturbance can changes in movement routes and pattern of River Dolphin.

Additional survey in the form of interview was conducted to obtain further information experts. The following table summarizes concerns and suggestions raised by th experts.

Expert	Major Concern	Suggestion
Seikh Muhammad Abdur Rashid Chief Executive, Centre for Advanced Research in Natural Resources & Management (CARINAM)	There is no recent study on River Dolphin of Meghna River but dolphin is seen both in the upstream and downstream of the Meghna Bridge. Its auditory perception is so decent that it can hear some sound generated far place. As the river dolphin depends on sound wave, therefore dredging	- Avoid the dredging activities during the Dolphin breeding period; - Use pingers to drive away dolphins prior to commencement of dredging; - Detail study is required prior to select the candidate dredging site; - Waste should not discharge in the

Expert	Major Concern	Suggestion
	activity noise will hamper their movement. Dredging activity will change the bottom sediment quality where the benthic animals present. River Dolphin chiefly feeds benthic animal. The changes of bottom sediment will affect the food chain of the Dolphin.	Water; -Oil spillage from dredger should control strictly; -Monitoring is required before and during the dredging activity
Mohammad Mamun Chowdhury Associate Professor, Department of Fisheries, University of Dhaka	River Dolphin has seen near the Meghna bridge during the wet season. Physical injury or mortality from collisions, noise production, and increased turbidity are the main ways dredging can affect the dolphin directly.	-Low noise generating dredging equipment should be used -Avoid the dredging activities during the Dolphin breeding period (March to June); -Use mesh/geo textile type to trap the sediment; -Detail study is required prior to select the candidate dredging site; -At least two month study is required to identify the presence of dolphin and need at least two years to know the dolphin movement route, habitat, nature and breeding areas; -Monitoring is required before and during the dredging activity
Mirza Shamim Ahsan Habib Principal Consultant / Ecologist, EQMS Consulting Limited	As per the previous experience, Dolphin has found both in the upstream and downstream of Meghna Bridge. Dredging activity will affect the dolphin movement due to the noise generation from dredging activity, collision risk with dredger head etc.	-Detail study is required prior to select the candidate dredging site;

Fish

As per discussion with fisherman, total 51 species are found in the study area. Among total 51 species, six are engendered, five are near threatened and three are vulnerable according to the IUCN Red list 2015. The following Table 3.1-33 is showing the list of fish species found in the study area.

Table 3.1-33: List of Fish Species found in the Study Area

S L	Local Name	English Name	Scientific Name	Family	IUCN Status*
1.	Koi	Climbing perch	<i>Anabas testudineus</i>	Anabantidae	LC
2.	Chanda	Glass-Perchlet	<i>Pseudambassis lala</i>	Ambassidae	LC
3.	Lomba Chanda	Elongate glass perchlet	<i>Chanda nama</i>	Ambassidae	LC
4.	Kaikka	Needle fish	<i>Xenentodon cancila</i>	Belonidae	LC
5.	Tengra	Striped dwarf Catfish	<i>Mystus vittatus</i>	Bagridae	LC

S L	Local Name	English Name	Scientific Name	Family	IUCN Status*
6.	Golsha tengra	Gangetic Mystus	<i>Mystus bleekeri</i>	Bagridae	LC
7.	Bujuri-tengra	Tengra	<i>Mystus tengara</i>	Bagridae	LC
8.	Ayre	Long-whiskered Catfish	<i>Sperata aor</i>	Bagridae	VU
9.	Gutum	Cross fish	<i>Lepidocephalichthys guntea</i>	Cobitidae	LC
10.	Rui	Rohu	<i>Labeo rohita</i>	Cyprinidae	LC
11.	Catla	Catla	<i>Catla catla</i>	Cyprinidae	LC
12.	Mrigel	Mrigal	<i>Cirrhinus mrigala</i>	Cyprinidae	NT
13.	Kalibaus	Orange fin labeo	<i>Labeo calbasu</i>	Cyprinidae	LC
14.	Bhangon Bata	Bata labeo	<i>Labeo bata</i>	Cyprinidae	LC
15.	Sarpunti	Olive barb	<i>Puntius sarana</i>	Cyprinidae	NT
16.	Jat punti	Pool barb	<i>Puntius stigma</i>	Cyprinidae	LC
17.	Mola Punti	Glass barb	<i>Puntius guganio</i>	Cyprinidae	LC
18.	Phutani punti	Spottedsail barb	<i>Puntius phutunio</i>	Cyprinidae	LC
19.	Chapchela	Sind danio	<i>Devario devario</i>	Cyprinidae	LC
20.	Kajuli, Bashpata	Gangetic Ailia	<i>Ailia coila</i>	Schikbedia	LC
21.	Batasi	Indian Potasi	<i>Neotropius atherinoides</i>	Schikbedia	LC
22.	Mola	Mola carplet	<i>Amblypharyngodon mola</i>	Cyprinidae	LC
23.	Dankina	Rasbora Finescale	<i>Rasbora rasbora</i>	Cyprinidae	NT
24.	Chela	Large razorbelly minnow	<i>Salmostoma bacaila</i>	Cyprinidae	LC
25.	Silver carp	Silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	LC
26.	Shol	Striped snakehead	<i>Channa striatus</i>	Channidae	LC
27.	Taki	Spotted Snakehead	<i>Channa punctatus</i>	Channidae	LC
28.	Magur	Air breathing Catfish	<i>Clarias batrachus</i>	Clariidae	LC
29.	Kachki	Ganges river spart	<i>Corica soborna</i>	Clupeidae	LC
30.	Chapila	Indian rivershad	<i>Gudusia chapra</i>	Clupeidae	VU
31.	Ilish	Hilsha	<i>Tenualosa ilisha</i>	Clupeidae	LC
32.	Bele	Tank goby	<i>Glossogobius giuris</i>	Gobiidae	LC
33.	Shing	Stinging catfish	<i>Heteropneustes fossilis</i>	Heteropneusti dae	LC
34.	Tara baim	One stripe spiny eel	<i>Macrognathus aculeatus</i>	Mastacembeli dae	NT

S L	Local Name	English Name	Scientific Name	Family	IUCN Status*
35.	Choukka	Indian pellona	<i>Pellona ditchela</i>	Pristigasterid ae	LC
36.	Sal Balm	Tire-track spiny Eel	<i>Mastacembelus armatus</i>	Mastacembeli dae	EN
37.	Chital	Humped Featherback	<i>Chitala chitala</i>	Notopteridae	EN
38.	Bheda/Meni	Mud perch	<i>Nandus nandus</i>	Nandidae	NT
39.	Khailsha	Giant gourami	<i>Colisa fasciata</i>	Osphronemid ae	LC
40.	Pangas	Yellowtail Catfish	<i>Pangasius hypophthalmus</i>	Pangasiidae	EN
41.	Gharua	Garu bacha	<i>Clupisoma garua</i>	Schilbeidae	EN
42.	Banspata	River catfish	<i>Ailia punctata</i>	Schilbeidae	LC
43.	Bacha	Bacha	<i>Eutropiichthys murius</i>	Schilbeidae	LC
44.	Batasi	Indian potasi	<i>Pseudeutropius alherinoides</i>	Schilbeidae	LC
45.	Kajuli	Jamuna Ailia	<i>Ailia punctata</i>	Schilbeidae	LC
46.	Shilong	Silond Catfish	<i>Silonia silondia</i>	Schilbeidae	LC
47.	Poa	Pama Croake	<i>Otolithoides pama</i>	Sciaenidae	LC
48.	Pabda	Indian butter Catfish	<i>Ompok pabda</i>	Siluridae	EN
49.	Boal	Freshwater shark	<i>Wallago attu</i>	Siluridae	VU
50.	Madhu pabda	Patio catfish	<i>Ompok pabo</i>	Siluridae	EN
51.	Boali pabda	Butter catfish	<i>Ompok bimaculatus</i>	Scincidae	LC

*Volume 5: Freshwater Fishes, Red List of Bangladesh, International Union for Conservation of Nature (IUCN), Bangladesh Country Office, 2015

Environmental Pollution

1) Air Pollution

Pre-construction Phase

Pre-construction phase will involve site clearance, leveling & filling activities for development of EZ. Upon land acquisition, BEZA plans land grading of the EZ in order for the land to be flooding resilient. Considering the amount of soil required for 218.84 ha project area. River sand dredge from the Meghna River and transferred through the water vessel into the unloading point of Shitalakhya River. Due to the distance between the nearest river and the EZ site, sending river sand may require intermediate unloading point between the river and the EZ. River sand may be transported by pipeline to the project site from the unloading point which will be located at Shitalakhya River.

It is estimated that minimum of 4-5.5 meters land filling must be practiced. Clearance of site will involve removal of wild vegetation, land leveling & filling activities. These activities will lead to dust generation. However, these emissions will be limited to the site only and have impact for short duration only during clearance activity.

Construction Phase

All earthworks construction, site clearing, small structures demolition, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, hauling of materials, construction of access road, construction of retention pond and canal will generate dust and affect the local air shed. Construction of access roads and its dust is likely to be the most significant direct potential impact on the local community.

Carbon dioxide and nitrogen oxides may be emitting from the combustion of the petroleum products in project related vehicles, machinery, generators etc during the construction period. Their impact on air quality will not be significant as the pollutant emission activities (point and area sources) will be limited within the project boundary and the activities will be short term (only for the construction period).

The retention pond excavation may generate huge dust in the air and it will influence directly on the workers as well as local community. Dust mites are a common cause of asthma in children. The soil extractor or soil collector truck will move continuously in the project that may be emitting CO₂ and NO₂ from combustion of gas, oil or fuel.

The air may be polluting due to dust arisen from unpaved road, sand/ earth stockpile by wind. Bitumen will use for construction of 400 meter access road and burning of bitumen may generate air pollution but the impact will be minimum.

The main sources of air pollution during the dredging activities and land development is dredger and booster operation, vessel transportation that will carry the sand to the loading point to unloading point. Diesel is used to operate these engines.

Diesel combustion will mainly consist of sulfur dioxide, nitrogen oxides, particulate matter and greenhouse gases like carbon dioxide and carbon monoxide. The fuel combustion will affect the ambient air quality. As the dredging activity will be short-term and localized in nature, therefore, the impact on air quality has been assessed as low.

Operation Phase

There will be minimal dust emissions from paved access and all internal roads. Post development of the economic zone & setting up of industries, there could be some impacts on the air quality of the area. Industrial development will involve generation of emissions, and increased vehicular movements. These altogether may have overall negative impact on the air quality of the site and the nearby areas. The industries proposed as per the feasibility study are light engineering, food processing, textile industries, pharmaceutical, motor bike assembly and readymade garment manufacturing. Significant air emissions result from light-engineering industries. These are particulate matter, sulphur dioxide, metals and other criteria pollutants like ozone, oxides of nitrogen and carbon monoxide. Lead may be generated in some of the processes. Air emissions from food processing industry will contain some volatile organic compounds but do not contain any hazardous compounds. These industries emit low process-air emissions. Most processes use electrical power and rarely emit harmful compounds to environment.

2) Water Pollution

Pre-construction Phase

Impact on water quality from muddy water flowing to the canal or adjacent river due to land reclamation work is expected. In the rainy season, dredged soil may contaminate the canal by runoff water. Therefore, proper management can reduce this impact.

Construction Phase

Run-off from the construction site may carry the higher quantity of sediments and oil which may pollute the surface water and impact the aquatic life. Thus measures are required to be taken to minimize the surface water pollution.

The retention pond excavation may generate huge dust that may mix with the canal/river water through rainwater. The soil extractor or soil collector truck will move continuously in the project site that may be spill oil, which will contaminate the adjacent water bodies.

The surface water may be polluting due to dust arisen from unpaved road, sand/ earth stockpile by wind and runoff water. Access road construction materials and debris (sand, bricks, stones, brick chips, cement etc) may cause water pollution.

Ground water is fresh shallow aquifers of the study area. No significant impacts are anticipated on the ground water quality due to development and construction of AEZ facilities.

Operation Phase

Impact on Surface Water Quality

Industries are likely to generate domestic and industrial effluent. Liquid waste which can be generated from light engineering industries will include waste acid, waste alkali, grease, used/spent oil, liquid metal, spent solvents etc. Wastewater is not generated in significant amount from these industries. Majorly domestic and cleaning waste is likely to be generated. No significant liquid waste is generated from RMG garments. Food processing industries similarly generate both liquid and solid waste.

Concern with wastewater from the food processing industry is high BOD levels, high TSS, excessive nutrient loading like nitrogen and phosphorus compounds and pathogens. This water is to be treated essentially to achieve DoE standards to prevent the soil, water and air quality pollution. Discharge of wastewater in soil will degrade its fertility and increase the toxicity which will make it unsuitable for growth of plants and survival of micro/macro organisms. If this water is discharge into water system, will pollute the water quality and have potential to threat the aquatic life. Uncontrolled discharge of these effluents to canal/river may severally pollute the canal/river water quality. Pollutants from these industries may be discharged into canals and may be carried away to Brahmaputra & Meghna River system which supports diverse variety of fish. Run-off may significantly increase post development of economic zone. It is required to manage storm water which will be generated from EZ site post development. Measures should also be taken to prevent contamination of storm water with any industrial pollutant.

Dredging activity will increase the turbidity, suspended solids, reduced light transmittance, changes in temperature and pH, reduced dissolved oxygen and release of nutrients, heavy metal, and organic contaminants. As a result, the dredging activity will change the present River water quality. Therefore, the impact has been assessed as significant.

Following measures should be adopted during operation phase to minimize impacts of development of Economic zone on surface water quality:

Impact on Ground Water Quality

There will be very minimal chance of contaminating ground water from wastewater and sewage during the operation phase. Pre-treated waste water will be collected from factories through anti-corrosive pipes to the treatment plant and only be discharged to nature after meeting the national discharge standards. Following measures should be taken to minimize the ground water pollution.

The proposed dredging site is located in the water bodies. The dredging activities will be continued on a temporary basis. No groundwater is required for dredging activity whereas the requirement of freshwater for the workers in the dredgers and vessel will be met from the outside of the project area, and the contractor will ensure it. It is expected that no impacts will be occurred on the groundwater resources in the area by the proposed dredging activity.

3) Waste

Construction Phase

General construction waste is expected and typically managed by the appointed contractors. Construction sludge by boring from underground and domestic waste from the base camp is generated during construction. Excavation of retention pond and access road construction may generate both solid and liquid waste that will affect water, soil & ecology.

Operation Phase

Industrial waste is expected. Appropriate waste management by law and regulation is the responsibility of the tenant factory/ facilities, which shall be approved by DoE for their own EIA.

4) Soil Pollution

Pre-construction & Construction Phase

Project site and surrounding area would be contaminated by dredged soil. Land will be filled and compacted after reclamation. In addition, sand will be required for construction of boundary wall, access road and administration building which will be sources from nearby markets or other part of the country. Sand should be purchased from authorized vendors only to minimize the illegal mining and dredging activities storage of raw material. Fuel and construction debris may contaminate the soil thus measures should be taken to prevent the soil pollution.

During the Retention pond excavation time, the upper layer of the soil will be damaged. Soil erosion caused by running water and other pest control measures; this leads to loss of fertile land for agriculture, forest cover, fodder patches for grazing etc. The presence of heavy metals in soil in toxic amounts can cause irreversible developmental damage in children. Improper disposal of waste may cause soil pollution.

Development of the structures and construction of the access road may disturb the soil profile of the area. Usually soil pollution by leaked petrol from pipe connection of ill-maintenance heavy equipment and storage tanks that are installed directly on the soil surface can cause oil leaking that result in pollution of subsoil and groundwater during construction. Road debris may also generate soil pollution

Mitigation measures to be adopted are mentioned below. Contractors are required to take all the proposed mitigation measures. AEZ will ensure that all the proposed mitigation measures are being incorporated in the bid document issued to the contractor and the implementation of the same during pre-construction & construction.

Operation Phase

No significant impact on soil quality is anticipated from the operations of AEZ. All waste including solid and liquid wastes will be treated properly before being disposed of into nature. After development of economic zone, disposal of industrial domestic and process waste may contaminate land and soil quality of the area. The impact can be significant and long term in case of uncontrolled discharges. Improper disposal of waste (hazardous and non-hazardous waste) may degrade soil, water, air quality and ecology of the area. As per the preliminary planning, it is planned that industries like light engineering, textile and food processing will come up in the EZ zone. These industries are not heavily polluting like tanneries, distilleries etc. but generate significant waste both hazardous and non-hazardous in nature, which can pollute the environment if not managed properly. Natures of the waste, which can be generated from these industries, are discussed below.

Waste to be generated from the light engineering industries can be solid and liquid in nature. Solid waste will include packaging waste, metal pieces, damaged electrodes, ends of coils, wires and spools, flux cored electrodes, greased clothes/cotton, damaged rods, burnt rods, scrap flux, slag (residue from flux reaction and composed of metal and nonmetal oxides), Dross (oxidized metal expelled during thermal cutting and gouging operations), metal dust, dust collected in filter ventilation systems/air pollution control devices, floor sweepings, coal ash (if coal used as fuel), solid waste recovered from treatment of wastewater like sludge etc. Solid waste from the food processing industries includes both organic and packaging waste. Organic waste that is the rinds, seeds, skin, and bones from raw materials, results from processing operations. Inorganic wastes typically include excessive packaging items that are plastic, glass, and metal. Solid waste from textiles majorly composed of resins, fabric, apparel, dye, discarded machinery and fibers. These waste required to be collected and disposed off periodically. Lubricate oil/waste oil is generated from the machineries as hazardous waste. Mitigation measures are required to be adopted to prevent soil pollution of the area.

5) Noise and Vibration

Pre-construction Phase

Pre-construction phase will involve site clearance and land filling activities. Clearance of site will involve removal of wild vegetation and leveling activities. Some noise may be generated during the pre-construction phase but that will be site specific and for short durations. Machinery to be used should comply with the noise standards prescribed by DoE.

Construction Phase

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

- Impacts of Noise to Immediate Neighbors
- Continuous exposure of neighbors to noise nuisance may result in noise induced hearing lose;
- Noise nuisance may reduce concentration of neighbors
- Noise Impacts to Employees
- High noise level will force employees to shout loud when communicating to one another;
- Exposure of employees to high noise level (above 85 dB) continuous for 8hoursper day may result in noise induced haring lose;
- Exposure of ear to peak sound level instantaneously may result to deafness

The retention pond excavation may generate noise that will influence directly on the workers as well as local community. Continuous exposure of neighbors to noise nuisance may result in noise-induced worker hearing lose. The soil extractor or soil collector trucks will movement will be main source of noise pollution.

The construction of access road is relatively near to residential area. Vehicles and machinery may generate noise. However, low-noise construction vehicles will be used and construction work will not do at night hour. Moreover, construction period will be done as soon as possible. Hence, there would be not significant impact.

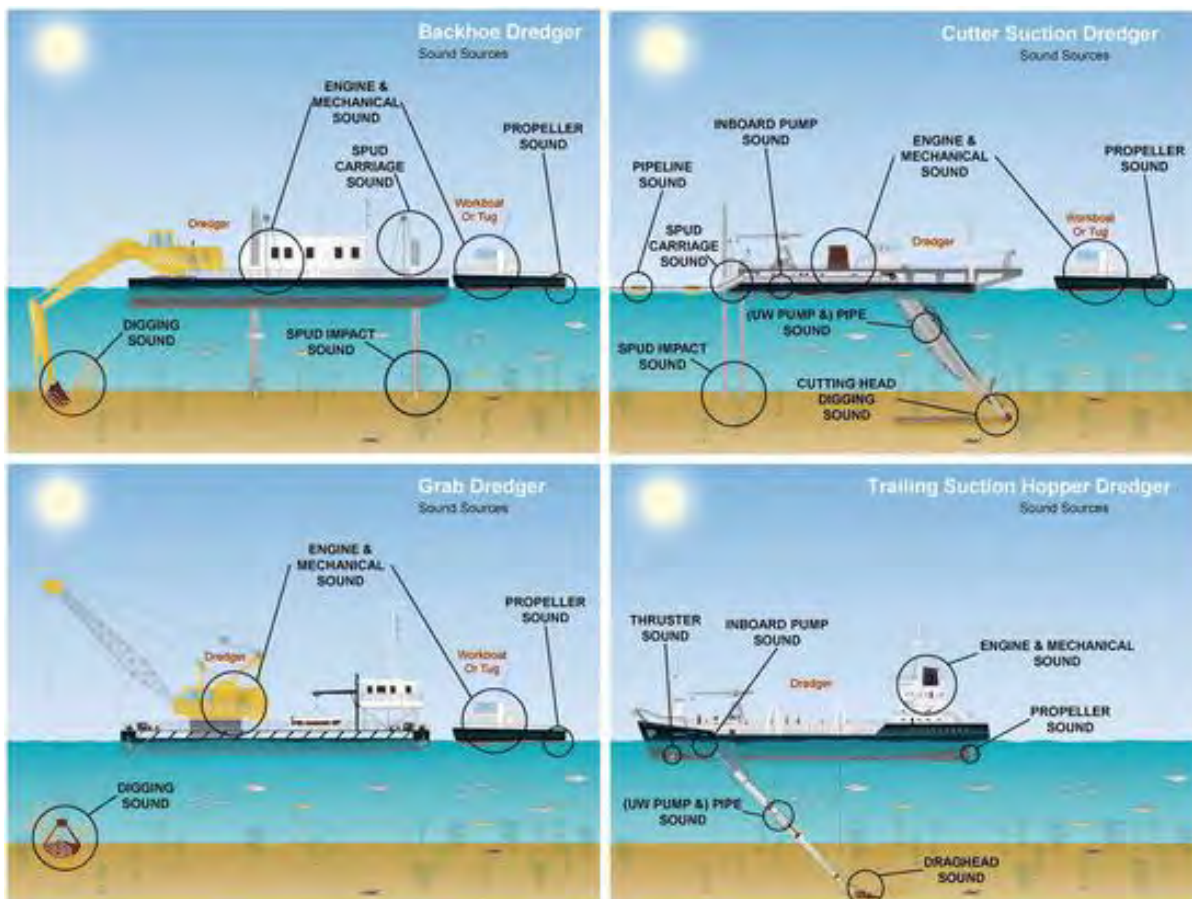
The noise level will be increased temporarily in the proposed dredging area due to the operation of dredgers, excavation of the dredge spoil, lifting of dredge materials from river floor up to the suction pipe,

transportation of dredging spoil up to the disposal site, pump, generators, propellers, and thrusters of the dredgers, movement of others support vessels in the waterway.

Noise levels generated by the dredging operation will vary according to the size and type of the equipment used, and more importantly, the size and type of the engines. Generally speaking during dredging operations, there are three categories of sound sources that are associated with:

- Dredging excavation
- Dredging vessels during transport
- Dredged material placement

The figure below gives an overview of the different types of dredging vessels and the sources of underwater sound for each type of vessel. Sound production is largely influence by sediment properties – to excavate hard, cohesive and consolidated soils; the dredger must apply greater force to dislodge the material. Sounds from dredges can be variable, depending on the phase of operation, and the type of dredge used, but typically occur at low frequencies (<500 Hz).



source: Arthur N. Popper, Anthony Hawkins (2015), The Effects of Noise on Aquatic Life II

Figure 3.1-24: Sources of Noise from several types of dredgers and associated vessels

Water is an excellent medium for sound transmission. Sound travels more than four times faster underwater than in air and absorption is less compared to air. The sensory modalities of vision, touch, smell, and taste are limited in range and the speed of signal transmission. As a consequence, many aquatic organisms use sound as their primary mode of communication – to locate a mate, to search for prey, to avoid predators and hazards, and for short- and long-range navigation. Activities generating underwater sound can affect these functions and, since sound can be far ranging, the spatial scale of impacts can be quite large. Concerns for underwater sound impacts on aquatic mammals, fishes, and other forms of

aquatic organisms have arisen primarily with the conduct of military operations, seismic exploration, dredging and various forms of construction in aquatic environments.

Total 14 sand unloading boosters will be placed on the Sitalakhya River at the unloading point, and approximately four boosters will be installed for each pipeline to carry out sand material from unloading point to economic zone site. Total 14 unloading pipelines will be placed through homestead and agricultural land. Settlements are not present near to the bank of both Meghna and Sitalakhya River. If the booster place in the homestead area, noise from booster will affect the nearby dwellers. Operation of the dredgers and unloading booster will affect the dwellers living near to the booster area, workers in the dredger, river mammals, fishes and others aquatic animals.

Operation Phase

In the operation phase of AEZ, traffic in the area will increase significantly which will increase the noise level of the area. Operation of tenants, water pumps, and light engineering factories in proposed EZ may increase the noise level. The following mitigation measures should be taken to prevent noise pollution during the operation phase:

6) Ground Subsidence

Construction Phase

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

Operation Phase

Based on the deep ground water surveys, enough ground water resources were confirmed at the deep aquifer that is deeper and different from the aquifer of the residential wells. Expansion of the EZ and other industrial subsidence could lead to subsidence without proper ground water resource management.

7) Offensive odors

No impacts or impacts are negligible

8) Sediment Quality

Pre-construction Phase

During the land development, earth-filling material may washout to canal and increase the sediment concentration.

Construction Phase

Development of the structures and construction of the access road and excavation of retention pond may disturb the bottom sediment profile of the water bodies. Storage of raw material, fuel and construction debris may contaminate the bottom sediment thus measures should be taken to prevent the sediment pollution.

During dredging process, the river bed will be disturbed, and a small part of dredge material are very likely to be in suspension due to the fine sediment content of the bed material. High levels of fine suspended sediment over long periods may have an adverse environmental impact.

Operation Phase

No significant impact on bottom sediment quality is anticipated from the operations of AEZ. Bottom sediment of the surrounding water bodies would be deteriorated by wastewater generated from the

industries. All waste including solid and liquid wastes will be treated properly before being disposed of into nature.

After development of economic zone, disposal of industrial domestic and process waste may contaminate land and bottom sediment of the area. Waste to be generated from the light engineering industries can be solid and liquid in nature. Solid waste will include packaging waste, metal pieces, damaged electrodes, ends of coils, wires and spools, flux cored electrodes, greased clothes/cotton, damaged rods, burnt rods, scrap flux, slag (residue from flux reaction and composed of metal and nonmetal oxides), Dross (oxidized metal expelled during thermal cutting and gouging operations), metal dust, dust collected in filter ventilation systems/air pollution control devices, floor sweepings, coal ash (if coal used as fuel), solid waste recovered from treatment of wastewater like sludge etc. Solid waste from the food processing industries includes both organic and packaging waste. Organic waste that is the rinds, seeds, skin, and bones from raw materials, results from processing operations. Inorganic wastes typically include excessive packaging items that are plastic, glass, and metal. Solid waste from textiles majorly composed of resins, fabric, apparel, dye, discarded machinery and fibers. These wastes required to be collected and disposed off periodically. Lubricate oil/waste oil is generated from the machineries as hazardous waste. Mitigation measures are required to be adopted to prevent bottom sediment pollution of the area.

Natural Environment

9) Protected areas

No impacts or impacts are negligible

10) Ecosystems

Pre-construction Phase

In addition to impact on land and structures, the Araihaazar Economic Zone project in Araihaazar has limited impact on trees. A total 1055 trees will be affected by the project where 349 fruits trees, 127 timbers, 253 bananas and 326 Bamboos are identified. A total of 349 fruits trees were identified of which 39 were large, 75 were medium and 235 were small and saplings. Impact on trees is presented in the table below;

Table 3.1-34: Number of Affected Trees (by Type and Size)

Categories of trees	Number of Trees by size (Nos)				
	Large	Medium	Small	Sapling	Total
Fruits	39	75	189	46	349
Timber	14	54	56	3	127
Banana					253
Bamboo	318	-	8	-	326
Total	440	260	290	65	1055

Source: JICA Study Team, December 2017

Grassland

A total 17 species belonging to 14 genera of 10 families were recorded from the study area (Table 3.1-35). Four (4) species of grasses were identified among them Barjavani (*Fimbristylis milliacea*) and Mutha

(*Fuirena ciliaris*) were found most commonly occurring. Herbs were represented by 5 species dominated by Kapalphutki (*Cardiospermum halicacabum*), Jhaljamani(*Cocculus hirsutus*), Marmarialata (*Cissus repens*)and Banorkalai (*Atylosia scrabaeoides*)list of grassland flora of the study area.

Table 3.1-35: list of grassland floral species in the study area

SI	Scientific name	Family	Common Name (Bengali name)	Status of distribution	Type
1	<i>Coccinia grandis.</i>	Cucurbitaceae	Telakucha	common	Wild
2	<i>Ampelocissus latifolia.</i>	Vitaceae	Angurlata	common	Wild
3	<i>Atylosia scrabaeoides.</i>	Fabaceae	Banorkalai	common	Wild
4	<i>Canavalia gladiata.</i>	Fabaceae	Mousim, Makhansim	common	Cultivated
5	<i>Cardiospermum halicacabum</i>	Sapindaceae	Kapalphutki	common	Wild
6	<i>Centrosema pubescens</i>	Fabaceae	Gandhya Sim	common	Wild
7	<i>Cissus repens.</i>	Vitaceae	Marmarialata	common	Wild
8	<i>Cocculus hirsutus.</i>	Menispermaceae	Doipata, Jhaljamani	common	Wild
9	<i>Dioscorea belophylla.</i>	Fabaceae	Sora Alu	common	Wild
10	<i>Ichnocarpus frutescens.</i>	Apocynaceae	Dudhilata	common	Cultivated
11	<i>Ipomoea aquatica</i>	Convolvulaceae	Panikalmi	common	Wild
12	<i>Ricinus communis</i>	Euphorbiaceae	Venna, Reri	common	Wild
13	<i>Xanthosoma sagittifolium</i>	Araceae	Dud Kachu	Common	wild
14	<i>Senna tora.</i>	Caesalpiniaceae	Kalkasunda	Common	wild
15	<i>Fimbristylis dichotoma subsp. podocarpa Koyama</i>	Cyperaceae	Nirbishi	Common	wild
16	<i>Fimbristylis milliacea.</i>	Cyperaceae	Barajavani	Common	wild
17	<i>Fuirena ciliaris.</i>	Cyperaceae	Mutha	Common	wild

Common plant of the study area

A total of 53 species, 48 genera belongs to 31 families were represented by terrestrial flora (Table 3.1-36). Mahogani (*Swietenia mahagoni*) tree species is endangered as per classification. Coconut (*Cocos nucifera*), Eucalyptus(*Eucalyptus citriodora*), Mango (*Mangifera indica*),Guava (*Psidium guajava*), *Ricinus cummunis*, Litchi (*Lichi chinensis*),Kul-boroi (*Ziziphus mauritiana*),Pepe (*Carica papaya*),Sajna(*Moringa oleifera*),Jambura(*Citrus aurantifolia*), Mahogani (*Sweitenia mahagoni*),Banana

(*Musa sapientum*), Kachkola (*Musa paradisiac*), Kathal (*Atrocarpus heterophyllus*) and Acasia (*Acacia nilotica*) were recorded most commonly occurring trees.

Table 3.1-36: list of common plant species in the study area

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
	<i>Polyalthia longifolia</i>	Annonaceae	Debdaru	T	sporadic	Cultivated
	<i>Gmelina arborea L.</i>	Verbenaceae	Gamari	T	sporadic	Cultivated
	<i>Eucalyptus citriodora Hook</i>	Myrtaceae	Eucalyptus	T	sporadic	Cultivated
	<i>Erythrina ovalifolia Roxb.</i>	Caesalpiniaceae	Mander, Patiyamander	T	sporadic	Wild
	<i>Dillenia indica L.</i>	Dilleniaceae	Chalta	T	sporadic	Wild
	<i>Areca catechu L.</i>	Mimosaceae	Supari, Gua	T	sporadic	Cultivated
	<i>Hibiscus rosa-sinensis</i>	Malvaceae	Joba	S	sporadic	Cultivated
	<i>Cestrum nocturnum L.</i>	Solanaceae	Hasnahena	S	sporadic	Cultivated
	<i>Corchorus aestuans L.</i>	Tiliaceae	Banpat	H	sporadic	Wild
	<i>Mimusops elengi.</i>	Sapotaceae	Bakul	T	rare	Cultivated
	<i>Delonix regia.</i>	Caesalpiniaceae	Krisnochura	T	rare	Cultivated
	<i>Lawsonia inermis.</i>	Lythraceae	Mehede	S	rare	Cultivated
	<i>Gardenia coronaria.</i>	Rubiaceae	Gandhyaraj	S	rare	Cultivated
	<i>Paederia foetida</i>	Rubiaceae	Gandhyabhadduli	C	rare	Cultivated
	<i>Ziziphus Mauritiana</i>	Rhamnaceae	Kul, Boro	T	common	Cultivated
	<i>Terminalia arjuna</i>	Combretaceae	Arjun	T	common	Cultivated
	<i>Tamarindus indica.</i>	Caesalpiniaceae	Tetul	T	common	Cultivated
	<i>Syzygium cumini (L.) Skeels</i>	Myrtaceae	Jam	T	common	Cultivated
	<i>Coccinia grandis</i>	Cucurbitaceae	Telakucha	C	common	Wild
	<i>Lablab purpureus</i>	Fabaceae	Shim	C	common	Cultivated

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
	<i>Lageneria siceraria</i>	Cucurbitaceae	Kadu	C	common	Cultivated
	<i>Alocasia indica</i>	Araceae	Mankachu	H	common	Wild
	<i>Colocasia esculenta</i>	Araceae	Bankachu	H	common	Wild
	<i>Cynodon dactylon</i>	Poaceae	Durba	H	common	Wild
	<i>Musa paradisica</i>	Mussaceae	Kachkola	H	common	Cultivated
	<i>Carica papaya</i>	Caricaceae	Pape	S	common	Cultivated
	<i>Sesbania canabina</i>	Fabaceae	Dhoincha	S	common	Cultivated
	<i>Phyllanthus acidus</i>	Euphorbiaceae	Arboroi	ST	common	Cultivated
	<i>Psidium guajava</i>	Myrtaceae	Peyara	ST	common	Cultivated
	<i>Aegle marmelos</i>	Rutaceae	Bel	T	common	Cultivated
	<i>Albizia procera</i>	Mimosaceae	Silkoroi	T	common	Cultivated
	<i>Annona squamosa</i>	Annonaceae	Ata	T	common	Cultivated
	<i>Aphanamixis polystachya</i>	Meliaceae	Roina	T	common	Wild
	<i>Artocarpus heterophyllus</i>	Moraceae	Kathal	T	common	Cultivated
	<i>Azadirachta indica</i>	Meliaceae	Neem	T	common	Cultivated
	<i>Bambusa balcooa</i>	Poaceae	Barakbans	T	common	Cultivated
	<i>Barringtonia acutangula</i>	Lecythidaceae	Hijal	T	common	Cultivated
	<i>Bombax ceiba</i>	Bombaceae	Shimul Tula	T	common	Wild
	<i>Borassus flabellifer</i>	Palmae	Tal	T	common	Wild
	<i>Citrus grandis</i>	Rutaceae	Jambura	T	common	Cultivated
	<i>Cocos nucifera</i>	Arecaceae	Narikel	T	common	Cultivated
	<i>Feronia lemonia</i>	Rutaceae	Kadbel	T	common	Cultivated
	<i>Litchi chinensis</i>	Sapindaceae	Lichu	T	common	Cultivated

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
						ed
	<i>Litsea monopetala</i>	Lauraceae	Menda	T	common	Wild
	<i>Moringa oleifera.</i>	Moringaceae	Sajna	T	common	Wild
	<i>Neolamarckia cadamba.</i>	Rubiaceae	Kadam	T	common	Wild
	<i>Phoenix sylvestris.</i>	Arecaceae	Khejur	T	common	Cultivated
	<i>Phyllanthus embelica.</i>	Euphorbiaceae	Amloki	T	common	Cultivated
	<i>Samanea saman.</i>	Mimosaceae	Rain Tree, Meghsirish	T	common	Cultivated
	<i>Streblus asper</i>	Moraceae	Sheora	T	common	Wild
	<i>Switenia mahogani</i>	Meliaceae	Mahogani	T	Common	cultivated
	<i>Acacia nilotica</i>	Fabaceae	Acasia	T	Common	Wild
	<i>Casia siamea</i>	Fabaceae	Cassia tree	T	Common	Wild

Aquatic Ecosystems

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

River Ecosystems

The impacts of dredging on biological resources can be short-term, direct or indirect. There can be short-term impacts from the dredging, and long-term impacts associated with habitat modification. Short-term impacts could include local changes in species abundance or community diversity during or immediately after dredging. Long-term impacts could include permanent species abundance or community diversity changes caused by changes in hydrodynamics or sediment type, or a decline or erratic trend beyond the normal range of variability in the years following new dredging. The following activities will influence potential sources of impacts of dredging phase to aquatic ecology at the project site:

- Dredging along the Meghna River;
- Spoil spread-out into aquatic ecosystem;
- Oil spillage from dredger and associated vessels;
- Noise from dredgers and associated vessels

Impact on Dolphin

As per discussion with fisherman and local people, the Ganges River Dolphin is found in the proposed dredging site and surrounding area. The dredging activity will increase the turbidity and noise level that would be effect on River Dolphin.

Potential impacts of noise on dolphins include mortality, hearing damage, masking of communication and other biologically important sounds, and behavioral responses. Mortality only occurs in the immediate vicinity of very high-energy noise sources, such as blasting, and is unlikely to occur for the considered pump noise. Noise and disturbance can change in movement routes and pattern of River Dolphin.

Construction Phase

Terrestrial Ecosystems

As indicated in baseline description, there is little of the project area that has not been significantly altered by human activities. As population expands rapidly after the initiation of human settlement in these plains the pressure on the existing system of production grows and hence biodiversity continues to decrease.

The project will have moderate impact both temporally as well as spatially on the terrestrial ecosystem. The severity of the impacts from project activities will also depend on the biological communities and their resilience to handle sudden alterations. Terrestrial species would also likely to suffer from long term impacts from the project.

Terrestrial Flora

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

Agricultural Land Flora

The project will have very similar impact on agricultural vegetation. Clearing of these crop cover from the construction area will create some negative impact on food security for the community as a whole. However, the impact on environment and ecosystem will be not very high.

Homestead Plantation Flora

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

Roadside Vegetation

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

Terrestrial Fauna

Relative impact on terrestrial fauna will be determined by their habitat preference, food source and sensitivity to human activities. Moreover, the species both vertebrates and invertebrate species found in the project sites, are highly adaptive to regular anthropogenic disturbance and so the impact from project activities will be short and non-severe. But, any overlap between the project activity and their breeding period will produce much greater impact.

Nine species of terrestrial mammals belonging to the 8 genera of 6 families were recorded in the Project area (Table 3.1-37). Golden Jackal (*Canis aureus*), Bengal Fox (*Vulpes bengalensis*) and Indian Gray Mongoose (*Herpestes edwardsii*) were seen visiting canal area, Sonpara during the field survey by the ecology team. Jungle Cat (*Felis chaus*) was reported to be seen by locals during field consultations in agricultural and homestead plantation areas. None of the species are reported to be listed in RED category of IUCN 2015 v2. However, Indian Gray Mongoose (*Herpestes edwardsii*), Jungle Cat (*Felis chaus*) and Asian House Shrew (*Suncus murinus*) are reported to be listed in

Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capturing.

Table 3.1-37: list of mammals found in the study area

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

Data source: Study team using IUCN classification system

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

Agricultural Land Fauna

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

Homestead Plantation Fauna

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

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

Roadside Vegetation Fauna

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

Aquatic ecosystem

Aquatic ecosystems provide support not only to aquatic inhabitants but also supply vital ingredients to terrestrial ecosystems. The impact on aquatic ecosystem will be negative, as the area under aquatic ecosystem will be disturbed. Especially, during construction many seasonal and perennial water bodies will lose their characteristics. Run-off from construction site may contain sediments or contaminant which may pollute water quality of canals and adjacent River which will impact the aquatic life. The

economic productivity of the wetlands will also decrease with the reduction of seasonally flooded areas and subsequent loss of wetland-dependent species. The seasonal wetlands provide the basis for many fisheries production of the area. Wetland vegetation provides important shelter for many fish species.

Aquatic Flora

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

Aquatic Fauna

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

Macro-invertebrate Fauna

Macro-invertebrate surveys were conducted in 22-23 October, 2017 survey. Macro invertebrate species such as water spiders (*Argyroneta aquatica*), Common Apple snail (*Pila globosa*), Disk Snail (*Macrochlamys sequax*), River Snail (*Bellamya begalensis*), Brotia Snail (*Brotia costula*), Lymneid Snail (*Lymnaea luteola*), Fresh water Mussels species such as (*Lamellidens corrianus*), (*Lamellidens marginalis*), (*Lamellidens jenkinsianus*) were observed in the study area. None of the species observed are of conservational significance.

Fish

In order to get secondary information as well as various literatures review found some data / information on the specific floodplain of the project area. The Sonakahli and Dhawrakhali canal interconnected with each other while they are connected to Old-Brahmaputra River. 31 species of 25 genera belonging to 17 families are reported from the canal and river (Table 3.1-38). Among of them 4 species are in endangered and 2 species are vulnerable and 3 are near threatened according to the Red list of IUCN (2015, Vol.3).

Table 3.1-38: list of fish in the study area

SL#	Local name	Common name	Scientific name	Family	IUCN Status
	Koi	Climbing perch	<i>Anabus testudines</i>	Anabantidae	LC
	Chela	Large Razorbelly Minnow	<i>Salmophasia bacaila</i>	Cyprinidae	LC
	Katol	Catla	<i>Catla catla</i>	Cyprinidae	LC
	Boal	Freshwater Shark	<i>Wallago attu</i>	Siluridae	VU
	Rui	Ruhu	<i>Labeo rohita</i>	Cyprinidae	LC
	Pangash	Yellowtail Catfish	<i>Pangasius pangasius</i>	Pangasiidae	EN
	Tengra	Striped Dwarf Catfish	<i>Mystus vittatus</i>	<u>Bagridae</u>	LC
	Shing	Stinging Catfish	<i>Heteropneustes fossilis</i>	Heteropneustidae	LC
	Shol	Snakehead Murre	<i>Channa striatas</i>	Channidae	LC
	Taki	Spotted Snakehead	<i>Channa punctata</i>	Channidae	LC
	Bele	Bele	<i>Glossogobius giuris</i>	Gobiidae	LC
	Chital	Humped	<i>Chitala chitala</i>	Notopteridae	EN

SL#	Local name	Common name	Scientific name	Family	IUCN Status
		Featherback			
	Gajar	Giant Snakehead	<i>Channa marulius</i>	Channidae	EN
	Pabda	Pabda catfish	<i>Ompok pabda</i>	Siluridae	EN
	Kakila	Silver Needle Fish	<i>Xenentodon cancila</i>	Belonidae	LC
	Mola	Mola Carplet	<i>Amblypharyngodon mola</i>	Cyprinidae	LC
	Chela	Large Razorbelly Minnow	<i>Salmophasia bacaila</i>	Cyprinidae	LC
	Bata	Bata Labeo	<i>Labeo bata</i>	Cyprinidae	LC
	Jat Punti	Spotfn Swamp Barb	<i>Puntius sophore</i>	Cyprinidae	LC
	Khailsha	Banded Gouram	<i>Trichogaster fasciata</i>	Osphronemidae	LC
	Gulsha Tengra	Bleeker's Mystus	<i>Mystus bleekeri</i>	Bagridae	LC
	Tengra	Striped Dwarf Catfish	<i>Mystus vittatus</i>	Bagridae	LC
	Magur	Walking Catfish	<i>Clarias batrachus</i>	Clariidae	LC
	Bacha	Batchwa Vacha	<i>Eutropichthys vacha</i>	Schilbeidae	LC
	Potka	Ocellated Pufferfish	<i>Tetraodon cutcutia</i>	Tetraodontidae	LC
	Choto Tengra	Tengara Catfish	<i>Mystus tengara</i>	Bagridae	LC
	Mrigal	Mrigal Carp	<i>Cirrhinus cirrhosus</i>	Cyprinidae	NT
	Tatkini	Reba	<i>Cirrhinus reba</i>	Cyprinidae	NT
	Silver carp	Silver carp	<i>Hypophthalmichthys molitrix</i>	<u>Cyprinidae</u>	NT
	Grass carp	Grass carp	<i>Ctenopharyngodon idella</i>	<u>Cyprinidae</u>	DD
	Olive barb	Sar punti	<i>Systemus sarana</i>	<u>Cyprinidae</u>	LC

Operation Phase

Green buffer all around the project site will include most of the native plant species, which will significantly improve the ecology of the area. This green buffer will provide habitat for the avifauna, reptiles and small mammals and will enhance ecology of the area. In addition, zone of 3 m will be left as no development zone along the length of canal. This zone will also be developed as green buffer. Post development of the economic zone & setting up of industries, there could be some impacts on the ecosystem of the area. Industrial development will involve generation of emissions, effluents and increased vehicular movements. These all together may have overall negative impact on the eco-system of the site and the nearby areas as the air pollutant will affect the existing vegetation and avifauna in the area. But the industries proposed as per the feasibility study are light engineering, food processing and textile. These industries are not heavily polluting. If appropriate measures for preventing air, water, soil and noise pollution are taken, there will be no significant impact on the ecosystem of the area.

11) Hydrology

Pre-construction Phase

Impact on drainage pattern & hydrology is temporarily expected caused by land modification. After land development of the project site, the adjacent land may inundate by high precipitation and over flow of canal/river water. The existing canal might be affected due to the land filling and increase the sediment concentration therefore some mitigation measures is required.

It was confirmed that the path and the direction of Dhawrakhali canal would be kept intact during all phases of the project. In general, the difference in elevation between adjacent points might change but their sequence would be almost kept unchanged. As a result, surface water flow would not change significantly and would keep its current water flow.

Construction Phase

The excavation of retention pond may disturb the existing water for shorter period at monsoon season. After land development of the project site, the adjacent land may inundate by high precipitation and over flow of canal/river water. It was confirmed that the path and the direction of Dhawrakhali canal would be kept intact during all the phases of the project. According to the land acquisition plan and the storm water drainage plan, the project area would be excavated and embanked to attain a level platform with E.L. 6.5 m and general slope would be 0.2% in the direction of the drainage system with Dhawrakhali canal and then toward Brahmaputra River. The excavation and slope protection work would be designed to minimize the excavation volume and slope protection volume as much as possible. In general, the difference in elevation between adjacent points might change but their order would be almost kept unchanged. As a result, surface water flow would not change significantly and would keep its current water flow.

Water consumed for the construction work and related activities during the construction phase would include water for washing vehicles and equipment, sprinkling water, and domestic water. The source of water during construction will be groundwater. The amount of water consumption is limited and short-term. It can be concluded that water uptake from the groundwater during the construction phase would be very limited and would not cause any significant impact on Ground aquifer as well as Dhawrakhali canal.

Operation Phase

Site has been raised with the sand dredged soil from Meghna River. The proposed site will be required to be leveled at 6 to 7m height from MSL after development of the AEZ. The ground level of the zone will be around 1 m above the average flood level. Rainwater drainage ditches will be located on both sides of internal roads and will drain rainwater to the canal located along the 60m main road. A retention pond will be located at the terminal of the canal, and it will have storage functions enabling it to perform the function, preventing the impact of the change of the runoff rate accompanying land preparation, and part of the pump drainage functions during flooding. The rainwater felled in EZ is planned to be discharged to the southern small river as current. The small river merges into Brahmaputra River. For controlling drainage, The flow capacity of the planned canal is, assuming the roughness coefficient is 0.035 and the water surface gradient is 0.02%, about 34.3m³/s when the water depth is 3.6m (if the canal bottom elevation is considered to be 2.5m, water surface elevation of 6.1m), and it can carry the planned flow rate and a water retention pond of about 108,000 m³ of water retention capacity will be constructed in the EZ for allowing smooth drainage in gravity during normal weather condition. Also the zone will be protected by an embankment to prevent the zone from flood. If the water level outside the surrounding level is nearly 5m, discharge by natural flow will be difficult, so the gate of the surrounding levee will be closed and the system switched over to pump drainage. No significant impact on drainage is anticipated with development of the zone and its facilities.

12) Topography and Geology

Pre-construction & Construction Phase

Since the AEZ is being developed in the naturally depressed area filling with dredged soil, the topography of the area is likely to be changed. Due to the significant sand reclamation from the surrounding riverbeds, erosion of the riverbank could occur without proper sand dredging. There will be requirement of road construction for AEZ to connect it with highways and also national power pass through the zone, thus no further excavation is required to electric poles but excavation may be required to lay pipeline.

After discussion with dredging contractors, it is found that the contractors usually acquire dredging concessions for the dredging sites in Meghna river and it is most likely that Meghna river will be dredging site for AEZ's land development work. Dredging is RED category in ECR 1997 and contractors are required to obtain Environment clearance certificate (ECC) for dredging site prior to acquisition of concession. Dredging activities in the Meghna river will effect on the physical environment by changing the geomorphology, bathymetry, current velocity and wave conditions. Changes in hydrography may also affect the sediment transport, which may again influence the bathymetry. The bottom topography will be affected.

The proposed dredging will be conducted in a specified three selected locations in the Meghna River.

The dredge level will be 1-2 meter. Estimated volume of dredge material is approximately 1,000,000 m³ per borrow pit. Total 9,002,673 m³ sand will be dredged from the Meghna River. The expected duration of the activities is approximately 24 months. Based on the volume, area, duration of dredging activity it has been accessed that the geomorphology and bathymetry of the proposed are might be changed.

Operation Phase

No activities are planned that will cause impact on topography and geology. Therefore, no impacts or impacts are negligible, so no further study is required.

Social Environment

13) Involuntary Resettlement

Pre-construction& Construction Phase

Land acquisition will be required and some scale of involuntary resettlement is expected. A total of 11 affected households have been identified through a series of resettlement survey. It is likely to have significant adverse impact on this item since more than 55resettlers are predicted. The proposed project required land acquisition and every affected household and landowner will be compensated properly according to government laws (approximately 1500). The entire land was lower agricultural land in the project site. There was no cultural, historical and aesthetic interesting the project land and no loss of sensible place. Detailed data is indicated in the resettlement action plan report.

The Araihaazar Economic Zone in Araihaazar requires approximately 500 acres of land. The entire land selected for the project is private land and need to be acquired. The project including canal area requires approximately 218.84 ha of private land need to be acquired. The project has very limited impact on living and commercial structures as well as on trees. Only 11 households will be displaced from the project area.

In general, communities in Bangladesh have a strong social tie among them. Special consideration shall be paid in order to mitigate the impact of the displacement on those 11 households who must be relocated. BEZA shall support those households who wish to stay in the same or an adjacent community so that those households will not be disconnected from the community that they currently belong to. Resettlement of those household shall be carefully monitored before and after the resettlement.

Summary of project is presented in below Table. The total estimated cost to be incurred for implementation of the RAP is about BDT 4,823,744,801(four hundred eighty- two crores thirty-seven lac forty four thousands eight hundred and one taka only) including 2% contingency provision.

Table 3.1-39: Summary of Impact

Descriptions	Unit	Quantity
Land required for the project	Ha.	218.84
Affected Households	Nos.	1714
Households losing structures	Nos.	11
PAPs losing land	person	6343
Affected Living & Commercial Structures	sft	6282.95
Affected Secondary Structures		
Tube – Well	No.	12
<i>Pucca</i> Latrine with safety tank	No.	1
Slab Latrine	No.	8
Tin Made Boundary Wall	rft	265
Affected Trees	Nos.	1055
Identified Vulnerable Households	Nos.	150
Identified Sharecropper	Nos.	23

Source: JICA STUDY TEAM, December 2017

Operation Phase

No impacts or impacts are negligible, so no further study is required.

14) Vulnerable Group

Pre-construction/Construction Phase

In Araihaazar Economic Zone project, out 1,714 households a total of 150 (8.75%) households were identified as vulnerable. Among them 25 are female headed having no male income earner, 58 are elderly headed and 67 were identified as extreme poor. Vulnerable households in the projec including retention pond area are presented in below Table categorically.

Table 3.1-40: Affected Vulnerable AHs.

Vulnerable Category	Total	%
Female Headed AH without male income earner	25	16.67
Elderly Headed Households (70+)	58	38.66
Households belonging below poverty line (96000 BDT yearly income)	67	44.67
Total	150	100.00

Source: JICA STUDY TEAM, December 2017

Vulnerable people in the project area would be affected. On the other hand, job opportunity and commercial activities would increase during construction activities.

Operation Phase

The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affectedly the project activities. Although women are also

considered as a vulnerable and marginalized group, the impacts on the same have been identified and assessed separately. These groups of people are at a greater disadvantage or susceptible to more risk due sudden change in their socio-economic environment. The primary reasons for their vulnerability are:

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

The Project should ensure that land acquisition and related aspects should not result in any additional vulnerability. In case such vulnerabilities arise appropriate measures should be taken to mitigate adverse impacts. Measures from vulnerable groups are mostly in relevance to employment and livelihood opportunities created from the project activities. Livelihood restoration plans should have special emphasis on these vulnerable groups and communities such as the landless, aged and the disabled groups so as to have a positive impact in terms of income and livelihood, skill development, poverty alleviation, sustenance as well as overall participation levels. However, these same groups are also at increased risk of being marginalized and at the low end of receiving project benefits due to their physical condition, awareness levels, low skill base, age, disability, illiteracy etc. due to which other groups may be given preference.

15) Indigenous and ethnic people

No indigenous/ethnic people live in the project affected area. No impacts or impacts are negligible, so no further study is required. According census and SES in 2017 conducted by the local consulting firm, no indigenous or ethnic minority populations were identified in the project area.

16) Local Economics, Such as Employment, Livelihood

Pre-construction& Construction Phase

PAPs who earn income from paddy fields and/or vegetable fields might lose their income source. Many sharecroppers (approximately 1714) depended on agriculture in dry season. They cultivate IRRI and vegetable that period. According to the census and SES findings, most of the affected household head (66.45%) are engaged with agricultural activities. About 248 including five women household head are doing business for their livelihood. Only 23 persons were identified as sharecroppers in the project area. A detail of occupation distribution of affected household head is presented in below

Table 3.1-41: Distribution of Occupation of Affected Household Head

Name of Occupation	Male		Female		Total	
	N	%	N	%	N	%
Agriculture	1110	64.76	29	1.69	1139	66.45
Teacher	10	0.58	3	0.18	13	0.76
Abroad worker	10	0.58	0	0.00	10	0.58
Private Job	94	5.48	5	0.29	99	5.78
Household work	0	0.00	165	9.63	165	9.63
Fishing	1	0.06	0	0.00	1	0.06
Business	243	14.18	5	0.29	248	14.47
Day Labor	2	0.12	0	0.00	2	0.12

Name of Occupation	Male		Female		Total	
	N	%	N	%	N	%
Mason	9	0.53	0	0.00	9	0.53
Tailor	4	0.23	3	0.18	7	0.41
Driver	2	0.12	0	0.00	2	0.12
Elder Person	14	0.82	5	0.29	19	1.11
	1499	87.46	215	12.54	1714	100.00

Source: JICA STUDY TEAM, December 2017

On the other hand, increase of job opportunity as construction workers or commercial opportunity targeted to the workers is expected.

Only 1 household, whose occupation is fishing, was identified during the RAP study. However, there are said to be more fishermen (10 to 15 fishermen according to the focus group discussion with local fishermen), who are not land title holder but depend on fishery as their main source of income. Those fishermen should be provided with income and livelihood restoration program or other means of assistance as they lose their source of income due to the project.

Operation Phase

Long-term livelihoods will be impacted by the project. As Araihaazar agrarian economy, a good percentage of the population is dependent on agriculture as an income resource. Families are taking paddy crops from their fields on an annual basis.

Consultations with select landowners (that were identified during the course of the social survey) suggest that most direct impact of land loss has been in terms of loss of earning. Stakeholders also suggest that loss of income or livelihoods will not expected to be significant for the land being acquired currently. This is due to the fact that the land is put to limited use by the affected people (it is flooded for a significant part of the year and cannot be used for agricultural purposes).

On the other hand, increase of job opportunity as workers of the industries or commercial opportunity targeted to these workers is expected. The proposed project will employ about 10,000 persons for operation and maintenance. Most of the skilled employees will be accommodated in the rented accommodations in Araihaazar. This along with other project related requirements like workers, security, housekeeping, gardening etc. will create a constant requirement for labour, though very high in numbers. In addition, raw material and necessities for the functioning of the Economic zone could be sourced from the local areas, thus creating several opportunities for local suppliers and contractors for a variety of resources and commodities.

17) Land Use and Utilization of local resources

Pre-construction Phase

Total land of the project site is seasonally agricultural land. During the monsoon season the proposed land is submerged by the Dhawrakhali canal water which is connected to the river. In the pre-construction phase, the temporary storage and stockyard are built up on the agricultural lands, and then the crop production will be obstructed in those areas. Crops will also be damaged when the equipments, and heavy vehicles will pass through agricultural fields of the proposed project areas.

Construction Phase

The 218.84 ha of agricultural land will be altered by the industrial zone. So the annual agricultural production rate of that upazila will diminish. In the project site, land is single cropped agricultural land so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development.

Operation Phase

Total 218.84ha land is required for of AEZ. No impact on agriculture resources is anticipated from economic zone development during the operation phase. So, no impacts are expected.

18) Water Usage

Pre-construction Phase

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

Construction Phase

Since Araihaazar EZ sites do not have existing public water supply facilities, it is necessary to utilize the nearby rivers or wells as water sources. Ground water will be used in the during the construction phase. Therefore, Excessive withdrawal of ground water may lead to depletion of aquifers. Source of water of these activities will be the ground water from own borehole.

The water source will be approximately 200m deep wells. A past survey estimated the arsenic contamination concentration to be low enough to not be a problem. Excessive withdrawal of ground water may lead to depletion of aquifers. Measures should be taken to minimize the water extraction by reducing water consumption and wastage. Mitigation measures are given below.

Operation Phase

It is obvious that there will be thousands of employees and workers who will use and consume water and generate wastewater from the office and the residential building. It is estimated app. 7,000 Cubic meter per day of water will be required during operation phase after development of Araihaazar economic zone at Araihaazar, Narayanganj. The water demand can be fulfilled by withdrawing ground water through the water supply system to be developed by the project. During the operation phase a plant of which water demand is about approximately 7,000m³/day.

Distribution in Groundwater of Dhaka Surrounding Area and EZ Site Well testing should be conducted before the implementation stage. The position, the depth, and the interval of wells should be determined based on the confirmation of the water supply capacity, the water level recovery time, and the change of groundwater level, which were confirmed by using the value of the aquifer depth, the water quality, and pumping test that were collected during well testing. Moreover it is necessary to prevent excessive depletion of wells due to excess water usage and the subsidence of surrounding ground.

Following Measures should be taken to minimize the impacts on water usage.

19) Existing Social Infrastructures and Services

Pre-construction& Construction Phase

No impacts or impacts are negligible

20) Social Institutions Such as Social Infrastructure and Local Decision-making institutions

No impacts or impacts are negligible

21) Misdistribution of Benefits and Damages

Pre-construction Phase

Only land owner and property owners and affected labours will be eligible for the compensation and rehabilitation. Displaced people may be suffered at the proposed project sites

Construction Phase

Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors.

Operation Phase

No impacts or impacts are negligible, so no further study is required.

22) Local Conflict of Interest

No impacts or impacts are negligible

23) Cultural Heritage/Asset

Nothing found in the development area would be affectedly the development. Therefore, no impact is expected on cultural heritage due to proposed project implementation.

24) Landscape

Pre-construction& Construction Phase

No impacts or impacts are negligible

The landscape will be changed by the construction work of Araihaazar Economic Zone. Moreover, 218.84 ha of agricultural land will be cleared and altered to industrial area as the part of Economic Zone development. All construction activities for administration building, land filling & boundary wall will be carried out within economic zone site and will not cause any impact on landscape and scenic beauty. A green buffer of 3.5 m only one row of trees will be developed all around the project site which will enhance the scenic beauty of the area.

Operation Phase

Landscape of EZ site is naturally depressed area which will be changed to industrial land use after development of EZ site. No major change in landscape is associated with the development of the EZ zone and other off-site facilities. Majorly land use is agricultural land, settlement and wetland area. Development of EZ will attract more infrastructural development around the project site to facilitate industrial growth changing the land use area from agriculture to industrial land use. Some of the other developments including construction of roads, housing facility, commercial areas including hotels, hospital, restaurants, schools, ancillary industries, cottage industries, etc may also occur in nearby areas. This will lead to change in landscape but will lead to significant development of the area.

Although semi-urbanization of landscape in and around Araihaazar Economic Zone is inevitable, the development will be implemented under the project proponent internal regulation which rules to secure the environmental friendliness for users and residents, and harmonization with the surrounding area. In addition, greening area will be established in each plot and public space. Therefore, as long as the industries follow the internal regulation and the project proponent will make effort to maintain the public area, the landscape of the project area is expected to be well-maintained semi-urbanized area.

25) Gender

Pre-construction& Construction Phase

Employment opportunities as well as wage difference may occur between male and female. It is anticipated that most of construction work will require male workers and there will be less opportunity for females.

Operation Phase

Once the EZ starts its operation and hire employments, wage difference may occur.

26) Children's Right

Pre-construction& Construction Phase

The following item was examined to forecast the impact:

- May impact on educational opportunity of school going children in PAHs of the Project;
- May impact on educational opportunity of school going children in local community;
- Impact of the project on increase of child labor;

Child labor at the construction site during the project implementation shall be strictly prohibited since both Bangladesh laws and JICA guidelines ban such practices. The RAP Implementing Agency and EZ authority shall regularly monitor project sites to guide contractors and their related firms to discourage child labor. A contract between contractor and EZ authority shall include provisions for prohibition of child labor. When the child labor will be detected, the RAP Implementing Agency shall immediately report to EZ authority and EZ authority shall take necessary and decisive actions including suspension and/or rescind of the contract (if the case is extremely malicious) to the violating firms based on the applicable laws and regulations of Bangladesh. If root cause of the child labor originated from impoverished living standard of project affected families due to improper or insufficient relocation assistance, EZ authority through RAP Implementing Agency, will provide the following assistance to parents of working child:

- Support of sending children to school;
- Helping the parents with hunting for a job, including the one at the construction site;
- Mediation for micro credit loan;
- Introducing them to assistance organizations such as NGO and so forth;

Operation Phase

There are 11 affected households who have school going children's. They must be relocating to other places and these children's educational opportunity will be temporarily disrupted due to the relocation. Currently, majority of the children of PAHs in the project area go to school in and around Araihaazar Economic Zone area. For primary school (Sonpara) students, they mostly go to schools in the nearest villages such as located outer boundary of Araihaazar Economic Zone.

The project proponents will implement "EZ neighbors students Support Program" as one of the community support programs targeting not only for children of PAH but also for surrounding communities. This program has contributed to provide more educational opportunity to children in the surrounding area of Araihaazar EZ and it is estimated that more than 1,000 students will be benefited from these activities in the local community. In addition, the project proponent will implement this kind of educational program continuously based on needs and requests from the community. Based on above, the educational opportunity is expected to improve by the effort of the project proponent in the local community.

According to the Labour Law of Bangladesh 2006, the minimum legal age for employment is 14. However, as 93 per cent of child labourers work in the informal sector – in small factories and workshops, on the street, in home-based businesses and domestic employment – the enforcement of labour laws is virtually impossible. As mentioned above, as long as the Project and industries keep laws in Bangladesh,

illegal child labor will be prevented in employment of labors. Hence, it is judged that the Project would not cause any significant negative impact on children's right in the surrounding area.

27) Infectious Diseases

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

The entire construction phase is expected to continue for about 3 years. This will require labour of unskilled, semi-skilled, skilled and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly of skilled labourers and workers. During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility with HIV/AIDS and the disease can spread among local people.

Operation Phase

This is a possibility to increase the risks of infectious diseases due to influx of workers of the industries and the semi-urbanization of the project area and its surroundings area.

Working Conditions, Including Occupational Safety

Working conditions are at the core of paid work and employment relationships. Working conditions cover a broad range of topics and issues, from working time (hours of work, rest periods, and work schedules) to remuneration, as well as the physical conditions and mental demands that exist in the workplace. Occupational safety and health (OSH), also commonly referred to as occupational health and safety (OHS), occupational health, or workplace health and safety (WHS), Community Health & Safety is a multidisciplinary field concerned with the safety, health, and welfare of people at work. The details of Occupational Health & Safety, Community health & Safety & Risk of fire are given in Section 7.5.17 to Section 7.5.19.

28) Occupational Health and Safety

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

There would be a possibility to occur accidents and incident during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful for workers health. In order to prevent accidents and incidents, the project proponent regulates to install security and maintain safety prevention measures and devices suitable for using in each plot for construction in the internal regulation. Therefore, construction contractor based on the international guidelines should manage the working condition during the construction.

River Traffic and Collision Risk

Dredging techniques and sand carrying vessel capacity not yet finalized. The appointed contractor will select the dredging techniques and sand carrying vessel based on the water draft of the Sitalakhya River. Based on the discussion with dredging company, the available vessel capacity in Bangladesh are ranges from 85-850 m³ therefore approximately daily 24 nos. vessel will move considering 850 m³ capacity from loading point to the unloading point through Sitalakhya River which is an important navigation route. Many industries are located both bank of the Meghna and Sitalakhya River near the Meghna and

Kanchpur bridge. So many goods carrying vessels are plying both Meghna and Sitalakhya River. No floating pipeline installation will be required for the disposal of dredging material. Sand will be pumped from the dredger and directly load in the sand carrying vessel. The Meghna River is wide enough. Therefore, dredging activity will not affect significantly. Sand carrying vessel movement in the Sitalakhya River may interrupt the existing river navigation, as the river width is less compare to the Meghna River.

Accidents of river transportation vessels in 2009 were 201 cases, in which, 10 cases were recorded in Shitalakshya River while 2 in Meghna River.

Health

The possible sources of impacts on occupational health and safety during the dredging phase of the project are exposure of noise from dredgers, accidental oil spillage from dredgers and sand carrying vessel, diesel and other chemical use in dredgers and associated vessels, Handling of chemical without health safety equipment's, improper management of waste in the workers facilities, fire, collisions, sink of dredgers, slip or fall into the water etc.

High-level noise exhausted from the dredger will be a great problem for the workers' health and safety condition. Use of diesel and other chemical without health safety equipment's can cause health-related problems to the workers. Accidental oil spillage from dredgers and vessel also will be another source of health problems.

Operation Phase

During operation phase each industry will start their operation, accidents or incidents are expected to occur more or less during the operation phase. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful for workers health. As same as construction phase, the project proponent regulates to install security and maintain safety prevention measures and devices suitable for use in each plot for operation as well in the internal regulation in order to prevent accidents and incidents. Based on the rules, the respective industries should prepare and implement appropriate mitigation measure under the respective impact assessment based on the international guidelines. Especially during the rainy season, countermeasures toward intense heat should be well prepared by each industry, while the project proponent will continuously give announcement to the operation period for the prevention of heat stroke. In addition, the accommodation for workers will be arranged according to the project proponent of logistic, residential and commercial area in order to provide dwelling place for them. Since the type of business is different in each industry, the mitigation measure should be prepared for the respective occupational risk based on the operation plan and working condition of each industry.

Community Health and Safety

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

Noise will be generated from the dredgers, sand carrying vessel engine, sand unloading booster and from booster which will install with pipeline. In the proposed dredging site and disposal site ambient noise level will be increased by the noise generation from the dredger. However, there is no settlement area close to the proposed dredging pit sites and offshore disposal site. As a result, it is expected that the proposed dredging activity will not affect the local community.

Total 14 sand unloading boosters will be placed on the Sitalakhya River at the unloading point and approximately four boosters will be installed for each pipeline to carry out sand material from unloading point to economic zone site. Total 14 unloading pipelines will be placed through homestead and

agricultural land. Settlements are not present near to the bank of both Meghna and Sitalakhya River. If the booster place in the homestead area, noise from booster will effect on the nearby dwellers.

It is envisaged that during the construction phase activities, a lot of the material and heavy equipments is scheduled to be brought to the site in vehicles via the inner access roads. Some of these impacts associated specifically with roadways are:

- Traffic congestions on roads and possible disruption to the community usage during peak movement hours;
- Increased risks with respect to safety associated with traffic movement;
- Inconvenience to community in terms of air and noise pollution caused by the movement of vehicles; and
- Structural and surface damage to road due to movement of heavy vehicles and equipments

Apart from the traffic, other community health and safety impacts resulting from the construction phase of activities would typically include (but not be limited to):

- Generation of dust, noise and odour from the construction site which may have health related impacts on the local community;
- Fire Safety from the ongoing construction activities which may include handling and storage of flammable chemicals and materials;
- Improper disposal and migration of sewage into the surroundings;
- Improper disposal of sewage and waste may lead to contamination of ground water, as the water table in the project area is very high.
- Any waste disposal in canal from the project would affect the population in downstream of water flow Potential impacts during the construction period on existing infrastructure and community health and safety is expected to be moderate. With the implementation of the following mitigation measures the potential impacts will be further reduced.
- Provision of infrastructure for migrant labour such as water supply, electricity, sanitary facilities, medical aid and other basic amenities to avoid dependence on limited local resources;
- Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area;
- Creating awareness among the drivers about speed, traffic safety, use of horns etc while driving through settlement areas;
- Covering of trucks while carrying soil, sand, cement, aggregates etc to minimise spread of dust and spill over;
- Avoiding unnecessary movement of vehicle through settlement area to minimise disturbance and traffic safety related issues;
- Creating awareness among children, women, and old age people in particular and the community in general on traffic safety by using existing mediums such as school, women self help groups, village union and religious occasions;
- Strengthening and regular maintenance of village road to minimize surface and structural damage of road;
- Sprinkling of water to suppress dust generation in the construction zone;
- Provide training and create awareness about fire and safety among workers at site;
- Disposal of wastes at pre identified waste dumping site to avoid unauthorized dumping;
- Avoid disposing of wastes in the canal and providing silt traps to arrest silt flowing into the canal during the rainy season.

Operation Phase

The health and safety risks in the plant during operations include potential for respiratory diseases, burns, allergies and industrial accidents among the employees and immediate neighboring communities if adequate mitigation measures to prevent the above are not implemented. In addition, local public health centres may report an increase in cases involving respiratory ailments like coughing, phlegm; eye irritation etc. due to the dust and particulate matter from operations.

Traffic: The impacts envisaged from the project activities on with respect to community usage of access roads are mostly confined to the construction phase as well as operation phase when the resource movement in and out of the site is higher. Also, the local people would be benefitted from the strengthening of road connecting the access road to the Project site.

Influx: Apart from the operation phase, skilled technicians and operators are also likely to be sourced for operating the plants/industries once it goes into operation. It is envisaged that during that phase these technicians would be housed in rented accommodation in and around Araihaazar. This population however would be significantly higher accounting to almost 2000 families due to which the associated impacts accounted for the operation phase. Also, the positive implications observed during construction phase would continue in operation phase.

Health and Safety: The key health & safety impacts on the local community during operation phase include:

- Emission & Noise generated from the operation of the industries. These emissions may include compounds of Nitrogen and Carbon which may be harmful to the surrounding community;
- Fire & Explosion Hazards;
- Improper sewage and waste disposal;

Risk of Fire

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

Risk of fire might increase due to the implementation of the construction work for the Project. Labour's camp will face high risk of fire at construction period. Faulty electricians are the biggest cause of workplace fires, loose wires, plugs that are over loaded and old equipment can all make for a potential death trap. Discarded cigarettes can cause fires if not put out and disposed of properly in the project area. Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present. It has to be said that one of the most common causes of fires in the workplace is human error. Fires can occur as a result of negligence in a variety of different ways including improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended.

However, it would be limited because the Araihaazar Economic Zone authority will regulate and apply the "building construction and fire safety" rules in the project area. According to the rules include the following drawings: 1) architectural drawings (layout plan, finishing schedule, floor plans, elevations and sections), 2) means of egress (fire escape plan), 3) emergency lighting and exit signs, 4) fire alarm and detection system, 5) emergency generator, 6) fire hydrant (hose reel), 7) fire extinguisher, 8) sprinkler (if necessary), 9) dry riser/ breeching inlet (if necessary), 10) lightning arrester, 11) hazardous material safety plan etc.

Operation Phase

Risk of fire would increase due to the economic activities of the industries and population growth in and around the project area. Electrical systems that are overloaded, resulting in hot wiring or connections or failed components might occur at operation phase.

Others

29) Accidents

Construction Phase

Construction accidents and road accidents around the project site are expected due to the construction activities. Construction workers can have harmful and critical troubles.

Excavation of retention pond and access road construction period, contractor will appointed many workers for civil work and there are some possibilities to occur accidents. Improper traffic management and safety issue can increase this problem significant.

Operation Phase

Road accidents would be increased due to industrial vehicles and commuter buses and motor lines.

30) Transboundary impact and climate change

Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming.

Pre-construction Phase

Impacts are negligible, no further study required.

Construction Phase

Although construction machines and vehicles generate greenhouse gases, quantities of generated gases do not give serious impact and negligible on this item. To minimize GHG emission during the construction phase, mitigation measures shall be taken by the contractor, such as management of operation time of construction machineries, avoidance of excessive loading operation, and education of construction workers/drivers about the idling stop practice for construction machineries and vehicles.

- Control of GHGs emission in the construction period;

Operation Phase

Amount of emission of Carbon Dioxides (CO₂) based on the increase of vehicles. But Emission from construction vehicles/equipment is negligible compared to the number of passing vehicles daily. In addition, energy-saving equipment and fuels that emit less GHG will be recommended to be installed to all tenants for their operations as much as possible. Besides, the utilization of commuter bus for workers to reduce traffic GHG emission will be initiated by the tenants.

3.1.7. Environmental Impact Assessment

In connection with the scoping matrix described in Table 3.1-10, the rating was reevaluated based on the survey and findings. Revised evaluation (rating) is presented in the table below.

Table 3.1-42: Environmental Impact Assessment based on survey

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	B-	B-	B-	PC: It is estimated that minimum of 6 to 7 meter land filling must be practiced. Clearance of the site will involve removal of wild vegetation, land leveling, & filling activities. These activities will lead to dust generation. CO: Impact on air quality due to operation of construction machineries and circulation of construction vehicles is expected. OP: Impact on air quality due to increase of vehicle traffic during industrial operation. Emissions would be generated from the industrial operation.
	2	Water pollution	A-	B-	A-	B-	PC/CO: Impact on water quality from muddy water flowing to the river due to land reclamation work is expected. Run-off from the construction site may carry the higher quantity of sediments and oil which may pollute the surface water and impact the aquatic life. And ground water is fresh shallow aquifers of the study area. OP: Impact on water quality of the surrounding water bodies is expected due to wastewater discharge from the EZ.
	3	Waste	B-	A -	B-	A -	CO: General construction waste is expected and typically managed by the appointed contractors. OP: Industrial waste is expected. Appropriate waste management by law and regulation is the responsibility of the tenant factory/facilities, which shall be approved by DOE for their own EIAs.
	4	Soil pollution	B-	B-	B-	B-	PC/CO: Project site and surrounding area would be contaminated by dredged soil. Development of the structures and construction of the access road may disturb the soil profile of the area. Land will be filled and compacted after filling. Also sand will be required for construction of access road and administration building which will be sources from nearby markets or other part of the country. Storage of raw material, fuel and construction debris may contaminate the soil.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							OP: Soil contamination would occur due to the improper operation of the EZ industries.
	5	Noise and vibrations	A-	B-	A-	B-	PC/CO: Increase of noise and vibration levels due to construction machineries operation, particularly by the sand compaction and traveling of construction vehicle would temporarily occur. OP: An increase in noise and vibration levels due to the circulation of vehicular traffic and operation of the industries would occur.
	6	Ground subsidence	D	C	D	D	CO: During construction, ground water usage may be very limited so there will be very minimum impact. OP: 2.5 million m ³ of ground water consumption is expected within the EZ, however the ground water will be taken from deep wells (260m to 300m) so that it will very unlikely to cause ground subsidence nor have impact on wells currently used by residents near the EZ.
	7	Offensive odors	D	D	D	D	Construction works that generate odors are not expected.
	8	Sediment quality	B-	B-	B-	B-	PC: During the land development, earth filling material may washout to the nearby canal and increase the sediment concentration. CO: Development of the structures and construction of the access road may disturb the bottom sediment profile of the water bodies. OP: Bottom sediment of the surrounding water bodies would be deteriorated by wastewater generated from the industries.
Natural environment	9	Protected areas	D	D	D	D	Since no natural preservation area and national parks exist in and around the Economic Zone, an impact on protected areas is not expected.
	10	Ecosystems	B-	B-	A-	B-	PC/CO: Extensive use of vehicle horns and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Many on land species of flora and fauna would be affected by waste water from land filling work. Dredging activities may disturb river / underwater creatures such as river dolphin. OP: Post development of the economic zone & setting up of industries, there

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							could produce some impacts to the ecosystem of the area. Industrial development will involve generation of emissions, effluent and increased vehicular movements. These all together may have overall negative impact on the eco-system of the site and the nearby areas as certain specific air pollutants will impact the existing vegetation and avifauna in the area.
	11	Hydrology	A-	B-	A-	A-	PC: Impact on drainage pattern & hydrology is temporarily expected caused by land modification. The adjacent land may inundate by high precipitation and over flow of canal/river water CO: Surface water movement would be significantly changed due to the construction of the retaining walls above the existing ground level. OP: without EZ drainage retaining systems, excess drainage water from the EZ could flood the surrounding area.
	12	Topography and geology	A-	D	A-	D	CO: Due to the significant sand reclamation from the surrounding river beds, erosion of the river bank could occur without proper sand dredging. OP: No impacts are expected
Social environment	13	Involuntary resettlement	A-	D	A-	D	PC: Land acquisition will be required and some scale of involuntary resettlement is expected. OP: No involuntary resettlement will occur during OP.
	14	Vulnerable group	C	C	B-	B-	PC/CO: Vulnerable people in the project area would be affected. OP: Vulnerable people such as disabled persons or low educated people would not be able to receive the benefits of the Project as they might not be able to obtain job opportunities.
	15	Indigenous and ethnic people	D	D	D	D	CO: no indigenous/ethnic people live in the project affected area. OP: no impacts are expected
	16	Local economies, such as employment, livelihood, etc.	A-	A+	A-	A+	PC/CO: PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. On the other hand, increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. OP: Impact on the livelihood of relocated households is expected. On the other hand, an increase of job opportunity as workers of the industries or commercial opportunity targeting workers is expected.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
	17	Land use and utilization of local resources	B-	C	B-	D	PC: Total land of the project site is seasonally agricultural land. During the monsoon season the proposed land is submerged by the Dhawrakhali canal water which is connected to the river. In the pre-construction phase, the temporary storage and stockyard are built up on the agricultural lands, and then the crop production will be obstructed in those areas. Crops will also be damaged when the equipments, and heavy vehicles will pass through agricultural fields of the proposed project areas. CO: The 218.84 ha of agricultural land will be altered by the industrial zone. So the annual agricultural production rate of that upazila will diminish. In the project site, land is single cropped agricultural land so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development. OP: No impact on agriculture resources is anticipated from economic zone development during the operation phase.
	18	Water usage	C	C	B-	B-	CO: Since Araihaazar EZ sites do not have existing public water supply facilities, it is necessary to utilize the nearby rivers or wells as water sources. Ground water will be used during the construction phase. So, Excessive withdrawal of ground water may lead to depletion of aquifers. OP: It is obvious that there will be thousands of employees and workers who will use and consume water and generate wastewater from the office and the residential building. It is estimated app. 7000 cubic meters per day of water will be required during the operation phase. Iron and other material may affect human health when consumed by employees in the EZ.
	19	Existing social infrastructures and services	B-	B-	B-	B-	PC/CO: <u>Impact to Relocated PAHs of the Project</u> Accessibility of PAHs to social Infrastructure/service would be affected more or less due to the relocation. On the other hand, the proposed relocation site will be arranged with basic social infrastructures as a part of the assistance by the project <u>Impact to Local People in the local Community of the project area</u> Accessibility of social infrastructure/ service will be affected due to the increase of

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
							construction vehicles. The traffic volume should be controlled by the construction contractor to avoid serious traffic congestion. OP: Accessibility to social infrastructure would be limited by the existence of the industries.
	20	Social institutions such as social infrastructure and local decision-making institutions	B-	B-	B-	B-	PC/CO: <u>Impact to Relocated PAHs of the Project</u> Accessibility of PAHs to social Infrastructure/service would be affected more or less due to the relocation. On the other hand, the proposed relocation site will be arranged with basic social infrastructures as a part of the assistance by the project <u>Impact to Local People in the local Community of the project area</u> Accessibility of social infrastructure/ service will be affected due to the increase of construction vehicles. The traffic volume should be controlled by the construction contractor to avoid serious traffic congestion. OP: Accessibility to social infrastructure would be limited by the existence of the industries.
	21	Misdistribution of benefits and damages	A-	D	A-	D	PC: Only land owner and property owners and affected labours will be eligible for the compensation and rehabilitation. CO: Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors. OP: No activity or little activity will cause misdistribution of benefits and damages.
	22	Local conflicts of interest	D	D	D	D	CO: Due to an increase in employment opportunity during construction; candidates of construction workers may experience some conflicts between communities but it is expected to be very minor. OP: Misdistribution of benefits and damages would occur since there are PAHs who lose their income source, while there are people who would get job opportunity as workers of the industries. But, more than 10,000 people will be involved directly in this Economic zone.
	23	Cultural	D	D	D	D	Nothing found in the development area would be affected by the development.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
		heritage					N/A
	24	Landscape	D	D	D	B-/B+	PC/CO: The landscape will change by the construction work of Araihaazar Economic Zone. Moreover, 218.84 ha of agricultural land will be cleared and altered to industrial area as the part of Economic Zone development. But All construction activities for administration building, land filling & boundary wall will be carried out within the economic zone site and will not cause any impact on landscape and scenic beauty. A green buffer of 3.5 m only one row of trees will be developed all around the project site which will enhance the scenic beauty of the area. OP: Although semi-urbanization of the landscape in and around Araihaazar Economic Zone is inevitable, the development will be implemented under the project proponent internal regulation that rules to secure the environmental friendliness for users and residents, and harmonization with the surrounding area.
	25	Gender	B-	B-	B-	B-	PC/CO: Employment opportunities may be limited for female during construction phase. Female laborers may be discriminated in wage at construction site. OP: Female laborers may be discriminated in wage during tenant operational period
	26	Children rights	B-	B-	B-	B-	PC/CO: Due to the relocation, children's education would be temporarily disrupted. OP: There are 11 affected households who have school going children. They must relocate to other places and these children educational opportunity will be temporarily disrupted due to the relocation. On the other hand, children would be indirectly influenced by the improvement of social infrastructure in the region as a result of the Project.
	27	Infectious diseases	B-	B-	B-	B-	CO: There is a possibility to increase the risks of infectious diseases due to an influx of construction workers into the Project area. OP: There is a possibility to increase the risks of infectious diseases due to influx of workers of the industries and the semi-urbanization of the Project area and its surrounding area.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
	28	Working conditions, including occupational safety	B-	B-	B-	B-	PC/CO: There would be a possibility to occur accidents and incidents during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful to workers health OP: During the operation phase each industry will start their operation, accidents or incidents are expected to occur more or less during the operation phase.
Others	29	Accidents	A-	B-	A-	B-	CO: Construction accidents and road accidents around the project site are expected due to the construction activities. OP: Road accidents would be increased due to industrial vehicles and commuter busses and motor bikes.
	30	Transboundary impact and climate change	D	B-	D	B-	CO: Few impacts are expected. OP: Emissions of GHGs would be generated from vehicle traffic and industrial operations.

3.1.8. Environmental Management Plan and Cost.

The proposed off-site developments may have some impacts on the environment and society such as change in land use, removal of vegetation, increased dust emissions etc. Health & Safety Plan along with the EMP has been drafted. Details of which are given below. All offsite facilities shall be constructed under supervision of BEZA. EMP implementation shall also be BEZA who will intern implement it through contractors. Additonally, BEZA is obligated to comply with the regulations stated in the EIA approval from DoE (the EIA approval is attached in the appendices).

Mitigation Plan for Pre-Construction, Construction Phase& Operation Phase

A summary of mitigation measures identified for the pre-construction, construction& operation phases of the Project is presented. This also identifies lead responsibility for implementing the mitigation measures and sources of funds for such implementation.

Table 3.1-43: Environmental Management Plan

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Pre-construction Phase						
Environmental Pollution	Air Pollution	(Off-site) - Involve site clearance, leveling & filling activities for development of EZ which generate air pollution - Clearance of site will involve removal of wild vegetation, land leveling & filling activities. These activities will lead to dust generation	- To minimize the dust generation, water should be sprinkled regularly at the site and low sulphur diesel should be used in land levelling equipment's to control the SO₂ emissions - Construction vehicles and machinery should be regularly serviced and check for pollution control	Contractor contracted by BEZA	BEZA	Contractor Cost
	Water Pollution	(Off-site) - Impact on water quality from muddy water flowing to the river due to land reclamation work is expected - Dredged soil may	- Avoid excavation activities during rain; - Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; - Minimize run-off by using sprays for curing; - Construct the project boundary by the earth material prior to the land filling for avoiding	Contractor contracted by BEZA	BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		contaminate the canal by runoff water during rain	tailwater runoff in the surrounding agricultural land and water bodies; • Ensure the proper drainage network to discharge the tailwater; • Leaching from the sediments as well as other site runoff shall be contained, either to seep into the subsoil, or to be discharged in a controlled manner so as to minimize release of sediment laden water in excess of 200mg/l of suspended materials into adjacent lands or waterways; • The contractor shall regularly monitor water quality of site runoff; • If necessary, additional siltation ponds shall be constructed and utilized by the contractor to settle out excess suspended materials prior to discharge into the environment			
	Soil Pollution	(Off-site) • Development of the structures and construction of the access road • Land filling activities • Land will be filled and compacted	• Raw material will be stored under covered sheds and paved surface; • Fuel storage area should be proper containment; • Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Adoption of best management practices to prevent any spillage of raw materials; • Debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites; • Waste from labour camps can be segregated at site. Food waste/wet waste should be composted in pits within the camp site; • Recyclable waste should be sold to the authorized dealers ensuring environmental friendly and the	Contractor contracted by BEZA	BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			remaining should be disposed off at designated sites through local agencies responsible for waste management in the area;			
	Noise& Vibration	(Off-site) • Operation of different machineries • Running of heavy load traffic for sand transportation • Regular traffic movement	• Vehicles and machinery should be regularly serviced and check for pollution control • Machinery to be used should comply with the noise standards prescribed by DoE. • No activities to be undertaken during night hours to prevent any disturbance to nearby residents and labours in labour camps • Fitting noise machines with noise reduction devices;	Contractor contracted by BEZA	BEZA	Contractor Cost
	Sediment Quality	(Off-site) • During the land development, earth-filling material may washout to canal and increase the sediment concentration.	• Earth filling material should be in proper containment; • Proper monitoring should be taken at land development	Contractor contracted by BEZA	BEZA	Contractor Cost
Natural Environment	Ecosystems	(Off-site) • Land filling • High presence of anthropological activity • Extensive use of vehicle horns • Disrupting feeding or nesting behavior • A total 1055 trees will be affected by the project where 349 fruits trees, 127 timbers, 253 bananas and 326 Bamboos are identify. • River dolphins may be	• No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labour camps and prevent its disposal in water body; • Toilets should be provided at site to prevent contamination of water due to open defecation in nearby areas; • Vehicle washing/equipment cleaning should not be allowed near canal/drains in EZ site; • Wastewater from the washing area should be collected and should be used for curing purpose or wheel washing purpose; • Excavation and filling should be carried out in	Contractor contracted by BEZA	BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		affected by dredging work and transportation of dredged material.	phased manner to minimize exposure of loose earth for longer duration; • Temporary storm water drainage system should be developed at site to channelize the storm water away from excavation/filling area, debris storage area and raw material storage area; • All the raw material and debris should be stored in covered sheds on paved surfaces to minimize the contamination of rainfall run-off; • Diesel, paints, cements etc should not be stored near the water bodies; • If any kind of trees cut down because of the project, in that case the project proponent should take NOC from Forest Department (FD). • During dredging work, illuminance at night should be minimized. Pingers can be used to chase away dolphins under supervision of dolphin expert(s), and using low noise machine for dredging activity. Further measure may be taken under supervision of experts if necessary. • In addition, following measures can be suggested to contractors; - Use dredgers that have low impact on sediment. - Regulate cutter rotational speed in order to minimize spillage. - Refrain dredging activity during flooding or rainy season when water current is high. - Use silt curtain to reduce turbidity. on the other hand, use of silt curtain may not be suitable because silt curtain would be influenced by the constant water current of Meghna river and its effect would be limited. Furthermore, when vessels pass through silt curtain, turbid can			

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			run off from the opening of the curtain. Using silt curtain at congested river area could aksı cause accidents with vessels, boats that pass by. Take caution of navigation route which may change in rainy season and dry season during implementation of dredging and transportation of sand.			
	Hydrology	(Off-site) - Impact on drainage pattern & hydrology is temporarily expected caused by land modification - The adjacent land may inundate by high precipitation and over flow of canal/river water	- It was confirmed that the path and the direction of Dhawrakhali Canal & Brahmaputra River would be kept intact during all phases of the project - In general, the difference in elevation between adjacent points might change but their order shall be almost kept unchanged. - Surface water flow would not change significantly and would keep its current water flow.	Contractor contracted by BEZA	BEZA	Contractor Cost
	Topography & Geology	- AEZ is being developed in the naturally depressed area filling with dredged soil, the topography of the area is likely to be changed. - Due to the significant sand reclamation from the surrounding river beds, erosion of the river bank could occur without proper sand dredging.	- Save topsoil removed at the start of the project and use it to reclaim disturbed areas upon completion of construction activities. - Apply protective covering on disturbed soils as quickly as possible. - Clean and maintain catch basins and drainage ditches regularly. - Reestablish the original grade and drainage pattern to the extent practicable. - Obtain borrow material from authorized and permitted sites. The contractor should monitor condition of the riverbanks near dredging site on weekly basis by visual inspection and/or communicating with local residents. If dredging work is found to be the cause of erosion, the	Contractor contracted by BEZA	BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			dredging work should be suspended and dredging location must be reconsidered in order to avoid further erosion. When the contractor obtain concession and conduct EIA for dredging site, the distances from river banks and impacts on river bank erosion should be taken in account.			
Social Environment/Social Environment	Involuntary Resettlement	- Land acquisition will be required - Total 218.84 ha of land will be acquired for Economic Zone - Approximately 1714 no of households and 6343 of populations will lose their land; - Total of 11 affected households will lose their structures; - A total of 6282.95 sft structures will be affected by the project of which 4231.95 sft is tin-made while 1511 sft structure were identified as pucca and need to be relocated.	- Proper resettlement action Plan (RAP); - Provide adequate compensation in time to PAPs; - The authority should be careful and take necessary measures that every displaced people can be resettled as per law of the land;	DC office/ BEZA / NGO	DC office/ BEZA	DC office/ BEZA
	Vulnerable Group	In Araihaazar Economic Zone project, out 1,714 households a total of 150 (8.75%) households were identified as vulnerable. Among them 25 are female	- Promoting payment of compensation in joint name of husband and wife; - Provide soft skill jobs (physically benign) and employment opportunities for vulnerable including affected fishermen and sharecropper that may increase their participation and support	NGO / Contractor	BEZA	BEZA

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		headed having no male income earner, 58 are elderly headed and 67 were identified as extreme poor.	them with income and livelihood. • Organising women in self-help group to operate canteens in the EZ; • Giving preference in physically less demanding jobs in the EZ such as cleaning, office assistant, computer operator etc ; • Ensure non-exploitation of women in terms of equal wage, opportunity, participation indecision making etc. • Create awareness among the workers, staff and women about the exploitation and sexual harassment at work place; • Create awareness about sexually transmitted disease, HIV/AIDS, exploitation etc; and • Implementation of social welfare programs targeted at vulnerable groups including old aged, physically handicapped etc. under CSR programs and activities			
	Local Economic, such as employment, livelihood	• PAPs who earn income from paddy fields and/or vegetable fields might lose their income source. • Total 1714 HH's will be affected by the project. Most of the affected household head (66.45%) are engaged with agricultural activities. About 248 including five women household head are doing business for their livelihood. • Only 23 persons were	• Income loss of PAPs, including sharecroppers and fishermen, can be mitigated by providing alternative job opportunities for PAPs; • Give proper compensation to farmers and sharecroppers as per LAP • All direct income loss, including fishermen and sharecroppers, must be adequately compensated within the RAP; • A major segment of the population on the area is unemployed. Construction activity will provide employment to huge nos. of people including skilled, unskilled and non-skilled workers. This will improve the quality of life of people; • Provision of proper training to all workers for	NGO / Contractor	DC office/ BEZA	DC office/ BEZA

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		identified as sharecroppers in the project area. On the other hand, increase of job opportunity as construction workers or commercial opportunity targeted to the workers is expected.	handling the construction equipment;			
	Land use and utilization of local resources	- The temporary storage and stockyard are built up on the agricultural lands, and then the crop production will be obstructed in those areas. - Crops will also be damaged when the equipments and heavy vehicles will pass through agricultural fields of the proposed project areas.	Plantation area which will be tentatively occupied during pre-construction, will be restored to original state and returned to the land owner after construction.	Contractor contracted by BEZA	BEZA	Contractor Cost
	Existing social infrastructures and services	Accessibility of PHs to social infrastructure and services more or less due the project	The project will construct diversion roads to ensure accessibility to the social infrastructures and services for local community.	Contractor contracted by BEZA	BEZA	BEZA
	Social institution such as social infrastructure and local decision-making institutions	Accessibility of PHs to social infrastructure and decision-making institutions would be affected	The project will construct diversion roads to ensure accessibility to the social infrastructures and services for local community.	Contractor contracted by BEZA	BEZA	BEZA
	Misdistribution of Benefits and Damages	Only land owner and property owners and affected labours will be eligible for the	- Prepare RAP involving the following measures - Assessed compensation will base on the market price - Payment will be carried out before resettlement	BEZA/ NGO /	BEZA	DC/BEZA

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		compensation and rehabilitation. Displaced people may be suffered at the proposed project sites	Establish external monitoring committee consists of the third party			
	Land scape	Due to the land development, agricultural land will be filled with sand and scenically change will occur.	As per the regulation, 5 trees will be planted for every removed tree in order to maintain and to increase the amount of greens	NGO / Contractor contracted by BEZA	BEZA	BEZA
	Gender	Employment opportunities may be limited for female during Pre-construction phase. Female laborers may be discriminated in wage at construction site.	BEZA shall encourage appointed contractor to provide sufficient employment opportunity for female.	Contractor contracted by BEZA	BEZA	Contractor Cost
	Children's Right	- Impact on educational opportunity on school children in PAHs of the Project; - Impact on educational opportunity of school children in local community; - Impact of the Project on increase of child labor;	- Support of sending children to school; - Helping the parents with hunting for a job, including the one at the construction site; - Mediation for micro credit loan; - Introducing them to assistance organizations such as NGO and so forth	NGO / Contractor contracted by BEZA	BEZA	BEZA
	Working conditions, including occupational safety	There would be a possibility to occur accidents and incidents during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting,	- To provide adequate health care facilities and sanitary condition and drinking water; - To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; - To promote the use of repellents, clothing, netting,	Contractor contracted by BEZA	BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapors, liquids are the major hazards which are harmful to workers health	and other barriers to prevent insect bites and snake bite; - To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; - To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
Construction Phase						
Environmental Pollution	Air Pollution	- Earthworks construction, site clearing, small structures demolition, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, and hauling of materials will generate dust - Construction of access roads and its dust is likely to be the most significant direct potential impact on the local community. - Carbon dioxide and nitrogen oxides may be emitted from the combustion of the petroleum products in project related vehicles, machinery and generators etc. - Excavation of retention	- Sprinkling of water at construction site and haul roads - Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; - Raw materials, excavated soil and other debris should be stored under covered sheds - Generators, compressors, and other equipment to be shut down when not in use; - Provision of face mask to workers to minimize inhalation of dust particles - Construction vehicles and machinery should be regularly serviced and check for pollution control - Low sulphur diesel should be used for running construction equipment and vehicles - Air emission monitoring programme to be undertaken quarterly by the contractor, according to the design specified in the EMP and the contract specifications. The programme must include, as a minimum monitoring of SPM, CO,	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	- Top supervision by BEZA -On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		pond • Access road construction	NO2, SO2, PM2.5 and PM10; • Green buffer should be developed all along the EZ boundary and plantation should be carried out along the both side of access road;			
	Water Pollution	Surface Water Quality • Run-off from the construction site may carry the higher quantity of sediments and oil which may pollute the surface water and impact the aquatic life Ground Water Quality • Ground water is fresh shallow aquifers of the study area. No significant impacts are anticipated on the ground water quality due to development and construction of AEZ facilities; • It was learned that 100% affected households have access to safe water for drinking, cooking and other regular household's uses. • Excavation of retention pond generate loose soil which may pollute the water bodies. • Access road construction material such as brick, brick	Surface Water Quality • Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Avoid excavation activities during rains; • Prevent piling up of excavated soil, raw material and construction debris at site by proper management and disposal; • Minimize run-off by using sprays for curing; • Maintaining appropriate flow of water sprinklers at site; • Construction of storm water drains along with sedimentation tanks with sand bags as partition as barrier for direct flow of run off to canal or river; • Collection & Reusing of curing over flow, tire wash water etc within the site; • Construction of adequate nos. of toilets and proper sanitation system to prevent open defecation along the canals/river banks/water supply lines; • Construction of soak pits/septic tanks to dispose-off the domestic waste water generated from labour camps to prevent disposal of sewage in surface water bodies; • Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies;	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	Top supervision by BEZA -On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		chips, sand, cement, stones etc may pollute the adjacent water bodies.	- No debris/construction material should enter water body in the area. Ground Water Quality - No sewage or waste water should be accumulated in any unlined structure; - Timely disposal of the construction/chemical/hazardous waste so as to prevent leaching of any pollutant to ground;			
	Waste	- General construction waste is expected and typically managed by the appointed contractors; - Construction sludge by boring from underground and domestic waste from base camp is generated during construction. - Excavation of retention pond - During access road construction may generate solid or liquid waste	- Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; - Minimize volume to use silt basin before disposing - Segregate waste to minimize waste material - Disposed in designated dumping site instructed by the section handling waste - Recycled as possible with consideration of soil property;	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	Top supervision by BEZA -On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost
	Soil Pollution	Development of the structures and construction of the access road may disturb the soil profile of the area.	- Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; - Raw material will be stored under covered sheds and paved surface;	-On-site-	Top supervision by BEZA -On-site-	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		- Fuel and construction debris may contaminate the soil - Excavation of retention pond - Access road construction	- Fuel storage area should be proper containment; - Adoption of best management practices to prevent any spillage of raw materials; - Construction debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites; - Waste from labour camps can be segregated at site. Food waste/wet waste should be composted in pits within the camp site. - Recyclable waste should be sold to the authorized dealers ensuring environmental friendly and the remaining should be disposed off at designated sites through local agencies responsible for waste management in the area.	Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	
	Noise and Vibration	- Operation of different machineries and equipment for construction activities, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise - Continuous exposure of neighbors to noise nuisance may result in noise induced hearing lose; - Noise nuisance may reduce concentration of neighbors in their private matters. - High noise level will force employees to shout loud when communicating to one	- Machinery to be used should comply with the noise standards prescribed by DoE; - Vehicles and machinery should be regularly serviced and check for pollution control; - Worker who will be work high noise area should provide ear plug; - No noise generating activity shall be carried out in the night; - No construction activities to be undertaken during night hours to prevent any disturbance to nearby residents and labours in labour camps; - Fitting noise machines with noise reduction devices; - Temporary noise barriers should be provided near the high noise generating areas like metal or tiles cutting sites, generator room etc; - Any employee who may complain about ear related pain and or complication while at work to	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by	Top supervision by BEZA -On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Natural Resources		another; • Exposure of employees to high noise level (above 85dB) continuous for 8hoursper day may result in noise induced hearing loss; • Exposure of ear to peak sound level instantaneously may result to deafness;	access medical attention at the expense of the contractor or project proponent;	LGED		
	Sediment Quality	• Development of the structures and construction of the access road may disturb the bottom sediment profile of the water bodies. • Storage of raw material, fuel and construction debris may contaminate the bottom sediment; • Excavation of retention pond may affect the sediment quality.	• Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Raw material will be stored under covered sheds and paved surface; • Fuel storage area should be proper containment; • Adoption of best management practices to prevent any spillage of raw materials; • Construction debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites; • Waste from labour camps can be segregated at site. Food waste/wet waste should be composted in pits within the camp site; • Recyclable waste should be sold to the authorized dealers ensuring environmental friendly and the remaining should be disposed off at designated sites through local agencies responsible for waste management in the area;	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	Top supervision by BEZA -On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost
	Ecosystems	• Biodiversity continue to decrease because of rapid population expands	• Implement the 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management;		Top supervision by BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		• Removal of vegetation from the project site • Clearing of agricultural crop cover from the construction area will create some negative impact on food security • Overlap between the project activity and their breeding period will produce much greater impact • Disturbance due to increased noise level and human activities • Medium and small mammals will avoid the locations due to increased human presence • Resident birds in the homestead vegetation will be disturbed • During construction, many seasonal and perennial water bodies will lose their characteristics • Run-off from construction site may contain sediments or contaminant which may pollute water quality of canals and adjacent river which will impact the aquatic life • The economic productivity	• No solid or liquid waste shall be discharged in water bodies; • Septic tanks/soak pit should be provided to treat sewage to be generated from labour camps and prevent its disposal in water body; • Toilets should be provided at site to prevent contamination of water due to open defecation in nearby areas; • Vehicle washing/equipment cleaning should not be allowed near canal/drains in EZ site; • Wastewater from the washing area should be collected and should be used for curing purpose or wheel washing purpose; • Excavation and filling should be carried out in phased manner to minimize exposure of loose earth for longer duration; • Temporary storm water drainage system should be developed at site to channelize the storm water away from excavation/filling area, debris storage area and raw material storage area; • All the raw material and debris should be stored in covered sheds on paved surfaces to minimize the contamination of rainfall run-off; • Diesel, paints, cements etc should not be stored near the water bodies;	-On-site- Contractor contracted by SPC -Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	-On-site- SPC / BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		of the wetlands will also decrease				
	Hydrology	- Impact on hydrology is temporarily expected caused by land modification - Excavation of retention pond	- The path and the direction of Dhawrakhali canal would be kept intact during all phases of the Project. - The excavation and embankment work shall be designed to minimize the excavation volume and embankment volume as much as possible. - The difference in elevation between adjacent points might change but their order shall be almost kept unchanged. As a result, surface water flow would not change significantly and would keep its current water flow. - Water consumed for the construction work and related activities during the construction phase would include water for washing vehicles and equipment, sprinkling water, and domestic water.	-Access Road- Contractor contracted by RHD / LGED -Retention pond & Canal- Contractor contracted by LGED	- Top supervision by BEZA -Access Road- RHD / LGED -Retention pond & Canal- LGED	Contractor Cost
	Topography & Geology	- AEZ is being developed in the naturally depressed area filling with dredged soil, the topography of the area is likely to be changed. - Due to the significant sand reclamation from the surrounding river beds, erosion of the river bank could occur without proper sand dredging.	- Save topsoil removed at the start of the project and use it to reclaim disturbed areas upon completion of construction activities. - Apply protective covering on disturbed soils as quickly as possible. - Clean and maintain catch basins and drainage ditches regularly. - Reestablish the original grade and drainage pattern to the extent practicable. - Obtain borrow material from authorized and permitted sites.	Contractor contracted by SPC	DC office/ BEZA	DC office

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	- The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities - The vulnerable people who involved in agricultural work will be affected mostly by this project	- Promoting payment of compensation in joint name of husband and wife; - Provide soft skill jobs (physically benign) and employment opportunities for vulnerable that may increase their participation and support them with income and livelihood. - Organizing women in self help group to operate canteens in the plant; - Giving preference in physically less demanding jobs in the plant such as cleaning, office assistant, computer operator etc; - Ensure non-exploitation of women in terms of equal wage, opportunity, participation in decision making etc. - Create awareness among the workers, staff and women about the exploitation and sexual harassment at work place; - Create awareness about sexually transmitted disease, HIV/AIDS, exploitation etc; and - Implementation of social welfare programs targeted at vulnerable groups including old aged, physically handicapped etc. under CSR programs and activities	NGO / Contractor contracted by SPC	SPC / BEZA	BEZA
	Local Economies, such as employment, livelihood	- PAPs who earn income from paddy fields and/or vegetable fields might lose their income source. - Many sharecroppers depended on agriculture in dry season. They cultivate IRRI and vegetable that period.	- Income loss can be mitigated by providing alternative job opportunities for PAPs; - Give proper compensation to farmers and sharecroppers as per LAP - All direct income loss must be adequately compensated within the RAP; - A major segment of the population on the area is unemployed. Construction activity will provide employment to huge nos. of people including	NGO / Contractor contracted by SPC	SPC / BEZA	BEZA

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		On the other hand, increase of job opportunity as construction workers or commercial opportunity targeted to the workers is expected.	- skilled, unskilled and non-skilled workers. This will improve the quality of life of people; - Provision of proper training to all workers for handling the construction equipment;			
	Land Use and Utilization of local resources	- The temporary storage and stockyard are built up on the agricultural lands, and then the crop production will be obstructed in those areas. - Crops will also be damaged when the equipments, and heavy vehicles will pass through agricultural fields of the proposed project areas.	Plantation area which will be tentatively occupied during construction, will be restored to original state and returned to the land owner after construction.	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost
	Water Usage	- Araihaazar EZ sites do not have existing public water supply facilities - Utilize the nearby rivers or wells as water sources. - Approximately 7973m³/day of water will be required during construction phase for the total development area - Excessive withdrawal of ground water may lead to depletion of aquifers.	- Rain water harvesting ponds should be constructed so as to store rain water for construction activities; - Water for curing can be saved by carrying out curing in early morning or late evening and covering structures with gunny bag so as the moisture can be restored for longer time; - Regular inspections at site to monitor leakages in water storage tanks; - Creating awareness among construction workers about the importance of water conservation; - Adoption of the advance technologies and machinery which helps in minimizing water requirement for construction; - Storing the curing run-off and waste from other construction activity and using the same for	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			sprinkling; • Covering the water storage tanks at site to prevent evaporation losses;			
	Existing social infrastructures and services	• Accessibility of PHs to social infrastructure and services more or less due the project	• The project will construct diversion roads to ensure accessibility to the social infrastructures and services for local community.	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost
	Social institution such as social infrastructure and local decision-making institutions	• Accessibility of PHs to social infrastructure and decision-making institutions would be affected	• The project will construct diversion roads to ensure accessibility to the social infrastructures and services for local community.	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost
	Misdistribution of Benefits and Damages	• Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors.	• Prepare RAP involving the following measures - Assessed compensation will base on the market price - Payment will be carried out before resettlement • Establish external monitoring committee consists of the third party	BEZA/ NGO /	BEZA	DC/BEZA
	Gender	• Employment opportunities may be limited for female during construction phase. Female laborers may be discriminated in wage at construction site.	• BEZA shall encourage appointed contractor to provide sufficient employment opportunity for female.	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost
	Children's Right	• Impact on educational opportunity on school children in PAHs of the Project; • Impact on educational opportunity of school children in local	• Child labor at the construction site during the project implementation shall be strictly prohibited since such practices are banned by both Bangladesh laws and JICA guidelines; • The RAP Implementing Agency and EZ authority shall regularly monitor project sites to guide contractors and their related firms to discourage	Contractor Contracted by SPC NGO	SPC / BEZA	Contractor Cost BEZA

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		community; • Impact of the Project on increase of child labor;	child labor; • Support of sending children to school; • Helping the parents with hunting for a job, including the one at the construction site; • Mediation for micro credit loan; • Introducing them to assistance organizations such as NGO and so forth			
	Infectious Diseases	• During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility with HIV/AIDS and the disease can spread among local people;	• To provide surveillance for worker's health; • Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; • To provide treatment through standard case management in on-site and community health care facilities as necessary; • Educating project personnel and area residents on risks, prevention, and available treatment; • Promoting collaboration with local authorities to enhance access of worker's families and the community to public health services and promote immunization as necessary; • Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites; • Prevention of larval and adult propagation through sanitary improvements and elimination of breeding habitats close to human settlements; • Elimination of unusable impounded water;	Contactor Contracted by SPC	SPC / BEZA	Contractor Cost
	Working conditions, including occupational safety	Occupational Health & Safety • There would be a possibility to occur accidents and incident during construction	• To provide adequate health care facilities and first aid within construction sites; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work	Contactor Contracted by SPC	SPC / BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		works; - Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapors, liquids are the major hazards which are harmful for workers health; - May insect and snake bite in the labour camp; - Road Accident	practices, and emergency procedure; - To provide adequate lavatory facilities for the number of people expected to work in the facility; - To provide adequate supplies and easy access of drinking water with a sanitary; - To provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; - To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; - To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; - Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labelling of equipment, communicate Hazard codes, electrical; - To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; - To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
		Community Health & Safety Traffic congestions on roads and possible disruption to the community usage during	Provision of infrastructure for migrant labour such as water supply, electricity, sanitary facilities, medical aid and other basic amenities to avoid dependence on limited local resources;	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		peak movement hours; • Increased risks with respect to safety associated with traffic movement; • Inconvenience to community in terms of air and noise pollution caused by the movement of vehicles; and • Structural and surface damage to road due to movement of heavy vehicles and equipment • Generation of dust, noise and odor from the construction site which may have health related impacts on the local community; • Fire Safety from the ongoing construction activities which may include handling and storage of flammable chemicals and materials; • Improper disposal and migration of sewage into the surroundings; • Improper disposal of sewage and waste may lead to contamination of ground water, as the water table in the project area is very high. • Any waste disposal in canal from the project would	• Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area; • Creating awareness among the drivers about speed, traffic safety, use of horns etc while driving through settlement areas; • Covering of trucks while carrying soil, sand, cement, aggregates etc to minimize spread of dust and spill over; • Avoiding unnecessary movement of vehicle through settlement area to minimize disturbance and traffic safety related issues; • Creating awareness among children, women, and old age people in particular and the community in general on traffic safety by using existing mediums such as school, women self help groups, village union and religious occasions; • Strengthening and regular maintenance of village road to minimize surface and structural damage of road; • Sprinkling of water to suppress dust generation in the construction zone; • Provide training and create awareness about fire and safety among workers at site; • Disposal of wastes at pre identified waste dumping site to avoid unauthorized dumping; • Avoid disposing of wastes in the canal and providing silt traps to arrest silt flowing into the canal during the rainy season.			

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		affect the population in downstream of water flow				
		Risk of Fire • Risk of fire might increase due to the implementation of the construction work • Faulty electrics are the biggest cause of workplace fires, loose wires, plugs that are over loaded • Old equipment can all make for a potential death trap • Discarded cigarettes can cause fires • Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present • Improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended • The most common causes of fires in the workplace is human error.	• To minimize the impact, the above mentioned rule and the internal regulation for the Economic Zone of Araihaazar will be applied and obligate industries to install appropriate security and safety system for their implementation; • Maintain safe housekeeping practices that reduce the risk of fire danger; • Implement a program that includes preparation, prevention, and recognition of fire Risk; • Proper handling of combustible and flammable material; • Keep all fires and heaters well-guarded, especially open fires; • Keep portable heaters and candles away from furniture and curtains; • Don't dry or air clothes over or near the fire, or the cooker; • Do not smoke in the project site;	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Others	Accidents	- Construction accidents and road accidents around the project site are expected due to the construction activities. Construction workers can have harmful and critical troubles. - Excavation of retention pond - Access road construction	- Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; - Provision of traffic signs, road mark, bump, zebra mark, guard rail and pole, and curb stones etc;	Contractor Contracted by SPC	SPC / BEZA	Contractor Cost
Operational Phase						
Environmental Pollution	Air Pollution	- Significant air emissions result from light-engineering industries. - These are particulate matter, sulphur dioxide, metals and other criteria pollutants like ozone, oxides of nitrogen and carbon monoxide. Lead may be generated in some of the processes. - Air emissions from food processing industry will contain some volatile organic compounds - Vehicles movement and its gaseous emission	- All industries should obtain clearance from DoE, Bangladesh; - Latest technology, methodology, and machinery involving minimal air emissions should be adopted by industries; - Air pollution control measures should be taken by industries as prescribed in the mitigation plan; - Periodic renewal of ECC should be obtained by all the industries; - Power Generators should be provided with stacks of adequate height (higher than nearest building) to allow enough dispersion of emission; - Process emission if any shall be control with the installation of adequate air pollution control systems; - All industries should obtain clearance from DoE, Bangladesh as applicable. Air pollution control measures shall be adopted by respective industries in line with DOE permission; - Air pollution monitoring should be carried out quarterly by all industries to check the air	-Factories-Tenant company	SPC/BEZA	Tenant Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			pollution level; • Preference of usage of clean fuel like LPG, low sulphur diesel should be explored; • Energy conservation should be adopted by adopting the alternate energy options like solar power and other energy efficient technologies; • Development of thick green belt (3.5 m) all along the EZ zone and organized greens within each industrial plot;			
	Water Pollution	Surface Water Quality • Industries are likely to generate domestic and industrial effluent. • Liquid waste which can be generated from light engineering industries will include waste acid, waste alkali, grease, used/spent oil, liquid metal, spent solvents etc • Domestic and cleaning waste is likely to be generated • Food processing industries similarly generate both liquid and solid waste. • Discharge of wastewater in soil will degrade its fertility • Uncontrolled discharge of these effluents to canal/river may severally pollute the canal/river water quality	Surface Water Quality • Each industry should obtain an ECC from the DoE Bangladesh before construction and operation of the factory and must comply with the conditions stated in the ECC. • Each industry has to arrange pre-treatment facility to treat their processed effluent and sewage they generate to meet certain level of pollution load set by the AEZ operator; • Industrial wastewater will be treated in ETP of each tenant to meet national and international wastewater discharge standards such as standards of ASEANs or IFC; • Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Online based monitoring system should be installed in CETP; • Storm and industrial wastewater will be collected in separate pipe networks to prevent contamination of storm water draining to natural wetlands; • Each industry should treat the effluent and sewage	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		Ground Water Quality • There will be very minimal chance of contaminating ground water from wastewater andsewage during the operation phase. • During the operation phase EZ of which water demand is about approximately 70,00m³/day;	generated by them so as to achieve zero discharge and no untreated effluent should be discharged into anywater body; • Proper management of waste should be done to prevent any contact between thewaste and storm water; • Common waste disposal sites should also be developed within EZ site as per the standards and prior permission of DoE should be taken before development; • Storm water system should be inspected & cleaned before monsoon every year; • Peripheral drain shall also be lined and shall not be connected to internal storm water drainage system; • River water quality shall be monitored periodically; Ground Water Quality • Each industry should pre-treat the effluents and sewage before sending them to CETP; • Treated wastewater will be passed through a lagoon to ensure bio monitoring of water quality • No leachate, waste water and waste material should be stored in pervious unlined area/pond. • Ground water quality shall be monitored periodically.			
	Waste	• Industrial waste is expected. Appropriate waste management by law and regulation is the responsibility of the tenant factory/ facilities, which	• SPC/BEZA shall establish proper waste management mechanism to treat waste and hazardous waste produced in AEZ. The cement factory could treat hazardous waste and Matuail waste filling site can accommodate non-hazardous waste from AEZ.	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		shall be approved by DoE for their own EIAs.	• Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Fail-safe containment of any facilities that could put the environment at risk • Adequate buffers to nearby sensitive land uses and water resources • Access to or provision of services that ensure potential wastes are reduced, recycled or adequately treated before safe disposal, such as pre-treatment of process fluids, then discharge to effluent treatment scheme • Site drainage controls to isolate potentially contaminated areas from discharge to the environment • Environmental training and awareness programs for tenant workers			
	Soil Pollution	• All waste including solid and liquid wastes may cause soil contamination • After development of economic zone, disposal of industrial domestic and process waste may contaminate land and soil quality of the area. • Improper disposal of waste (hazardous and non-hazardous waste) may degrade soil, water, air quality and ecology of the area.	• Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Treatment of the effluents and sewage and ensuring proper disposal; • Segregate non-hazardous solid waste from hazardous one and dispose properly; • Industrial waste generated will be stored in impervious storage tanks. • All factories will ensure proper storage for their chemical and hazardous materials to prevent accidental spillage; • Provision shall be made for proper storage and disposal of industrial waste by receptive industries;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		• Significant waste both hazardous and non-hazardous in nature, which can pollute the environment if not managed properly • Lubricate oil/waste oil is generated from the machineries as hazardous waste.	• Common waste storage areas shall be designated for industrial domestic waste; • Waste should be segregated at source into hazardous and non-hazardous waste. Further the waste should be segregated into recyclable and rejected waste; • Recyclable waste should be sent to authorize vendors for recycling and rejected waste should be disposed off as per the norms specified by DoE for the particular waste; • Industrial waste generated should be stored on sealed surfaces and should be disposed off as per guidelines of DoE, Bangladesh; • No chemical/hazardous raw material should be allowed to spill over the land and should be operated in covered systems; • Excessive packaging should be reduced and recyclable products such as aluminum, glass, and high-density polyethylene (HDPE) are being used where applicable; • Organic waste should be resold to value addition industries or can be feeded to live stock; • Advanced wastewater treatment should be adopted by industries; • Use of advanced techniques to control specific portions of the manufacturing process to reduce wastes and increase productivity; • Use of radiation to kill pathogenic microorganisms; • Reduction or total elimination of effluent from the manufacturing process;			
	Noise and	• Traffic in the area will	• Pumps should be fitted in acoustic enclosure to	-Factories-	SPC/BEZA	Tenant Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
	vibration	increase significantly • Operation of tenants, water pumps, and light engineering factories to be operated in proposed EZ may increase the noise level	reduce the noise generation; • Noise barriers will be mandatory for the factories generating a lot of noise during operations; • Plantation should be developed along the roads and boundary to form continuous barrier that will reduce the noise level significantly; • Green buffer of 3.5 m should be developed all along the project boundary. Green buffer should compose of the only one row of plants of variable height and thick canopy so as to form continuous barrier. This will help in reducing the noise level significantly;	Tenant company -Utilities- SPC		SPC Cost
	Sediment Quality	• Bottom sediment of the surrounding water bodies would be deteriorated by wastewater generated from the industries. • After development of economic zone, disposal of industrial domestic and process waste may contaminate land and bottom sediment of the area. • Solid waste from textiles majorly composed of resins, fabric, apparel, dye, discarded machinery and fibers. • Solid waste from the food processing industries includes both organic and packaging waste.	• Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; • Treatment of the effluents and sewage and ensuring proper disposal; • Segregate non-hazardous solid waste from hazardous one and dispose properly; • Industrial waste generated will be stored in impervious storage tanks and will be disposed of as per guidelines of the DoE; • All factories will ensure proper storage for their chemical and hazardous materials to prevent accidental spillage; • Raw material will be stored under covered sheds and paved surface; • Fuel storage area should be proper containment; • Advanced wastewater treatment should be adopted by industries; • Adoption of best management practices to prevent any spillage of raw materials;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		Organic waste that is the rinds, seeds, skin, and bones from raw materials, results from processing operations.	A site for disposal of hazardous waste can be identified within the EZ and it should be developed as per the norms of DoE and upcoming Hazardous Waste Management rules of Bangladesh.			
Natural Environment	Ecosystems	- Post development of the economic zone & setting up of industries, there could be some impacts on the ecosystem of the area. - Industrial development will involve generation of emissions, effluents and increased vehicular movements may have overall negative impact on the eco-system. - Air pollutant will impact the existing vegetation and avifauna in the area	- Periodic monitoring shall be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact; - Implement the national 3R (Reduce, Reuse and Recycle) strategy for both solid and liquid waste management; - No waste shall be discharged in water bodies, i.e. canal and agricultural land etc. - Central ETP should install to treat the effluent generated and to re-use and recycle it completely. No untreated effluent should be discharged in water bodies, i.e. canal and agricultural land; - Tree survival rate shall be monitored; - Native species should only be planted in the region;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost
	Hydrology	Impact on hydrology is expected caused by the existence of development area.	- Natural drainage pattern should be maintained. - Run-off assessment shall be made of catchment area and peripheral/garland drains shall be constructed around EZ site based on the assessment of catchment area (frequency, and storage area); - Storm water drain shall have the provision of de-siltation before discharge to river;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost
Social	Vulnerable group	Vulnerable people such as disabled persons or low educated people would not be able to receive the	Provide soft skill jobs (physically benign) and employment opportunities for vulnerable that may increase their participation and support them with income and livelihood.	Tenant	SPC/BEZA	Tenant Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		benefits of the Project as they might not be able to obtain job opportunities.	• Giving preference in physically less demanding jobs in the plants/tenants such as cleaning, office assistant, computer operator etc; • Ensure non-exploitation of workers of vulnerable group in terms of equal wage, opportunity, participation in decision making etc. • Implementation of social welfare programs targeted at vulnerable groups including old aged, physically handicapped etc. under CSR programs and activities			
	Water Usage	• Thousands of employees and workers who will use and consume water and generate wastewater from the office and the residential building; • Water demand can be fulfilled by withdrawing ground water • During the operation phase a plant of which water demand is about approximately 7,000m³/day;	• Rain water harvesting system and storage should be developed to minimize ground water extraction; • Implement the national 3R (Reduce, Reuse and Recycle) strategy for reusing the recycled solid waste and treated water in the EZ area; • Centralized rainwater harvesting system will be implemented; • Treated effluent will be recycled; • Water efficient technologies will be adopted in central utility service divisions and also at the factory process level; • Adoption of best management practices to prevent water wastage and minimize water loss; • Usage of water conservation fixtures to minimize water consumption; • Installation of leakage detection system to minimize the water loss; • Regular monitoring of ground water level in the area should be carried out. Estimated should be made to calculate the draught and recharge of the ground water aquifers. More green space will	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			planted to foster aquifer recharge; • Ground water aquifer assessment studies may be undertaken to assess the ground water potential. Peizometer shall be installed to monitor variation in ground water level in the area. • In order to remove Iron other material, water purification system shall be installed for the water supply facility.			
	Existing social infrastructures and services	• Accessibility of PHs to social infrastructure and services more or less due the project	• The project will construct new community roads to ensure accessibility to the social infrastures and services for local community.	SPC	BEZA	SPC Cost
	Social institution such as social infrastructure and local decision-making institutions	• Accessibility of PHs to social infrastructure and decision-making institutions would be affectedt	• The project will construct new community roads to ensure accessibility to the social infrastures and services for local community.	SPC	BEZA	SPC Cost
	Landscape	• Although semi-urbanization of landscape in and around Araihaazar Economic Zone is inevitable;	• The development will be implemented under the project proponent internal regulation, which rules to secure the environmental friendliness for users and residents, and harmonization with the surrounding area. • Green area will be established in each plot and public space; • Therefore, as long as the industries follow the internal regulation and the project proponent will make effort to maintain the public area; • The landscape of the project area is expected to be well-maintained semi-urbanized area.	SPC	BEZA	SPC Cost
	Gender	• Employment opportunities may be limited for female	• BEZA shall enourage tenant companies to provide sufficient employment opportunity for	-Factories- Tenant company	SPC/BEZA	Tenant Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		during operation phase. Female laborers may be discriminated in wage at construction site.	female at fair wage	-Utilities- SPC		
	Children's Right	- Children's educational opportunity will be temporarily disrupted due to the relocation - Child Labour	- Project proponents will implement "EZ neighbors students Support Program" as one of the community support programs targeting not only for children of PAH but also for surrounding communities. - The project proponent will implement this kind of educational program continuously based on needs and requests from the community. - Support of sending children to school; - Introducing them to assistance organizations such as NGO and so forth - According to the Labour Law of Bangladesh 2006, the minimum legal age for employment is 14. - The Project and industries keep laws in Bangladesh; illegal child labor will be preventing in employment of labors.	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost
	Infectious Disease	This is a possibility to increase the risks of infectious diseases due to influx of workers of the industries and the semi-urbanization of the project area and its surroundings area.	- Conduct mitigation measures stipulated in the international guidelines such as EHS Guidelines of IFC - To conduct Information, Education and Consultation Communication (IEC) campaign at least every other month to all site staff, employees, and immediate local communication concerning the risks, dangers and impact and appropriate avoidance behavior with respect to, of Sexually Transmitted Disease (STD) or Sexually Transmitted Infection (STI) in general and	-Factories- Tenant company	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			HIV/AIDS in particular, • To provide male or female condoms for all staff and laborers as appropriate and • To provide for STI and HIV/AIDS screening, diagnosis, counseling and referral to dedicated national STI and HIV/AIDS program.			
Others	Working Conditions, including occupational Safety	Occupational Health and Safety • Accidents or incidents are expected to occur more or less during the operation phase • Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful for workers health. • Road Accident	• To provide adequate health care facilities and first aid within construction sites of industries or operation phase; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; • To provide adequate lavatory facilities for the number of people expected to work in the facility; • To provide adequate supplies and easy access of drinking water with a sanitary means To provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; • To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; • To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labeling of equipment, communicate	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			hazard codes, electrical; • To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors; • Proper maintenance of PPE and the instruction of proper use;			
		Community Health and Safety • The health and safety risks in the plant during operations include potential for respiratory diseases, burns, allergies and industrial accidents among the employees and immediate neighboring communities • The impacts envisaged from the project activities on with respect to community usage of access roads • Emission & Noise generated from the operation of the industries. These emissions may include compounds of Nitrogen and Carbon which may be harmful to the surrounding community;	• Adequate provision for suppression of dust and particulate matter originating at source; • Provision of first aid box and trained personnel to deal with minor cut, bruise and burn; • Provision of paramedic staff and ambulance in industry site for serious bodily injuries; • Developing a disaster management plan and community health and safety plan to deal with emergency situations; • Regular training of plant personnel on health and safety aspects; • Creating awareness among the general public around the plant about possible emergency situations and way to respond to them; • Use of water ways for movement of goods to minimise heavy traffic movement through settlement areas; • Develop an influx management plan to address the influx related issue; • Release of nitrogen and carbon compounds within permissible limit so that human health is not affected;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		• Fire & Explosion Hazards; • Improper sewage and waste disposal;	• Disposal of wastes in pre identified and approved locations.			
		Risk of fire • Risk of fire would increase due to the economic activities of the industries and population growth in and around the project area. • Electrical systems that are overloaded, resulting in hot wiring or connections or failed components might occur at operation phase. • Old equipment can all make for a potential death trap • Discarded cigarettes can cause fires • Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present • Improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended • The most common causes of fires in the workplace are human error.	• To minimize the impact, the above mentioned rule and the internal regulation for the Economic Zone of Araihaazar will be applied and obligate industries to install appropriate security and safety system for their operations; • The industries shall install and maintain an effective fire alarm system and firefighting system for each building in the plot, and implement emergency drill with reference to the rule and regulation; • Implement a program that includes preparation, prevention, and recognition of fire Risk; • Proper handling of combustible and flammable material; • Do not smoke in the project site; • Fit approved smoke detectors on each floor. Choose a smoke alarm that is mains operated or one with a long life (ten year) battery; • Proper handling of combustible and flammable material; • Keep all fires and heaters well guarded, especially open fires; • Keep portable heaters and candles away from furniture and curtains; • Don't dry or air clothes over or near the fire, or the cooker; • Do not smoke in the project site;	-Factories- Tenant company -Utilities- SPC	SPC/BEZA	Tenant Cost SPC Cost
Oth	Accident	• Road accidents would be	• Follow Health and Safety Management Plan	-Factories-	SPC/BEZA	Tenant Cost

	Item	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
		increased due to industrial vehicles and commuter buses and motor lines.	(HSMP) rules and regulations designated by contractors; • Provision of traffic signs, road mark, bump, zebra mark, guard rail and pole, and curb stones etc	Tenant company -Utilities-SPC		SPC Cost
	Transboundary impact and climate change	• Emission of Carbon Dioxides (CO₂) • The utilization of commuter bus for workers to reduce traffic GHG emission will be initiated by the tenants;	• Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible; • Provision of commuter bus;	-Utilities-SPC	BEZA	SPC

COST ESTIMATION FOR ENVIRONMENTAL MITIGATION MEASURES

BEZA will allocate a separate budget for environmental management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment etc, need to be included in the contract cost estimation and/or operating cost estimation. The environmental management budget estimation for construction and operation phase of the Project is provided in Table 3.1-44 and Table 3.1-45. The EZ's tenant companies will be required to acquire their factory/facility environmental clearances from DoE, and they will have to enforce the instructions from EMP and secure a budget to monitor instructed environmental parameters accordingly. The following table shows the overall estimated costs for the EZ development and its monitoring only without individual tenant factories/facilities' requirements.

Table 3.1-44: Estimated Environmental Management Cost (A) in BDT

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Pre-construction/Construction Stage					
01	Dust management by water sprayer	LS	-	-	1,000,000
02	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	200,000
03	Campsite waste disposal facilities	Nos.	-	-	1,000,000
04	First aid box for treatment of injuries in emergency situations	Nos.	-	-	200,000
05	Water Supply	Nos.	-	-	500,000
06	Sanitary facilities	Nos.	-	-	200,000
07	Tree plantation and green area development plan	LS	-	-	5,000,000
08	Water quality protection measures: soil erosion and sedimentation control at the construction site and prevention of spillages, leakages of polluting materials, etc. to be at the satisfaction of the engineer.	LS	-	-	100,000
09	Stripping topsoil from borrowed agricultural lands, stockpiling and replacing the same to rehabilitate the land to the entire satisfaction of the owner and the engineer	LS	-	-	Included in the construction cost
10	Rehabilitation of ancillary sites including stockpile sites, brick crushing sites, borrow areas, work force camps/ site office, etc and turfing to the entire satisfaction of the engineer.	Sq.m	-	-	200,000
11	Orientation to the technical personnel/ Construction worker associated with the Economic Zone about the key issues of EMP	LS	-	-	Included in the construction cost
Total Environmental Management Cost (A)					8,400,000

Table 3.1-45: Estimated Environmental Monitoring Cost (B) in BDT

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Operation Stage (Yearly)					
01	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	100,000
02	Campsite waste disposal facilities	Nos.	-	-	100,000
03	First aid box for treatment of injuries in emergency situations	Nos.	-	-	50,000
04	Water Supply	Nos.	-	-	Included in Operation & Maintenance Cost
05	Sanitary facilities	Nos.	-	-	Included in Operation & Maintenance Cost
06	Tree plantation and green area development plan	LS	-	-	300,000
07	Orientation to the technical personnel/ Construction worker associated with the Economic Zone about the key issues of EMP	LS	-	-	Included in the Operation & Maintenance Cost
Total Environmental Management Cost (B)					550,000

3.1.9. Monitoring Plan

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards or other standards if stated specifically. A monitoring schedule has been sketched based on the environmental components that may be affected during the construction for 3 years time period and operation of the project for 1 year is given below (Table 3.1-46). Estimated Environmental Monitoring Cost in BDT is presented in Table 3.1-47.

Table 3.1-46: Environmental monitoring plan

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Pre-Construction (Site Preparation) and Construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project Activity areas and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of Contractor	Contractor Cost
Ambient Air Quality	Dust generation	SPM, PM _{2.5} , PM ₁₀ , CO, SO _x , NO _x	At 4 Locations	24-hour	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq _{day} , Leq _{night} and hourly Leq	At 5 Locations (Important Sensitive Receptors)	24-hour Once every fortnight	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Soil	Quality of filling earth/sand	pH, salinity, NH ₄ ⁺ , total- P, heavy metals, oil & grease	Barge/ trawler	Standard analytical methods	The first delivery from any source and then random sampling of deliveries from that source	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Water	Contamination of surface	Turbidity, pH, DO,	At 2 locations	Standard	Monthly	Contractor/	Contractor

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	water	Total dissolved solids, oil & grease, total coliform, heavy metals		Analytical methods		3rd Party Environmental Consultant	Cost
	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR 1997	At 2 locations	Standard Analytical methods	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Ecosystem	Extensive use of vehicle horns and dust creation could cause disruption to the surrounding inhabiting floral and faunal species. Many species of flora and fauna would be affected by waste water from land filling work. Dredging activities may disturb river creature such as river dolphin.	Compliance with mitigation measures presented in the EMP and ECR 1997.	Well near the construction site	Retain biologists or field surveyors to inspect species under influence in and near the site.	Twice/year 1 time in Dry season and 1 time Rainy season	Contractor	Contractor Cost
Hydrology	- Groundwater level - Ground elevation level - Consumption of groundwater amount	Compliance with mitigation measures presented in the EMP	Well near the construction site	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Social Environment	-Involuntary Resettlement -Living and Livelihood -Vulnerable Group -Existing social infrastructure and services -Social institutions such as social infrastructure and local decision-making institutions -Misdistribution of Benefit	-Monitoring of the implementation status of Resettlement works such as provision of assistance package for project affected persons, and common assets; -Monitoring of the implementation status for CSR activities such	In / Around project site	Reviewing monitoring reports from implementing NGO or Firm. Visual inspection of all active work areas	Monthly	BEZA	BEZA

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	and Damage -Gender -Children's Right	as community support program -Monitoring of construction and availability of diversion roads. -Fair employment opportunity and wage for female					
Occupational Health and Safety	Accidents or incidents due to construction activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by contractor	As defined in H&S Plan	Contractor/ EHS Team of Contractor	Contractor Cost
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Approach Road	Incidents, accidents and community complaints	Based on occurrence	Contractor/ EHS and/or Community Liaison Officer of Contractor	Contractor Cost
Operation Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project activity areas and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of BEZA and individual industry	Included in operation and maintenanc e (O&M) cost
Air Pollution	Stack emissions concentrations	NOx, SOx, CO, SPM	Stack of individual industry who has stack for exhaust emission			Tenant/3rd Party Environmental Consultant	O&M cost
	Ambient air	PM10, PM2.5, SOx,	At 4 Locations	Standard methods	Quarterly	Tenant /3rd	O&M cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	quality	NOx, CO				Party Environmental Consultant	
Noise	Noise generation by individual industry operation	Sound Pressure Level	1 m from the noise generating equipment	Noise monitor	Monthly	Tenant / EHS Team or 3rd Party Environmental Consultant	O&M cost
	Ambient noise	Ambient noise levels	At 5 locations (Important Sensitive Receptors)	Noise monitor with data logger	Quarterly	Tenant /3rd Party Environmental Consultant	O&M cost
Water	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR1997	Borewell water to be used for domestic purposes and treated water quality to be used for drinking	Standard analytical methods	Quarterly	Tenant /3rd Party Environmental Consultant	O&M cost
	Wastewater	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	Outlet of discharge canal	Standard analytical methods	Quarterly	Tenant /3rd Party Environmental Consultant	O&M cost
	Surface water quality	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	At 2 locations	Standard analytical methods	Quarterly	Tenant/individu al industry EHS Team or 3rd PartyEnvirone mental Consultant	O&M cost
Solid & hazardous waste	Internal domestic/ kitchen waste, and medical	Solid waste	Waste disposable point	Waste a quality	Daily	Tenant	O&M Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	centre waste						
Soil Pollution	Status of control of solid and liquid waste which causes soil contamination	Solid waste and liquid waste	Each Tenant	Visual inspection of all active work areas	Half yearly	Tenant	O&M Cost
Aquatic Ecology	Fisheries	Visible fish kills	Outlet of the discharge	Visual inspection	Fortnightly	Tenant EHS Team	O&M Cost
Terrestrial Ecology	Ecology	Visible flora and fauna monitoring	Plant surrounding area of 2km radius	Abundance, species composition	Half yearly initial 2 years of operations. Any further monitoring based on the analysis of results	Tenant /3rd Party Environmental Consultant	O&M cost
Social Environment	-Living and Livelihood -Vulnerable Group -Existing social infrastructure and services -Social institutions such as social infrastructure and local decision-making institutions -Misdistribution of Benefit and Damage -Gender -Children's Right	-Monitoring of the implementation status of Income and livelihood restoration programme -Monitoring of the implementation status for CSR activities such as community support program -Monitoring of construction and availability of newly constructed community roads. -Fair employment opportunity and wage for female	In / Around project site	- Reviewing monitoring reports from implementing NGO, Firm or tenant companies. - Visual inspection of all active work areas	Monthly	BEZA	BEZA

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Works health and safety Monitoring	Accidents or incidents due to operation and maintenance activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrence etc.	Project activities areas	As to be defined in the H&S plan to be prepared BEZA	As defined in H&S plan	Tenant and monitored by BEZA	O&M Cost
Health Monitoring	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complains	Access Road	Accidents, incidents and complains	Based on occurrence	Tenant and monitored by BEZA	O&M Cost
	Public Concern	Complains	Neighboring communities	As to be defined in the H&S plan to be prepared by BEZA	Continuous	Tenant and monitored by BEZA	O&M Cost
Disaster Management Plan (DMP) Monitoring	Earthquake	Structure Design	Project Area	As to be defined in the DMP to be prepared by BEZA	Continuous	Tenant	O&M Cost
CSR Activities	Community Development	Activities/Programmes and No. of beneficiaries	Neighboring communities around the Project activity areas	No. of beneficiaries and outcome of the activities	Periodic and need based	Admin/ HR Manager and Station Manager	CSR Budget

Table 3.1-47: Estimated Environmental Monitoring Cost (C) in BDT

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Involuntary Resettlement	Pre-Construction & During Construction	Monitoring of Compensation for impact	-	-	Included in RAP Cost
Accident	During Construction	Ensuring that HSMP works right on the road track	-	-	Included in Construction Cost
	During Operation	Installing traffic signs, road mark, bump, zebra mark, guard rail and pole, and curb stones etc	-	-	Included in Construction Cost
HIV/ AIDs	During Construction	Ensuring that contractor's personnel and local community understand HIV-AIDS awareness campaign	-	-	200,000
	During Operation	HIV-AIDS awareness campaign	-	-	200,000
Air pollution	During Construction	Measurement of SPM, PM 2.5, PM10, CO, SOx, NOx	50,000	48	2,400,000
	During Operation	Measurement of PM10, PM2.5, SOx, NOx, CO	50,000	16	800,000
Water pollution (Surface & Ground Water)	During Construction	Surface Water Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals Ground Water Drinking water quality parameters as per Schedule 3 of ECR 1997	30,000	48	1,440,000
	During Operation	Surface Water Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals Ground Water Drinking water quality parameters as per Schedule 3 of ECR 1997	30,000	16	480,000
Waste	During Operation	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	30,000	4	120,000
Noise	During Construction	Periodical maintenance of construction vehicles and installation of sound insulation cover (Noise levels)	5,000	180	900,000
	During Operation	Securing of a buffer zone around 100m as noise decay distance (Noise levels)	5,000	60	300,000

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Soil	During Pre/Construction	pH, salinity, NH ₄ ⁺ , total-P, heavy metals, oil & grease	-	LS	240,000
Offensive odor	During Construction	Odor inspection to ensure harmful odor is not released from equipment and waste	-	-	Included in Construction Cost
Occupational Health & Safety and Community Health & Safety	During Construction	Accident or incidents due to construction activities, dangerous occurrences	-	-	Included in EMP Cost
	During Operation	Hazard due to road traffic	-	-	Included in EMP Cost
Ecology	Aquatic and Terrestrial Ecology	Visible flora and fauna monitoring	-	-	Included in EMP Cost
Total Environmental Monitoring Cost (C)					7,080,000
Environmental Training	During Operation	Orientation Workshop and follow up training program for capacity building/ institutional development program	-	LS	2,000,000
Environmental Training Costs (D)					2,000,000
Grand Total (A+B+C+D)					18,030,000

3.1.10. Institutional arrangement for EMP and EMoP

The main purpose of this environmental assessment is to delineate the correct measures to enhance the environmental sustainability of the proposed project through providing suggestion on design considerations, implementation, management and operation as suggested in the EMP. The effective implementation and operation of EMP depends on regular monitoring.

The organogram of the proposed Environmental management & monitoring during construction phase directorate may be as **Figure 3.1-25**. Each contractor will implement EMP and EMoP for each subproject and submit the environmental monitoring report to BEZA and Consultant based on its IEE/EIA. BEZA will submit the monitoring report to DoE and JICA based on the results of implementation of EMP and EMoP.

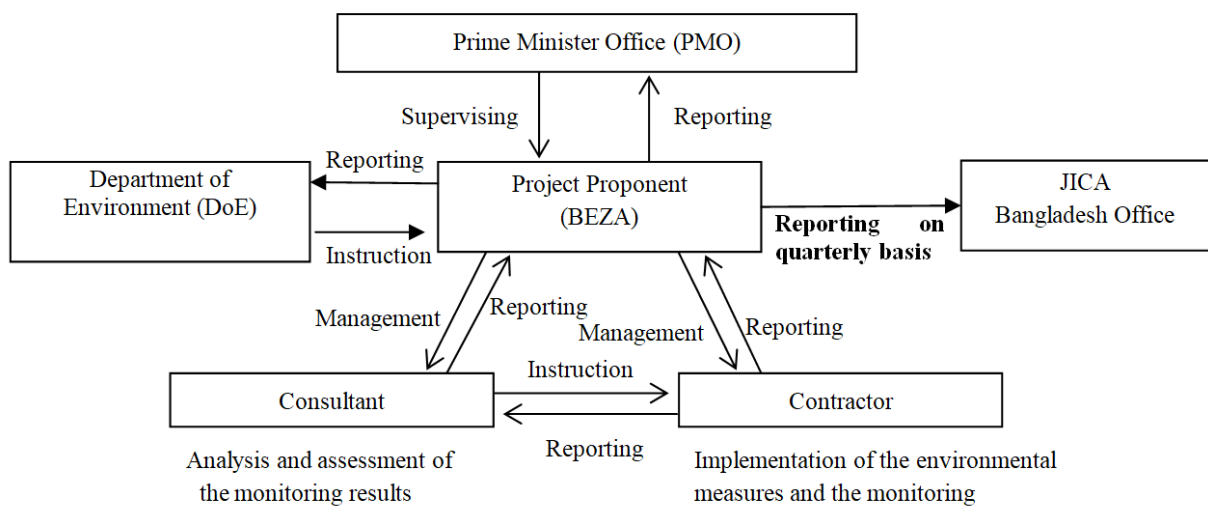


Figure 3.1-25: Implementation Structure / Mechanism of Environmental Management and Monitoring during Construction Phase

The organizational structure for the operation and management of environmental monitoring is shown in the **Figure 3.1-26**. Each tenant will implement EMP and EMoP for each business and submit the environmental monitoring report to SPC based on its IEE/EIA, and SPC will submit the whole result to the project proponent. BEZA will submit the monitoring report to JICA based on the results of implementation of EMP and EMoP which will be submitted by SPC.

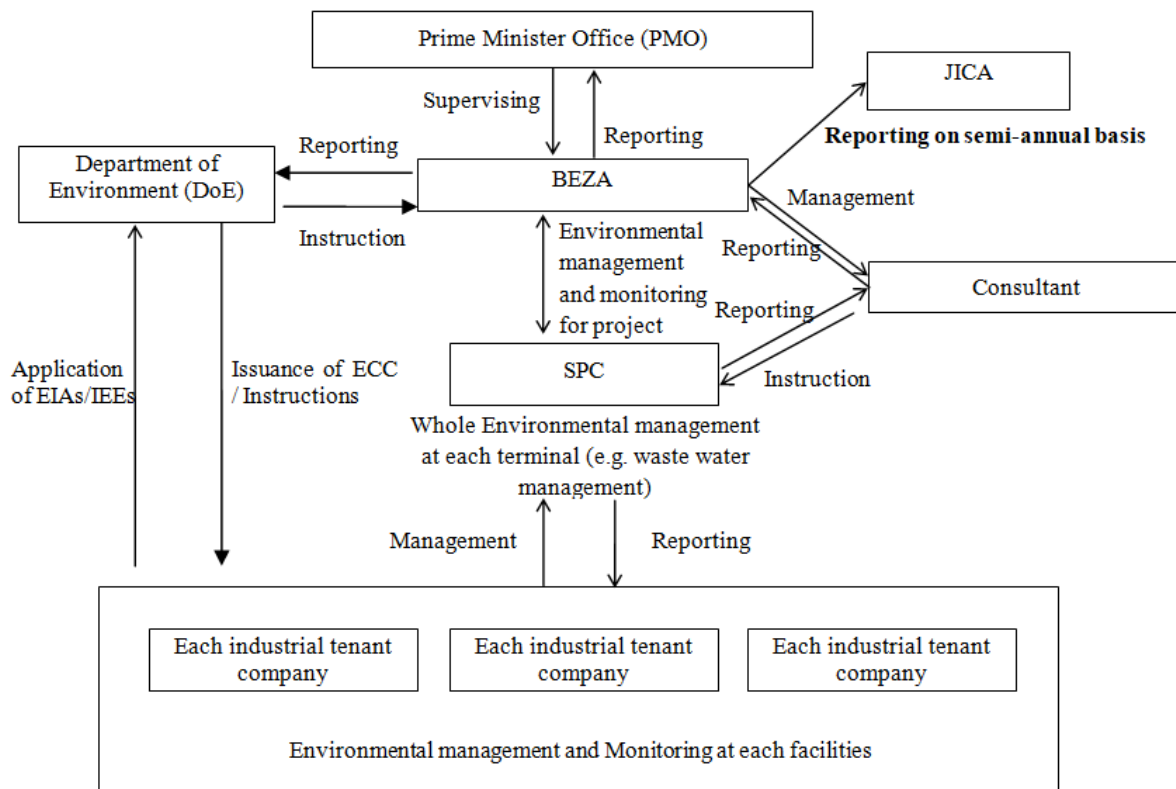


Figure 3.1-26: Implementation Structure / Mechanism of Environmental Management and Monitoring during Operation Phase

3.1.11. Public Consultation Meetings

Time and Date	1st Public Consultation Meeting: Date: 22 November, 2017 Day: Wednesday Time: 10:00 AM to 1:00 PM Consultation Meeting focusing on persons to be displaced: Date: 22 November, 2017 Day: Wednesday Time: 1:00 AM to 2:00 PM
Venue	Satgram Union Parishad, Purinda Bazar, Araihaazar, Narayanganj
Invitees	Deputy Commissioner (DC), Narayanganj Manager (Administration), BEZA Police Super, Narayanganj Upazila Nirbahi Officer, Araihaazar, Narayanganj Executive Engineer, Roads & Highway Department/ DPHE, Narayanganj Director General, PBS, Narayanganj Assistant Commissioner (Land), Araihaazar, Narayanganj Social Specialist, BEZA project Chairman, Araihaazar upazila parishod Upazila Agriculture/ Fisheries/ Education Officer, Araihaazar upazila Union Chairman, Shatgram union parishod Union Chairman, Duptara union parishod Local residents in and around Araihaazar EZ area Other organizations and individuals who are interested in the Project
Attendee	1st Public Consultation Meeting: 95 people (men: 91, women: 4) Age range: 21-74 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Police, Student & Unemployed Persons Consultation Meeting (same day) focusing on persons to be displaced: Age range: 35-70 Category of participants: Person to be displaced
Agenda	Brief explanation on the past EIA-related studies Project brief in the industrial area, residential and commercial areas, and the logistic area planned in Araihaazar EZ area Major positive and negative findings on the draft scoping results Scope of the EIA study Further schedule of EIA
Language Used	In local language: Bangali language

As per the JICA Environmental Guidelines, BEZA has disclosed the project information and provided opportunities for stakeholders, particularly project affected people including landless share croppers, to participate the EIA and RAP preparation. Based on the past records in Bangladesh, stakeholders' participation could lead timely land acquisition and resettlement as well as fewer conflicts during the construction and operation stages between project proponents and local stakeholders. It is particularly important to understand the community needs for livelihood recovery assistances, which are not provided by the government funded projects but are mandatory for the JICA funded projects. BEZA has been

committed to comply with the JICA Environmental Guidelines and adapted to enhance the benefits of the project affected persons (PAPs) throughout the project activities and livelihood recovery assistance programs.

1st Public Consultation Meetings (scoping stage)

A joint public consultation for the EZ EIA preparation and stakeholder meeting for the RAP preparation was held on 22th November 2017 at the union office of one of the major project impacted communities (Satgram Union Parishad, Purinda Bazar). Prior to the notice, BEZA consulted with the union leader and was requested to conduct the joint consultation/meeting at the primary school behind the union office where there are enough space for more than 100 persons under the shadow. As per the JICA Environmental Guidelines, advanced newspaper notice of the consultation was published on 18th November (Appendices: Public notification). In addition to the notice, BEZA also invited experts and NGOs familiar with the natural environment or social development needs of the project affected area.

. Key points raised by the participants are shown in the table below;

Table 3.1-48: Key Points Raised by the Participants

Name & Address of Participant	Issues Raised	Response
Md. Motiur Rahman Member, Guptara Union Parishad.	Economic Zone main entry gate will be at Duptara Union side.	BEZA representative said that there will be only one entrance into the EZ. Entry point will be finalized as per final technical design.
Md. Shahjahan, Farmer, Panchrukhi	Demanding compensation at 3 times more of Mouza rate. Could we cultivate the land for next cropping season?	For the project, the DC issued notice under section-3 in accordance with Acquisition and Requisition of Immovable Property Ordinance-1982 on 18 th September 2017 which has provision for 50% premium on land value. But Government gazette new Acquisition and Requisition of Immovable Property Ordinance 2017 making provision of additional 200% of land value. BEZA and DC office is trying to bring it under new law. BEZA confirms that affected person can cultivate the acquired land for next crops season.
Md. Abdul Malek Farmaer, Panchrukhi Nasir Haider Almas Farmer, Pancrukhi	Want compensation for acquired land according to new law. Satisfied to have EZ in this area.	Answer to the question regarding compensation is the same as mentioned above. They are satisfied with the project as it will bring immense opportunity for them.
Saiful Islam shakil Villager and affected person, Panchrukhi	Paper/document of acquired land of some person is not legally valid. What is system for verification?	Mrs. Surya Khan, UNO of Araihaazar Upazila told in reply that compensation disbursed according mutation record. Verification will be done through deed and bia deed.
Almas Villager, Sonpara Panchrukhi	There is canal within the project. Is there any negative impact will occur due to project?	Representative from BEZA assured that all necessary mitigating measure will be undertaken to avoid any negative impact whether it is environmental or social.
Md. Alamgir	The project location is low land.	The project doesn't obstruct natural flow of water.

Name & Address of Participant	Issues Raised	Response
Affected Person, Panchrukhi	Permanent water lodging will be starting in surrounding area due to land filling on project. What is the mitigating measure? There was plan to erect a bund. Is this plan will be implemented? Land loser list will be published in public. There are many middlemen in DC office. He urged the authority concern to avoid middlemen in compensation disbursement.	Rather it will be more peoples friendly. The project will follow standard of DoE and JICA environmental and Social Consideration to mitigate any negative impact. About protection bund, BEZA will consult with Bangladesh Water Development Board (BWDB). Both BEZA representative and UNO told that no need to go by middlemen to receive compensation from DC office.
Md. Masum Journalist, the Daily Financial Express	What about waste management? How to manage air and water pollution? Waste and pollution management should up to developed countries.	Modern and technology based waste management will be followed <i>i.e.</i> establish ETP, Water Treatment Plant (WTP) etc. Necessary action will be taken to protect environment.
Mrs. Shahida Chairwomen, Duptara Ubion	In rural area, peoples are not aware about land management. Due to ignorance some affected person could not get compensation in proper time.	Representative of DC asked the peoples to come with genuine and legal document. Document regarding land ownership must be genuine.
Mr. Mahbubur Rahman Roman, Member, Narayanganj District Council	The price of land adjacent to the national highway is very high. He asked the authority concern to think the issue specifically.	The land price always vary according to its proximity to the important establishment. But in the land acquisition process there is no scope to make separate provision as per land location. Only category or classification of land is considered.

2nd Public Consultation Meetings (Draft stage)

The 2nd PCM was held jointly with PCM for the RAP. Please refer to 3.2.11 “Accountability, Community Participation and Stakeholder Meeting” in the following section for details.

Focus Group Discussion (FGD) (EIA study)

Focus group Discussion (FGD) is a small, but demographically diverse group of people and whose reactions are studied especially in market research or political analysis in guided or open discussions about a proposed project or something else to determine the reactions that can be expected from a larger population. It is a form of qualitative research consisting of interviews in which groups of people are asked about their perceptions, opinions, beliefs, and attitudes towards the project, service, concept, advertisement, idea or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members.

Discussion was held with the local people at near the proposed project site. Date, location and the number of participants of each discussion is listed in the table below.

Photographs of focus group discussion are shown in **Appendices**.

Table 3.1-49: Details of Focus Group Discussions (FGDs)

Sl.	Date	Location of the FGD	Participants			Category of participants
			Total	Male	Female	
	22.11.2017	Sonpara	11	11	0	Local Community
	22.11.2017	Pachrukhi	8	8	0	Land Owners and Farmers
	23.11.2017	Maizpara	6	6	0	Sharecroppers and Agriculture labor
	23.11.2017	Bonderpara	6	6	0	Fishermen

Summary of FGD per different group categories of the affected people are shown in the following tables.

Table 3.1-50: Summary of Focus Group Discussion with Local Community

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the various surveys that have taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated;
Does the proposed Project create any problem with ambient air, noise quality or water quality?	Most of the Participants don't have proper knowledge regarding this issue. Few emphasized that "client should take care surrounding environment of the proposed project"	Impact of the project upon ambient air, noise quality, water quality has been assessed during EIA study;
Any critical issue or concern by the local people regarding the project? On the other hand, any criteria you would like to see considered during project design, construction and operation stage?	Participants requested that environmental hotspots (like school, hospital, graveyard etc.) should be avoided as much as possible. Moreover, dust suppression, noise mitigation must be considered;	Dust suppression measures and noise mitigation will be considered in the EMP;
Is the proposed project going to provide better traffic system?	All the participants assumed that traffic will be increased after the proposed project starting its construction. Participants came to the consensus that better traffic system should be developed by the proponent;	Design measures such as increased number of sign board, road mark, bump etc. will be proposed to develop.
Protected areas (national parks, protected forest, religiously sensitive sites, historical or	There is no such kind of protected area in proposed project construction site.	No concerns over the park, the nearest sites with terms of cultural or religious significance are far from the project area.

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
archaeological sites) if any		Project is designed to avoid most of those structures.
Employment Status: Percentage of employment/unemployment/ underemployment	Employment opportunity is expected to increase in the project area. Participants expected that local people might be given priority for employing in the required fields.	Job chance and employment will be enhanced and promoted once the construction is started. Will propose to pay extra priority for the local people;
Others Benefits	Most of the participants believed that infrastructural development will be accelerated. Secondly, majority also believed that basic services and business opportunity will also be increased.	
Other Negative Impacts	This proposed project will produce a large amount of waste periodically. Most of the participants believed that in absence of proper waste management plan and proper implementation, living standards of surrounding community will be hampered.	Proper waste management plan and implementation will be proposed;

Table 3.1-51: Summary of Focus Group Discussion with Land Owners and Farmers

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the DC's notice and various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated.
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. Though, this land acquisition will create landlessness for the limited affected peoples but for the national development it can be considered if properly compensated.	All development projects require land acquisition which causes land loss. But in compared to national development this loss is very negligible.
What are the characteristics of the lands those are going to be taken for the proposed project?	Proposed land is low in nature. Therefore, during wet season no agricultural activities can be done. Thus most of the land is used for single cropping production especially in winter season. Some lands of the southern east side are used for double cropping production because this land. Most of the lands are used for paddy production and small amount of mustard is also produced. Production rate is very high in these lands. Paddy produced	-

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
	approximately 26kg per decimal.	
How do the land owners and farmers depend on the lands those are going to be taken for the proposed project?	Paddy that produced from the land is mostly used for daily life consumption. After that the surplus amount is sold. Thus the dependency is two folds, daily life consumption and financial benefits.	Detailed RAP along with proper compensation packages and livelihood assistance will be proposed to prepare for all affected persons respective to all dependencies so that all affected persons can restore their livelihood after the land acquisition.
How does this dependency contribute to the livelihood?	Most affected persons have other job or business too. Agricultural production contributes to enhance the food availability and solvency for these affected households. But there are some affected persons too who only depend on agricultural production for their livelihood.	
How do other people who are not land owners depend on the acquired land?	Some people do sharecropping production. These people are usually landless. They don't have land but they rent this land for specific time duration to produce crop for their livelihood.	-
What are the common practices for renting lands to the sharecroppers?	Two common practices are prevailed in this area those are One, yearly 3 thousand BDT rent per 30 decimal and the sharecropper will use this land for one year. Second, sharecroppers do not give any rent but share the yields in 50:50 ratios.	
What should be done to minimize the livelihood impacts on the land users? (land owners, sharecroppers)	Land compensation should be compatible to market price so that land owners can buy land in adjacent area. Some believed that land availability is another challenge for the affected farmers. Sometimes farmers may not be able to buy land in the adjacent area; in that case it won't be possible to go miles for doing agricultural production. Moreover, sharecropper will not get any land compensation but they will be affected. So, affected persons should be given priority when job opportunity creates in the proposed project site.	Extra privileges for the affected persons in getting job respective to their skills will be proposed.

Table 3.1-52: Summary of Focus Group Discussion with Sharecropper and Agricultural Labor

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the DC's notice and various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the	The Consultants informed that during the design and layout of all infrastructures all the adverse

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
	environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	impacts have been anticipated.
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. Though, this land acquisition will create landlessness for the limited affected peoples but for the national development it can be considered if properly compensated.	All development projects require land acquisition which causes land loss. But in compared to national development this loss is very negligible.
How much are the sharecroppers depended on the lands those are going to be acquired?	Most of the sharecroppers are landless or marginal landowners. Due to lack of agricultural land ownership, they have to depend on other land owners for continuing their agricultural activities. Their livelihood is totally depended on the acquired land seasonally. They engage in agricultural production in winter. That time they also work as agricultural labor to other land owners' land and earn extra which help them financially. One time yields support them approximately for six months. Rest of the months, they usually engage in non-agricultural works.	-
How does land sharing happen between the land owners and the sharecroppers?	Sharecropping happens based on personal relationship. Landowners give the land to those sharecroppers whom they personally know and have trust on them. Barely written deed is incurred between the landowners and the sharecroppers. In that case, how would the sharecropper's number be confirmed?	Proper guideline will be proposed to confirm the exact numbers of the sharecropper.
What are the common practices for renting lands to the sharecroppers?	Two common practices are prevailed in this area those are One, yearly 3 thousand BDT rent per 30 decimal and the sharecropper will use this land for one year. Second, sharecroppers do not give any rent but share the yields in 50:50 ratio.	-
What should be done to minimize the livelihood impacts on sharecroppers and agricultural labor?	If land owners lost their land, sharecroppers won't manage to cultivate on other land owners' land as sharecropping is incurred on the basis of personal relationship. They assumed that permanent seasonal inactivity will be happened as a result. They think that if project proponent considers employing them in the project works based on their skills or assisting them to get alternative occupations, this will help them to restore their livelihood.	Study will propose to design and implement proper livelihood restoration plan for the affected persons.

Table 3.1-53: Summary of Focus Group Discussion with Fishermen

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated.
How much are the fishermen depended on the lands those are going to be acquired?	Usually this proposed project site remains inundated almost for six months in a year. There is a canal goes through the proposed project site which is connected to the River. Therefore, a large amount of indigenous fisheries are always available in this location. Fishermen (10-15) catch fishes in this location all the time during wet season and live their livelihood. In other time, they catch fishes from other location or buy and sell fishes to the local market. Fishermen though have no land in the proposed project site but they will lose to access to the fishing area.	-
What should be done to minimize the livelihood impacts on fishermen?	If fishermen permanently lose to get the access in the project site area, they preferred to get work opportunity from the project proponent.	Study will propose to design and implement proper livelihood restoration plan for the affected persons.

3.2 Social Impact Assessment for On-site and peripheral infrastructure (RAP 1)

3.2.1. Social Conditions of Project Area and Identification of Potential Impacts

- 1) General Description of Environmental and Socioeconomic Setup
- 2) Demography

In the 5-kilometer study area, there are 159,785 households (HHs) including squatters with a total population of 534,281 that will be somehow affected (directly or indirectly including both positive and negative) by the implementation of the Project. Population density per square km of the study area is 2,973, which is very much higher than the national figure of 976 per square km. The average sex ratio is 107 against the national figure of 100, which depicts a higher male population than the female population. Moreover, where national household size is 4.44, the average household size of the study area is slightly higher (4.7). Table 3.2-1 shows the Demography of the project study area.

Table 3.2-1: Demography of the project area

Upazila	Union	Total population	Total HHs	Average HH size	Sex Ratio	Population density (Sq. Km)
NarsingdiSadar	Amdia	42,118	8,637	4.9	102	2,078
	Meher Para	43,700	9,434	4.6	110	4,685
	MadhabdiPaurashava	49,583	11,323	4.3	139	3,315
	Kanthalia	38,390	7,986	4.8	100	3,204
Araihazar	Sadasardi	39,615	7,956	4.9	106	3,460
	Duptara	37,495	7,911	4.7	107	2,242
	Araihazar	25,593	25,593	4.4	102	3,215
	Fatehpur	20,834	4,354	4.8	103	2,938
	Brahmandi	48,999	10,561	4.6	101	3,002
	Satgram	41,731	8,366	5	103	2,126
Rupganj	KanchanPaurashava	49,468	10,912	4.5	103	3,031
	Golakandail	62,747	12,744	4.9	114	3,380
	Bholaba	34,008	34,008	4.9	96	1,973
Project Study Area		534,281	159,785	4.7	107	2,973

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

(1) Ethnic Composition

According to population and housing census (2011), only 10 ethnic households consisting 31 populations are found in the Union lied within the 2km radius boundary from the project site. These ethnic groups are Marma, Chakma and Others. JICA Study Team confirmed that these ethnic groups are not included in the PAPs.

(2) Religion

As per BBS, Population and Census (2011), the population of the project study area primarily consists of Muslims constituting almost 94.9% of the total population. The remaining 5.6% is primarily comprised of by Hindus with Christians, Buddhists and others comprising far lesser percentages. The following Table 3.2-2 indicates the various religious profile of the project study area.

Table 3.2-2: Religion Profile of Project Area

Upazila	Union	Total pop.	Muslim		Hindu		Christian		Buddhist		Others	
			Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
NarsingdiSadar	Amdia	42118	40855	97.0	1262	3.0	0	0	0	0	1	0.002
	Meher Para	43700	40923	93.6	2774	6.3	2	0.005	0	0	1	0.002
	Madhabdi	49583	44377	89.5	5194	10.5	4	0.01	7	0.01	1	0.002
	Kanthalia	38390	37891	98.7	499	1.3	0	0	0	0	0	0.000
Araihazar	Sadasardi	39615	34786	87.8	4822	12.2	7	0.02	0	0	0	0.000
	Duptara	37495	35181	93.8	2313	6.2	0	0	0	0	1	0.003
	Araihazar	25593	23603	92.2	1984	7.8	6	0.02	0	0	0	0.000
	Fatehpur	20834	20273	97.3	559	2.7	0	0	0	0	2	0.010
	Brahmandi	48999	48276	98.5	723	1.5	0	0	0	0	0	0.000
	Satgram	41731	41519	99.5	212	0.5	0	0	0	0	0	0.000
Rupganj	Kanchan	49468	46504	94.0	2914	5.9	35	0.07	8	0.02	7	0.014
	Golakandail	62747	57669	91.9	5035	8.0	19	0.03	3	0.00	21	0.033
	Bholaba	34008	32416	95.3	1592	4.7	0	0	0	0	0	0.000
Project Study Area		534281	504273	4949	29883	645	73	0401	18	04000	34	0.006

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

3) Socio-Economic Condition

Villages Adjacent to Project Site

Socio-economic assessment of adjacent population of the proposed project is very much crucial for project planning and implementation. Therefore, villages adjacent to the proposed project site within a 2km radius were surveyed for intense socio-economic assessment. Villages are so close to the proposed project and communities of the villages are rigorously connected in their daily life to the proposed project area.

Villages situated within the 2km radius from the proposed project were considered for the focus of a social survey. To get the actual population/households of the studied villages, secondary sources; population and housing census, District Statistics and District web-portal) have been used. When total numbers of the households/populations had been confirmed, considering all villages as cluster 5% households were finalized for random sampling along with specific interval.

Table 3.2-3: Villages and numbers of households surveyed

Union	Villages	Frequency	Percent
Amdia	Kandail	20	6.8
Bholaba	Gutulia	10	3.4
Dhuptara	Kumar Para	13	4.4
	Monehor	6	2.0
	Panchbaria	30	10.2
	Raghobdi	11	3.7
	Shingrati	6	2.0
	Ghosh Para	7	2.4
Satgram	Gojariapara	7	2.4
	Khan Para	7	2.4
	Noapara	29	9.9
	Maizpara	10	3.4
	Pashchim Para	31	10.5
	Purinda	45	15.3
	Sonpara	10	3.4
	Tekpara	52	17.7
Total		294	100.0

Source: JICA STUDY TEAM.

Basic Demographical Characteristics of the Households

Basic demographic characteristics include total population, gender, age, marital status, households' structures, and health status. The table below illustrates the basic demographical characteristics of the households. Survey results show a total population of about 1,349 living within the 294 households, whereas about 55.7% are male and the rest, 44.3%, are female. Average family size is 4.59. On the other

hand, 1-98 age range has been found within the selected households of specific villages. Importantly around 81% population belongs to 14-64 age range signifying that most of the population is eligible to be active in economic activities. Contrary, only 19% of the population is found to be dependent. Additionally, 54.4% of the population is married. The overall health status among the households surveyed has been found to be quite well. Around 97.2% of the population were found to be healthy and only 2.8% were found to have chronic disease or were disabled at birth. The Study area was found to be predominantly Muslim with about 98.6%- of surveyed households found to be Muslim with the remainder Hindu.

Table 3.2-4: Basic Demographic Characteristics of the Selected Villages

SL No	Details	Frequency	Percent
1)	Total Population	Male	55.7
		Female	44.3
		Total	100
2)	Age	1-13	16.6
		14-34	46.1
		35-55	29.7
		56-64	5.2
		65-65+	2.4
		Total	100.0
3)	Marital Status	Married	54.4
		Unmarried	45
		Divorced/Widowed	0.6
		Total	100.0
4)	Health Status	No disease	97.2
		Handicapped	1.2
		Chronic Health Problem	1.6
		Total	100.0
5)	Religion	Muslim	98.6
		Hindu	1.4
		Total	100.0

Source: JICA STUDY TEAM.

Households Structures and Sanitation and Other Utilities

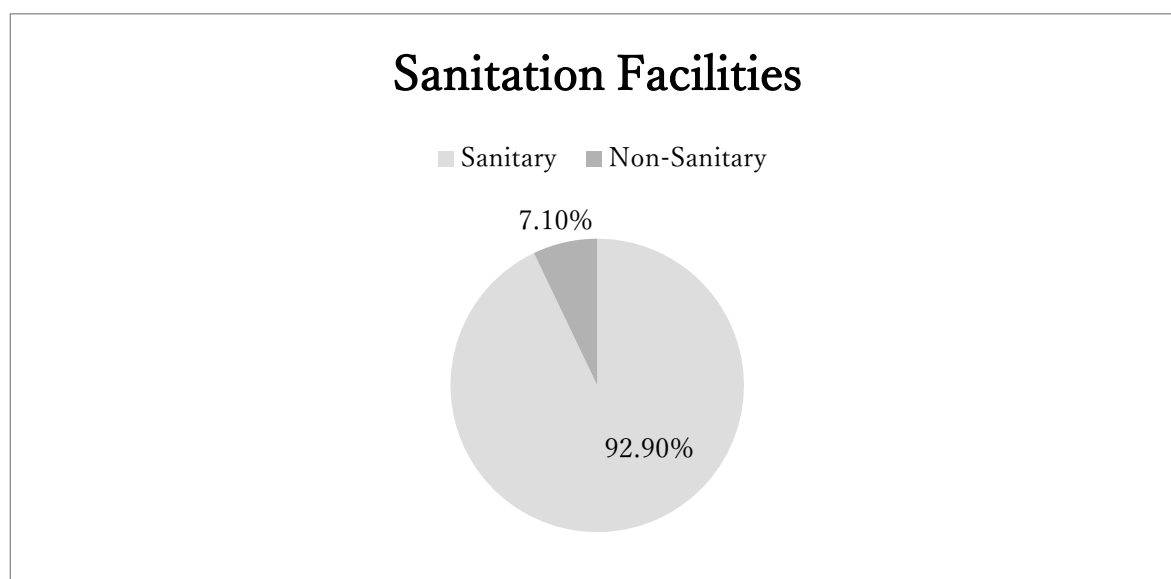
The Survey found that among all households surveyed, about 7.0% of household structures are fixed permanent buildings and 21.4% are non-permanent buildings. Moreover, about 69% of household structures are made of tin. In addition, about 2.5% of all household structures were found to be thatched roof dwellings.

Table 3.2-5: Structures of the studied households

Types by Usage	No.	Types of Structures			
		Building	Semi-Building	Tin Made	Thatched
Living	439	45	134	260	0
% of Total	68.7	7.0	21.0	40.6	0.0
Kitchen	189	0	2	172	15
% of Total	29.6	0	0.3	26.9	2.3
Cattle shed	7	0	1	6	0
% of Total	1.1	0	0.2	0.9	0
Others	4	0	0	3	1
% of Total	0.6	0	0	0.5	0.2
Total N	639	45	137	441	16
% of Total	100	7.0	21.4	69	2.5

Source: JICA STUDY TEAM

Among the surveyed households, about 92.9% have sanitary toilets and the rest 7.1% have non-sanitary toilets. No open defecation was found around the 2km radius of the villages.



Source: JICA STUDY TEAM

Figure 3.2-1: Sanitation facilities

Utilities available in the surveyed households are using Tube-wells, Water Pumps, and Water Tanks with averages of .68, .42 and .41 respectively. Poultry rearing is a very common practice in all households and this study found that households averaged .93 poultry followed by .07 Goat and .04 Sheep maintained in the homes.

Table 3.2-6: Households' utilities and domestic animals

	Tube-well	Water-pump	Water-tank	Cattle-shed	Cow	Buffalo	Sheep	Goat	Poultry
Mean	0.68	0.42	0.41	0.02	0.03	0.00	0.04	0.07	0.93
Median	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Std. Deviation	0.466	0.502	0.755	0.130	0.246	0.058	0.230	0.324	4.596

Source: JICA STUDY TEAM

Education

The study found that about 81.5% of the total population is literate. About 19.5% and 48.8% of the population were found to lie within the Illiterate and primary level education category. About 22.3% and 6.2% of the population were found to have completed Secondary and Higher Secondary level of formal education. On the other hand, only 3.2% were found to have graduated or went on to higher educational.

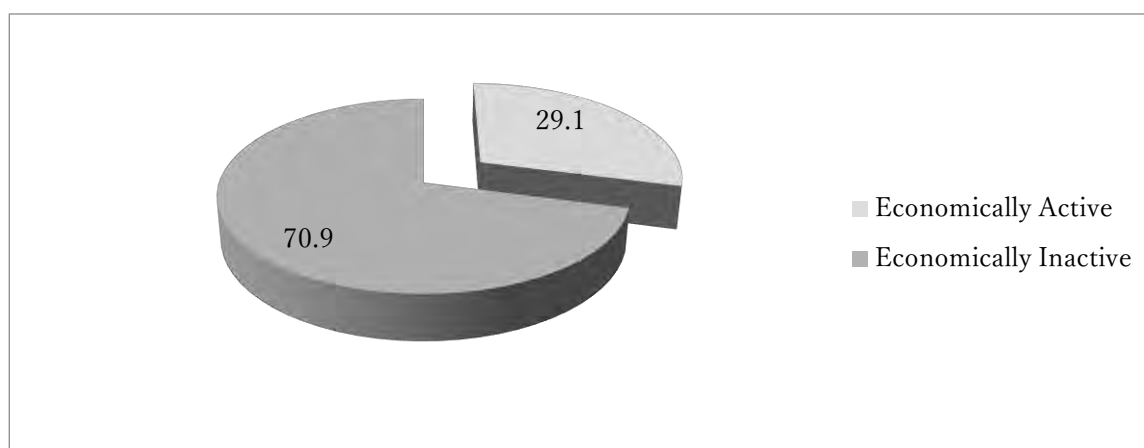
Table 3.2-7: Educational Attainment of the Population

Sl No.	Details	Frequency	Percent
1	Illiterate	263	19.5
2	Primary	658	48.8
3	Secondary	301	22.3
4	Higher Secondary	84	6.2
5	Graduation or Higher	43	3.2
Total		1349	100.0

Source: JICA STUDY TEAM

Occupation and Income

Among the total surveyed population, 29.1% are gainfully employed by engaging in a variety of occupations. Unlike other parts of Bangladesh, occupations within the selected villages are found to be non-agriculture based. The majority (12.4%) of the total population are engaged in business or small-scale industry activities. Moreover, 5.5% of the population is engaged somehow in agricultural activities. Non-Agricultural labor (2.8%) and private enterprises (2.7%) are also common in the study area, as this area is well known for different types of industries. Other activities (4.1%) include driving, working in bakeries, etc.



Source: JICA STUDY TEAM

Figure 3.2-2: Economically active population of the surveyed population

Table 3.2-8: Occupation and Yearly Income of the Households

Occupations	Number	5000 less	or	5000 10000	to	10000 15000	to	15000 20000	to	20000 more	or
Agriculture-Business	N 3	1		2		0		0		0	
	% 0.8	0.3		0.5		0.0		0.0		0.0	
Agriculture-Fishing	N 11	0		5		4		2		0	
	% 2.8	0.0		1.3		1.0		0.5		0.0	
Agriculture-Others	N 1	0		0		1		0		0	
	% 0.3	0.0		0.0		0.3		0.0		0.0	
Agriculture	N 46	12		23		9		2		0	
	% 11.8	3.1		5.9		2.3		0.5		0.0	
Agriculture labor	N 13	5		3		1		0		0	
	% 3.3	1.3		0.8		0.3		0.0		0.0	
Non Agriculture labor	N 38	17		11		6		4		0	
	% 9.7	4.3		2.8		1.5		1.0		0.0	
Business	N 167	8		68		53		22		16	
	% 42.7	2.0		17.4		13.6		5.6		4.1	
Fishing/Fish culture	N 8	3		0		5		0		0	
	% 2.0	0.8		0.0		1.3		0.0		0.0	
Govt. Job	N 9	0		2		5		2		0	
	% 2.3	0.0		0.5		1.3		0.5		0.0	
Private Job	N 36	2		19		11		4		0	
	% 9.2	0.5		4.9		2.8		1.0		0.0	
House Made	N 4	4		0		0		0		0	
	% 1.0	1.0		0.0		0.0		0.0		0.0	
Others	N 55	11		26		12		4		2	
	% 14.1	2.8		6.6		3.1		1.0		0.5	
Total	391	63		159		107		40		18	
Total Percentage	100.0	16.1		40.7		27.4		10.2		4.6	

Source: JICA STUDY TEAM

Occupation based monthly income has also been considered during survey. It is found that most of the occupations' (Agriculture, non-agriculture labor, private enterprises, and other occupations) incomes lie within 5-10 thousand BDT monthly. Secondly, 27.4% of occupational income is between 10-15 thousand followed by 10.2% occupations have 15-20 thousand monthly income. On the other hand, only 4 % occupations have more than 20 thousand monthly income.

Survey result shows that about 30.3% households somehow depended on agriculture. Among them, 26.5% have ownership on agriculture land, garden, pond and open land. The rest of the households 3.7%) do not have ownership but engage in agricultural activities.

Table 3.2-9: Agriculture and types of ownership of land

Ownership Types	N	Ownership Types			
		Agriculture land	Garden	Pond	Open land
Self-owned	78	46	5	21	6
%	26.5	15.6	1.7	7.1	2.0
Sharecropping	11	4	0	7	0
%	3.7	1.4	0.0	2.4	0.0
Total	89	50	5	28	6
	30.3	17.0	1.7	9.5	2.0

Source: JICA STUDY TEAM

The survey noted several land types and cropping patterns of the villages in a 2km radius from the proposed project. Most of the agricultural land is used for single cropped production. Only 1.4% households use land twice a year for agricultural production. Rice and vegetable are the two sessional products. On the other hand, 15.6% of households use agricultural land once a year for producing rice (13.6%) and vegetables (2.0%).

Table 3.2-10: Agricultural cropping pattern

Agriculture Products	Frequency	Percent
Not involved in Agriculture	244	83.0
Rice	40	13.6
Vegetable	6	2.0
Rice and Vegetable	4	1.4
Total	294	100.0

Source: JICA STUDY TEAM

About 12.6% of the surveyed households were found that are involved in businesses and small industrial activities. Among them, 10.2% are involved in business whereas 2.4% are involved in small industries. Ownership patterns are self-owned 10.5% and rest 2.0%.

Table 3.2-11: Business and industries' ownership types

Ownership Types	N	Business	Industries
Self-owned	31	24	7
% of Total	10.5	8.2	2.4
Rent	6	6	0
% of Total	2.0	2.0	0.0
Total N	37	30	7
% of Total	12.6	10.2	2.4

Source: JICA STUDY TEAM

Common businesses are found Karbari-shops 2%, Tea stalls 1%, Grocery stores 3.4%, Clothing stores 2.7% and medicine shops 1%.

Table 3.2-12: Business types

Business Types	Frequency	Percent
Karbari Shop	6	2.0
Tea and pan shop	3	1.0
Grocery	10	3.4
Clothe	8	2.7
Medicine	3	1.0
Total	30	10.2

Source: JICA STUDY TEAM

Common industries related to the clothing business are Boutiques - .7%, Blocks - 1% and Dying businesses - .7%.

Table 3.2-13: Industry types

Small Industrtry Types	Frequency	Percent
Boutique	2	.7
Block	3	1.0
Dying	2	.7
Total	7	2.4

Source: JICA STUDY TEAM

Annual Income of Affected Households at the EZ site

The project is located in between two major industrial and business hub of the country. But two-third of affected households depends on agriculture for their livelihood. Annual income level of the Affected Household Heads are shown in Table 3.2-14. The 1st and lowest income category is up to BDT96000 thousand/year pertaining to the income vulnerability calculated on Cost of Basic Need (CBN) approach. Among the 1714, a total of 17 (0.99%) AHs fall into the vulnerable group. Survey result depicted that 258 AHs (15.05%) live below the poverty line. Census reveals that a substantial numbers of AHHs has higher income and belong to middle-class and upper middle-class strata of the society as the project location are a prominent business area in the country.

Table 3.2-14: Annual income of affected HHs at the EZ site

Level of Income (BDT)	Number	Percentage (%)
Up to 96000	17	0.99
97000 to 144000	258	15.05
145000-194000	335	19.54
195000-244000	679	39.61
245000-294000	58	3.38
295000-344000	129	7.53
345000-394000	157	9.16
395000-444000	14	0.82
Above 444000	67	3.91
Total	1714	100.00

Energy Access

Lighting and cooking sources are the very important needed energy for any households and higher quality and easy access to quality energy can ease household's daily life. Results have found that 99.0% of the total households have access to electricity and only 1% of the total households do not have access to electricity.

Table 3.2-15: Different Energy Access by the Households

SL No	Details	Frequency	Percent
1.	Lighting Source	Electricity	291
		Kerosene	3
		Total	294
2.	Fuel/energy used for Cooking	Gas	126
		Crop Residue, Firewood,	168
		Cow-dung Cake	57.1
		Total	294

Source: JICA STUDY TEAM

In the case of cooking fuel, it is found that all the households are relying on the conventional ways of cooking. Firewood, crop residue and cow-dung cake are used for cooking fuel. Usually women are engaged in preparing these cooking fuels. In the absence of any more modern cooking system, women have to work and prepare these fuels, consequently women are depriving themselves from engaging in economic activities. About 57.1% of households are relying on natural fuels (Firewood, crop residue and cow-dung cake), whereas the remaining 42.9% use gas for cooking.

Access to Social Market and Medical Services

Convenient and easy access to markets and medical services help households get basic needs and health services when it is necessary or urgent. Distance may hinder easy access to these services. Survey results have found that 68.71% of households have easy access to main markets lying less than 1km followed by 31.29% lying 1-2 km from the market. They can get all sorts of amenities from the markets. Purinda Bazar is the most preferable bazar for the villagers. About 43.2% households go to Purinda Bazar for their daily purposes followed by Kalibari Bazar at 15.0% and Pachrokhi Bazar at 13.3%.

Table 3.2-16: Access to Social Market and Medical Services

Sl #	Main Market	Village Name	Distance				Total
			<1km	%	1 to 2km	%	
1	Pachrokhi Bazaar	Shingrati	0	0	6	2.0	2.0
		Khan Para	0	0	7	2.4	2.4
		Gojariapara	0	0	7	2.4	2.4
		Maizpara	0	0	10	3.4	3.4
		Sonpara	1	0.3	8	2.7	3.1
		Sub Total	1	0.3	38	12.9	13.3
2	Kalibari Bazaar	Kumar Para	13	4.4	0	0.00	4.4
		Pashchim Para	30	10.2	0	0.00	10.2
		Sonpara	1	0.3	0	0.00	0.3
		Sub Total	44	14.97	0	0	15.0
3	Purinda Bazaar	Tekpara	52	17.69	0	0.00	17.7
		Purinda	42	14.29	3	1.02	15.3
		Panchbaria	15	5.10	15	5.10	10.2
		Sub Total	109	37.1	18	6.1	43.2
4	Shornokhali Bazaar	Gutulia	0	0.00	10	3.40	3.4
5	Kandail Bazaar	Kandail	20	6.80	0	0.00	6.8
6	Patore Bazaar	Raghobdi	0	0.00	11	3.74	3.7
7	Duptara Bazaar	Pashchim Para	1	0.34	0	0.00	0.3
8	SamajKallyan Bazaar	Noapara	27	9.18	2	0.68	9.9
9	Baliachi Bazaar	Ghosh Para	0	0.00	7	2.38	2.4
10	Madhobdi Bazaar	Monehor	0	0.00	6	2.04	2.0
Total			202	68.71	92	31.29	100.0

Source: JICA STUDY TEAM

Easy access to hospitals enhances the frequency of health services taking frequency. Higher distance may hinder taking health services, which ultimately increase the health risk. Survey results have found that only 11.6% and 31.0% households are staying less than 1km and 1-2 km distance respectively from the hospitals. Conversely, significant numbers of the households (57.5%) are residing more than 3km distance from the hospitals. It will be clear if you look at each individual village separately. Major preferred area for taking health services is Pachrukhi 18.0% followed by Araihaazar 15.6%, Purinda 10.9% and Panchbaria 10.2%.

Table 3.2-17: Access to Medical Services

Sl #	Hospital Name/Location	Village	Distance						Total
			<1km	%	1 to 2km	%	>3km	%	
	Pachrukhi	Gutulia	0	0	2	0.7	8	2.7	3.4
		Shingrati	0	0	6	2.0	0	0.0	2.0
		Khan Para	0	0	7	2.4	0	0.0	2.4
		Gojariapara	0	0	7	2.4	0	0.0	2.4
		Maizpara	0	0	10	3.4	0	0.0	3.4
		Purinda	1	0.3	0	0.0	0	0.0	0.3
		Ghosh Para	0	0	3	1.0	0	0.0	1.0
		Sonpara	1	0.3	8	2.7	0	0.0	3.1
		Sub Total	2	0.7	43	14.6	8	2.7	18.0
	Gausiya	Kandail	0	0	0	0.0	20	6.8	6.8
	Patore	Raghobdi	0	0	11	3.7	0	0.0	3.7
	Araihasar	Kumar Para	0	0	0	0.0	13	4.4	4.4
		Pashchim Para	0	0	0	0.0	31	10.5	10.5
		Ghoshpara	0	0	0	0.0	1	0.3	0.3
		Sonpara	0	0	0	0.0	1	0.3	0.3
		Sub Total	0	0	0	0	46	15.6	15.6
	Satgram	Noapara	0	0	0	0.0	29	9.9	9.9
	Mobidi	Tekpara	0	0	1	0.3	26	8.8	9.2
	Podotto		0	0	0	0.0	25	8.5	8.5
	Purinda	Purinda	32	10.9	0	0.0	0	0.0	10.9
	Chanpara	Purinda	0	0	0	0.0	12	4.1	4.1
	Panchbaria	Panchbaria	0	0	30	10.2	0	0.0	10.2
	Ajharpur	Ghosh Para	0	0	0	0.0	3	1.0	1.0
	Madhobdi	Monehor	0	0	6	2.0	0	0.0	2.0
Total			34	11.6	91	31.0	169	57.5	100

Source: JICA STUDY TEAM

3.2.2. Land Acquisition and Social Safeguard Legal Frameworks

- (1) The Acquisition and Requisition of Immovable Property Ordinance-1982, and the Acquisition and Requisition of Immovable Property Act-2017.
- (2) JICA Guidelines for Environmental and Social Consideration

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

- Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
- When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
- People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their

standard of living, income opportunities and production levels to pre-project levels.

- Compensation must be based on the full replacement cost as much as possible.
- Compensation and other kinds of assistance must be provided prior to displacement.
- For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12.
- In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
- Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
- Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Land	Agricultural Land	Compensation at mouza rate+ additional 200% of mouza rate for each type of acquired land. Upon consensus between the BEZA and JICA, no transaction cost include in Replacement Cost calculation.
	Land in Urban Areas	Compensation at mouza rate+ additional 200% of mouza rate for each type of acquired land. Upon consensus between the BEZA and JICA, no transaction cost include in Replacement Cost calculation
Structure	Houses and Other Structures	Compensation determined by the DC with additional 100% of assessed value for structures, trees and crops.

It is stated in the JICA Guideline that “JICA confirms that projects do not deviate significantly from the World Bank’s Safeguard Policies.” Additional key principles based on World Bank OP 4.12 are as follows:

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

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

(3) Gap between Bangladeshi Legal Frameworks and JICA Policies

Table 3.2-18: Summary of gaps between Bangladeshi Legal Framework and JICA Environmental Guidelines

SL No.	Aspects/Issues	ARIPO-1982	ARIPO-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted in the project.
1	Avoid Involuntary resettlement	Avoidance of resettlement is not specifically mentioned in the 1982 Ordinance.	Same as ARIPO-1982	Involuntary resettlement and loss of means of livelihood should be avoided by exploring all viable alternatives.	Gaps with regard to this principle to avoid resettlement impact thru alternative options.	AEZ RF adheres to this principle - i.e., avoid resettlement impacts where feasible.
2	Minimize involuntary resettlement	The law only implicitly discourages unnecessary and excess land acquisition, as excess land remains idle and unused and lands acquired for one purpose cannot be used for a different purpose. Land that remains unused should be returned to the original owner(s).	Same as ARIPO-1982	When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.	Section 3/under 1982 Ordinance requires notification only; no consultation is required.	-Minimize displacement of people as much as possible by exploring all viable design alternatives. -If unavoidable, provide for prompt payment of just compensation, replacement cost (for lost assets and income) and rehabilitation and livelihood assistance, towards better condition than before relocation for all displaced households, regardless of (land) tenure. Unused land be returned back to the original owners through de-acquisition.
3	Mitigate adverse social impact	The mitigation measures are cash compensation only for lost assets. The complexities of resettlement are not addressed by the Ordinance.	Persons displaced from homestead or living place should resettle properly or government takes appropriate measures to resettle.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner.	Only cash-based compensation for acquired assets. The impacts of loss of land, houses and the need for resettlement are not considered.	(1) Provision for replacement value/cost for lost assets (i.e., land, structures, trees etc.) at replacement cost. (2) Separate Livelihood and Income Restoration Plan be prepared. (3) Mitigation measures/RAPs to be disclosed to the community and available in <i>Bangla</i> .

SL No.	Aspects/Issues	ARIPO-1982	ARIPO-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted in the project.
4	Identify, assess and address the potential social and economic impacts	The 1982 Ordinance requires preparation of a Land Acquisition Plan (LAP) for land acquisition and compensation purposes. However, GOB environmental rules/guidelines (1997) synchronize various applicable laws and policy frameworks of the country for early identification of impacts on biophysical, socioeconomic and cultural environment of a project intervention and their mitigation. Requires the assessment of technical alternatives, including the no action alternative to minimize adverse environmental impacts, include impact on human health and safety. EIA identifies measures to minimize the problems and recommends ways to improve the projects.	Same as ARIPO-1982	The impacts to be assessed with regard to environmental and social considerations. These also include social impacts including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.	Impact assessments are typically done in the case of externally funded projects; otherwise, a land acquisition plan is prepared for acquisition purposes. Project impacts on properties, livelihoods and employment, health and environment are discussed in IEE/EIA reports, but do not provide enough information to determine losses and basis for compensation. Existing laws do not have provision for identification of indigenous people to recognize their particular problem and inconveniences due to the project.	RF requires identification of impacts caused by displacement whether or not through land acquisition (maintaining the principle that lack of formal title to land should not be a bar to compensation and resettlement assistance), including number of affected persons. The Framework also addresses both direct and indirect impacts.
5	Prepare mitigation plans for affected persons	The Deputy Commissioners (DCs) has the mandate in their respective jurisdiction as per law to acquire land for any requiring person (public agency or private person). The requiring body requests the Deputy Commissioners for acquisition of land for their project/scheme. DCs investigate physically the requirement of land and carry out Joint Verifications of assets and	Procedures are same as in ARIPO-1982. But as per new law compensation will be assessed by enhancing additional 200% of mouza rate for land and additional 100% for structures and	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner.	Existing law and methods of assessment do not ensure Replacement Cost of property at current market price. The law does not consider resettlement or rehabilitation of affected persons or their loss of income or livelihood resources. "Market value" of property	AEZ RF requires full census and/or updating, where possible, for up-to date database. RAPs will be developed on the updated survey data Provide guidelines to ensure compensation for lost assets at full Replacement Costs and other assistance to help them improve or at least restore their standard of living at pre-project

SL No.	Aspects/Issues	ARIPO-1982	ARIPO-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted in the project.
		type of land for assessing the quantity of losses (u/s 8(1) of the law). Affected titled holders receive the assessed through minimum <i>mouza</i> rates plus 50% more on that for compulsory acquisition for land. The Deputy Commissioner follows the rate of PWD for structure, DAE for crops, DoF for trees, etc.). Affected owners have the right to appeal on acquisition or on the compensation amounts determined as per law.	other properties.		is often found low in respect of current market price, it can be raised, if appealed, by a maximum of 10 percent each time which in most case is not sufficient to match with real market price.	level. Includes special attention to gender and preparation of gender action plan.
6	Consider alternative project design	Feasibility studies including social, political, cultural and environmental impact assessments, detailed engineering surveys as basis for acquisition of private property or rights.	Same as ARIPO-1982	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	No specific laws for considering project design to avoid or minimize involuntary resettlement. Feasibility study considers cost benefit more from technical than socio cultural considerations	AEZ RF considers feasible alternative project design to avoid or at least minimize physical or economic displacement, while balancing environmental, social, technical and financial costs and benefits.
7	Involve and consult with stakeholders	The 1982 Ordinance have provisions (Section 3 and 3/2) to notify the owners of property to be acquired. Any party having any objections can appear to DC for a hearing with 15 days of notification	The 1982 Ordinance have provisions (Section-4) to notify the owners of property to be acquired. Any party having any objections can appear to DC for a hearing with 15 days of notification	Appropriate participation by affected people and their communities must be integrated in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood.	There is no provision in the law for consulting the stakeholders but the land allocation committees at district, division and central government level. People have limited scope to negotiate with the government on the price of land, but have no right to refuse acquisition	AEZ RF has provisions for community consultation and public disclosure of impacts as well as mitigation measures, including disclosure of Resettlement Action Plan. Further, grievances redress procedures involving cross-section of people, including representative of affected persons, have been established for accountability and transparency.
8	Disclose and inform APs of	The 1982 Ordinance requires serving a “notice” to be published	Same as ARIPO-1982	In preparation of a resettlement action plan,	Disclosure takes place in case of donor-funded	AEZ RF requires disclosure of Draft RAPs to the affected

SL No.	Aspects/Issues	ARIPO-1982	ARIPO-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted in the project.
	RP and mitigation measures	at convenient places on or near the property in a prescribed form and manner stating that the property is proposed to be acquired (u/section 3).		consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	projects.	communities in a form or language(s) that are understandable to key stakeholders, civil society, particularly affected groups and the general public in an open gathering. Further, updated RAPs will be disclosed based on material changes as a result of the concerns of affected families.
9	Support existing social and cultural institutions of the affected persons	No provision in the 1982 Ordinance.	Generally, any religious performing places, graveyards and cremation center should not be acquired.	The impacts to be assessed with regard to environmental and social considerations. These also include social impacts, including social institutions such as social capital and local decision-making institutions, existing social infrastructures and services.	No provision in any existing laws.	Affected households were given options for relocation in accordance with their choices and support available forms existing social networks. Host-resettlers' relation was enhanced by providing civic amenities and infrastructure services to the host villages.
10	Build capacity of the borrower(s) in IR implementation	No provision in the 1982 Ordinance.	Same as ARIPO-1982	JICA makes efforts to enhance the comprehensive capacity of organizations and operations in order for project proponents etc., to have consideration for environmental and social factors, appropriately and effectively, at all times.	There is a gap in regards to build capacity of borrower or clients of managing resettlement action plan implementation.	AEZ could follow other projects implemented by RHD, BWDB, BBA and the Railway. Special scope could be made for enhancing BEZA's capacity to manage Resettlement Action Plan implementation.

3.2.3. Assessment of Socio-economic Impacts

The project has significant impact on land, living structures and trees. In project first phase about 1714 household affected with a population of 6343. A summary of impact is presented in below table:

Descriptions	Unit	Quantity
Land required for the project	Ha.	218.84
Affected Households	Nos.	1714
Households losing structures	Nos.	11
PAPs losing land	person	6343
Affected Living & Commercial Structures	sft	6282.95
Affected Secondary Structures		
Tube – Well	No.	12
Pucca Latrine with safety tank	No.	1
Slab Latrine	No.	8
Tin Made Boundary Wall	rft	265
Affected Trees	Nos.	1055
Identified Vulnerable Households	Nos.	150
Identified Sharecropper	Nos.	23

3.2.4. Eligibility and Entitlements

Affected Households (AHs) entitled for compensation or at least rehabilitation provisions under the project of the Economic Zone project at Araihaazar, are those lost their structures, land crops, trees, and objects attached to the land and those lost income and livelihood.

BEZA and the JICA Mission agreed that time of serving notice section 3 which was on 18th September 2017 under the law (Ordinance–II of 1982 and its 1994 amendments) has been used as the cut-off date for compensation to Title holders at EZ area. And further agreed that the date of the socio-economic survey for the ARAP on 5th December 2017 has been used as the cut-off date to Non-title holders at EZ area.

BEZA and the JICA Mission confirmed that time of serving notice section 3 under the law (Ordinance–II of 2017) has not been declared as the cut-off date for compensation to Title holders at Canal and Retention pond area. BEZA intends to declare notice section 3 for the canal and retention pond area in 2019. On the other hand, both sides confirmed that the date of the socio-economic survey for the ARAP on 21st March 2018 has been used as the cut-off date to Non-title holders at Canal and Retention pond area.

AHs who settle in the affected areas after the cut-off date will not be eligible for compensation. Beside, the topographic map illustrates and detailed information of all the structures within the project site and can be used as a record. The PAPs, who need to resettle, will be given sufficient advance notice requesting to vacate premises and dismantle affected structures prior to project implementation.

Eligibility for Compensation and Entitlement Matrix

The Entitlement Matrix of the RAP is prepared in accordance with the Acquisition and Requisition of Immovable Property ordinance-1982 of Bangladesh and JICA Guidelines for Environmental and Social Consideration on involuntary resettlement. As per ARIPO-1982, the Deputy Commissioner could enhance additional 50% of mouza rate in assessing of land price. As this provision found insufficient and inadequate, the Government of Bangladesh enacted new Acquisition and Requisition of Immovable Property Act-2017 (Act 21 of 2017) ensuring additional 200% of mouza rate as market price.

Extensive consultation was carried out through series of Focus Group Discussion and Public Consultation Meeting to obtain their perception and views on compensation of acquired properties. In all consultation events, the land owners demanded the amount of compensation to be equivalent to the compensation under the new law even though the first phase of the project followed ARIPO-1982 for land acquisition. After a number of discussions with BEZA to determine compensation, BEZA has agreed to adopt the additional 200% as per new law to the amount of compensation to ensure the full replacement cost will be compensated as per JICA guideline. The RAP also benefitted from other previous and ongoing Resettlement Action Plan/Resettlement Plan in Bangladesh

Loss Item 1: Loss of Agricultural Land			
Persons Entitled	Entitlements	Application Guidelines	Additional Services
Legal owner/ titleholders as identified by Deputy Commissioner (DC) in the process of CCL payment.	Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. BDT 650/decimal as one year crop compensation. The cultivators will be allowed to harvest the standing crops free of cost.	Replacement Cost (RC) will be recommended by PVAC enhancing additional 200% of mouza rate. DC will pay Cash Compensation under Law (CCL) for the land. If Replacement Cost is higher than CCL the differential (Top-up) between RC and CCL will be paid directly by BEZA with the assistance of implementing Firm/NGO.	Legal owners will be assisted by Firm to organize legal documents in support of their ownership. Implementing Firm will identify, assess and calculate loss and entitlement of female owners and co-sharers through share determination at the field upon receipt of CCL payment data from DC office.
Implementation Issues: Persons entitled will be informed of the details about the land acquisition and compensation policy, process, resettlement package and payment procedures. DC will determine and pay the price of acquired land with 50% enhancement of mouza rate as CCL. With assistance from RAP implementing NGO/Firm, BEZA will pay the residual additional 150% of Replacement Cost (RC) For khas land (if any, DC is the owner at respective districts on behalf of the government), CCL will be the assessed as the market price without 50% enhancement and further additional.			
Loss Item 2: Loss of Homestead, Commercial Land and Common Property Land			
Persons Entitled	Entitlements	Application Guidelines	Additional Services
Legal owner/ title holders as identified by DC in the process of CCL payment.	Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. BDT 10000/decimal as Land Development Allowance for developing homestead land.	Replacement Cost (RC) will be recommended by PVAC enhancing additional 200% of mouza rate. . DC will pay Cash Compensation under Law (CCL) () for the land The differential (Top up) between RC and CCL will be paid directly by BEZA with the assistance of implementing Firm/NGO.	Legal owners will be assisted by implementing Firm to organize legal documents in support of their ownership. NGO/Firm will identify loss and entitlement of female owners and co-sharers through share determination at the field upon receipt of CCL payment data from DC office.
Implementation Issues: Persons entitled will be informed of the details about the land acquisition and compensation process, resettlement package and payment procedures. DC will determine and pay the price of acquired land with 50% enhancement of mouza rate as CCL. With assistance from implementing NGO/Firm, BEZA will pay the residual additional 150% of Replacement Cost (RC).			

For Khas land (if any, DC is the owner at respective districts on behalf of the government), CCL will be the assessed as the market price without 50% enhancement and further additional.

Loss Item 3: Loss of Water Bodies (Ponds, Both Cultivated and Non-Cultivated)

Persons Entitled	Entitlements	Application Guidelines	Additional Services
Legal owner/ titleholders as identified by (DC) in the process of CCL payment.	Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. . BDT 400/decimal to be considered as one year compensation for fish cultivation. The fish cultivators will be allowed to catch/harvest all the fishes free of cost before taking possession.	Replacement Cost (RC) will be recommended by PVAC enhancing additional 200% of mouza rate. DC will pay CCL (Cash Compensation under Law) for the pond. The differential (Top up) between RC and CCL will be paid directly by BEZA with the assistance of implementing Firm/NGO.	Legal owners will be assisted by FIRM to organize legal documents in support of their ownership FIRM will identify loss and entitlement of female owners and co-sharers through share determination at the field upon receipt of payment data from DC office.

Implementation Issues:

Persons entitled will be informed of the details about the land acquisition and compensation policy, process, resettlement package and payment procedures.

DC will determine and pay the price of acquired land with 50% enhancement of mouza rate as CCL. With assistance from implementing NGO/Firm, BEZA will pay the residual additional 150% of Replacement Cost (RC). For Khas land (if any, DC is the owner at respective districts on behalf of the government), CCL will be the assessed as the market price without 50% enhancement and further additional.

Loss Item 4: Loss of All Types of Structures With or Without Title to Land

Persons Entitled	Entitlements	Application Guidelines	Additional Services
Legal owner/ titleholders as identified by DC Or as identified through the JVC and census/IoL.	Cash Compensation as Replacement Cost (RC) for structures with additional 100% of assessed value determined by the DC with the assistance of PWD. BDT 15/sft, but not exceeding BDT 8000 as Transfer Grant (TG) for shifting affected structures. BDT 20/sft, but not exceeding BDT 10000 as Reconstruction Grant (RG) for reconstruction of affected structures. BDT 10000 for each HH as Re-installation Grant of utility services (electricity, gas, tube-well and latrine). As structure demolition grants, the owners will be allowed to take away all the salvageable materials free of cost within the declared date of BEZA.	Replacement Cost (RC) will be recommended by PVAC enhancing additional 100% of assessed value of structures. • Applicable to all structures located within the project RoW at the cut-off date. • DC with the assistance of the PWD will assess and finalize the rate of CCL for affected structures. • DC will disburse CCL. • BEZA will provide other resettlement benefits directly or with the assistance from implementing Firm.	Firm will assist the EPs in relocation/reconstruction and compensation disbursement process.

Implementation Issues:

Firm will identify the structures loser EPs according to Joint Verification Survey and assess and calculate

structures type and amount of structures to be displaced. DC will determine the value for structures with assistance of PWD and pay the value for structures with 50% enhancement as CCL. With assistance from implementing NGO/Firm, BEZA will pay the residual additional 50% of Replacement Cost for structures. Payment of benefits will be made following the Administrative Manual approved by BEZA assisted by implementing NGO/Firm.			
Loss Item 5: Loss of crops grown in the acquired areas without lease agreement, informally Without Title to Land.			
Persons Entitled	Entitlements	Application Guidelines	Additional Services
Socially recognized land users/farmers or share-croppers without titles identified by census/IOL.	Dislocation Allowance at BDT 650/decimal/year for 1 (one) year. EP will be allowed to take away residual crops/stock free of cost. Training, additional cash grants, micro-credit etc. will be provided through implementing Firm.	EP must be a recognized land user as identified by census. Crops specific average price rate of Department of Agricultural Extension (DAE). PVAC will verify eligibility.	EP will be brought under LRP. Involvement of qualified and eligible affected HH member for construction work in the project.
Implementation Issues: Compensation to EPs must be paid fully one month before start of civil works to give time to EPs to harvest or take the residual crops. Payment of resettlement benefits will be made following the Administrative Manual approved by BEZA. The Grievance Redress Committee (GRC), if any claims and grievances will settle.			
Loss Item 6: Loss of Trees With or Without Title to Land			
Persons Entitled	Entitlements	Application Guidelines	Additional Services
Legal owner/ titleholders as identified by DC Socially recognized owners of trees grown on public or other land, as identified through census. Owners of trees such as Forest Department, Cooperatives society, Zilla Parishad, City Corporation, Lessee on public land	BDT 5600 for each large, BDT 3500 for each medium, BDT 1500 for each small and BDT 150 for each plant of fruits trees respectively. BDT 10800 for each large, BDT 6300 for each medium, BDT 3000 for each small and BDT 80 for each plant of timber trees respectively. BDT 250 for each banana trees. BDT 250 for each bamboo. Owners of the trees will be allowed to take away the salvageable materials free of cost within the BEZA declared date.	PVAC will determine CCL for trees and fruits in accordance with the Department of Forest.. Applicable to all trees and plants located within the project RoW at the cut-off date. DC will pay CCL as applicable for trees/plants. If DC does not pay, then BEZA will pay compensation for trees with assistance of NGO/Firm.	Firm to explain resettlement policies regarding compensation for the trees of different categories and size and make the EPs aware that they could take the timber and fruits free of cost
Implementation Issues: Standard rates for trees and fruits of different species available with the Department of Forestry/Horticulture will be considered by DC in calculating the CCL. PVAC will finalized the market price of trees and fruits with assistance from Department of Forest/Horticulture and enhance it by 100% to fix up under Cash Compensation under Law (CCL) Forest Department, Cooperatives society, Zilla Parishad, City Corporation will not be considered for resettlement benefits. The Firm will provide guidance in plantation and post-plantation care.			
Loss Item 7: Loss of Income from sharecropping and fishing (non-title holders)			
Persons Entitled	Entitlements	Application Guidelines	Additional Services

Share croppers cultivating land or seasonal fishermen within the project RoW, as identified through census and SES.	Transitional allowance of BDT 5000.00/month for 3 months. EPs will be eligible for Skill Development Training on suitable income generating activities and micro-credit to be provided	BEZA will pay the entitlement to the EPs with the help of NGO/Firm The net income per month will be assessed through census and to be finalized by the PVAC.	Vulnerable EPs will be brought under income generating program with assistance of Firm under LRP. Implementing Firm will assist in relocation and reconstruction.

Implementation Issues:

Census will identify (records, Nos. and category)

Eligibility to be based on businessmen identified by the census

Firm will assist BEZA to provide Business Restoration Grant and others.

Compensation must be paid one month before EP dismantles and removes the structures as per works requirements.

Item 8: Grants to Vulnerable AHs

Persons Entitled	Entitlements	Application Guidelines	Additional Services
Vulnerable households (Poor, female headed HHs, Elderly headed HHs, disabled/physically challenged, Indigenous, and Homeless) will be considered as vulnerable HHs.	BDT 15000 for each HHs as Vulnerability Allowance (VA) Provision for one member of the vulnerable household for Skill Development Training. BDT Tk. 6000 thousand training Allowance including during the training period No AH will get training allowance, if their family members do not participate to the training.	The EPs will be identified as per the census. The entitlement will be provided to the identified EPs by BEZA with the help of Firm Costs of training and trainer will be borne from BEZA with the help of Firm	FIRM will motivate the EPs for appropriate skill training EPs will be brought under LRP with suitable trainings Involvement of qualified and eligible EPs in construction works

Implementation Issues:

Vulnerable households losing income from business, employment and livelihood resources will be assessed by the Firm

Identified Vulnerable EPs will be covered under the skill training program and the allowances will be paid following the entitlement package

Loss Item 9: Unforeseen Adverse Impacts

Persons Entitled	Entitlements	Application Guidelines	Additional Services
Households/ Business Structures persons affected by any unforeseen impact identified during RAP implementation	• Entitlements will be determined as per the Entitlement Matrix	• The unforeseen impacts will be identified through special survey by the Firm as directed by BEZA • BEZA will take necessary action based on GRC decision • The entitlements will be approved by BEZA • The payment will be made by BEZA with the help of Firm	• Affected persons will consult with Firm. • Firm will assist the concerned persons for solving those issues.

Implementation Issues:

- The unforeseen impacts and displaced persons will be identified with due care as per policy of the project.

Compensation and Benefits Payment Mechanism

BEZA will ensure that the properties (land, structures and other assets) to be displaced for the Economic Zone project will be compensated at full replacement cost, determined by legally constituted bodies like the Property Valuation Advisory Committee (PVAC). The principle for determining valuation and

compensation for assets, incomes, and livelihoods is replacing the loss of affected assets and restoring the loss of income and workdays experienced by the displaced households. Income Restoration and Livelihood Assistance will be provided to vulnerable households and business enterprises as well as non-title holders.

This RAP ensures Replacement Cost for land will be paid by BEZA. AHs will receive compensation from BEZA assisted by the INGO/Firm according to the replacement value. Other assistances, as indicated in the RAP (entitlement matrix) will be provided by the BEZA.

The legal owners of acquired land as identified by Deputy Commissioner in the process of CCL payment are eligible to receive Replacement Value and other resettlement assistance from BEZA.

Box-1: Compensation and Resettlement Procedures for Titled Holders.

Deputy Commissioner's (DC) Compensation to Titled Holders (TH)
1. BEZA produced and prepared Land Acquisition Plan (LAP) and submit to the Deputy Commissioner (DC). 2. The DC will carry out a feasibility study of the acquisition and submit the report to the Ministry of Land (if the land is more than 16.67 acres) or to the divisional commissioner (if the land is less than 16.67 acres) for approval. 3. Upon approval of the LAP from Ministry of Land (MOL) or from Divisional Commissioner, the DC will issue notice under section 3 of ARIPO to the recorded owner of the affected property 4. Representative from the acquiring body (DC) and requiring body (BEZA) will conduct a joint verification survey of the affected property within 3 days of serving notice u/s-3 and wait 15 days to receive any complain from land owners. 5. The DC will issue notice u/s 6 to entertaining claims from affected persons. 6. On the basis of the joint verification survey data, the DC will request valuation of structures, trees and crops from the Public Works Department (PWD), the Forest Department and Agriculture Department, respectively. 7. The DC will collect recorded land price from the concerned Sub- register's office from the last 12 months previous to the date of notice under section 3. 8. After receiving the rates from PWD, Forest and Agriculture Departments, the DC will prepare an estimate, adding 50% premium where applicable and send it to the requiring body (BEZA) for placement of fund within 60 days. 9. The DC will prepare the award for compensation in the name of recorded owner. 10. Upon placement of fund, the deputy commissioner will issue notice u/s 7 to the titled owners for receiving cash compensation under law (CCL) within 15 days from the date of issuing notice u/s 7. 11. The affected persons will need to produce record of rights to the property with updated tax receipt of land, declaration on non-judicial stamp; photograph etc. to the DC office with the claim. 12. Upon fulfillment of documentation requirements, the DC office disburses CCL in the office or at field level issuing prior notice to the landowners.
BEZA/INGO will: 1. Assist the TH and Non-Title holders in opening bank account in their names (if necessary). 2. Prepare ID card with photograph of the affected titled holders based on the CCL award list. These will be attested by concerned local administration representatives. 3. Prepare entitlement files for each affected TH and Non-Title holders. 4. Prepare the list of sharecroppers (Non-Title holders) certified by identified land owner. 5. Prepare the list of affected TH losing land

6. Prepare necessary documents and papers (payment debit voucher, etc.) to disburse “top ups” (i.e. difference between replacement cost and CCL) as well as other resettlement benefits (income loss allowances, transfer, reconstruction and vulnerability grants) to TH and Non-Title holders.
7. Distribute checks to the titled owners in a public place in the presence of concerned local administration representatives.

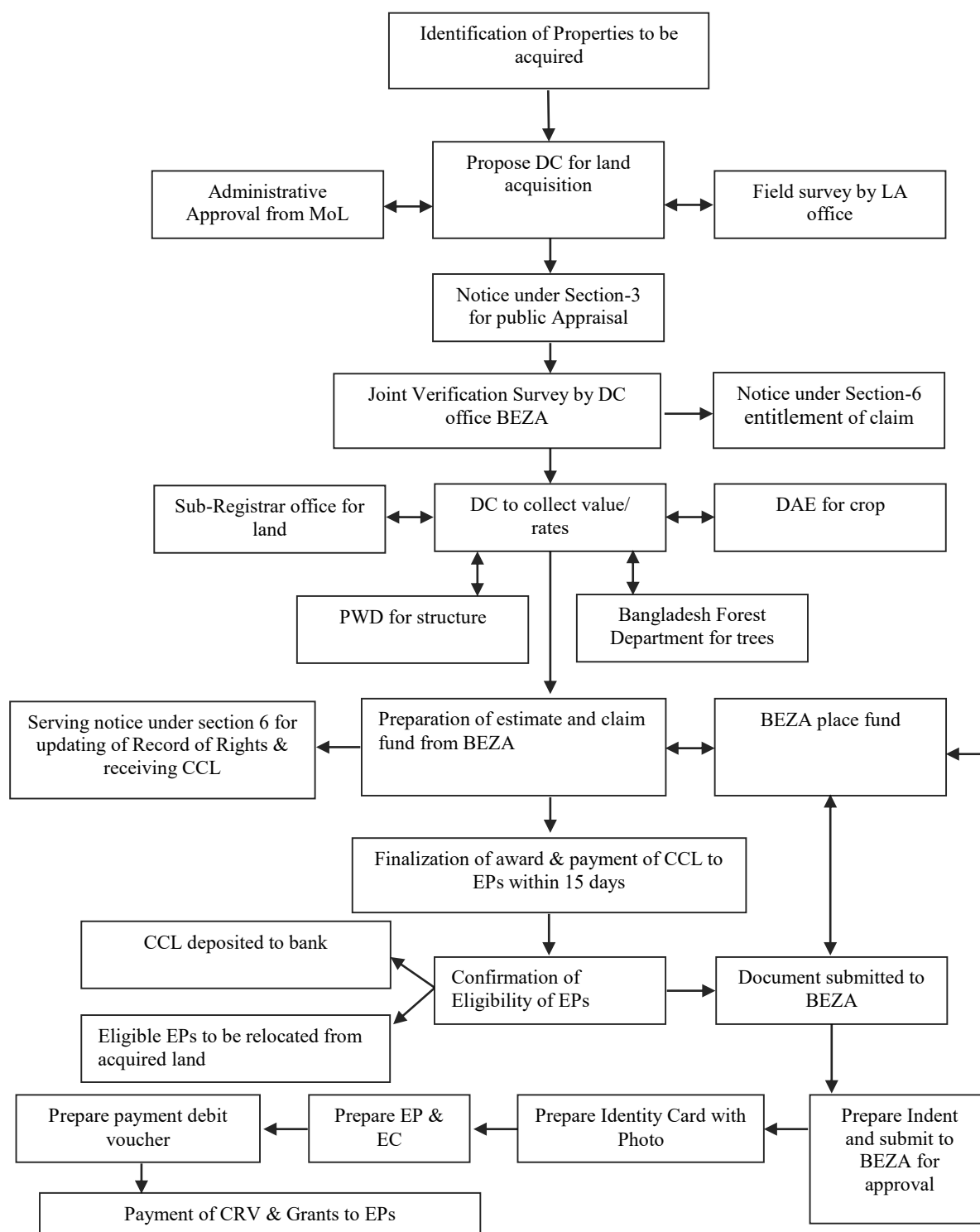
Steps to be followed in paying due compensation and other benefits for titled AHs

- The RAP implementing NGO will prepare a personal file and entitlement card for each AP.
- The NGO will assist the APs in opening bank accounts in their names.
- The NGO will issue ID card with number, name, and photograph of the APs.
- The ID card will be jointly signed by the BEZA and NGO representatives and the photograph will be verified by the concerned ward councilor /UP chairman.
- The NGO will assist BEZA in preparing payment debit vouchers as per EP file and EC card, and the BEZA will disburse account payee cheque in a public place or the office of the ward councilor /UP chairman after issuing prior notice to the AHs.
- The NGO will provide the APs a copy of the signed receipt of their compensation amount.

After payment of compensation, APs will be allowed to take away the trees and salvaged materials from their dismantled houses and shops, and no charges will be levied upon them for the same. A notice to that effect will be issued by BEZA to take away salvaged materials within 30 days from the date of payment. Payment of compensation and benefits will be made at least 1 month prior to removal of the structures and trees from the RoW so that they get sufficient time to dismantle and remove all salvageable material for rebuilding of houses and re-establishment of businesses elsewhere.

Compensation and Resettlement Assistance Payment Mechanism

Compensation and Resettlement Assistance payment mechanism is shown in following chart. Selection of project site, demarcation of acquired land, CCL payment system as well as resettlement assistance payment mechanism is shown in figure below:



CRV: (Cash for Replacement Value) CCL: (Cash Compensation under Law) CRV: (Cash for Replacement Value), CMV: (Current Market Value) EC: (Entitled Card)

Figure 3.2-3: Compensation and Resettlement Assistance payment mechanism

3.2.5. Income and Livelihood Restoration Program

Impact on PAPs

Affected Person will experience loss of livelihood sources mainly due to loss of agricultural land and agricultural productive base. The Affected Persons compel to surrender their land due to the project experienced temporary disturbance in their income and working habit. A significant numbers (327) of Affected Households will become landless due to the land acquisition for the project. They can't purchase replacement land with the compulsory compensation and other resettlement assistance as there is acute land scarcity in the project area and price of land sky-rocketing every day. They might be go into the impoverishment situation due to the project.

In addition sharecroppers, seasonal fishermen, and tenants of agricultural land also have impact on their income and thus have also been included in the Income and Livelihood Restoration Program (ILRP). Total 1549 households experienced direct impact on their income due to land acquisition for the project. Out of 1549 Project Affected Households (PAH), 150 AHs were identified as vulnerable households including 25 women headed households. A total of 23 persons identified as sharecroppers, who are engaged in agri-farming on lease and informal agreement with the land owners in the project area. All of them may experience impoverishment due to loss their income base in project area. Identified vulnerable and sharecroppers and would be landless. Ahs will come under Income and Livelihood Restoration Program.

Measures of ILRP

Provisions for Income and Livelihood Restoration program focused on improvement or at least restoration of livelihood and income of all APs. The measures consider diminishing of income and disruption of livelihood earning due to the project. In addition to provided compensation at full replacement cost, appropriate strategies has been designed for continuing their income earning opportunity and improve or restore living standard to at least at pre-project level. All affected households who lost their livelihood resources and places of generating income due to project intervention will be supported with skill development training, business assets and job placement priority in AEZ. Cash allowances will be provided to supplement the lost income and workdays to the identified vulnerable households. These will enable them to mainstreaming the transitional period of disturbance to sustain their previous sources of livelihood or taking alternative source.

- Compensation for land at full replacement cost prior to relocation;
- Compensation for trees and structures at current market rate before vacating land for construction;
- Special allowances for supporting lost income and weekdays during the transitional period after relocation;
- Special assistance, appropriate to vulnerable groups such as women and very poor households.
- Income and Livelihood Restoration program must be conceived as development program.
- As it expecting that the project will have huge opportunity for improvement of national economy, then those who are lost their land and income resource base will be benefited by the project.

The allowances and entitlement targeting the restoration of income and rehabilitation of Affected Household are as follows:

Special Allowance for Vulnerable Groups:

Affected Households (AHs) below the poverty line and identified through census will be provided with one time special allowance of BDT 15,000 In addition to applicable compensation other allowance described above.

Special Allowance for Sharecroppers and fishermen:

As sharecroppers and seasonal fishermen have been identified through surveys, affected wage losers identified through census and SES will be provided with one time transitional allowance at BDT 5000/month for 3 months.

Livelihood Restoration Training and Grants:

AHs including sharecropper and fishermen will receive skill development trainings and grants to restore their livelihood. Livelihood and income generation training will help them to use the compensation money in the best possible ways.

Involve NGO/Firm for Implementing ILR Program

As a part of Resettlement Action Plan (RAP) implementation, BEZA will appoint and engage either same or separate NGO/Firm with specific terms and responsibilities to implement Income and Livelihood Restoration Plan (ILRP). The ILRP implementing NGO/Firm with assistance from BEZA and RAP implementing NGO/Firm will undertake and implement specific task in regards to Income and Livelihood Restoration activities.

Identifying and preparing list of PAPs for ILRP

The ILRP implementing NGO/Firm will create a database of young, qualified and capable PAPs. According to the census and SES carried out by JICA STUDY TEAM, the ILRP implementing NGO/Firm will identify potential and capable persons for skill development training on various income generating activities. The ILRP implementing NGO/Firm with assistance from RAP implementing NGO/Firm will create potentials capable and qualified PAPs among the affected households with name, father/husband's name, age, qualification and suitability for expected occupation, business and enterprise choices.

Based on census and SES, it was learned that a total of 39 of PAPs finished their education at different level. But still they were found unemployed. About 852 PAPs were found studying at different level of education. Among them 609 are male and 243 are females. A total of 116 out of 852 are studying at tertiary level and others are at secondary and higher secondary level. It is expected that all of them will entered into work or job market within next 2-5 years. The ILRP implementing NGO/Firm will identify this segment of PAPs and recommend for job placement based on their qualification and capability in the AEZ.

Training

Based on occupation choice survey, the ILRP implementing NGO/Firm will take all necessary action in regards to skill development training. The ILRP implementing NGO/Firm will prepare and develop appropriate training manuals, identify potentials candidates for training, conduct training and evaluate skill level of trained persons for business or enterprise development. The training curriculum and approaches will be approved by BEZA. Appropriate training module will be developed by ILRP Implementing NGO/Firm suitable for PAPs including sharecroppers and fishermen. Identified sharecroppers, capable and efficient one member from each vulnerable households and landless or would be landless households participated in skill improvement training on various income generating activities.

Table 3.2-19: Suggested Training for PAPs

Training	Duration of the course	Major Training Contents	Training Outcome
Cow Rearing	06 days	Efficient livestock rearing methods, including any technological	Improve basic idea and skill level for cow rearing. Trained PAPs will be able

Training	Duration of the course	Major Training Contents	Training Outcome
		developments that can be incorporated into current cow rearing activities. Practical training and breed selection, feed, housing, disease control etc for cow. Training on income and expenditure.	to rearing cow commercially. PAPs will get sufficient knowledge and skill on technical issues and it applicability. Through skill improvement training PAPs will become more confident.
Poultry Rearing	06 days	Efficient poultry rearing methods, including any technological developments that can be incorporated into current chicken, duck rearing activities. Training on rearing different types of poultry. Practical training and breed selection, feed, housing, disease control, etc. for chicken, duck.	Improve basic idea and skill level for poultry rearing. Trained PAPs will be able to rearing poultry commercially. PAPs will get sufficient knowledge and skill on technical issues and it applicability. Through skill improvement training PAPs will become more confident.
Handicrafts and Tailoring	6 days	Training on different handicrafts such as boutique, tailoring, designing, toys, showpieces etc. and market linkages	Improve basic idea and skill level for Handicrafts and Tailoring rearing. Trained PAPs will be able to running Handicrafts and Tailoring shops commercially. PAPs will get sufficient knowledge and skill on technical issues and it applicability. Through skill improvement training PAPs will become more confident.
Fish Cultivation	6 days	Efficient fish cultivating methods, including any technological developments that can be incorporated into current fish species and cultivating activities. Training on cultivating different types of fish. Practical training and breed selection, feed, housing, disease control, etc. for fish.	Improve basic idea and skill level for fish cultivation. Trained PAPs will be able to cultivate fish commercially. PAPs will get sufficient knowledge and skill on technical issues and it applicability. Through skill improvement training PAPs will become more confident.
Basic Computer Training	30 days	Basic knowledge on computing, data entry, data analysis on MS word, Excel Auto Cad, STRATA, SPSS Internet and online activities including outsourcing etc.	Training on basic computer will create some self-employed youths. Through this course, a new intervention in livelihood activities will be added in affected communities.
Beef Fattening	6 days	Efficient livestock rearing methods, including any technological developments that can be incorporated into current cow rearing activities. Practical training and breed selection, feed, housing, disease control etc for cow. Training on income and expenditure.	Improve basic idea and skill level for Beef Fattening. Trained PAPs will be able to rearing cow and produce meat commercially. PAPs will get sufficient knowledge and skill on technical issues and it applicability. Through skill improvement training PAPs will become more confident.

Employment opportunities / Job Placement in AEZ

The ILRP implementing NGO/Firm will develop and maintain liaison with BEZA and potential investor in AEZ to find out job opportunity and will recommend qualified PAPs for employment placement. The ILRP implementing NGO/Firm will create and update database of potentials job seekers from PAPs with their educational qualification, knowledge and skill and efficiency level and forward to the investors/company in the AEZ with recommendation of BEZA. Project Affected Persons (PAPs) will

get preference in employment in the forthcoming industrial ventures in AEZ according to their qualification, experience and suitability. Gender Consideration

Due attention has already been paid to women headed household and female income earner. In the project area, 25 female headed household was identified as vulnerable through census. The identified women headed vulnerable AHs will get compensation and Income and Livelihood Restoration assistance as outlined in RAP. Moreover, qualified and suitable female will get preference in employment into the companies will be established in the AEZ.

3.2.6. Grievance Mechanism

Objectives

BEZA will establish Grievance Redress Mechanism (GRM) to voice and resolve social and environmental concerns linked to the project and ensure greater accountability of the project authorities towards all project affected persons (PAPs). The complaints and grievance redress mechanism will allow PAPs for appealing any disagreeable decision, practice or activity arising from census, IOL, land acquisition and from construction related activities. PAPs will be informed fully about their rights and of the procedures for addressing grievances/complaints whether verbally or in written during consultation, census and at the time of compensation disbursement. The project planning and implementation will be cautious enough to avoid or prevent grievances through advance counseling and technical assistance to the PAPs in the census, IOL, SES and compensation collection process. This will be ensured through careful RAP design and implementation, by ensuring full participation and consultations with PAPs, and by establishing extensive communication and coordination between the affected communities, the BEZA, and local governments in general

Grievance Redress Committee

BEZA will form Grievance Redress Committees at Union and project level to resolve complaints or grievances formally through community participation. The GRC at union level will be composed of five members who include representative from BEZA, Union Parishad Chairperson, two representatives including one woman from PAPs and Implementing NGO/Firm representative. Representative of BEZA chaired the committee while INGO/Firm representative will act as member secretary of the committee.

The project level GRC will be composed of 3 member which include the Project Director, Team Leader of INGO/Firm and Social Safeguard Specialist of BEZA. The project director will chair the committee while Safeguard Specialist will act as member secretary of the committee.

Legitimacy of GRC

The Project Director will form required numbers of committees with specific terms of reference and forwarded those to the respective ministry for approval. The ministry enacted these committees through a gazette notification. Any complaints on ownership title or other suits falling under arbitration and which is to be resolved by the judiciary system will not be within the purview of the GRCs.

Scope and Jurisdiction of GRC

The GRC will be activated with the responsibilities to resolve resettlement and compensation related grievances/issues not to be addressed under legal suits in the courts. Scope of work and jurisdiction of GRC is as follows:

- The GRC will receive grievances, complaints or disputes through implementing NGO/Firm from

affected persons in written.

- The INGO/Firm will assist Affected Person to lodge/register any resettlement grievance, complaints or disputes over ownership title of acquired land/assets to the GRC.
- The GRC will review, consider and resolve grievances related to social/resettlement and environmental mitigation during RAP implementation.
- Any grievance, complaints and problems should ideally be resolved on the first day of hearing or within a period of one month, in case of any complicated one requiring additional and field investigation.
- Grievance of Indirectly affected persons will also be reviewed by GRC.
- GRC decisions should ideally be arrived at through consensus, failing which resolutions will be based on majority vote.
- Any decision made by GRC must be within the purview of social, resettlement, and environmental policy framework.
- The GRC will not deal with any issues/matters pending in the court of law. But if the parties agree on through written appeal, then GRC can only mediate for withdrawing of litigation.
- Other than disputes relating to ownership right under the court of law, GRC will review grievances involving all resettlement benefits, relocation and other assistances. However, the major grievances that might require mitigation include:
 - Dispute over APs not enlisted in the original IOL or census.
 - Losses not identified correctly.
 - Compensation/assistance not as per entitlement matrix.
 - Delay in disbursement of compensation/assistance.
 - Disputes over ownership
 - Improper distribution of compensation/assistance in case of joint ownership
- A minimum three (3) members shall form the quorum for the meeting of GRC.

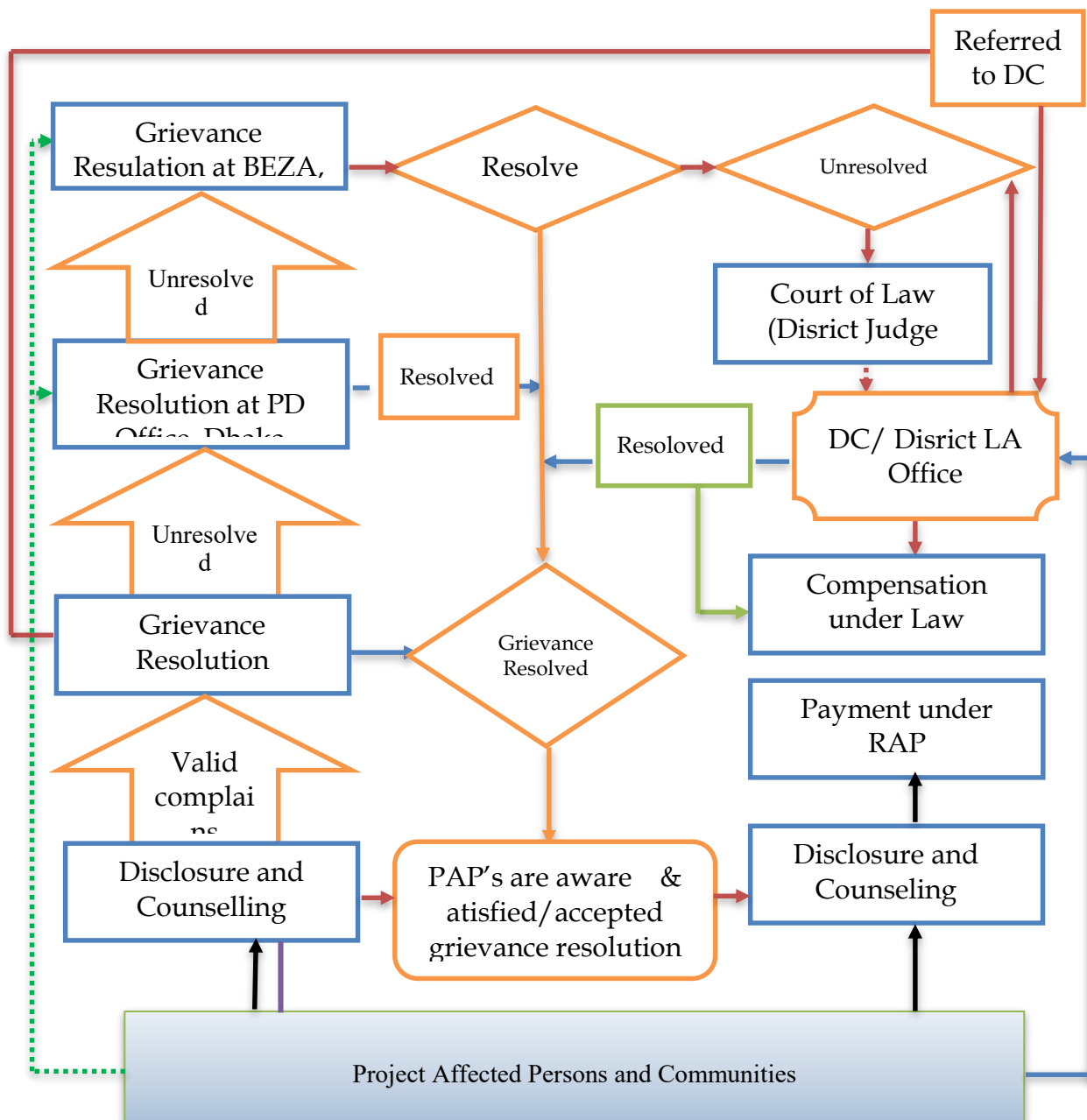


figure 3.2-4: Grievance Redress Mechanism Chart

Disclosure and Procedures

Upon mobilization of Resettlement Action Plan (RAP) implementing NGO/Firm, BEZA will form Grievance Redress Committee. Prior to the payment of compensation or implementation of any assistance, BEZA and its representative will make sure to the PAPs about the establishment of grievance redress mechanism and the process. All relevant contact information and the grievance redress steps posted at every UP office involved as well as INGO/Firm office. The poster will be in local language and posted as soon as the RAP implementing NGO/Firm is mobilized. The BEZA representative will check at least every month to ensure that the posters are properly displayed and contact instructions and numbers are clearly provided.

GRC meeting will be held in the respective field office of BEZA or INGO/Firm or any other location as agreed by the Committee and also convenient to the Project Affected Persons (PAPs). If needed, GRC members may take field visits to verify and review the issues at dispute, including ownership/shares, reasons for any delay in payments or other relevant matters.

The INGO/Firm and BEZA will try as much as possible to address grievances locally before these are submitted to the GRC. If grievances are not resolved, the following procedures and timeline are described in below Table:

table 3.2-20: Steps of GRM

Steps		
Step 1	Counseling	Complaints and grievances from displaced person will first be heard during personal contact and focus group meetings at the village level. The RAP implementation operatives on site will counsel PAPs for gaps in information about the policy and eligibility for compensation and resettlement assistance. If the case/complaint found outside the mandate of GRC, the RAP implementing operatives will advise the aggrieved PAPs to lodge their complaints in the court of law at the district level. If the case/complaint is within the jurisdiction of GRC, the RAP implementing operatives will advise the aggrieved APs to formally lodge their complaints with the GRC.
Step 2	GRC Resolution	Member secretary of GRC will scrutinize the complaints and prepare case file for hearing and resolution. A formal hearing will be held before GRC at a date fixed by the member secretary of GRC in consultation with the chair and other aggrieved APs. On the date of hearing, the aggrieved PAP will appear before the GRC at a place set in consultation with the PAPs and BEZA and produce proof in support of his/her claim. The member secretary will note down the statement of the complainants and documents with all proofs. The decisions from majority of the members will be considered final from the GRC and will be issued by the Convener and signed by other members of the GRC. The case records will be updated and the decision will be communicated to the complainant APs by the member secretary of GRC at the village level.
Step 3	Decision from Project Director Office, BEZA	If any aggrieved PAP is not satisfied with the GRC decision, the next option will be to lodge grievances to the Project Director of the Araihaaz Economic Zone project at Dhaka within two (2) weeks after receiving the decision from GRC. The AP, in the complaint, must produce documents supporting his/her claim. The PD with the assistance from the Resettlement Specialist on the supervision consultants will review the proceedings of the GRC hearing and convey its decisions to the aggrieved PAPs within two (2) weeks after receiving the complaint.

Steps		
Step 4	Decision from PD	Should the resolution from Project Director office fail to satisfy the aggrieved PAPs, they will facilitate to forward their case for further review and settlement with the office of the Chairman of BEZA at Dhaka. The aggrieved PAP will submit the petition with all documentary evidences of complaints and the resolution proceeding of step 2 and 3 within two weeks after the decisions from the Project Director Office is received.
Step 5	Decision from Court	Should the grievance redress system fail to satisfy aggrieved APs, they can go/pursue further action by submitting their case to the appropriate court of law at the district level.

Documentation and record keeping

All GRC documents will be maintained by INGO/Firm for review and verification by supervision consultants and JICA. Implementing NGO or BEZA field offices will act as secretariat to the GRCs. As a result, the record will be up-to-date and easily accessible on-site.

3.2.7. Institutional Framework

Deputy Commissioner's Office

The Deputy Commissioner (DC) has the key role in the RAP implementation process. The DC has the legal responsibility of acquiring land and paying compensation directly to the AHs as per the Acquisition and Requisition of Immovable Property Ordinance 1982 (Ordinance II of 1982) and subsequent amendments made there under. DC has access to official record and the Legal/Administrative authority for determining market price of acquired and updating ownership title of land for Cash Compensation under Law (CCL). The District Land Acquisition Officer (DLAO) will assist and support Deputy Commissioner in land acquisition process. The Deputy Commissioner will conduct joint verification to assess quantum of acquired property and estimate cost for acquisition. The DC offices will receive funds from BEZA for payment of compensation to the directly affected persons. Participation of DC is necessary in project area meeting to avoid any unwanted circumstances related to law and order. Similarly, DC's interventions/assurances will be required in matters such as disposal of land ownerships disputes, allotment of surplus land for construction of common properties.

Project Director Office

Bangladesh Economic Zone Authority (BEZA) has established a Project Management Unit (PMU), headed by a Project Director (PD) who is responsible for the overall execution of the Project. The Project Director will perform as Chief Resettlement Officer (CRO) assisted and supported by an Assistant Manager and Social Development Specialist. The PD will hire and appoint an experienced NGO or Firm for implementation of the Resettlement Action Plan if BEZA requires external organization for assistance.

The PD/CRO will be responsible for:

- Overall resettlement and rehabilitation work.
- Call and chair regular coordination meeting between PMO-SIU, INGO
- Coordinate the implementation of Resettlement & Rehabilitation activities with Head Office and Field office.
- Appoint NGO for implementation of RAP and M&E consultant for monitoring and evaluation.

- Ensure conducting resettlement training program for Executing Authority staff for capacity building as well as field level NGO and partner agencies capacities.
- Approve micro plan prepared by implementing NGO.
- Monitor monthly progress of RAP implementation.
- Guide staff of BEZA, INGO and M&E agency on policy related issues during implementation; and
- Ensure timely release of fund for Resettlement & Rehabilitation activities.

Safeguard Implementation Unit

The executing agency (here is BEZA) will implement the RAP through setting a Safeguard Implementation Unit (SIU), headed by the Assistant Manager as Resettlement Officer under the PMU. The SIU, under the Project Director will accomplish day-to-day activities pertaining to resettlement/compensation issue and ILRP with the active support of the NGO. The concerned Resettlement Officer (RO) with the status of Assistant Manager at the SIU, in case of need will work as the Convener of the Property Valuation Advisory Committee (PVAC). The Assistant Manager will act as the Convener of the Grievance Redress Committee (GRC) and the Resettlement Advisory Committee (RAC).

The SIU, with the assistance of resettlement implementation NGO/Firm, will coordinate and manage compensation claim and other relevant matters of the AHs, disburse due compensation and other resettlement benefits, and ensure unhindered AHs access to the program. The SIU will carry out the following specific tasks relating to RAP finalization and its implementation:

- Coordinate necessary arrangement to support RAP finalization and implementation activities, *i.e.* appointing GRC and PVAC members, etc.;
- Submit updated RAP to JICA, prepared by the consultant for review, endorsement, and disclosure before RAP implementation;
- Ensure meaningful consultations and stakeholder participations during RAP updating and its implementation;
- Perform the overall responsibility of planning, management, monitoring, and implementation of the program;
- Ensure availability of necessary budget for complying with all necessary activities;
- Synchronize compensation payment activity and handover required land to the contractor;
- Develop RAP implementation tools and forms, including necessary Committees; and
- Monitor the effectiveness of entitlement packages and payment modality.

3.2.8. Monitoring and Evaluation

BEZA is going to form 1) an internal monitoring to confirm the progress of the RAP implementation and adequacy of the entitlements and to plan necessary additional safeguard measures if it is necessary, and 2) independent evaluations to evaluate the effectiveness of the proposed entitlements, monitor the recovery of the living standards for the PAPs, and recommend BEZA to enforce necessary additional measures if it is necessary.

Internal Monitoring

The project Director is responsible to oversee proper and timely implementation of all activities in RAP. The PD has been operating and managing implementation of the RAP with assistance from and appointed implementing NGO/Firm. The monitoring will be carried out with support from the BEZA-SIU offices

and the resettlement implementing NGO/Firm (if NGO/Firm is appointed). BEZA or the Implementing NGO/Firm will collect appropriate data from the field and provide feedback to SIU on progress of RAP implementation and the day to day problems arising out of the process.

BEZA or the implementing NGO prepared monthly/quarterly reports on the progress of RAP implementation. SIU have to collect information from the project site and assimilate in the form of monthly progress of RAP implementation and adjust work program where necessary, in case of delays or problems. An automated MIS designed, developed and operated by NGO/Firm to monitor the output indicators at the PD's office.

Independent Evaluation

An External Monitoring Agency (EMA), independent of the project, with prior experience in resettlement and rehabilitation of development induced displacement engaged to carry out external M&E and reporting of the implementation of the RAP. The EMA will carried out quarterly, annual, mid-term and final evaluation and recommend necessary changes to the SIU and the Social and Environment Circle (SEC) for consideration. The scope of external monitoring will cover compliance monitoring and social impact evaluation of RAP implementation.

The EMA covered compliance issues such as: (i) compensation and entitlement policies, (ii) adequacy of organizational mechanism for implementing the RAP, (iii) restoration of APs income, (iv) settling complain and grievances and (v) provisions of adequate budgetary support by SIU for implementation of the RAP. The EMA will assess if the APs: (i) have been provided with alternative place to relocation, (ii) have re-established their structures, (iii) re-established their business and (iv) were extended assistance to restore their incomes at pre-project level. It also appraised accounting documents used in recording the payments of compensation to APs by BEZA. In addition to this at least once a year and annual impact evaluation to assess the effectiveness of the work being undertaken and level of result achieved.

3.2.9. Cost and Financial Source of Mitigation Measures

Land market survey

As a part of preparation of RAP, market survey was conducted to obtain actual market price of land in the area. The main objective of Land Market Survey is to get existing open market price practiced in land selling and buying for different categories of land in the project area. During land market survey a total of 32 persons of which 16 are affected person and 16 are from outside of the project have been interviewed. Sample of respondents were selected purposively among informative and knowledgeable person on land transaction like teachers, businessmen, land brokers, land sellers and buyer and Imam (religious leader) in order to avoid biased market rate.. A structures questionnaire was used for conducting land market survey.

Calculation of Replacement Cost

The government of the Peoples Republic of Bangladesh promulgated and enacted the Acquisition and Requisition of Immovable Property Act on 21st September 2017 replacing old law. Since the compensation provision in Acquisition and Requisition of Immovable Property Ordinance 1982 (ARIPO-1982) found insufficient and unrealistic, the government updated the acquisition laws after long 34 years. The ARIPO-2017 ensures compensation of acquired land with additional 200% of mouza rate for land and additional 100% of assessed value by DC for other assets. The agreed compensation rate at 3 times higher than mouza rate or additional 200% of mouza rate is commensurate with the ARIPO-2017. The survey result also shows that the agreed rate is found higher than market assessed price. Therefore compensation rate with additional 200% of mouza rate considered as Replacement Cost rate of acquired land.

Necessary fund needed for meeting the compensations and other benefits will be provided by BEZA, based on the financing plan agreed by the Government of Bangladesh and JICA. Funds for IGA training to the VHs will be provided under the LIRP based on vulnerability and needs assessed through a special surveys and consultation exercise by BEZA through RAP implementing NGO/Firm. BEZA will also ensure that the RAP is submitted to JICA for concurrence, and that funds for entitlements under the RAP is fully provided to AHs prior to the award of the civil work contract. Resettlement cost will be incurred from GOB revenue budget source.

The total estimated cost to be incurred for implementation of the RAP is about BDT **4,823,744,801**(four hundred eighty two crores thirty seven lac forty four thousands eight hundred and one taka including contingency at 2%).

Table 3.2-21: summary of land acquisition cost of the EZ site

SL No.		Compensation and Assistance Head	Estimated Cost (in BDT)
Replacement Cost for Land, Structures and Tress			
A	1	Replacement Value for Land	4,676,974,275
B	2	Compensation for Structures (Residual additional 50%)	5,400,000
C	3	Compensation for Tress	1,573,690
Sub Total			4,683,947,965
Resettlement Assistance and Allowances			
D	1	Relocation allowance for crops and fish	34,488,700
	2	Land Development Assistance	4,400,000
	3	Transfer Grants (TG)	94,245
	4	Reconstruction Grants	125,660
	5	Re-Installation of Utilities	110,000
	6	Grants to Vulnerable Households	2,250,000
	7	Grants to Sharecroppers	345,000
	8	Training Allowance for Vulnerable Households	900,000
	9	Skill development training cost under ILRP	2,500,000
		Sub Total	45,213,605
		Estimated Cost	4,729,161,570
		Contingency at 2%	94,583,231
		Grand Total	4,823,744,801

Unit Cost of Land and Others

Price of land in Bangladesh varies substantially depending on productivity, commercial utility, and proximity to urban centers and access to communications. Therefore, land price also varies within a given geographical boundary like the smallest land administration unit called “Mouza”. The Deputy Commissioner determined mouza-wise price by “Land Category” which differs from mouza to mouza. The land types in the project area recognized by DCs are as follows:

- Null (Agricultural/crops Land)
- Homestead
- Viti (comparatively high land, but have no habitation)
- Pond

The land Losers, whether purchasing or not will be provided with Replacement Cost of land that include titling cost and Current Market Price. Replacement Cost of all categories of land has been established as per mouza rate plus additional 200. Replacement Cost with additional 200% for **retention pond/canal area** will be paid directly by Deputy Commissioner. For that reason, no budgetary provision for land of canal area is made here. Details estimated Replacement Cost for Land is presented in below Table.

table 3.2-22: Estimated Replacement Cost for Land

District	Upazila	Mouza	Type of Land	Amount of Land in Dec.	Estimated Cost (Residual additional. 150%)
Narayanganj	Araihazar	Panchrukhi	Null	31,620	3,049,700,775
Do	Do	Do	Homestead	225	26,156,250
Do	Do	Do	Vita/	300	141,750,000
Do	Do	Do	Pond	400	50,940,000
Do	Do	Retention pond/Canal	Null	5,000	0
Do	Do	Panchgoan	Null	16,058	1,360,915,500
Do	Do	Do	Homestead	215	24,477,750
	Do	Do	Vita/	110	14,025,000
	Do	Do	Pond	220	9,009,000
Sub Total	Estimated Replacement Cost			54,148	4,676,974,275

Estimated Cost for Structures

The Deputy Commissioner of Narayanganj assessed Cash Compensation under Law (CCL) for structures in accordance with the ARIPO-1982. The ARIPO-1982 has provision for enhancing 50% of assessed value. As per ARIPO-2017, the affected structures loser person to be compensated with 100% additional of assessed value for structures. Estimated cost for structures is presented in below Table:

DC Assessed Value for Structures	Residual additional 50%	Estimated Cost for Structures
16,200,000	5,400,000	21, 600,000
Total		21, 600,000

Estimated Cost for Trees

The Deputy Commissioner didn't assessed and budgeted compensation for tress. In the project right-of way, some tress was identified during census. PAPs will be compensated for affected tress according to the acquisition laws in Bangladesh. JICA Guideline for Environmental and Social Consideration confirms Replacement Cost for tress. In compliance with acquisition law and JICA policy, an estimated budget for tress is calculated in this RAP. Valuation of tress is assessed in line with the methods and rates of the Department of Forestry.

Table 3.2-23: Estimated Cost for Trees

	Compensation for Trees	Nos.	Rate	Estimated Cost
	Fruit Trees			
	Large	39	5,600	218,400
	Medium	75	3,500	262,500
	Small	189	1,500	283,500
	Plant	46	150	6,900
	Timber Trees			0

	Big	14	10,800	151,200
	Medium	54	6,300	340,200
	Small	56	3,000	168,000
	Plant	3	80	240
	Banana	253	250	63,250
	Bamboo	318	250	79,500
Total				1,573,690

Allowance for Income from Crops & Fish

The Deputy Commissioner will pay compensation for standing crops as per ARIPO-1982 for approximately 200 ha and ARIPO-2017 for canal area. Other than compensation paid by DC, the RAP prescribes compensation for the affected crops and produce on acquired land at market price as resettlement assistance. The land in the project area has been used for different purposes. Ongoing Resettlement Action Plan/Resettlement Plans in Bangladesh were consulted for provisioning the budget. The type and category of land is already described in chapter 2. The estimated volume of production and the income from the harvested crops has been assessed and calculated following the methodology of Department of Agriculture Extension (DAE) for farm land and Fisheries Department for pond of 2017. Table 32 below presents estimated budget of the loss of standing crops.

Table 3.2-24: Relocation Allowance for Crops and Fish-stock

Quantum of Land (decimal)	Rate of Allowance/Decimal	Estimated Cost
52,678	650	34,240,700
620.00	400	248,000
298		488,700

Land Development Assistance for Homestead

The project has limited impact on homestead land. Affected Persons need to relocate elsewhere from their homestead land with living structures. Generally developing a plain land to homestead requires few years and comparatively expensive also. The RAP recommends special assistance to person lost homestead land in the project. The project first phase will take a total of 440 decimal of homestead land. Estimated cost for land development is presented in below Table:

Table 3.2-25: Land Development Assistance

Quantum of Homestead Land	Rate of Assistance/Decimal	Estimated Cost
440	10,000	4,400,000

Transfer and Reconstruction/Re-installation Grants

The RAP prescribes for relocation allowance for affected persons lost living structures from project area to elsewhere suitable for them. The relocation allowances include transfer and reconstruction grants for shifting the structures and also include re-installation of utility services. A total of 6283 square feet living structures of 11 households affected by the project. Transfer and reconstruction grants calculated on total lost amount while re-installation grants provisioned for each households. A detail the relocation allowances is presented in below Table.

Table 3.2-26: Estimated Transfer and Reconstruction/Re-installation Grants

Item	Units (Sft/Nos.)	Rate	Estimated Cost
Transfer Grants	6283 sft	15	94,245
Reconstruction Grants	6283 sft	20	125,660
Re-installation	11	10,000	110,000

Total	329,905

Allowances for Vulnerable and Sharecroppers Households and Livelihood Training Costs

Identified vulnerable households (women headed, elderly and having income below poverty line) and sharecroppers will get special allowance due to loss of livelihood resource base in the project area. These allowances provided as subsistence until start of new income venture. The RAP prescribed for Income and Livelihood Restoration of whom might experience impoverishment due to the project intervention. Details budget for vulnerability allowance, Grants to cover income for sharecroppers and livelihood training cost is presented in below Table.

Table 3.2-27: Allowances for Vulnerability, Grants to Sharecroppers and Training Cost

Item	Number of Households	Rate of Allowances	Estimated Cost
One time Transitional Cash Grant to Vulnerable households @ BDT 15000 per household	150	15,000	2,250,000
Transitional cash grant to Share Cropper @ BDT 5000 per Month for 3 Months	23	15,000	345,000
Special Assistance to Vulnerable Households as Training Allowance @ BDT 6000	150	6,000	900,000
			3,495,000

Approval of Resettlement Budget

The rates of compensation and cash entitlements for providing due compensation and benefits payable to AHs will be adjusted annually, based on the actual annual inflation rate. BEZA will determine the annual inflation rates to be applied to all cash entitlements in each year. The RAP implementing NGO/Firm will assist the Safeguard Implementation Unit (SIU) BEZA to prepare final resettlement budget covering all eligible loss and entitlements confirmed through determination or endorsement by PAVC. This budget will need approval of the BEZA and concern ministries. SIU will take necessary initiative to get approval of the budget from the Chairman of BEZA or Ministry. Payment of additional compensation and resettlement benefits will be started after approval of the budget.

Table 3.2-28: Estimated detailed cost (payment by DC and BEZA separately calculated)

Sl. No.	Category of loss	Unit /Quantity decimal/No./sft	Mouza Rate/decimal/No./sft	CCL Rate (Mouza rate+50%) per decimal	CCL To be paid By DC (Mouza rate + 50%)	Top-UP To be paid by BEZA (residual additional 150%)	Estimated budget in BDT	In USD (USD 1=82 BDT)
A	Compensation at current market value for land (in Acre)							
A-1	Panchrukhi Mouza							
	Null	31,620	64,300	96,450	3,049,700,775	3,049,700,775	6,099,401,550	75,301,254
	Homestead	225	77,500	116,250	26,156,250	26,156,250	52,312,500	645,833
	Vita	300	315,000	472,500	141,750,000	141,750,000	283,500,000	3,500,000
	Doba	400	84,900	127,350	50,940,000	50,940,000	101,880,000	1,257,778
Sub Total					3,268,547,025	3,268,547,025	6,537,094,050	80,704,865
A-2	Null land for canal area (calculated as per new Law. CCL rate calculated with additional 200% of mouza rate)	5,000	64,300	192,900	964,500,000	0 (No Top-UP is needed)	964,500,000	11,907,407
A-3	Panchgaon Mouza							
	Null	16,058	56,500	84,750	1,360,915,500	1,360,915,500	2,721,831,000	33,602,852
	Homestead	215	75,900	113,850	24,477,750	24,477,750	48,955,500	604,389
	Vita	110	85,000	127,500	14,025,000	14,025,000	28,050,000	346,296
	Doba	220	27,300	40,950	9,009,000	9,009,000	18,018,000	222,444
Sub Total					1,408,427,250	1,408,427,250	2,816,854,500	34,775,981
Total Compensation for Land					5,641,474,275	4,676,974,275	10,318,448,550	127,388,254
B	Compensation for Structures				16,200,000	5,400,000	21,600,000	
	Sub Total				16,200,000	5,400,000	21,600,000	266,667
	Compensation for Trees							
	Fruit trees (Large)	39	5,600			218,400		
	Fruit trees (Medium)	75	3,500			262,500		
C	Fruit Trees (Small)	189	1,500			283,500		
	Fruits Trees (Plants)	46	150			6,900		
	Timber Trees (large)	14	10,800			151,200		
	Timber Trees (medium)	54	6,300			340,200		
	Timber Tress (small)	56	3,000			168,000		
	Timber (Plants)	3	80			240		
	Banana	253	250			63,250		
	Bamboo	318	250			79,500		
	Sub Total					1,573,690	1,573,690	19,428
D	Additional Resettlement Assistance for Land		Unit Rate					
	Allownce of Tk. 650 per decimal for income from agricultural land.	52678	650			34,240,700		
	Allownce of Tk. 400 per decimal for income from Doba land.	620	400			248,000		
	Assistance @ BDT 10000 per Decimal for ldeveloping homestead	440	10,000			4,400,000		
	Sub Total					38,888,700	38,888,700	480,107
E	Assistance for Structures							

Sl. No.	Category of loss	Unit /Quantity decimal/No./sft	Mouza Rate/decimal/No./sft	CCL Rate (Mouza rate+50%) per decimal	CCL To be paid By DC (Mouza rate + 50%)	Top-UP To be paid by BEZA (residual additional 150%)	Estimated budget in BDT	In USD (USD 1=82 BDT)
	Transfer Grant	6,283	15			94,245		
	Reconstruction Grant	6,283	20			125660		
	Reinstallation Grants per household @ BDT 10000 for utility services (Gas, Electricity, Tube-well etc.)	11	10,000			110,000		
	Sub Total					329,905	329,905	4,073
F	Special Allowances							
	Transitional cash grant to Share Cropper @ BDT 5000 per Month for 3 Months	23	15,000			345,000		
	One time Transitional Cash Grant to Vulnerable households @ BDT 15000 per household	150	15,000			2,250,000		
	Livelihood restoration training assistance for one person per vulnerable household @ BDT 6000	150	6,000			900,000		
	Sub Total					3,495,000	3,495,000	43,148
	ILRP Training							
G	Skill development Training for Selected PAPs	500	5,000			2,500,000	2,500,000	
	Sub Total	Total (BDT)			5,657,674,275	4,729,161,570	10,386,835,845	128,232,541
	Contingency 2% of the total					94,583,231	207,736,717	2,564,651
	Grand Total					4,823,744,801	10,594,572,562	130,797,192

Management of Resettlement Budget

The BEZA does not have any set codified rules for payment of grants to AHs eligible for resettlement assistance from the project. BEZA also does not have separate specialized wing in its organogram for implementing Resettlement Action Plan (RAP). BEZA could disburse compensation and resettlement assistance payment mechanism by establishing Safeguard Implementation Unit (SIU) under the jurisdiction of Project Director. With support from SIU, the Project Director will prepare and place the budget according to Entitlement Matrix to Chairman of BEZA to get approval. Upon getting approval from the chairman, The Project Director will approve the administrative guideline and payment modalities. There will be a bank account in any commercial bank with appropriate signatories at SIU. The account may be operated by two signatories with compulsory of PD.

BEZA will appoint and engage an experience NGO/Firm for implementing the Resettlement Action Plan of Japanese Economic Zone in Araihasar. Implementing NGO/Firm will assist SIU in disbursement of compensation and resettlement assistance. NGO/Firm will prepare necessary documents, maintain vouchers and register and operate MIS to keep disbursement related information up to date.

The payment debit voucher will be quadruplicate, of which one will be original with revenue stamp, and remaining three will be photocopies of the original one. The original one will be submitted to the SIU on a monthly basis by the NGO/Firm. The second copy will be retained by the NGO/Firm head office, and remaining two will be preserved at the Project Director office and other one is for EP.

3.2.10. Implementation Schedule

SL No.	Activities	2017												2018												2019												2020												
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
A	LAND ACQUISITION																																																	
1	Preparation of LAP and Submit DC																																																	
2	Notice u/s-3, JVS and u/s-6 1st: EZ area, 2nd: Canal area																																																	
3	LA Estimate and Fund Placement with DC																																																	
4	Possession and Handing over Land																																																	
B	SOCIAL PREPARATION																																																	
1	Mobilization of NGO in the Field																																																	
2	Disclosure of RAP																																																	
3	NGO Assistance to APs for CCL Collection																																																	
4	Formation of PVC, GRC and RAC																																																	
5	Identification of EPs/Issuance of ID cards for compensation as well as assistance																																																	
6	Determination of Entitlement																																																	
C	PAYMENT OF COMPENSATION																																																	
1	Coordinate with DC office on Land Acquisition																																																	
2	Assist PAPs in the Process of CCL Collection																																																	
3	Prepare Application for CCLCollection																																																	
4	Opening Bank Accounts by the EP/PAPs																																																	
5	PAPs Apply and Receive CCL																																																	
6	EP/PAPs Approach for Resettlement Assistance																																																	
D	RELOCATION																																																	
1	Payment of Transfer and Reconstruction Grants																																																	
2	PAPs Mobilization and Relocation																																																	
3	Monitoring of Relocated Households																																																	
E	GRIEVANCE REDRESS																																																	
1	Complaints receive from aggrieved PAPs																																																	
2	Review, approval and actions																																																	
F	MONITORING																																																	
1	Internal Monitoring																																																	
2	Independent External Monitoring																																																	
G	IMPLEMENTATION OF ILRP																																																	
1	Implement ILRP (includes Gov program)																																																	
2	Hiring ILRP Implementing NGO (job placement for EZ)																																																	
3	Develop/Update ILRP implementing plan																																																	
4	Monitoring of ILRP Implementation																																																	

3.2.11. Accountability, Community Participation and Stakeholder Meeting

Accountability and Community Participation

As per the JICA guidelines for Environmental and Social Consideration, BEZA has disclosed the project information and provided opportunities for stakeholders, particularly project affected persons including landless share croppers, to participate the EIA and RAP preparation through public consultations meetings and focus group discussion.

Based on the past records in Bangladesh, stakeholders' participation could lead timely land acquisition and resettlement as well as fewer conflicts during the construction and operation stages between project proponents and local stakeholders.

It is particularly important to understand the community needs for livelihood recovery assistances, which are not provided by the government funded projects but are mandatory for the JICA funded projects. BEZA has been committed to comply with the JICA Environmental Guidelines and adapted to enhance the benefits of the project affected persons (PAPs) throughout the project activities and livelihood recovery assistance programs.

1st Public Consultation Meetings (Scoping phase)

A substantial number of populations will be affected due to land acquisition. Information disclosure and public consultation is core safeguard requirement of JICA for financing to any project. According to the JICA's Environment and Social Consideration, affected populations must be and meaningfully consulted at project preparatory stage. In compliance with JICA's policy, the BEZA organized and conducted 1st Public Consultation Meeting (PCM) on 22nd November 2017 from 11 a.m. for disclosing the outline of the project and anticipated environmental and social impact.

"Purinda Bazar Govt Primary School" was selected for the PCM after consultation with Satgram Union chairman. The meeting was held at the opening area where there would be no disruption to the the classes and the children so that the classes were held as usual. The venue is well-accessible and located on Dhaka-Sylhet Hwy, approximately within 500 m from the project site and has sufficient room to accommodate about 150 people or more.

To ensue stakeholders' participation, a rigorous publicity have been undertaken through local newspaper advertisement by BEZA issued one week prior to the meeting date. The project proponent (BEZA) also issued invitation letters to the concerned stakeholders and NGOs to participate in public consultation meeting

Senior consultant of the local consulting firm. Mr. Abdul Halim welcomed all participants on behalf of BEZA with thanks and conducted introducing session among the participant. Upazila Nirbahi Officer of Araihasar Upazila Mrs. Suraya Khan presided over the meeting.

Mr. Abdul Kader Khan, Social Specialist of BEZA took the floor and explained the project background, objective and rationale, importance and significance of Japanese investment in Bangladesh comparing other countries. Potential benefits and opportunity for local communities in different sectors were discussed. *i.e.* it will improve communication system, brings huge employment opportunity for local populations, improve health services and ensure utility services like gas, electricity supply, water supply system. The project will have huge positive impact on improvement of education facilities. The project will create tremendous business opportunity for the local populations.

At this stage Mr. Moniruzzaman, Joint Secretary of BEZA initiated the question-answer session. The incumbent of project proponent in the chair invited questions, demands and grievances from the audience. In this session participants were allowed to raise any question and grievances regarding land acquisition process, compensation policy and environmental issues as well. Issues regarding project and land acquisition are presented in the table below:

Relation	Comment/Question	Respondent: Response
Land Owner, Pachrukhi Village	We are very happy to know that our local people will be privileged by the all benefits of EZ. Initially, land owner like us have to pay for it for the better future and we are ready for it. However, if we get proper land value as compensation compared to market price, we may survive. Otherwise, we will be marginalized or landless. In that case, other benefits of EZ may not solely be sufficient to restore our livelihood. We came to know that land acquisition is incurred by the Deputy Commissioner (DC) and the land price is finalized by the the DC's Mouza rate. According to the 1982 act, the DC pays 1.5 times of the Mouza rate. But usually, the DC's Mouza rate is 3-4 times lower than the market price. Lately, he heard that a revised on 1982 act has been gazette. Where, the DC's payment rate has been mended 1.5 times to 3 times. What would be the DC's rate in the proposed project? How will the legal land owners be paid?	BEZA: We are working hard to implement the revised gezetted act. We have already approached our administrative procedure. Hopefully, we will be successful in doing so. UNO: After reviewing all land ownership deeds, R.S. allocation holders' name and the relevant documents, an actual legal owner will be identified and compensated.
Resident, Sonpara	There are more than hundred residential settlements are residing in northern side those are actually very close to project site. Is there any chance to acquire this adjacent residential side too?	BEZA: At the screening stage, we tried to minimize the adverse impact as much as possible and design this project. We redesigned our project for not impacting the residential settlements. There is no plan to acquire this residential site. BEZA will try and take all precautions not to cause any negative impacts on this residential community.
Resident, Sonpara	There is an existing canal going through the project site. When the construction work starts, land filling will occur. Water flow of the canal may be disrupted. Consequently, adjacent low lands will be inundated during wet season. Is BEZA aware of this situation	BEZA: The existing canal will be improved with a well drainage system. I detailed master plan will be designed and implemented as well.
Resident, Maizpara	The adjacent resident(s) may be directly affected adversely by air and water pollution. Is there any consideration to protect the local community?	BEZA: ETP, WTP will be established. Moreover, in accordance to the DoE regulation, industries will be established. Therefore, pollution will be reduced to a minimum level.

2nd Public Consultation Meetings (EIA and RAP)

At the ESIA and RAP preparation stage, following the 1st consultation meeting which was held on 22nd November 2017, BEZA organized 2nd public consultation meeting to disclose the findings and measures taken to minimize the impact of the project in compliance with JICA's policy, on 30th April 2018.

Time and Date	2nd Public Consultation Meeting: Date: 30 th April, 2018 Day: Monday Time: 10:00 AM to 12:30 PM
Venue	Begum Anwara Degree College, Pachbaria, Araihaazar, Narayanganj
Invitees	Joint secretary (General Manager Investment Promotion) of BEZA; Joint Secretary General Manager (Planning & Development); Deputy Secretary Manager (Planning & Development); Senior Assistant Commissioner of Narayanganj LAO; Chairman of Dhuptara Union; Chairman of Satgram Union; Social Specialist, BEZA project Local residents in and around Araihaazar EZ area Other organizations and individuals who are interested in the Project
Attendee	2nd Public Consultation Meeting: 130 people (men: 61, women: 69) Age range: 17-70 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Journalist, Police, Student & Unemployed Persons
Agenda	Brief explanation on the potential impacts, measures and management plan. Brief explanation on the Resettlement Action Plan & Livelihood Restoration Plan. Major positive and negative findings on the draft EIA and RAP study. Findings verification, community perceptions etc.
Language Used	In local language: Bangali language

Similarity to the 1st PCM, BEZA issued newspaper advertisement through a local newspaper one week before the date of the PCM. Additionally, invitation letters were provided to NGOs and relevant stakeholders. Further, to ensure that the PAPs would be well informed about the PCM, the local union office made public announcement through speakers on the streets.

Public Consultation Meeting started at 10.00 am. On behalf of BEZA, senior consultant of the local consulting firm, Tauhidul Hasan welcomed all participants with thanks and conducted introducing session among the participant. Joint secretary (General Manager Investment Promotion) of BEZA, Mr. Moniruzzaman presided over the meeting. Meeting was also enlightened with the presence of Mohammed Shoheler Rahman, Joint Secretary (photos are available in Appendix 3)

General Manager (Planning & Development); Saleh Ahmed, Deputy Secretary Manager (Planning & Development); Sarwat Mehjabin, Senior Assistant Commissioner of Narayanganj LAO; Shahida Mosharaf, Chairman of Dhuptara Union; Wadud Mahmud, Chairman of Satgram Union.

Initially, Mirza Shamim Ahsan Habib, Principal Consultant of EQMS conducted the ESIA presentation covering all potential impacts, mitigation measures and management plan for proposed AEZ. Afterwards, Abdul Halim, Senior Consultant of THE LOCAL CONSULTING FIRM conducted another session covering Resettlement Action Plan & Livelihood Restoration Plan for the affected persons.

At the last session Mr. Moniruzzaman, Joint Secretary of BEZA initiated the question-answer session. The incumbent of project proponent in the chair invited questions, demands and grievances from the audience. In this session participants were allowed to raise any question and grievances regarding land acquisition process, compensation policy and environmental issues as well. Issues regarding project and land acquisition are presented in below Table:

Sl	Relation	Comment/Question	Response/Reply
	Wadud Mahmud, Chairman, Satgram Union	We all know that in December 2017 a publication consultation was held. In that public consultation we already shared our opinion and perception regarding this proposed AEZ. What is the purpose of the second public consultation meeting?	BEZA: Field works for Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP) was initiated from December 2017 and continued up to 25th March 2018. Before the initiation a public consultation meeting was held on 22nd November to disseminate the basic information regarding RAP & LRP and why this study is required so that people/affected persons get the importance of this study as well as cooperate with this at highest level for successful assessment. Eventually, people and affected persons understood the importance of the RAP & LRP study and helped during the assessment period. AHs' survey and FGDs were conducted with the sincere participations of all affected persons and groups. After 4 months rigorous field works, extent of being affected respective of persons and groups has been assessed using appropriate methodological tools. Finally, an entitlement matrix has been developed/proposed addressing amount of compensations to be paid or additional assistance to be given against specific losses. Now this second public consultation is being held to share the entitlement matrix with the affected persons/groups for verification. Affected persons/groups are allowed to comments on the proposed entitlement matrix and will be incorporated, if required, with the Final RAP & LRP report.
	Shahida Mosharaf, Chairman, Dhuptara Union	What are the extents of losses? How many people will be affected?	BEZA: Proposed AEZ project requires 218.84 ha lands for acquisition consisting 375.445 and 166.03 acres from Pachrukhi and Pachgaon Mouza respectively. Affected land is mostly (526.775 acres) agricultural with small amount of (6.2 acres) Pond, (4.1 acres) Viti and (4.4 acres) homestead. A total of 1714 households consisting 6343 population will be directly affected from this land acquisition. A total of 28 residential structures including 5 Buildings, 1 Semi-building and 22 Tin-made covering aggregated 6282.95 sft. Only 11 households will lose these residential structures. Besides this, other associate structures like 12 tube-well, 1 Pucca Latrine with safety tank, 8 Slab Latrine, 3 motor/water pump and 265 rft tin made boundary wall will be affected. A total of 1055 trees including 349 Fruit bearing, 127

Sl	Relation	Comment/Question	Response/Reply
			Timber, 253 Banana and 326 Bamboo with different sizes will be affected.
	Land Owner, Sonpara	What is the final rate of compensation considered for land? When will the affected persons get the compensation? Will BEZA take the land before paying the compensation?	BEZA: Compensation for land loss is considered 3 times of mouza rate determined by DC. Already DC office at Narayanganj is working on it. We hope the compensation payment will be started soon. It is to be noted that, BEZA will not take the land possession before paying the compensation. Meanwhile, people's right of land usage will remain on their own hand.
	Structure loser, Sonpara	What will residential structure and other immovable structures loser get?	BEZA: Compensation for structures, trees and crops are considered 2 times of rate determined by DC. Moreover, structure losers will get transfer (not exceeding BDT 8000) and reconstruction (not exceeding BDT 10000) grants. Other grants for land development, utility installations etc. are proposed to be provided.
	Woman, Affected household member, Maizpara Village	Is there any provision for local women community?	BEZA: Women headed households, directly affected from the land acquisition, will get additional BDT 15000 as vulnerable allowance. Elderly headed and Moreover, women from affected households also can participate in skill improvement training. Local people irrespective of gender will get work opportunity based on their skill and educational competency.
	Sharecropper, Pachrukhi Village	Sharecropper does not have any legal right of land ownership. Nevertheless, sharecroppers of the affected land depend on these lands for their livelihood. Is there any provision for the affected sharecroppers?	BEZA: In this study, 22 sharecroppers were socially identified who will lose their right to use land. They will be paid BDT 5000/month compensation for 3 months. They also can participate in skill improvement training program.
	Satgram Chairman	Union We are happy to know that local people will get preference working in the proposed AEZ. But, most of the local people may have no required competency. We come to know that proposed AEZ will require workforce related to garments and textiles etc. Thus, we humbly propose to set up a textile engineering college in our locality, so that local workable population can easily get access to this and earn their competency.	BEZA: Construction of textile engineering college is secondary need rather than primary need. Initially we are working to meet primary needs of the projects i.e. infrastructural development required for the proposed project, access roads etc. Though we don't have any plan or requirement to establish any textile engineering college, but we take it as a suggestion and of course will meet that if this project requires it in future. Initially this project will use "national highway No.2 (Dhaka-Sylhet Expressway) to the Araihaazar EZ" as access road. In future, if Sonpara via Kanchan bridge to Dhaka road is required to use, we will consider to develop/improve this road.

Sl	Relation	Comment/Question	Response/Reply
		Sonpara via Kanchanbridge to Dhaka is used for easy and comfort communication by the local people. Project Company may also use this road but we expect to develop or improve this road by the project company.	
	Resident, Maizpara Village	In previous public consultation meeting, we were informed that the existing canal located within the project site will be improved with well drainage system. Is detail master plan of this completed? Is any precaution taken keeping in mind for the adjacent community so that they won't get inundated during the wet season?	BEZA: Detailed master plan for drainage system is yet to be completed. Well drainage system is not only required for the adjacent communities but also for the project itself. Industries within the AEZ will produce a large amount of waste water daily which needs to be drained away after the treatment. Water congestion is not desirable as this may hamper the production activities of the industries. Thus keeping all these things, a detailed master plan will be developed so that water flow remains uninterrupted and doesn't inundate the adjacent locality.
	Resident, Sonpara Village	We heard that large scale industries i.e. textiles, automobiles etc. will operate its production activities. Therefore, we are assuming that production activities will generate huge noise which may turn to noise pollution. What measures have been taken to minimize this problem?	BEZA: During construction period Machineries those comply with the noise standards prescribed by DoE will be suggested to use; Vehicles and machinery will be regularly serviced and checked for pollution control; Fitting noise machines with noise reduction devices and Temporary noise barriers, where required, should be provided near the high noise generating areas. During Operation Period Industries will comply with the noise standards prescribed by DoE; Regular noise monitoring will also be taken place and mitigation measures will be taken when noise level doesn't comply with the DoE standards.
	Resident, Pachrukhi Village	Production activities, workforce and population influx will produce different types of wastes. Is any waste specific management plan taken to manage the different types of wastes?	BEZA: Two folds waste management plan will be adopted Waste Management Plan for short term Tenant companies are responsible for the management of industrial wastes following applicable laws. Non-hazardous high calorific wastes will be served at cement factory in Chhatak. For other wastes, BEZA is going to facilitate a waste management at Matuail waste treatment/landfill site Waste Management Plan for long term BEZA has a plan to set up a comprehensive industrial waste treatment complex not only for the AEZ but also for the other private & public industrial zones and businesses in Narayanganj district.
	Resident,	We are well informed about the possible impacts and mitigation measures. What if the proposed	THE LOCAL CONSULTING FIRM: Periodical monitoring and evaluation activities will be

Sl	Relation	Comment/Question	Response/Reply
	Pachbaria Village	mitigation measures are not sufficient or not maintained during construction and operation period? What if new unknown impacts arise? Local people will face problem in consequence of that. Therefore, how to address problems created from the project to minimize for the betterment of the community?	taken place. Any breach or irregularity on measures and meeting standards, if happens, will be identified and necessary mitigation procedure will be taken accordingly. Specific Grievance Redress Mechanism has been developed and proposed to implement during construction and commissioning period. Proposed Grievance Redress Mechanism constitutes with the stake of local stakeholders. Thus, all addressed problems will be understood in view of own problems and redressed immediately in line with the proposed time frame. As a part of GRM, grievance procedure will be well published and disseminated through all over the adjacent communities to encourage addressing grievances.

Focus Group Discussion (RAP study)

A total of 12 Focus Group Discussions were held with the different group of populations during SIA and census so far. The land acquisition and implementation of the project has significant impact on PAPs and surrounding populations in both negative and positive form. Persons who lost land and other assets due to the project identified as directly affected person. Persons having no title to the land, but lost livelihood resource base are identified as indirectly (sharecroppers) affected persons. Furthermore communities and populations surrounding the project are somehow beneficiary of the project. The project located in between the two industrial hub of the country and a significant number of persons involve with multiple business and commercial ventures. All of them have interest in the project. Focus Group Discussion was conducted to obtain views and perception about the project from different groups of peoples in and around the project. General norms and procedures for holding a FGD followed to ensure spontaneous participation of affected populations. Summary of Focus Group Discussion is presented below table:

Date & Place	Target Group	No. of Participant			Issues/Topic discussed	Opinion of APs	Project Responses
		M	F	T			
04/12/2017 Boro Bari, Pachrukhi	Farmers	9	0	9	Project objective and goals opportunities will be created by the project, land requirement, livelihood and income restoration, compensation and resettlement benefits, improvement of service facilities etc.	In all FGD, the participants mostly affected person expressed their concern on land acquisition. They requested the authority concern to shift the project site nearest elsewhere to save their agricultural land. If it unavoidable, they demand compensation at 3 times higher than mouza rate. They also demanded job placement priority in the Japanese Economic Zone according to their qualification.	In reply to their questions, quires and demand, the project proponent confirmed that fair and just compensation will be provided for acquired land other assets. Households displaced with housing will be resettled properly. A comprehensive resettlement and rehabilitation plan has prepared to restore income and living standard of the affected persons. The project will brings huge opportunity for affected populations and surrounding populations for their economic enhancement. Affected young and educated persons will get preference in employment in JEZ according to their qualification and experience.
05/12/2017 Pachrukhi	Farmers	7	0	7			
12/12/2017 Pachbaria	Business men	8	0	8			
13/12/2017 Pachrukhi	Women	0	8	8			
20/12/2017 Pachrukhi	Teachers	4	3	7			
23/12/2017 Pachbaria	Women	0	8	8			
05/12/2017 Pachbaria	Sharecroppers	9	0	9			
13/12/2017 Pachrukhi	Elderly						
20/12/2017 Pachrukhi	Students	8	0	8			
20/12/2017	Rickshaw/Van Puller	10	0	10			
10.02.2018	Students	10	15	25			
15.02.2018	Young Groups	10	10	20			

Table 3.2-29: Details of Key informant interview

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
26.11.17	Department of Fisheries	Mohammed Anisuzzaman, Fisheries Officer, Araihasar Upazila Md. Najmul Hossain, EQMS Consultant, Consulting Limited Abu Mohammed Nasiruddin, Assistant EQMS Consultant, Consulting Limited	- Role and responsibility of the local fisheries departments - Where are the primary fishing point located in and around in Araihasar Upazila and respective Union. - Details of Fishing production in respective Unions - Details on the key species of fishes observed in adjacent Rivers and water bodies, - Understanding on the Fishermen community and their practices, - Total number of fisherman - Critically endangered fish species - Type of fishing activity - Fish landing site - Commercial fish drying activity - Possible threats in fisheries as the consequence of proposed Economic Zone.	- The Department of Fisheries (DoF) is under the administrative control of the Ministry of Fisheries and Livestock. It is headed by a Director General, who is assisted by four Directors (one reserve) and 2 Principal Scientific Officer (equivalent to Director). There are administrative set-ups at division, district and Upazila (sub district) levels headed by Deputy Director, District Fisheries Officer and Senior/Upazila Fisheries Officer respectively. - Upazila Fisheries office renders its services to achieve the mission and vision of the DoF. - Total areas of capture and culture fisheries in Araihasar are 2503.44 hectare and 1036.98 hectare respectively. All over production in this upazila is comparatively low than other districts of Bangladesh. - In Satgram Union, fish culture and capture practice is comparatively low. About 165.26 hector fish culture and 19.64 hector fish capture is recorded. - No major fishing sanctuary is located in project surrounding area. - There is a canal named Dhawrakhali goes through the proposed project site. It goes Northern to Southern West direction. This canal is an important source of indigenous fish for this locality. As this Canal is connected to river, in wet season a large amount of indigenous fish come through this canal. Local fishermen catch fish from this canal and live their livelihood on that time. - A total of 50 registered fishermen identified in Satgram (19) and Duptara (31) Union. - Approximately 8-12 fishermen do fishing in the project area during wet season. - Fishermen use push net for fishing. - No major fish landing site is situated adjacent to project site - No Commercial fish drying activities are carried out. - Heavy metal and chemical may use in the Proposed Economic Zone. Appropriate measures should be taken for not contaminating the open water bodies. - Existing Dhawrakhali Canal should be kept as it is. Affected fishermen, who can't continue to fishing activities as the consequence of the project, should be considered for livelihood assistance for alternative income generation.
26.11.17	Department of Agriculture	Md. Abdul Kadir, Agriculture Officer,	Understanding and Broad overview of the agricultural sector in Araihasar Upazila and respective	Total agriculture land of the Araihasar Upazila is 18,115.7 hector where in Araihasar union is 1963.97 hector that represents 4.4% of whole Upazila.

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
		AraihazarUpazila, Md. Najmul Hossain, EQMS Consultant, Consulting Limited Abu Mohammed Nasiruddin, Assistant Consultant, EQMS Consulting Limited	Unions, Information on the cropping pattern in the area and agricultural practices, Wage rate in agricultural labor (with food and without food), Agricultural production per acre Price of paddy and Mustard Possible threats in Agriculture as the consequence of proposed Economic Zone.	In Satgram Union about 75.38% land is agricultural land. Single cropped area is 237 ha (16%), Double cropped area is 888 ha (60%) and triple cropped area is 355 ha (24%). Most of the proposed acquired lands are used for single cropped production. But some portion is sometimes used for double cropped production. Mostly paddy is produced in these lands but sometimes mustered is produced also. Common agricultural products are Paddy, Mustard, Dhaincha, Potato, Jute, Pulses and vegetables. Proposed 166.03 acre land of Panchgaog Mouza underlies in Panchgaog Block. This block comprises Low and middle low land. Most of the lands of this Mouza are used for double cropped production namely Buro and RupaAmon. Approximately 400 agricultural land owners and 250 sharecroppers may involve in this proposed land area. Proposed 325.45 acre land of PanchrukhiMouza underlies in Panchrukhi Block. Most of this block land comprises low in nature and are used for single cropped production namely Buro. Maximum production (paddy) 3700kg per ha and (Mustard) 1300 kg per ha; (Paddy) BDT 1200-1250 per 40 kg and (Mustard) BDT 1700-1800 per 40 kg; Wage rate in agricultural labor vary from season to season 350-400 tk. There is a Canal goes through the proposed project site. It works to drain up the excessive water during the rainy season. This Canal should be kept as it is otherwise adjacent agricultural land will be inundated during the rainy season.
26.11.17	Department of Public Health Engineering	Al Farhad, Assistant U.D., Araihazar Upazila, Md. Najmul Hossain, EQMS Consultant, Consulting Limited Abu Mohammed Nasiruddin, Assistant Consultant, EQMS Consulting Limited	Number of deep tube-well and shallow tub-well number in project area, Arsenic and Iron concentration of the project located union and upazila Source of water for drink and agriculture, Testing water quality when installed the tube-well	A numbers of deep tube-well and shallow tube-well is installed in the project area, Arsenic and Iron level within the project location is in standard limit. Standard Deep tube-well depth is 650 feet and shallow tube-well depth is 250-300 feet. Tube-well is used for drinking and cooking purpose and deep/shallow tube-well, pond and cannel water are used for agriculture production purposes. Test for Arsenic and Iron contamination has been considered before tube-well installation

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
26.11.17	Department of Education	Rabeya Khatun Education officer, Arai hazar Upazila Md. Najmul Hossain, Consultant, EQMS Consulting Limited Abu Mohammed Nasiruddin, Assistant Consultant, EQMS Consulting Limited	General educational institution information; Possible threats in Agriculture as the consequence of proposed Economic Zone; What short of awareness need to highlight during this construction phase; Sufficient mitigation measures and safe waste management plan should be developed; How may BEZA contribute in primary education development the in project area people?	There are 12 primary school are situated within the 2 km radius from the proposed EZ consisting approximately 5100 students. Use less noise generating machines Considering not creating any dust during construction period. Sufficient mask and caution sign will be required for the health and safety of the school going students. Reduce Air and noise pollution. Industrial solid wastes dump the safe place. Ensure the waste water treatment. BEZA may help by contributing in the improvement of the existing schools' facilities.
26.11.17	Grameen Bank, NGO	Shanjay Kumar Das, Manager, Purinda Bazar Branch Md. Najmul Hossain, Consultant, EQMS Consulting Limited Abu Mohammed Nasiruddin, Assistant Consultant, EQMS Consulting Limited	Perception about the proposed project; Details of NGO activities in the project area Number of Beneficiaries How may NGO help the project organization to engage in community development implementation?	This kind of project creates opportunity to enhance economic and social development. Job, business opportunity will be created. Unemployment rate for both male female will be decreased. Economic solvency may contribute to reduce the social/gender based violence. Grameen Bank is working in the project area for giving microfinance facilities to the local people. Currently, seven groups consisting 50-55 people each group are active beneficiaries of Grameen Bank. Most of the people take micro-credit for doing cloth and boutique business. Grammen Bank works for the financial sovereignty of the local people only. Other community development activities are not the major concern of Grameen Bank.

3.3 Environmental Impact Assessment (EIA 2) for gas transmission line and power generation plan.

3.3.1. Project Component

EIA for Part 2 is further sub-divided by 2 major infrastructures;

- 1. A power plant including a sub-station and transmission line (hereinafter referred to as “the power plant”)**
- 2. Gas transmission pipeline**

Due to the fact that the characteristic and nature of the two components differ significantly, the project descriptions, scoping, ToRs, Baseline data, impact assessments, mitigation and management measures, monitoring measures, institutional framework etc have been prepared respectively for each component.

This EIA was prepared in accordance with the Terms of Reference (ToR) approved by the Department of Environment (DoE) as shown in Appendices.

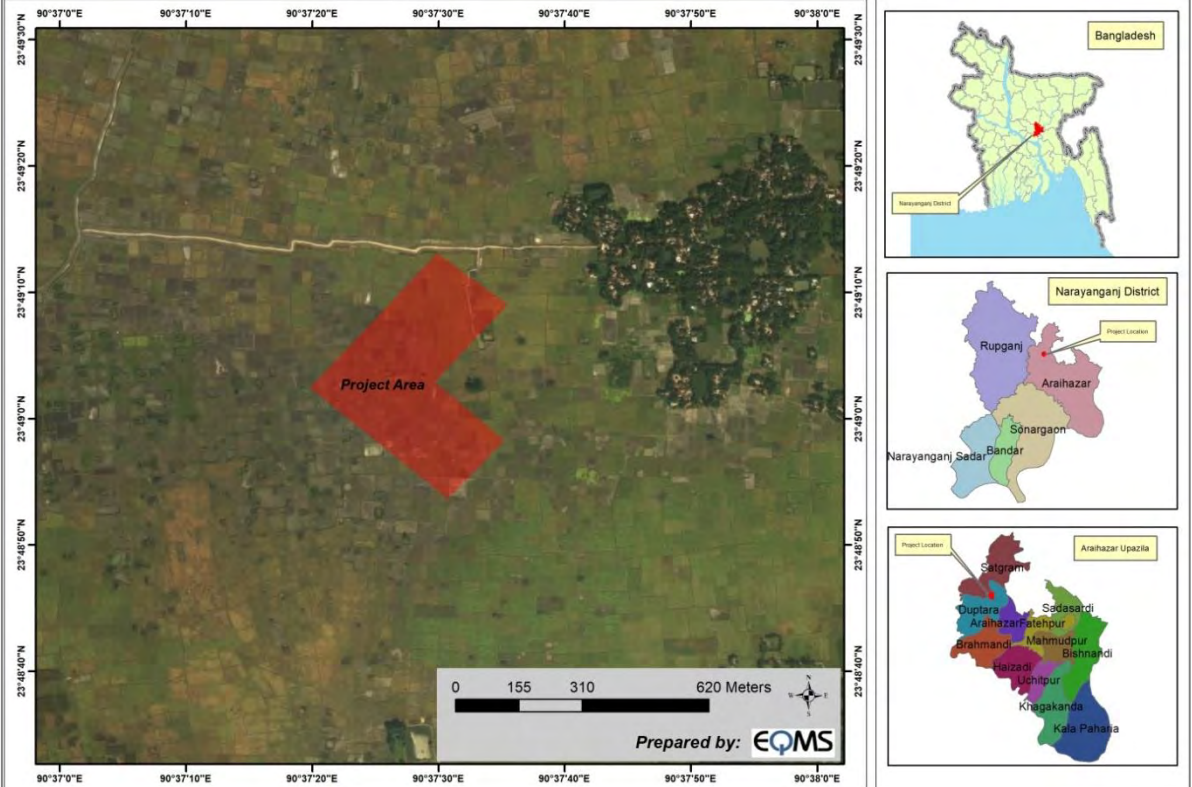
First, the project descriptions are provided for the power plant, then the Gas transmission pipeline follows.

It should be noted that the environmental and social impact assessment of the land acquisition and development for the power plant site have already been covered in Section 3.1 and 3.2 of this chapter. Therefore, this section will avoid unnecessary repetition of descriptions and assessments.

Project Description of the power plant

Table 3.3-1: Summary of the Power plant, Sub-station and Transmission line

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

	
Development area	9.28 ha
Landuse	Farmland, single or double cropping
Site preparation	Embankment: 0.6- 2.6m (Avg.1.6m), Land elevation: Approx.6-m above MSL, Flood water level due to rivers of Shitalakhya and Meghna: Approx.7.52m (1/100), Elevation of land preparation: 8.0m. EIA for the site preparation (land development) has already been conducted and approved by DoE. The site preparation work for the power plant will not be within the scope of this EIA.
Environmental and social conditions	Resettlement Action Plan study has been conducted and it has confirmed no resettlement of houses and people in the power plant project site. No precious ecology and cultural heritages sites exist.
Development Concept and Advantages	The grid frequency fluctuation level is high and not suitable for sensitive manufacturing processes therefore Araihaazar Economic Zone (AEZ) requires an uninterrupted electricity supply. Considering the current grid situation, proposed EZ has a provision to install a power plant including a sub-station and transmission line (inclusive of substation and transmission line when referred to as “the power plant”). With the proposed power plant, Araihaazar Economic Zone will be able to provide highly reliable power supply which will be one of key features to attract international and Japanese investors whose requirement for power supply quality cannot be achieved in other EZs in Bangladesh. Since power demand of AEZ is small in the beginning of EZ operation, a small capacity Diesel Engine will supply power to EZ during the period. In accordance with power demand increase, medium capacity GEs, then a large capacity GT will supply power to the EZ accordingly. During low power demand of AEZ, remaining generated power will expected to be sold to the national grid in order to optimize its power generation

	productivity. The following combination of generation systems was selected. • GT: 1 set of approximately 31MW GT on ISO conditions (ambient temperature 15deg, relative humidity 60%) which becomes approximately 25MW GT on Bangladesh site conditions (35deg, 70%). Gas fuel only. • GE: 2 sets of 6MW GE • DE: 1 set of 3MW DE: used for the following occasions; For starting GT during black out / Emergency power supply / Shortage of gas fuel supply / Continuous power supply during low power demand of EZ operation, etc. Total capacity of Power plant is approximately 46MW on ISO conditions i.e. 40MW on Bangladesh site conditions.
Industries to be promoted	Agriculture/food processing industry, Plastic and Rubber Products, RMG/ apparels, Wooden Products, Knitting and Textile, Yarn, Spinning, Jute and Jute Goods Materials, Pharmaceutical and Healthcare Goods, Footwear and Leather Goods, Bi-cycle, Automobile/Motor cycle parts, Electrical and Electronics, Garments Accessories and Light Engineering industry (source: the previous survey) as a result of AEZ development.

Component of the Power Plant Layout

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

The following generation procedure may be followed in accordance with EZ power-demand increase.

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

Generators not supplying power to the EZ should supply power to the grid for the sale of electricity. For this purpose, all generators of GT, GE, and DE are equipped with change-over circuits for supplying power to the EZ or grid connection.

The components of the proposed power plant are as follows.

Gas Turbine Package,	33/11kV Transformer
Gas Turbine Generator,	230/33 kV Step-Up Transformer
GT Inlet Air Filter Unit	230 kV Switchyard
GT Fuel Gas Filter unit	230 kV Substation Control Room
GT CO ₂ Bottle Skid	Oil Water Separator
Gas Chromatography	Cooling Tower
Remote I/O Panel	Cooling Tower Pumps
Continuous Emission Monitoring System (CEMS)	Cooling Tower Chemical Feed
11 kV Switchgear	Pre-Treatment Plant

Gas Engine	Raw Water Tank
Diesel Engine	Raw Water Pumps
Electrical Building for the Plant	Fuel Oil Tank
Bypass Stack	Fuel Oil Pump
Coalescer Filter	Holding Pond with Pumps
33/11kV GT Generator Step Up Transformer	Fire Water Pumps
33/11kV Gas Engine Step Up Transformer	Fuel Gas Filter Separator
33/11kV Diesel Engine Step Up Transformer	Gas Compressor
33/11kV SGT Step Up Transformer	Air Compressor
Station Service Transformer	Air Dryer
Auxiliary Service Transformer	Air Receiver
33/11kV Switchgear Building	Warehouse/Workshop

The general layout plan of the proposed power plant is shown in Figure 2.5-7 in 2.5.1 of Chapter 2.

Power Generation Method

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

Power Evacuation and Distribution

Initially different studies were conducted to find out the best option for evacuating generated power as well as receiving power for the economic zone. Best advantage of the proposed power plant is a 230 kV transmission line passes over south corner of the proposed substation and power station location. For connecting the new Substation with the 230kV Transmission line, branch towers and terminal towers will be newly installed.

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

Power factor improvement capacitors are not planned since some of generators run during operation of factories in the EZ and supply reactive power for improving power factor. Key single line diagram is shown in Figure 2.5-11.

Fuel consumption

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

Water consumption

Total water consumption is 160 m³/day of which 80 m³/day will be used for gas turbine cooling and rest 80 m³/day will use for gas booster compressor.

Manpower Requirement**During Construction Phase**

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

During Operation Phase

This project will create direct job opportunity for about 50 people in various official capacities.

Project Schedule

The construction of proposed power plant is expected to on October 2019. The power plant commissioning will start on March 2021. The overall schedule of the proposed power plant is shown in the following table. However, this schedule is subject to change due to the ongoing land acquisition process, as well as unforeseen circumstances of the tendering process and the duration required for the detailed design process etc.

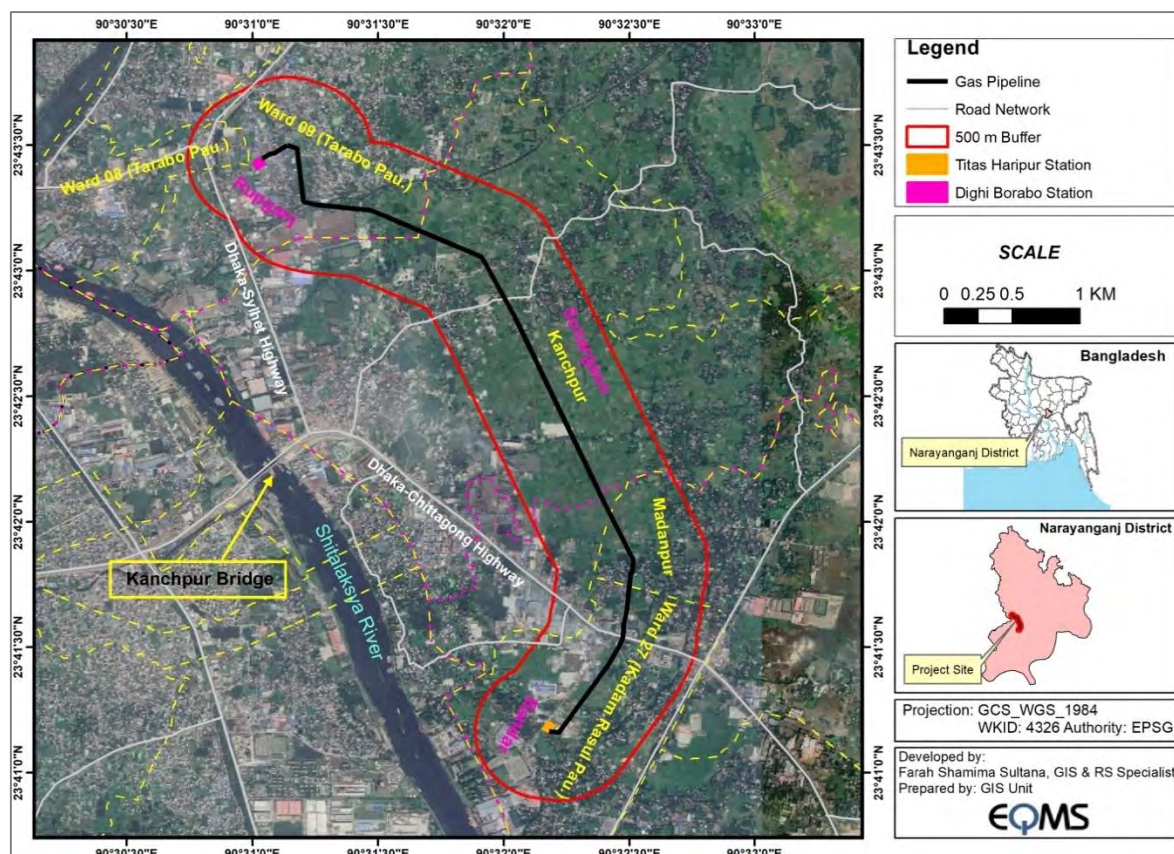
Table 3.3-2: Tentative construction schedule of the power plant

Bangladesh SAPI Project			2019												2020												2021											
			10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11										
			Year-1												Year-2																							
Delivery month	-1	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											
Milestone Events		▼ Notice to Proceed (NTP) ▽ Temporary Power Receive for Construction ▽ Mobilize to Site ▽ Water Receive ▽ Power Receive ▽ Gas In Plant Taking Over ▼																																				
<u>Gas Turbine</u>																																						
Manufacture / Procurement																																						
Installation																																						
<u>Gas Engine / Diesel Engine</u>																																						
Manufacture / Procurement																																						
Installation																																						
<u>BOP / Electrical System Engineering and Procurement</u>																																						
Fuel Gas Sytem																																						
Raw / Cooling Water System																																						
Waste Water System																																						
Fuel Oil System																																						
Compressed Air System																																						
Electrical System																																						
Civil Work / Building Construction (*1)																																						
Piping / BOP Equipment Installation Work																																						
Cabling / Wiring / Electrical Equipment Installation Work																																						
Plant Commissioning																																						

Project Description of the Gas Transmission Line

Table 3.3-3: Summary of the Gas Transmission Line

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



source: google map (partially modified by SAPI JICA Study Team)

Figure 3.3-1: Location map of the proposed Gas transmission line and surrounding area

Development area	Required Land Acquisition: approximately 3.5 ha [20 feet by 5,825 meter = 6.01 meter by 5,825 meter = appx 35,000 square meters] Required Land Requisition: approximately 3.28 ha [20 feet by 5,825 meter = 6.01 meter by 5,460 meter = appx 32,800 square meters] Some part of the alignment may use the existing RoW. Some area may not require land requisition due to the adjacent terrain or existing structure, or to minimize impact. After detail site assessment and detailed design by TITAS construction team and engineers, there may be minor modification.
Landuse	Mainly farmland, double cropping, partially industrial
Site preparation	Not required but land acquisition and requisition must be completed before

	construction.
Environmental and social conditions	Resettlement of houses and people is expected. There will be 255 affected land owners. Details are presented in the RAP. Several factories will be affected No precious ecology and cultural heritages sites exist.
Development Concept and Advantages	An initial agreement has been signed between TITAS and BEZA to supply 100 MMCFD gas for the proposed Araihaazar Economic Zone. Main portion of this component is the approximated length of 5.8 km long, 1,000 psig and 20-inch diameter Gas transmission line constructed from the Horipur TBS to Dighiborabo CGS in order to connect to existing gas transmission pipelines that goes through AEZ. The existing gas transmission line cannot supply sufficient pressure of gas to AEZ, thus the existing line must be connected to other line (the proposed gas transmission line) at Dighiborabo CGS to supply gas to AEZ. Thus the project also requires; Off take modification of Horipur TBS and Dighiborabo CGS Metering arrangement at Dighiborabo CGS Cathodic Protection
Industries to be promoted	Agriculture/food processing industry, Plastic and Rubber Products, RMG/ apparels, Wooden Products, Knitting and Textile, Yarn, Spinning, Jute and Jute Goods Materials, Pharmaceutical and Healthcare Goods, Footwear and Leather Goods, Bi-cycle, Automobile/Motor cycle parts, Electrical and Electronics, Garments Accessories and Light Engineering industry (source: the previous survey) as a result of AEZ development.

Location of the Project

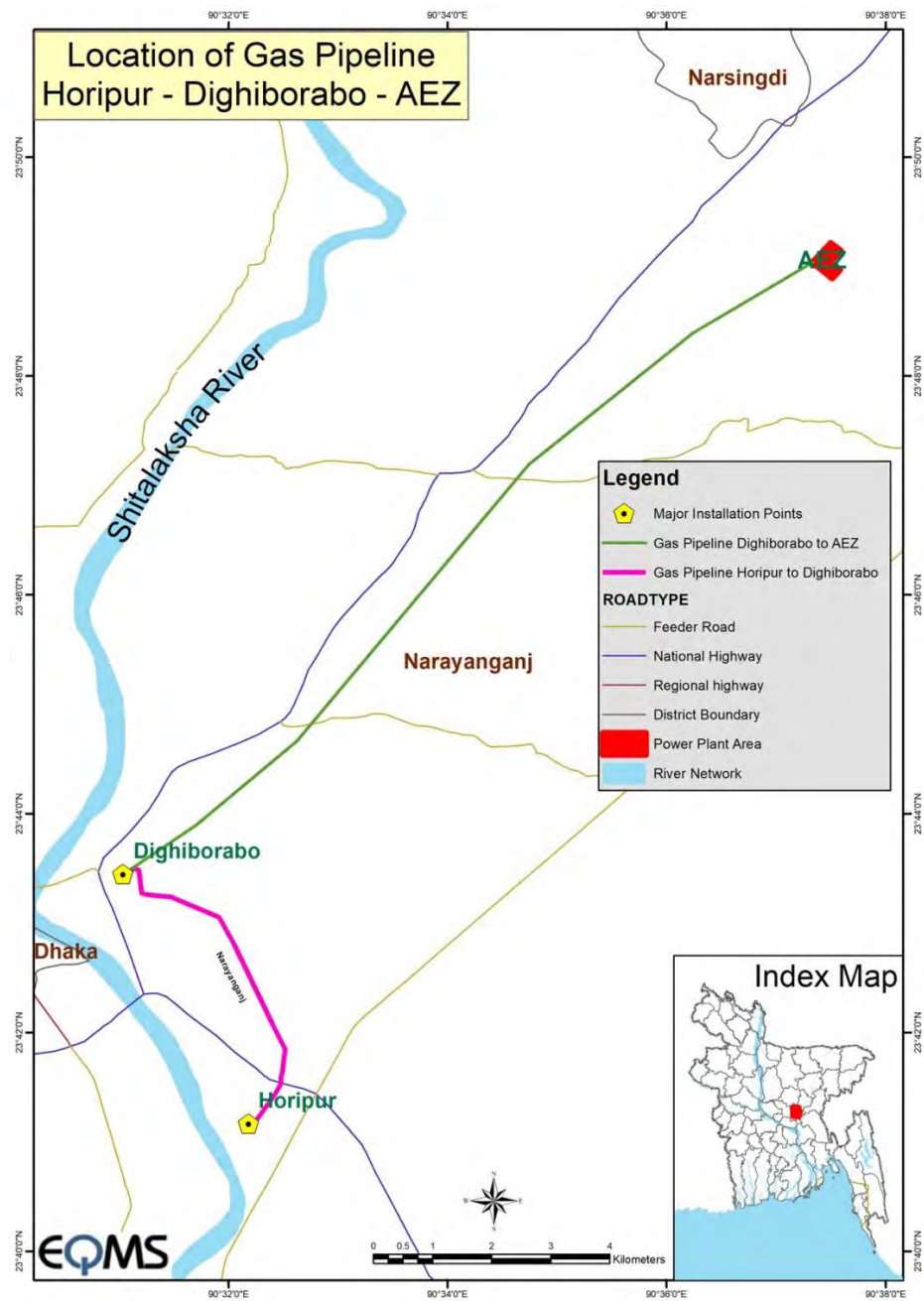
Approximated length of 5.8 km Gas transmission pipeline will be construct from Haripur TBS located at Word no-9 under Kadam-Rasul Paurashava to Dighiborabo CGS at Tarabo Paurashava as shown in Figure 3.3-1.

In order to determine the alignment of the gas transmission line, BEZA first needed TITAS to grant permission to conduct a route survey, EIA and RAP study of the gas transmission line. BEZA also needed TITAS to appoint designated supervisor(s) for this project, thus BEZA requested cooperation of TITAS as shown in a letter (Appendix 9-1).

TITAS officially agreed to allow BEZA to conduct necessary survey (Appendix 9-2). The location was determined by the route survey conducted by SAPI consultant team representing BEZA under supervision of TITAS engineers based on TITAS's official permission (), which also granted permission to BEZA to perform EIA and RAP study for the project area under several conditions.

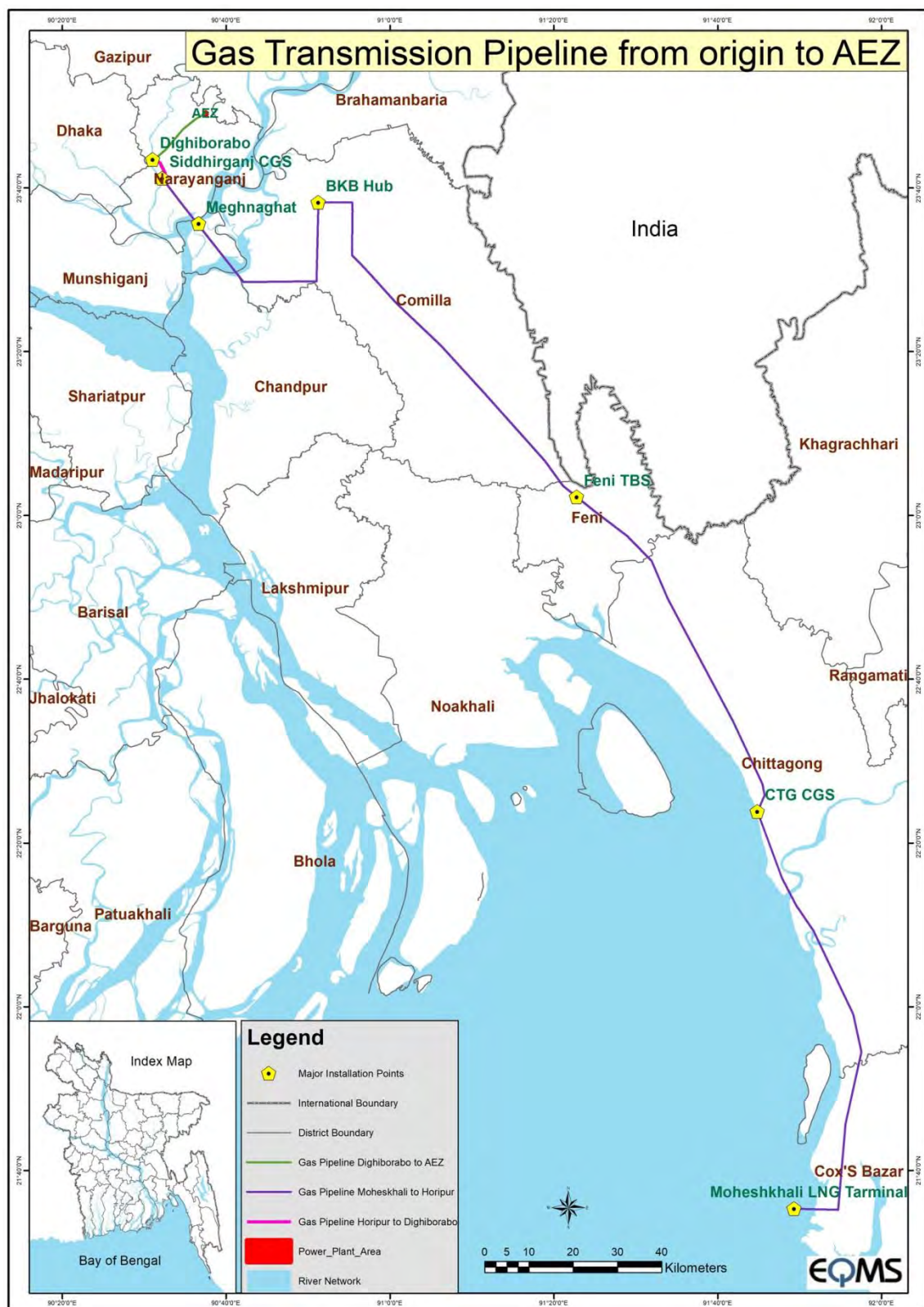
Geographical relationship and gas transmission connection between the proposed gas transmission line and AEZ is shown in Figure 3.3-2. The pink line indicates the proposed gas transmission line. The green line indicates the existing pipeline between AEZ and Dighiborabo station which will connect Dighiborabo CGS and AEZ.

Further, a broader gas transmission line connectivity is illustrated in Figure 3.4-3 illustrates a broader view of gas transmission connectivity.



Source: JICA STUDY TEAM

Figure 3.3-2: Gas transmission connection from the proposed gas transmission line and AEZ.



Source:

JICA STUDY TEAM

Figure 3.3-3: Gas transmission connectivity from Moheshkhali and the proposed gas transmission line and AEZ.

Route Survey

In order to determine the alignment of the gas transmission line, a route survey was required. After confirming that there would be no legal issues or restriction for BEZA to conduct a route survey on behalf of TITAS, BEZA officially asked TITAS for cooperation and appointment of designated persons for the gas transmission line. (see the official letter in Appendices)

In response, TITAS assigned the following two personnel;

Engr. Sarwar Jahan, Deputy Manager, Planning Division, TGTDC

Engr. Ishrak Ahmed, Asst. Engineer, Pipeline Design Division, TGTDC

In the initial stage, July-August 2018, TITAS proposed an alignment which would utilize the existing RoW. However, after reconnaissance evaluation conducted by JICA STUDY TEAM (consultants) hired by BEZA/JICA in August-September 2018, it was confirmed that the proposed RoW of TITAS would require displacement of a number of large structures such as large industrial areas, businesses and residential houses. This route also would require a considerable amount of time to negotiate with those business owners and workers and cost for compensation before starting construction.

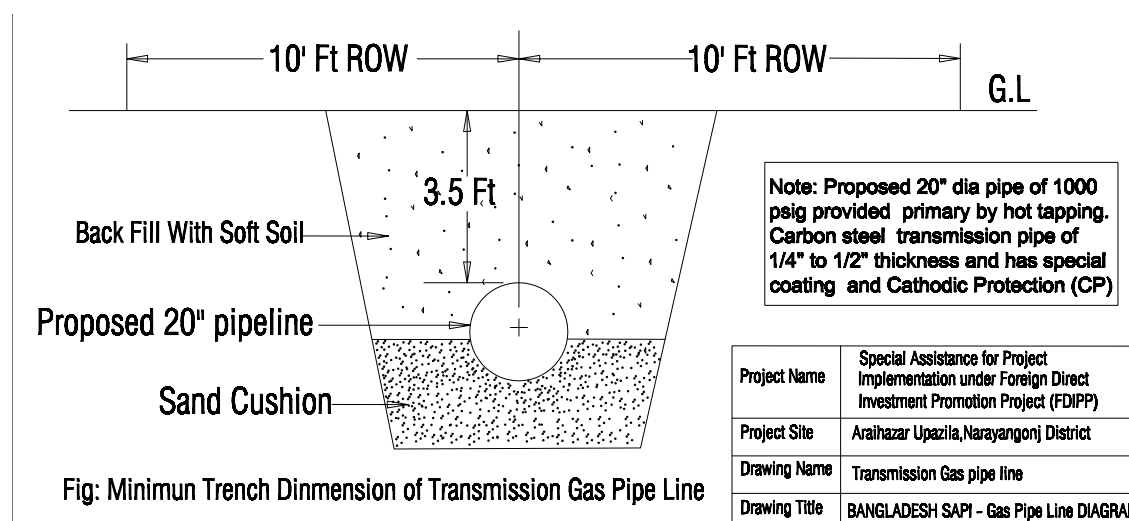
After discussion with TITAS and JICA STUDY TEAM (consultants), alternative alignments were assessed and proposed in order to minimize impact to existing structures. During the joint meeting in September 2018 with TITAS, BEZA and the consultants, a route with least influence on the structures and businesses was selected.

Further studies and topographic survey were carried out by JICA STUDY TEAM under supervision of TITAS engineers, and the alternative alignment has been unofficially approved by TITAS engineers. Additionally, in accordance with topographic survey and a series of consultation between JICA Study Team and TITAS, the proposed alignment was further modified to minimize impact on existing structures as much as possible.

Methods of installation

The proposed Gas transmission line will be installed mostly following the open cut method. The Gas transmission line needs to cross the Dhaka-Chittagong highway and a canal. The road will be crossed using the thrust boring method whereas the canal will be crossed following the open cut method. These crossing methods have been selected primarily. It will be finalized during the detail design stage.

The typical cross section of the gas transmission line is illustrated in Figure 3.3-4.



Source: JICA STUDY TEAM

Figure 3.3-4: Typical cross section drawing of the gas transmission line



Figure 3.3-5: sample image of thrust boring for road crossing

source: <https://www.uea.com.au/trenchless/tunneling/thrust-boring/>

Topographic drawing and the proposed RoW with surrounding structures are available in the Appendix 7.

3.3.2. Current Natural and Social Environmental Condition

Introduction

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

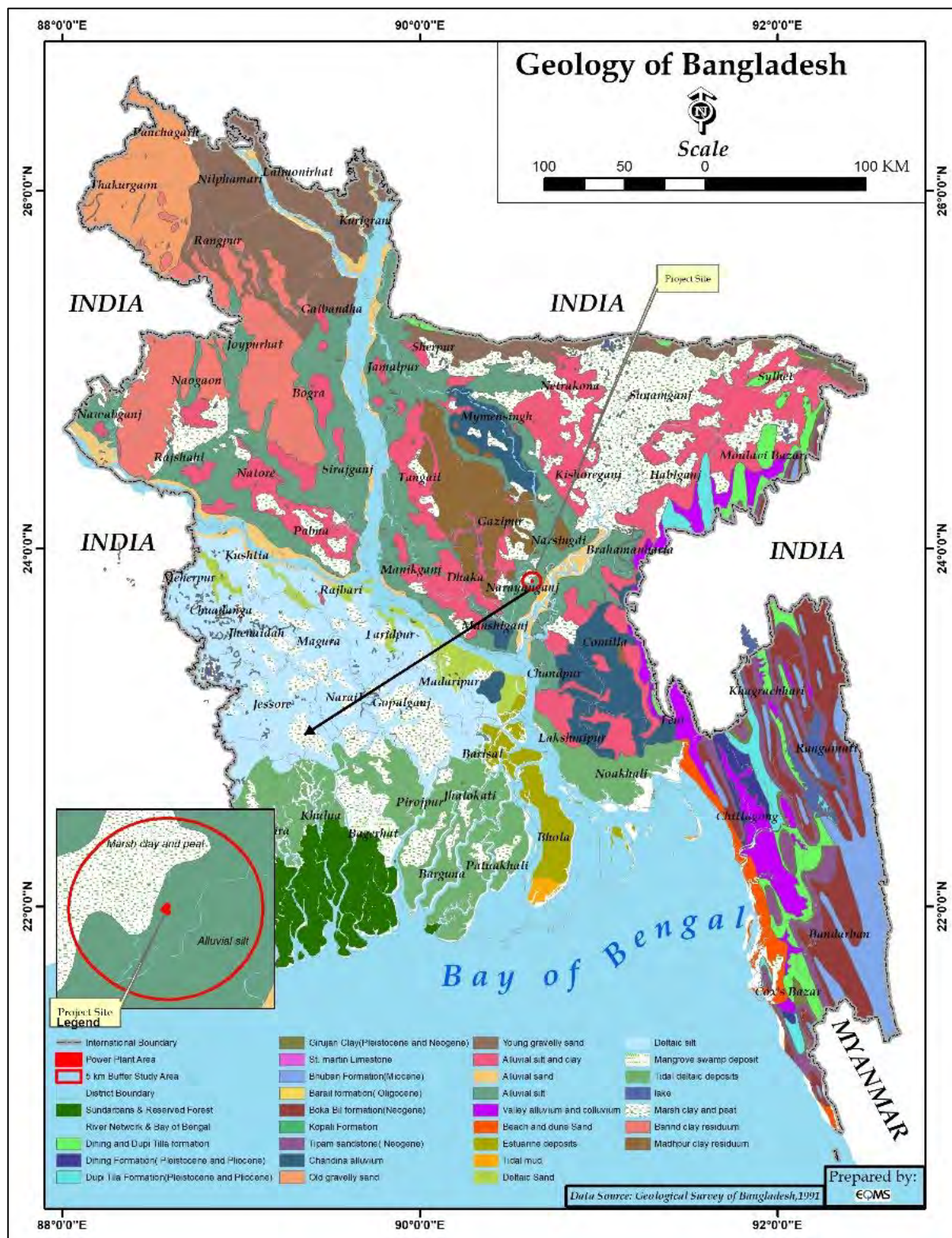
Site Description and its Environment

The site and surrounding details have already been presented under “Project component” section. The study area considered major settings, villages, roads, river, airport and railway around the proposed power plant site. The project activity areas are considered as core area and remaining study area as buffer zone. Environment setting around proposed power plant site and surroundings of access road are given in Table 3.3-4 below.

Table 3.3-4: Environmental Setting for Power plant & Gas Transmission Pipeline Project

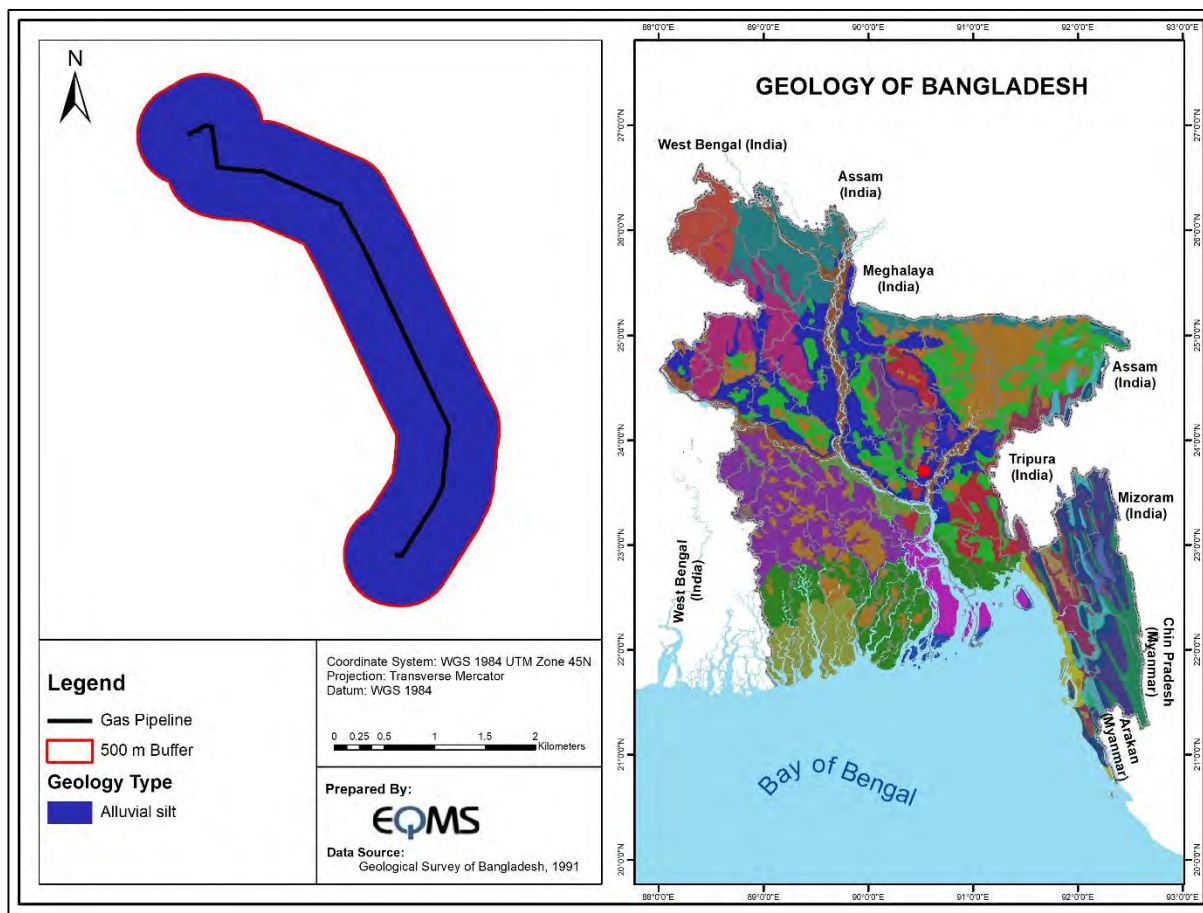
Particulars	Details
Location	Power plant site is located at Union: Duptara, Upazila: Araiuhajar, District: Narayanganj Gas transmission pipeline site is located at Union: Word-9 at Tarabo paurashava, Word no-27 at Bandar Paurashava and Kanchpur at Shonargong upazila under District: Narayanganj
Mouza	Power Plant: Panchrukhi & Panchgaon Gas Transmission Pipeline: Dighiborabo, Jatramura, Behakair, Nagar Kanchpur, Manohar Khanerbagh, Uttar Chandpur, Fular
Project Area	Proposed Power plan area approximately 9.28 ha or 22.93 acres Approximately 8.65 acres land need to be acquired and 8.11 acres land will be leased for construction of Gas transmission line.
Road Access	Adjacent Dhaka-Sylhet Highway
River Access	Proposed Power plant is Approx. 1.5 km from Brahmaputra River Proposed Power plant is Approx. 5.5 km from Shitalakhya River Gas transmission pipeline Haripur station is Approx. 740 meters from Shitalakhya River
Nearest Airport	Proposed Power plant is Approx. 30.2 km from Hazrat Shah Jalal International Airport (Dhaka)
Nearest Railway Station	Proposed Power plant is Approx. 30.3 km from Kamalapur Railway Station, Dhaka
Climatic conditions	Avg. Monthly wind speed– 2-5 m/s; Avg. Monthly Min. Temp. – 19.0°C January 1991; Avg. Monthly Max. Temp. – 40.2°C in April 2014; Annual Avg. Rainfall – 1994.6 mm; Average maximum humidity ranges – 94% to 97%; Average minimum average ranges – 31% to 64%;
Seismic Zone	Zone II
Forests / National Parks	None within 5 km
Archaeologically important places/monuments	No Archaeologically important places/monuments near to the site

Source: Google Earth & Site Visits



Source: Geological Survey of Bangladesh, 1991

Figure 3.3-7: Geology of 5 km Radius of Study Area

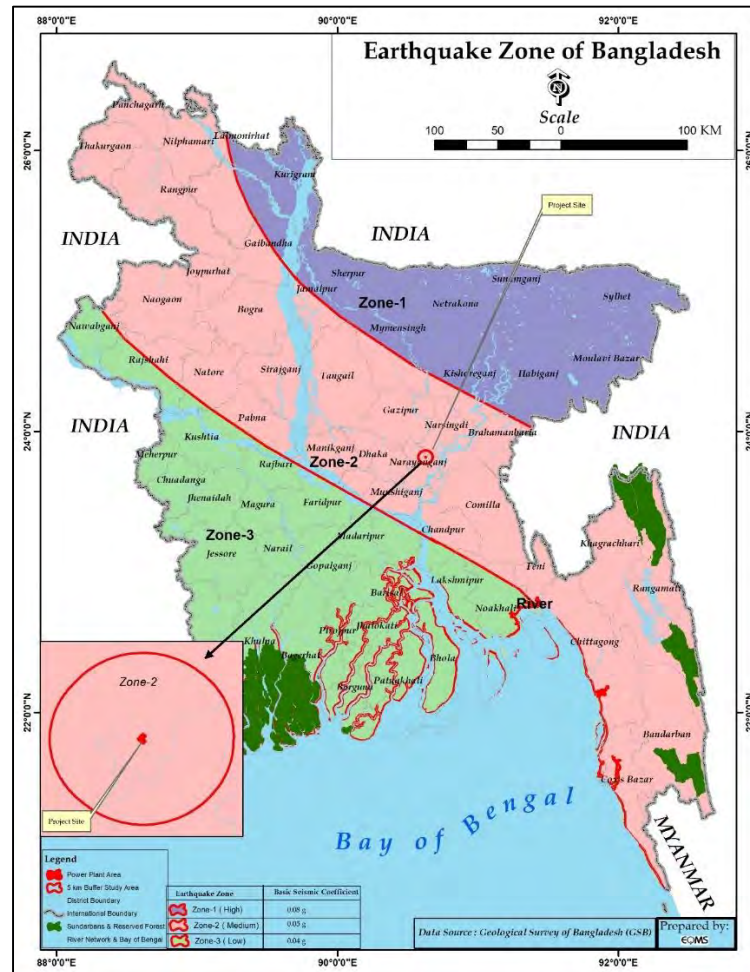


Source: Geological Survey of Bangladesh, 1991

Figure 3.3-8: Geology of 500 m Buffer Study Area

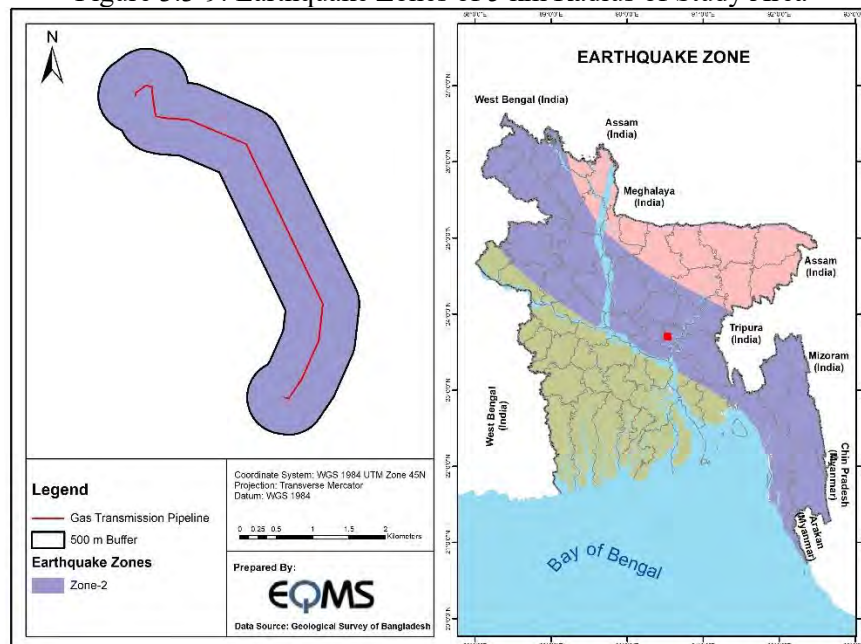
Seismology

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



Source: Geological Survey of Bangladesh (GSB)

Figure 3.3-9: Earthquake Zones of 5 km Radius of Study Area



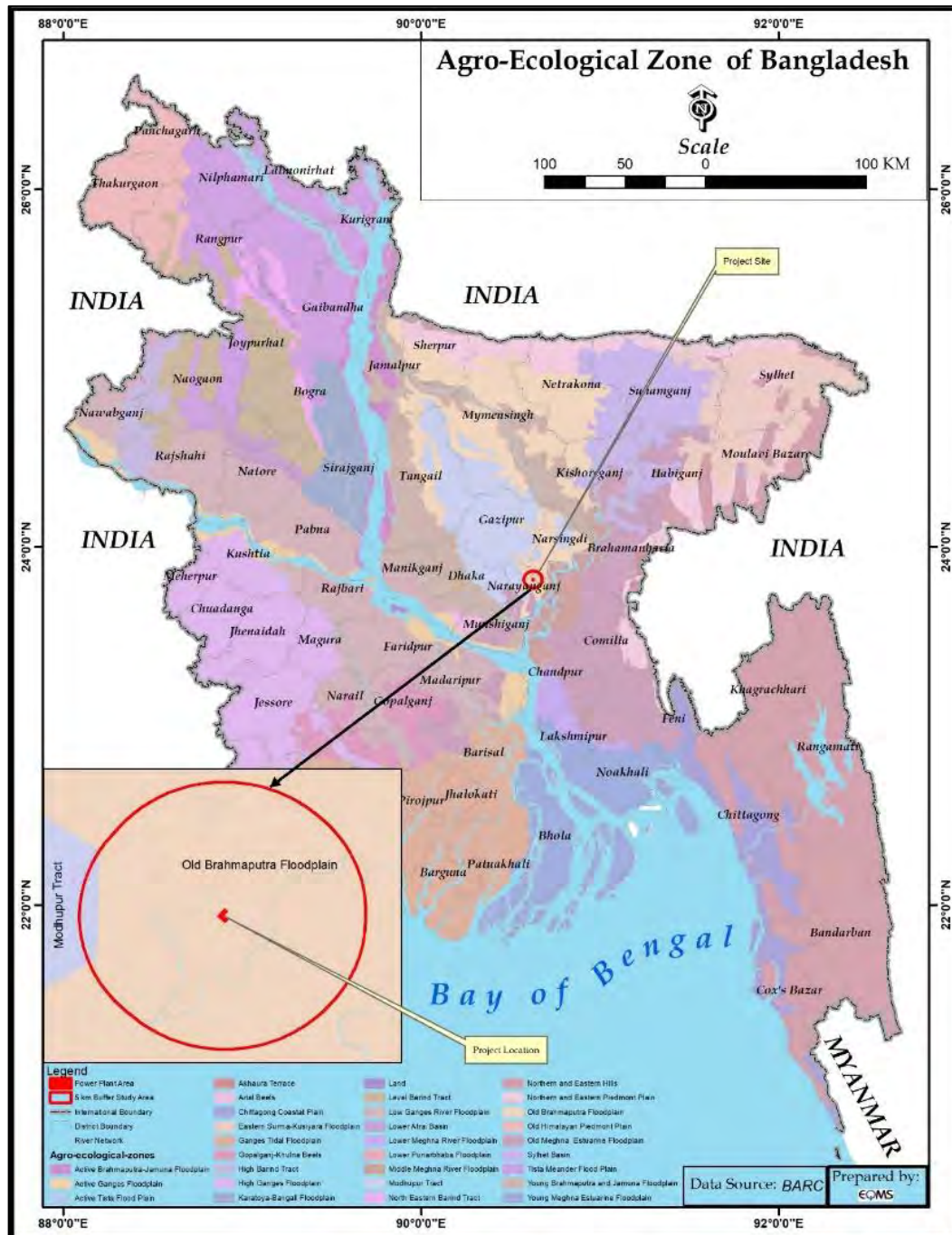
Source: Geological Survey of Bangladesh (GSB)

Figure 3.3-10: Earthquake Zones of 500 m Buffer Study Area

Soil Characteristics

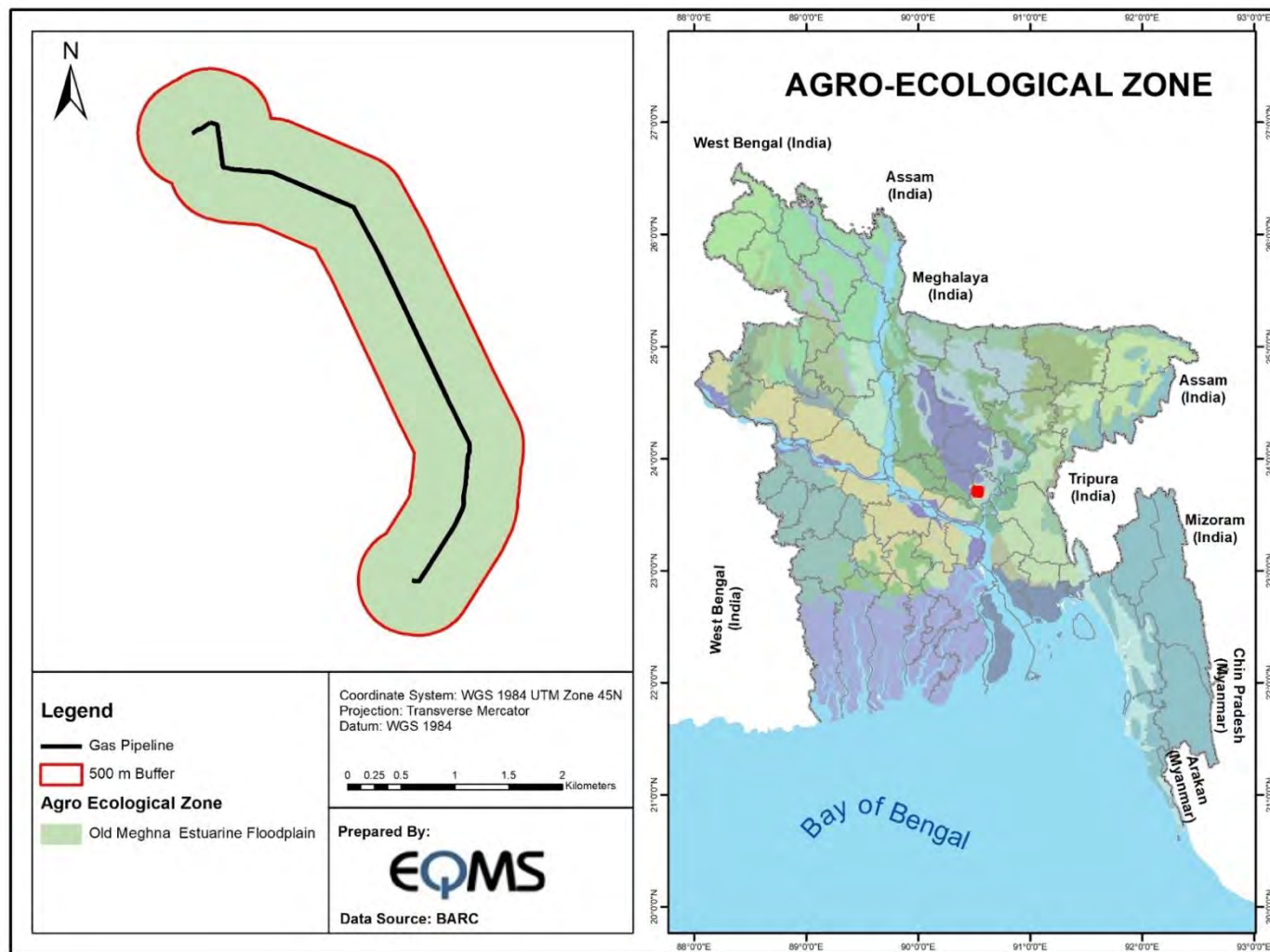
Agro ecological Regions

The 5 km study area covers four distinct agro-ecological zones; they are the Old Brahmaputra Floodplain and Modhupur Tract. The proposed power plant site falls under Old Brahmaputra Floodplain zone. In addition, the Gas transmission pipeline area falls under Old Meghna Estuarine Floodplain zone. Agro-ecological zones of Bangladesh have shown in Figure 3.3-11 & Figure 3.3-12. Details of these agro ecological zones has discussed in Table 3.3-5.



Source: BARC

Figure 3.3-11: Agro-ecological Zones of 5 km Radius of Study Area



Source: BARC

Figure 3.3-12: Agro-ecological Zones of 500 m Buffer Study Area

Table 3.3-5: Details of Agro-ecological zones of Bangladesh within study area

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

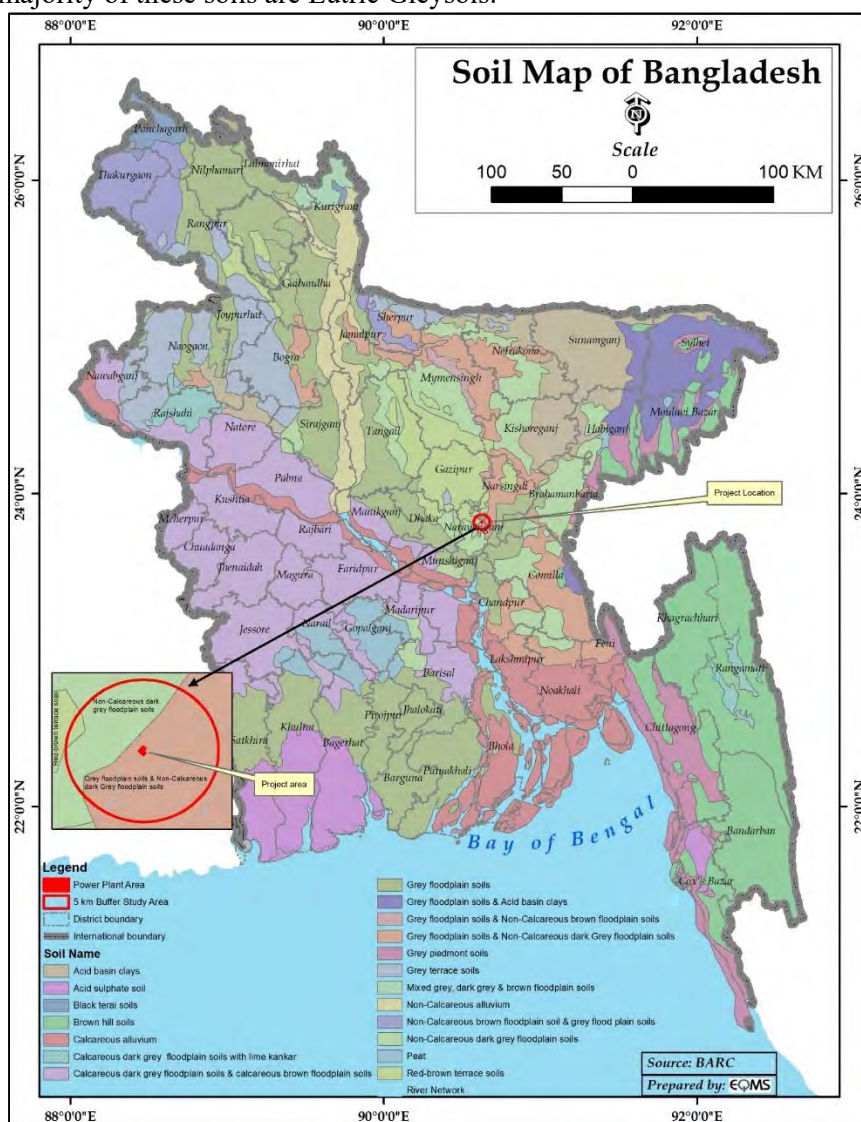
Source: BARC

Soil Type

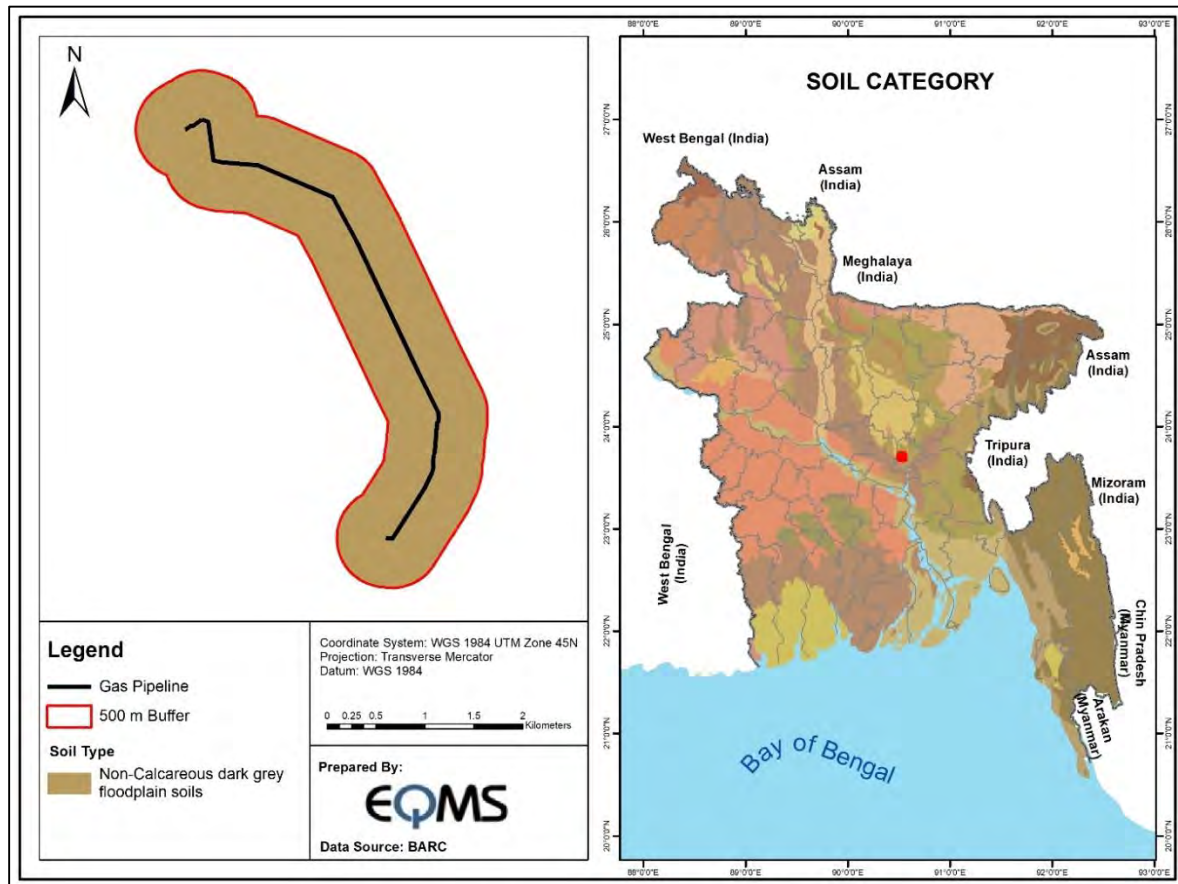
The 5 km study area covers three distinct soil type; they are the Gray Flood plain soil, Non-Calcareous Dark Grey Floodplain soils and Red Brown terrace soils. Proposed power plant site soil covers Grey Floodplain Soils & Non-Calcareous Dark Grey Floodplain soils. The Gas Transmission pipeline area covers Non-Calcareous Dark Grey Floodplain soils. The soils category of Bangladesh Map is given in (Figure 3.3-13 & Figure 3.3-14).

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

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



Source: BARC
Figure 3.3-13: Soils Category of 5 km Radius of Study Area



Source: BARC

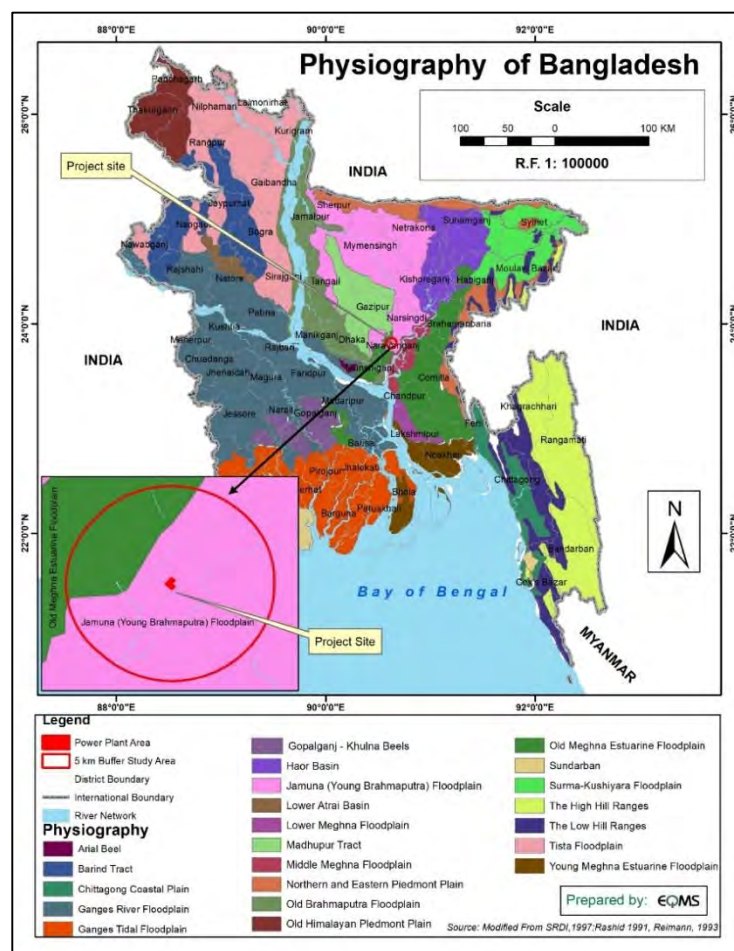
Figure 3.3-14: Soils Category of 500 m Buffer Study Area

Topography

The proposed power plant site is a naturally depressed area, which remains submerged during monsoon and dry in winter. The land use of the project site is agricultural land. Area is classified as a Jamuna (Young Brahmaputra) Floodplain. A river network is present close to the site that floods during monsoon season. The physiographic zone of gas transmission pipeline falls under Madhupur tract and Old Meghna Estuarine Floodplain Zone. The RoW of pipeline is also depressed area, which remains submerged during monsoon and dry in winter. A physiographic map of Bangladesh is depicted in Figure 3.3-15 & Figure 3.3-16.

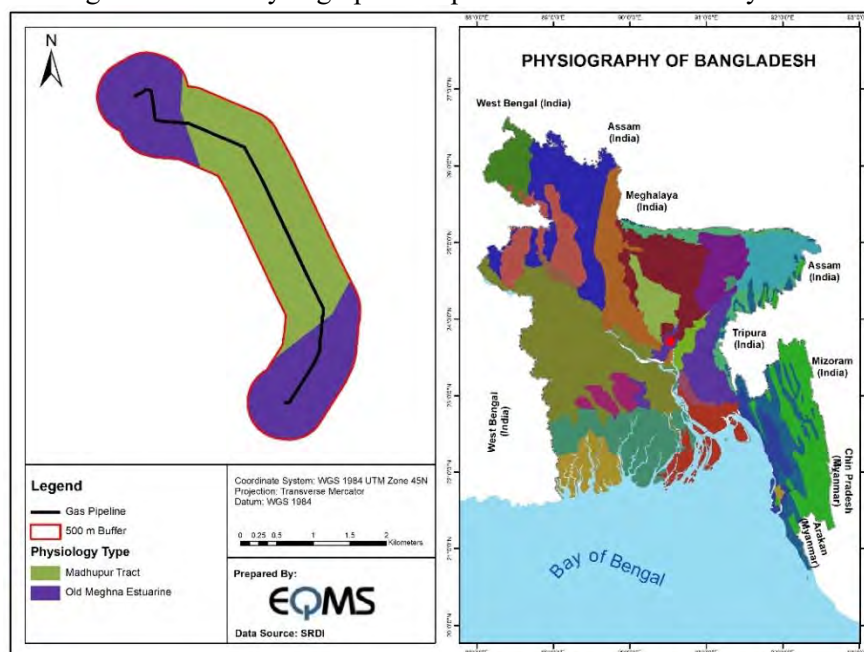
The Power plant candidate site is flat agricultural land (paddy field) with an elevation of MSL + 2.5 m, and is submerged in the rainy season. The Dhawrakhal canal pass adjacent the proposed project boundary. The area on the southeastern side of the candidate site, along National Road N2 and along the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

A DEM map of study area is shown in Figure 3.3-17 & Figure 3.3-18.



Source: SRDI; Rashid 1991, Reimann, 1993

Figure 3.3-15: Physiographic Map of 5 km Radius of Study Area



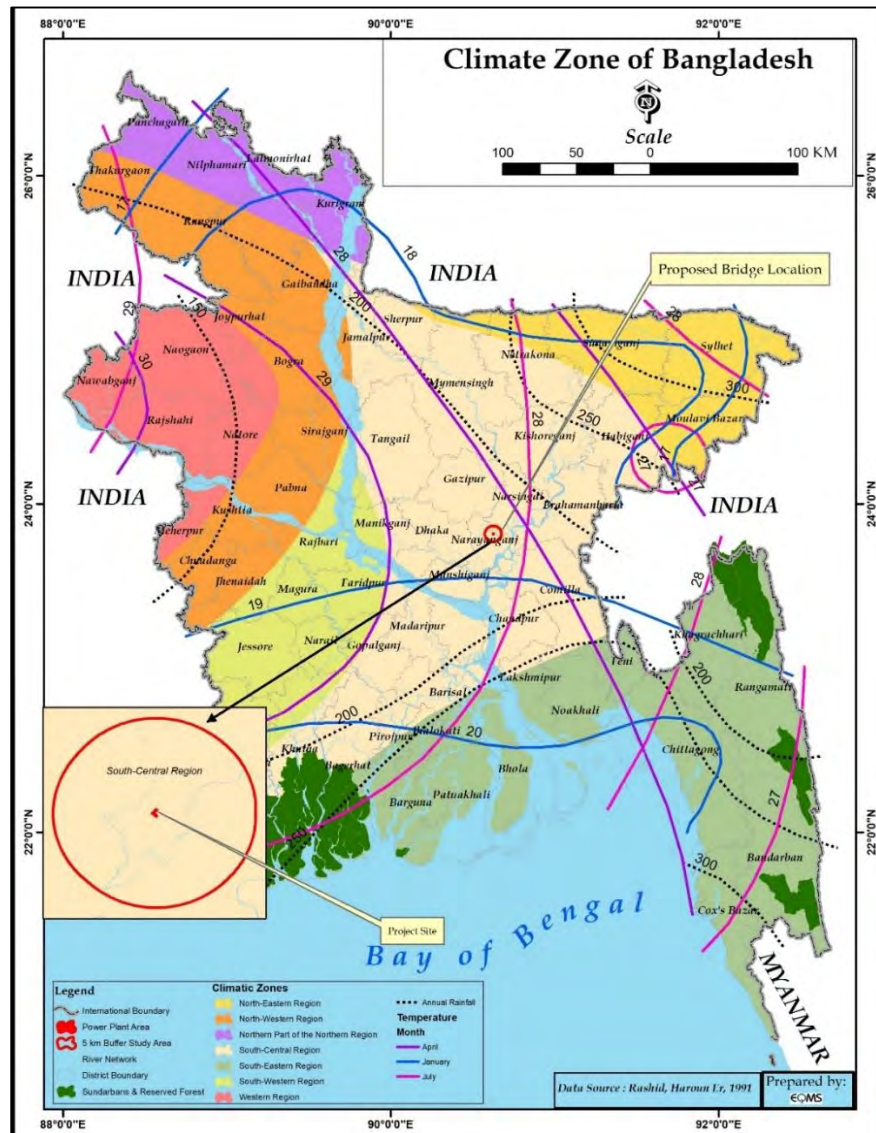
Source: SRDI; Rashid 1991, Reimann, 1993

Figure 3.3-16: Physiographic Map of 500 m Buffer Study Area

Meteorology

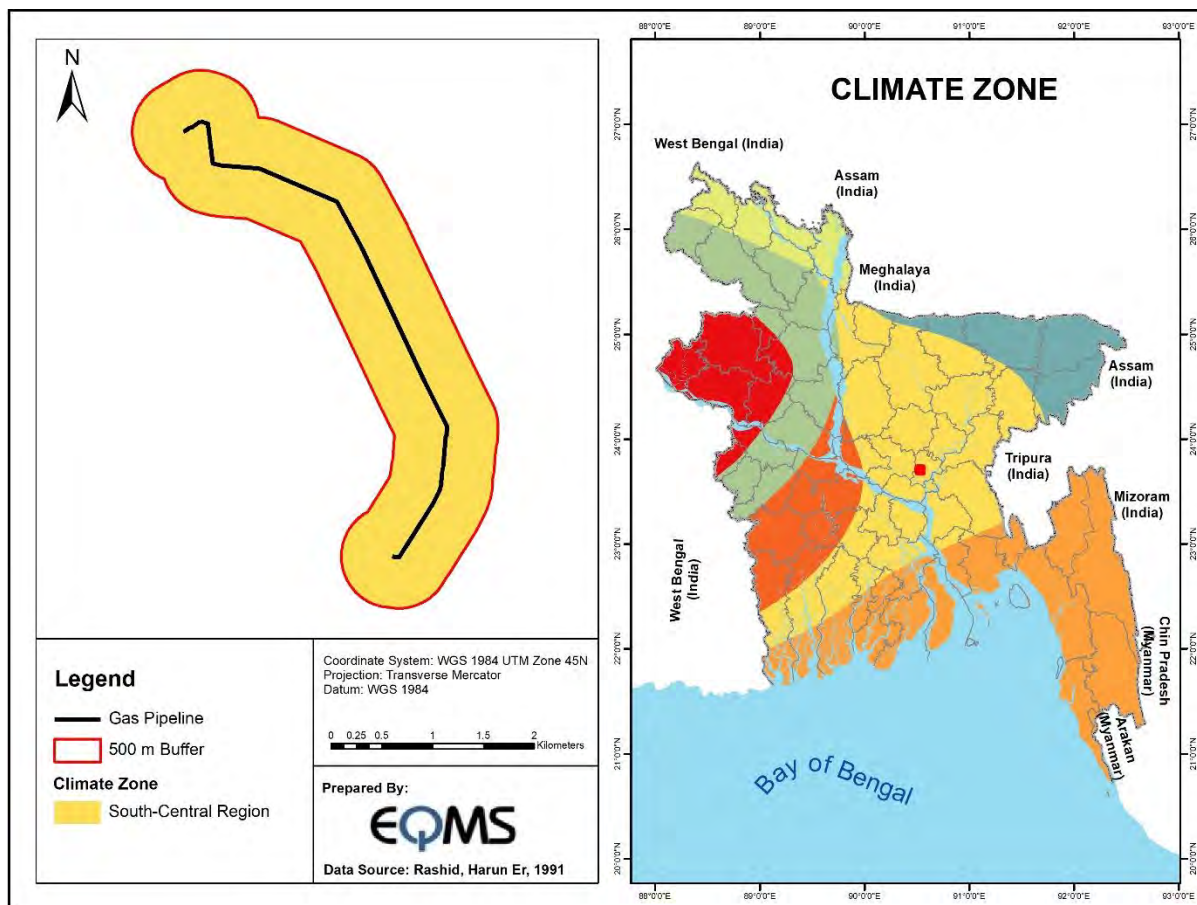
Bangladesh experiences a subtropical monsoon climate, which is characterized by wide seasonal variations of rainfall, high temperatures and humidity throughout the year. There are three distinct seasons in Bangladesh: hot and humid summer stretches from March to June; a wet and cool rainy season from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

Within the study area, the proposed power plant and Gas transmission pipeline area falls in the south central climatic sub zone of Bangladesh. This sub climatic zone experiences abundant rainfall (more than 1,900 mm) and moderate temperatures. Eighty percent 80% of the rain falls during the monsoon season. Hail storms and nor westers are also observed in this area. However, in order to investigate the climatic conditions of the study area, data from different secondary sources have been collected. Long-term Meteorological data of the last 30 years have been collecting from the nearest BMD stations (Dhaka) and analyzed to get the overall micro-climatic conditions of the study area.



Source: Rashid, Haroun Er, 1991

Figure 3.3-19: Climate Region Map of 5 km Radius of Study Area



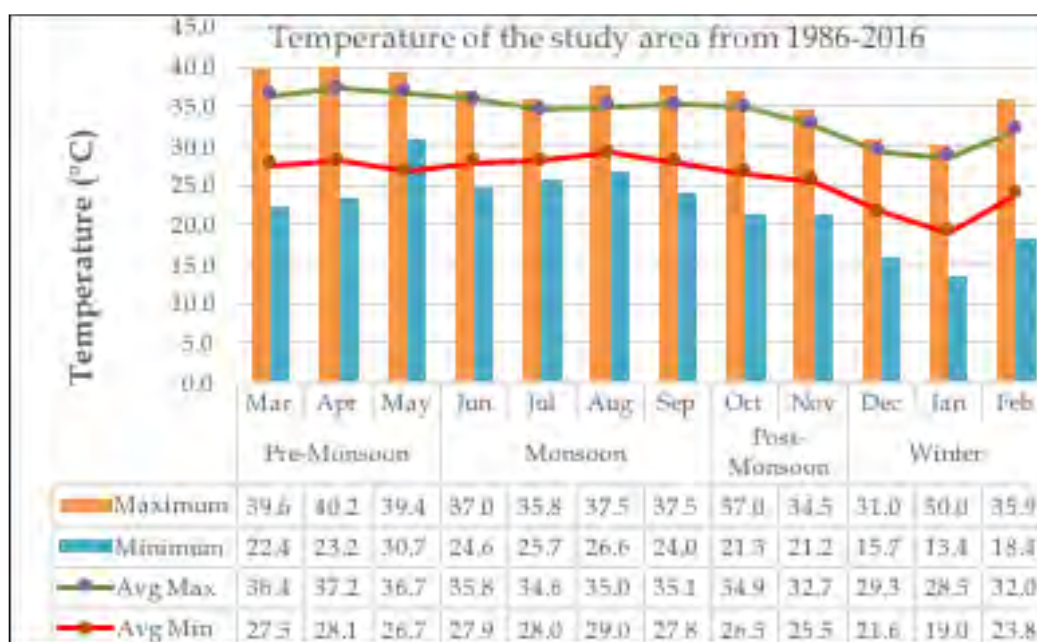
Source: Rashid, Haroun Er, 1991

Figure 3.3-20: Climate Region Map of 500 m Buffer Study Area

Temperature

The maximum, minimum and average temperatures recorded at the Dhaka weather station are presented below in Figure 3.3-21.

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

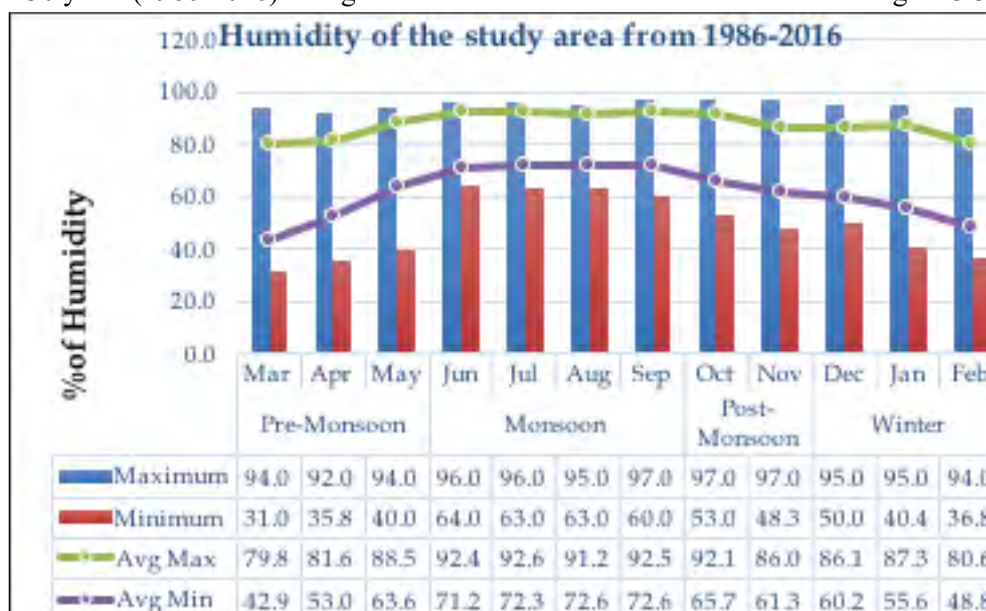


Source: Bangladesh Meteorological Department, Dhaka

Figure 3.3-21: Monthly Maximum, Minimum and Average Temperatures (1986-2016) registered at the Dhaka Weather Station

Humidity

Due to the heavy rainfall and high air temperature, the humidity levels in Bangladesh remains high. Analyzing the meteorological data, it has been found that during the pre-monsoon period the humidity level remained at its lowest point. Within the study area, February is the driest month with an average minimum of around 49% humidity. However, humidity increases to maximum in the monsoon period. The average maximum humidity ranges from 94% to 97%, whereas the minimum average ranges from 31% to 64%. The monthly maximum, and maximum averages and minimum, minimum average of the last 30 years (1986-2016) of registered Dhaka weather station are shown in Figure 3.3-22.

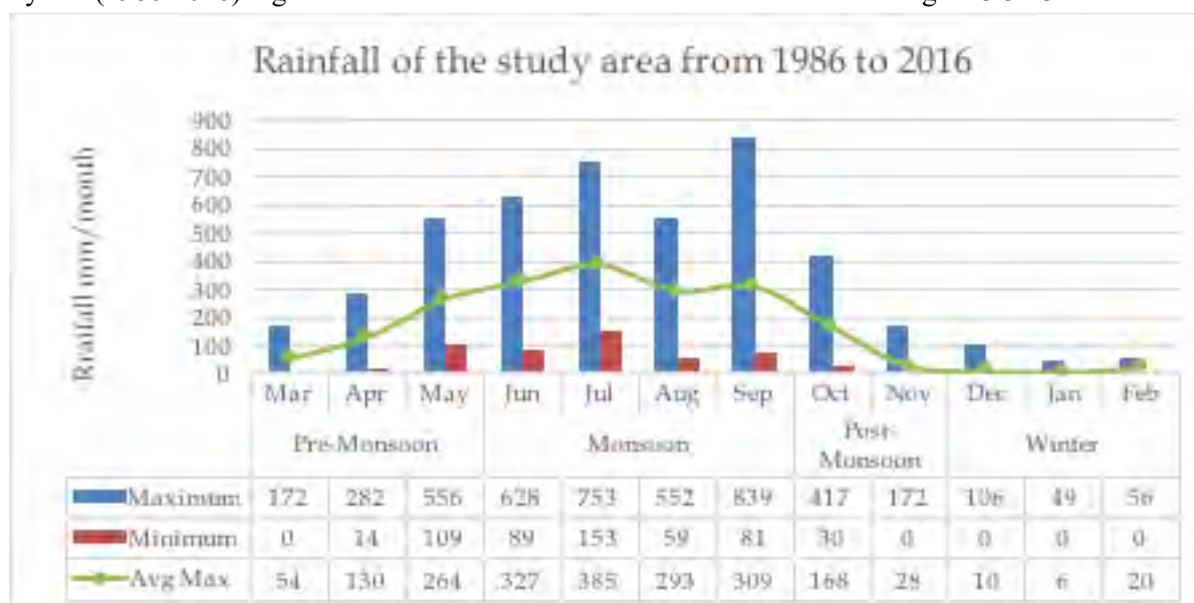


Source: Bangladesh Meteorological Department, Dhaka

Figure 3.3-22: Monthly Maximum, Minimum and Average Humidity (1984-2014) registered at the Dhaka Weather Station

Rainfall

About 80% of the rainfall occurs during the six monsoon months (May to October) with June and July getting the maximum average rainfall. Minimum rains are reported during the months of November to February whereas the average showering occurs in March, April and November. The meteorological data of the last 30 years from the Dhaka meteorological station shows that the annual average of total rainfall recorded as 1,994.6 mm/year. According to the analysis of the historical data, the monthly average of total rainfall occurs in July at 1,049 mm whereas monthly minimum rainfall is recorded during the winter season. The monthly maximum, minimum and average rainfall data of the last 30 years (1986-2016) registered at the Dhaka weather station is shown in the Figure 3.3-23.



Source: Bangladesh Meteorological Department, Dhaka

Figure 3.3-23: Monthly Maximum, Minimum and Average Rainfall (1986-2016) registered at the Dhaka Weather Station

Evaporation

Evapo-transpiration reaches its maximum level in April when temperature, sunshine and wind are all at, or close to, their maximum levels for the year. Potential evapo-transpiration data for Dhaka stations presented in Table 3.3-6. In Dhaka, evapo-transpiration varies from 60 to 147 mm/day and yearly evapo-transpiration in Dhaka is 1245 mm/day.

Table 3.3-6: Monthly Potential Evapo-Transpiration Data of Dhaka Meteorological Station

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

Source: Bangladesh Meteorological Department, Dhaka

Wind Speed and Direction

Like the countries wind characteristics, the region characterized by Southerly wind from the Bay of Bengal during monsoon and Northwesterly wind from Himalaya during winter. As per BMD, windiest month is May with average wind speed of 2.6 knot and least windy month is October with average wind speed of 0.6 knot. Average monthly wind speed data of the Dhaka meteorological station given in Table 3.3-7.

Table 3.3-7: Average Monthly Wind Speed Data of Dhaka Meteorological Station

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

Source: Bangladesh Meteorological Department, Dhaka

Sun Shine Hours

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

Hydrology and Water Resources

Surface Water System

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

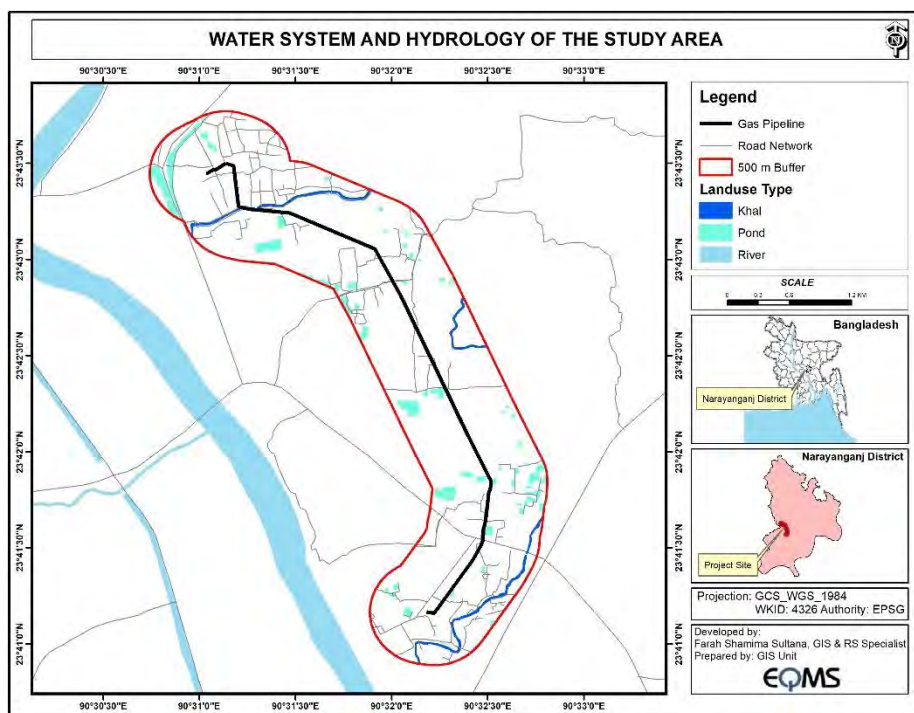
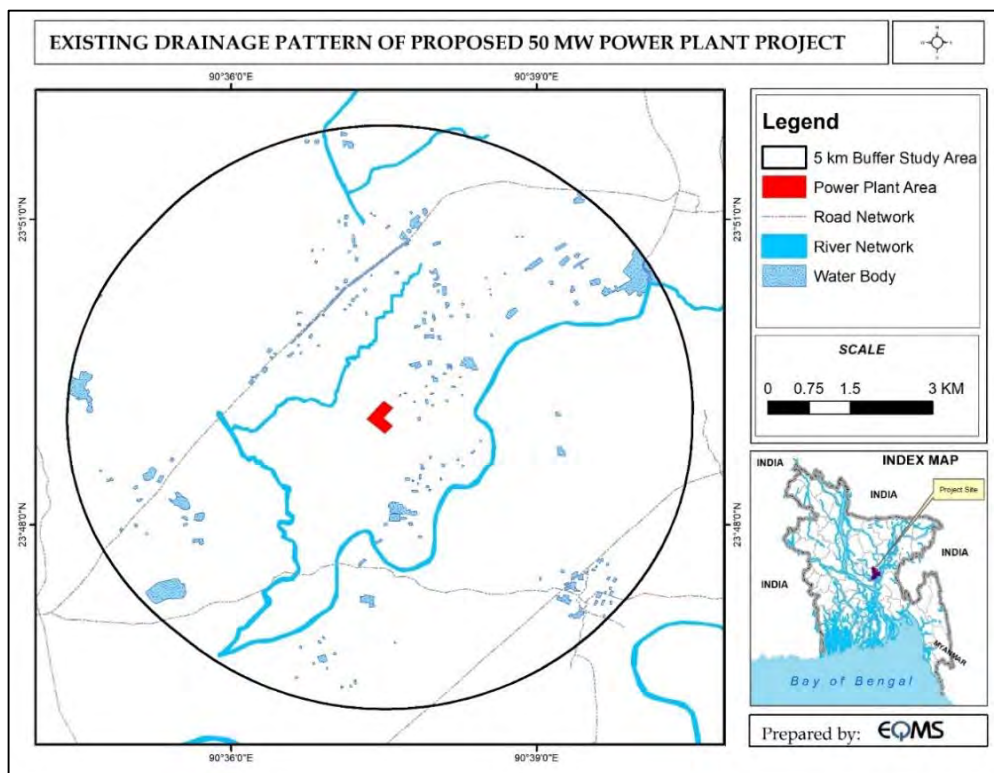
Dhawrakhali canal flows at the middle of the project site which width is approximately 5-7meters. It's downstream connected with Brahmaputra River which width is 24-27 meters. Brahmaputra River is also connected with Meghna River. After consultation with local fishermen, the survey team try to identify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

Project site is located on a naturally depressed area, which remains submerged during monsoon and dry in winter. Drainage pattern in 5 km area is given in Figure 3.3-24 and drainage pattern in 500 m study area is given in Figure 3.3-25.

The closest river is Shitalakhya River, which is 5.5 km far from the proposed power plant area and Gas transmission pipeline route. The Shitalakhya River originates from the Old Brahmaputra River and is part of the Old Bhahmmapura-Lakhya-Meghna river system. The Shitalakhya flows down toward the south and joins the lower Daleswari near Narayanganj, whereupon the combined tributary meets the Meghna River. The Shitalakhya River is a well-defined channel, which traverses the erosion-resistant soils of the Madhupur Tract without meanders and braiding. The length of the river from its off take to the point of confluence with the Dhaleswari is about 112 km and its peak discharge during high flood ranges between 1,800 and 2,700 m³/s. At Narayanganj, the recorded water level peaked at 6.93 mPWD during the 1988 flood which is more than 1.0m higher than the natural ground level. The river was once famous for its clear and cool water. At present Industrial affluent dumped into the river, resulting in high levels of pollution is a cause for concern. Numerous launches move out along the river to different parts of Bangladesh. The government has approved construction of an AK khan container terminal on the river Shitalakhya with foreign investment. The river goes under tidal effect for about five months of the year but never overflows its banks.

Drainage Congestion and Water Logging

The study area of proposed site is flat agricultural land (paddy field) with an elevation of MSL + 2.5 m, and submerged in the rainy season. Small water channels a few meters lower than the surrounding agricultural ground elevation exist. Water logging observed at site during monsoon season. According to the information collected through focus group discussions (FGD), the area affected in normal floods. However, during heavy rainfall and monsoon season the river water enter in the low laying area causes water stagnation in the area for some time. Rainwater inside the power plant site flows from the northeast to the southwest and drains into the southwestern side of the river, which is connecting to the Meghna River. The elevation of the candidate site is lower than past flood levels of surrounding large rivers such as the Meghna River and the Shitalakshya River. Hence, it is necessary to ensure surface water diversion around the candidate site after site formation.



Ground Water System

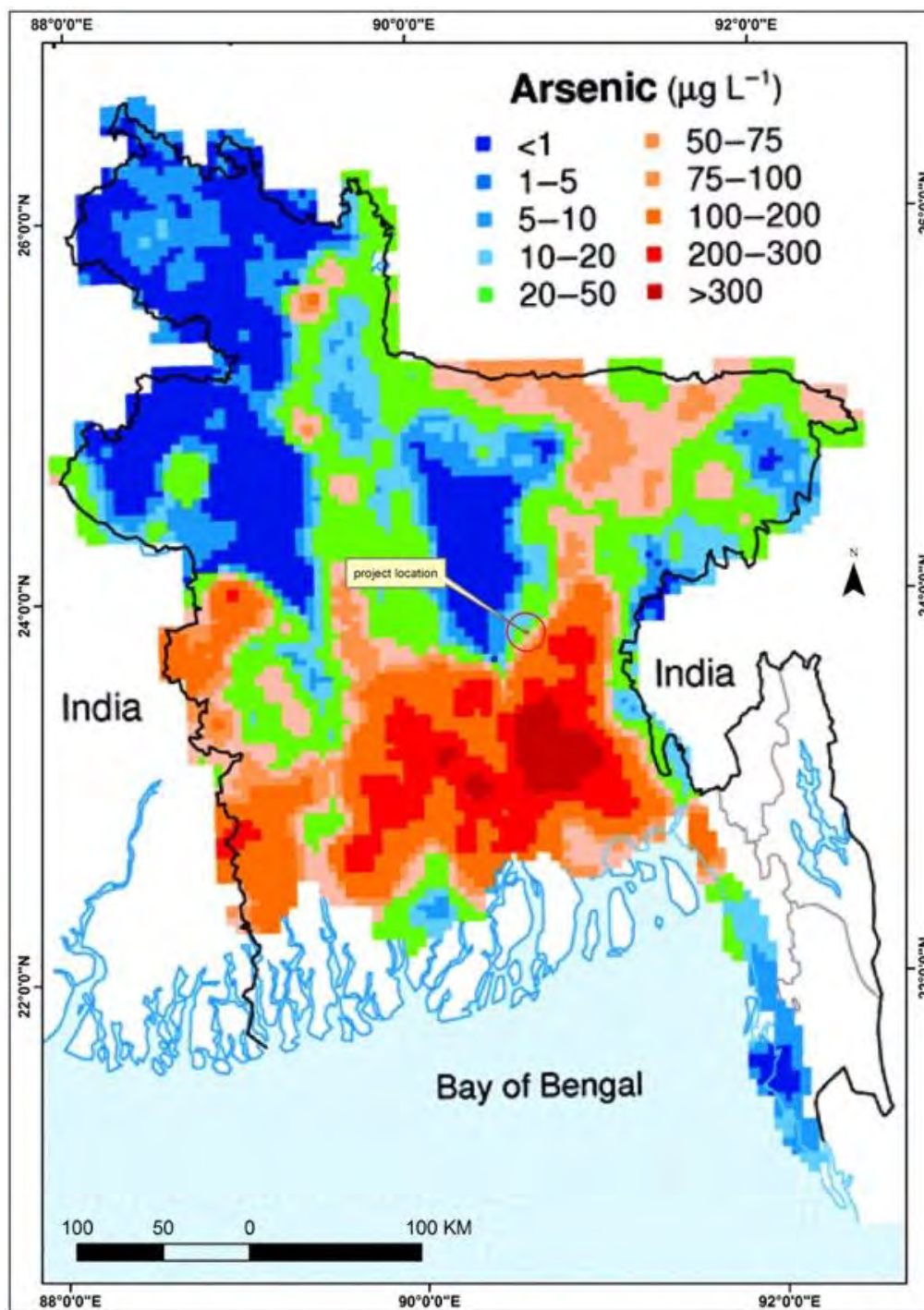
There are three main aquifers in the central region of Bangladesh, where the proposed project is located:

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

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

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

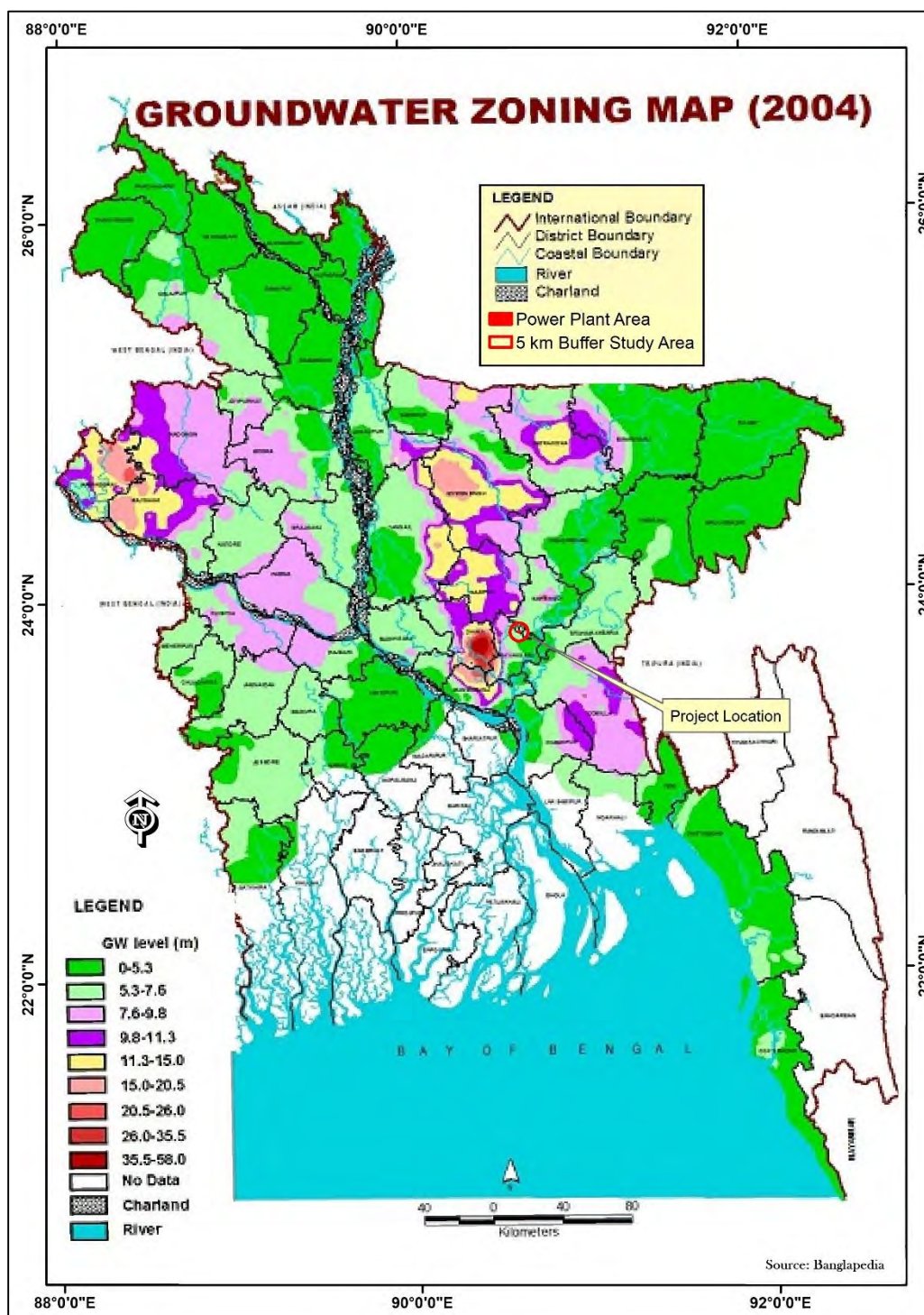
The JICA Study Team (Survey 2000) conducted analysis of 55 TWs altogether, 38 STWs (69.1%) and 17 DTWs (30.9%); 26 (47.3%) in Duptara Union and 29 (52.7%) in Satgram Union. Most of the area is relatively safe with only two TWs in Duptara Union having arsenic exceeding the Bangladeshi standard for drinking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



Source: AAN

Figure 3.3-26: Distribution of Arsenic (As) in Groundwater

Figure 3.3-27 is showing the Ground Water Zoning Map, which indicated that the project site is located at the area of ground water level 0-5.3, 5.3- 7.5m. This area also receives sufficient amount of rainfall and there is a good availability of ground water that being used by hand pumps for drinking and domestic purposes. The homesteads are using hand deep tube well to meet their domestic demand. Potable ground water is available at an average depth of 110m to 220m. During site visit, it is observed that sufficient quantity of water was coming out from the HTW. However, after discussion with the local people it is learnt that there is no specific complaint about non-availability of ground water.



Source: Bangladesh Agriculture Development Corporation, 2011

Figure 3.3-27: Ground Water Zoning Map of Bangladesh

Tropical Cyclones

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

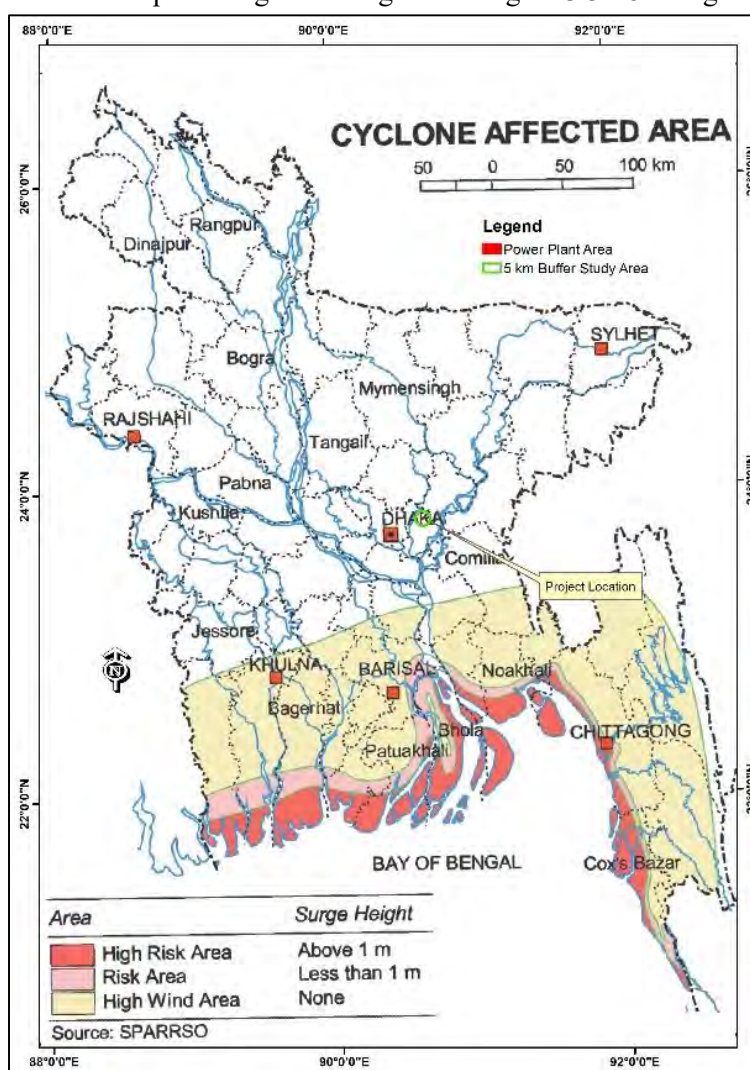
Devastating cyclones hit the coastal areas of Bangladesh almost every year usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and 3-10m high waves, causing extensive damage to life, property and livestock. Because of the funnel shaped coast, Bangladesh repeatedly becomes the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

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

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

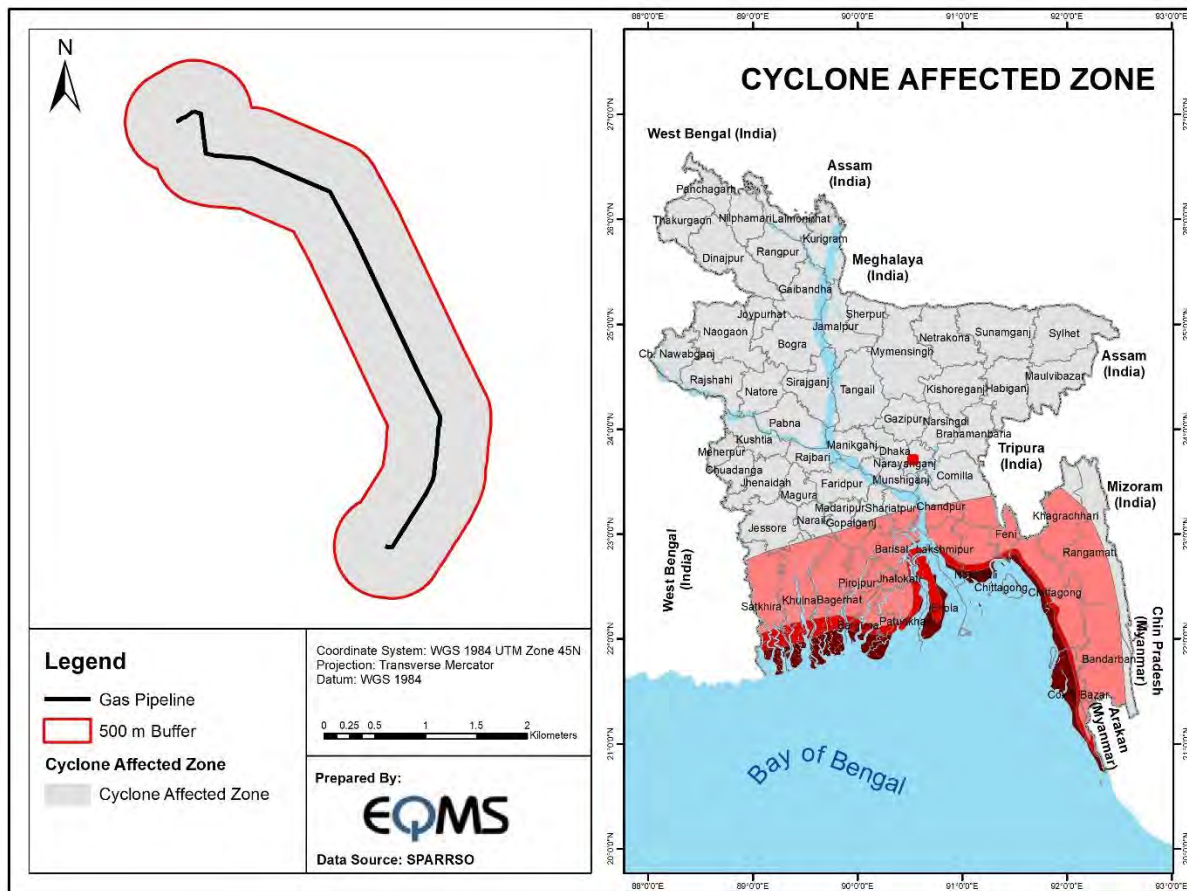
Project site is located in far away from the coastal areas of Bangladesh. Araihaaz, Rupganj, Shonargaong & Bandar upazila of Narayanganj district where the project site is located not falls in the cyclone affected areas of Bangladesh (Figure 3.3-28).

Numbers of cyclones have struck Bangladesh in past and has cause severe damages at few times. Cyclone affected area map of Bangladesh is given in Figure 3.3-28 & Figure 3.3-29.



Source: SPARRSO

Figure 3.3-28: Cyclone Affected Area of 5km Study area

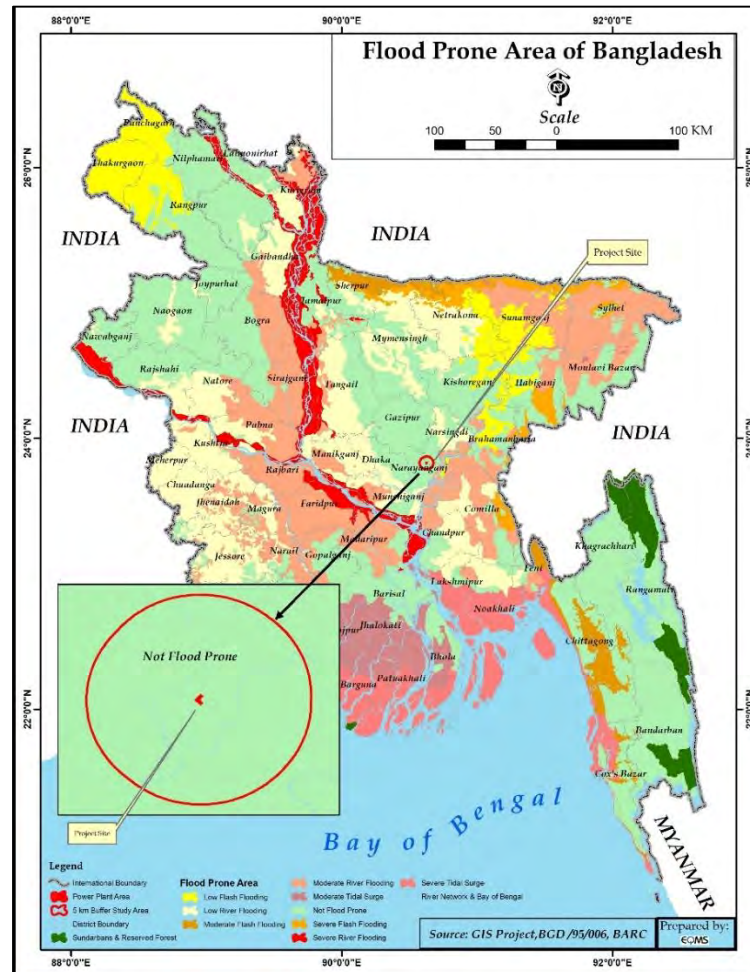


Source: SPARRSO

Figure 3.3-29: Cyclone Affected Areas of 500 m buffer area

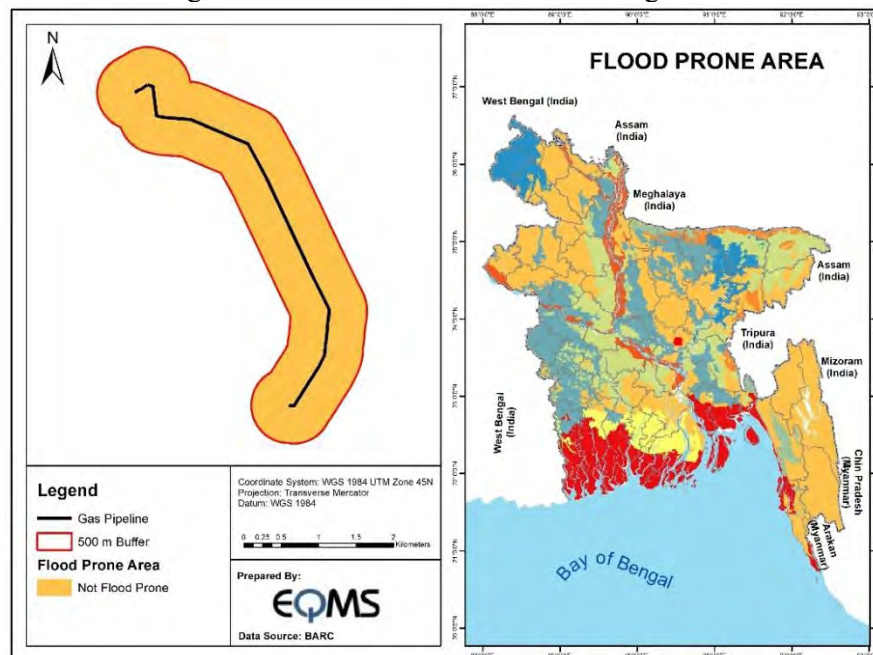
Tidal Flooding

Floods are the most significant natural hazard in the country causing extensive damage to human life and property. The country lies on the downstream part of three major river basins: Brahmaputra, Ganges and Meghna and thus is frequently flooded. There have been many destructive floods in Bangladesh, including very severe floods of 1987, 1988 and 1998. The 1988 flood set a new record for flooded area, while 1998 flood was unprecedented with its long duration. The flood damage potential in Bangladesh is increasing due to the possible causes of climate change, urban concentration in the three river basins, encroaching of settlements into flood prone areas, and overreliance on the safety provided by flood control works such as levees, reservoirs. There are two types of floods which occur in Bangladesh: annual floods (barsha) that inundate up to 20% of the land area; and low frequency floods of high magnitude that inundate more than 35% of the area (bonna). The major floods that occurred in 1954, 1955, 1974, 1984, 1987, 1988, 1993, 1998, 1999, 2000, 2007 and 2017 have been very destructive and caused serious threat to lives and economy. In the context of human exposure in flood hazard zones, nearly 19,279,960 people are present in these zones and Bangladesh ranks 1st among 162 nations. Similarly, the modeled amount of GDP in seismically hazardous zones puts Bangladesh 3rd among 162 countries. The project site falls under not flood prone area. Moreover, within 5 km radius of power plant and 500 m buffer of Gas transmission line area major portion are free from river flooding. Flood hazard map of the Bangladesh is shown in Figure 3.3-30 & Figure 3.3-31.



Source: BARC

Figure 3.3-30: Flood Prone Areas of Bangladesh



Source: BARC

Figure 3.3-31: Flood Prone Areas of Bangladesh

In order to confirm the real site flood levels of Araihasar, hearing surveys have been conducting for residents and upazilas of Project sites. The main target high water levels are obtained from hearing surveys of local residents (patriarchs) who experienced the 1988 and 1998 floods, then converted to the altitude of digital mapping. According to the results of these surveys, the past average flood water level of Araihasar was + 6.3 m (Table 3.3-8). The past flood water levels of Araihasar was affected by the high water level of the nearby rivers, and can be treated as a static water surface for simplicity's sake.

Table 3.3-8: Flooding Trace Survey of Power Plant Area

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

Source: JICA Feasibility study

The highest water levels and relevant return periods of the three nearest stations are shown in Table 3.3-9. The highest water level of Power Plant site was calculated based on an irregular triangular network (TIN) by the weighted average method. The water level of a 100-year return period is 7.21 m.

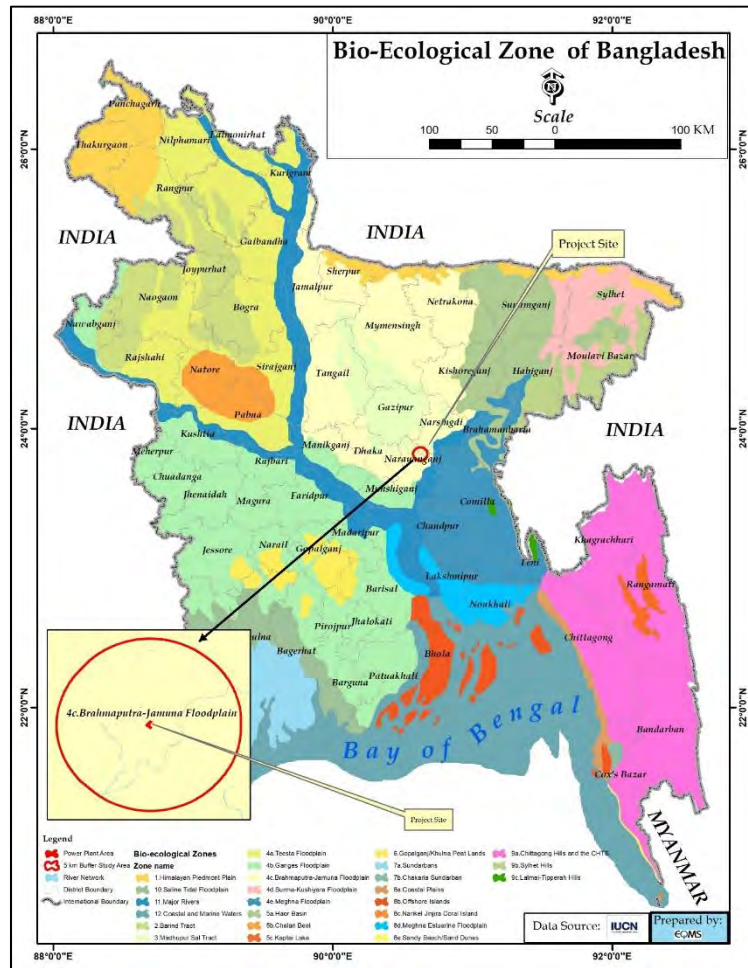
Table 3.3-9: Maximum Water Level at Nearby Water Level Stations and Estimated Maximum Water Level of Power plant Site

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

Biological Environment

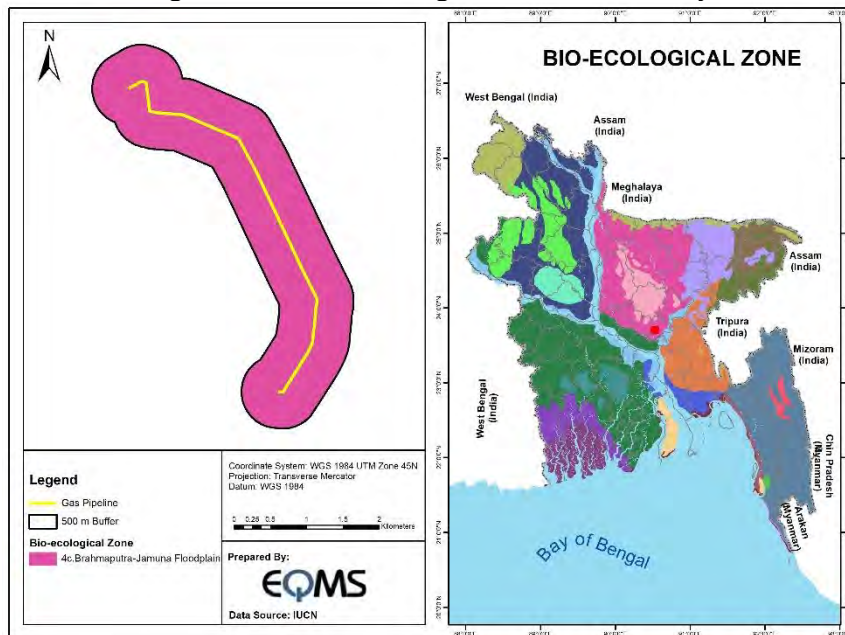
Bio-ecological Zone

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



Source: IUCN

Figure 3.3-32: Bio-ecological zones of the study area



Source: IUCN

Figure 3.3-33: Bio-ecological zones of the study area

Common flora and fauna

Introduction

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

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

Aquatic Flora

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

None of the species observed are of conservational significance.

Terrestrial Flora

Grassland

A total 17 species belonging to 14 genera of 10 families were recorded from the study area listed in Table 3.3-10. Four (4) species of grasses were identified among them Barajavani (*Fimbristylis milliacea*) and Mutha (*Fuirena ciliaris*) were found most commonly occurring. Herbs were represented by 5 species dominated by Kapalphutki (*Cardiospermum halicacabum*), Jhaljamani (*Cocculus hirsutus*), Marmarialata (*Cissus repens*) and Banorkalai (*Atylosia scrabaeoides*) list of grassland flora of the study area.

Table 3.3-10: A checklist of grassland floral species in the study area

SI	Scientific name	Family	Common Name (Bengali name)	Status of distribution	Type
1	<i>Coccinia grandis</i> .	Cucurbitaceae	Telakucha	common	Wild
2	<i>Ampelocissus latifolia</i> .	Vitaceae	Angurlata	common	Wild
3	<i>Atylosia scrabaeoides</i> .	Fabaceae	Banorkalai	common	Wild
4	<i>Canavalia gladiata</i> .	Fabaceae	Mousim, Makhansim	common	Cultivated
5	<i>Cardiospermum halicacabum</i>	Sapindaceae	Kapalphutki	common	Wild
6	<i>Centrosema pubescens</i>	Fabaceae	Gandhya Sim	common	Wild
7	<i>Cissus repens</i> .	Vitaceae	Marmarialata	common	Wild

SI	Scientific name	Family	Common Name (Bengali name)	Status distribution	of Type
8	<i>Cocculus hirsutus.</i>	Menispermaceae	Doipata, Jhaljamani	common	Wild
9	<i>Dioscorea belophylla.</i>	Fabaceae	Sora Alu	common	Wild
10	<i>Ichnocarpus frutescens.</i>	Apocynaceae	Dudhilata	common	Cultivated
11	<i>Ipomoea aquatica</i>	Convolvulaceae	Panikalmi	common	Wild
12	<i>Ricinus communis</i>	Euphorbiaceae	Venna, Reri	common	Wild
13	<i>Xanthosoma sagittifolium</i>	Araceae	Dud Kachu	Common	wild
14	<i>Senna tora.</i>	Caesalpiniaceae	Kalkasunda	Common	wild
15	<i>Fimbristylis dichotoma subsp. podocarpa Koyama</i>	Cyperaceae	Nirbishhi	Common	wild
16	<i>Fimbristylis milliacea.</i>	Cyperaceae	Barajavani	Common	wild
17	<i>Fuirena ciliaris.</i>	Cyperaceae	Mutha	Common	wild

Common plant of the study area

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

Table 3.3-11: A checklist of common plant species in the study area

SI	Scientific Name	Family	Common Name	Habit	Status distribution	of Type
1.	<i>Polyalthia longifolia</i>	Annonaceae	Debdaru	T	sporadic	Cultivated
2.	<i>Gmelina arborea L.</i>	Verbenaceae	Gamari	T	sporadic	Cultivated
3.	<i>Eucalyptus citriodora Hook</i>	Myrtaceae	Eucalyptus	T	sporadic	Cultivated
4.	<i>Erythrina ovalifolia Roxb.</i>	Caesalpiniaceae	Mander, Patiyamander	T	sporadic	Wild
5.	<i>Dillenia indica L.</i>	Dilleniaceae	Chalta	T	sporadic	Wild
6.	<i>Areca catechu L.</i>	Mimosaceae	Supari, Gua	T	sporadic	Cultivated
7.	<i>Hibiscus rosa-sinensis</i>	Malvaceae	Joba	S	sporadic	Cultivated
8.	<i>Cestrum nocturnum L.</i>	Solanaceae	Hasnahena	S	sporadic	Cultivated
9.	<i>Corchorus aestuans L.</i>	Tiliaceae	Banpat	H	sporadic	Wild
10.	<i>Mimusops elengi.</i>	Sapotaceae	Bakul	T	rare	Cultivated
11.	<i>Delonix regia.</i>	Caesalpiniaceae	Krisnochura	T	rare	Cultivated
12.	<i>Lawsonia inermis.</i>	Lythraceae	Mehede	S	rare	Cultivated
13.	<i>Gardenia coronaria.</i>	Rubiaceae	Gandhyaraj	S	rare	Cultivated
14.	<i>Paederia foetida</i>	Rubiaceae	Gandhyabhaduli	C	rare	Cultivated
15.	<i>Ziziphus Mauritian</i>	Rhamnaceae	Kul, Boroi	T	common	Cultivated
16.	<i>Terminalia arjuna</i>	Combretaceae	Arjun	T	common	Cultivated
17.	<i>Tamarindus indica.</i>	Caesalpiniaceae	Tetul	T	common	Cultivated
18.	<i>Syzygium cumini (L.) Skeels</i>	Myrtaceae	Jam	T	common	Cultivated

SI	Scientific Name	Family	Common Name	Habit	Status of distribution	Type
19.	<i>Coccinia grandis</i>	Cucurbitaceae	Telakucha	C	common	Wild
20.	<i>Lablab purpureus</i>	Fabaceae	Shim	C	common	Cultivated
21.	<i>Lageneria siceraria</i>	Cucurbitaceae	Kadu	C	common	Cultivated
22.	<i>Alocasia indica</i>	Araceae	Mankachu	H	common	Wild
23.	<i>Colocasia esculenta</i>	Araceae	Bankachu	H	common	Wild
24.	<i>Cynodon dactylon</i>	Poaceae	Durba	H	common	Wild
25.	<i>Musa paradisiaca</i>	Mussaceae	Kachkola	H	common	Cultivated
26.	<i>Carica papaya</i>	Caricaceae	Pape	S	common	Cultivated
27.	<i>Sesbania canabina</i>	Fabaceae	Dhoincha	S	common	Cultivated
28.	<i>Phyllanthus acidus</i>	Euphorbiaceae	Arboroi	ST	common	Cultivated
29.	<i>Psidium guajava</i>	Myrtaceae	Peyara	ST	common	Cultivated
30.	<i>Aegle marmelos</i>	Rutaceae	Bel	T	common	Cultivated
31.	<i>Albizia procera</i>	Mimosaceae	Silkoroi	T	common	Cultivated
32.	<i>Annona squamosa</i>	Annonaceae	Ata	T	common	Cultivated
33.	<i>Aphanamixis polystachya</i>	Meliaceae	Roina	T	common	Wild
34.	<i>Artocarpus heterophyllus</i>	Moraceae	Kathal	T	common	Cultivated
35.	<i>Azadirachta indica</i>	Meliaceae	Neem	T	common	Cultivated
36.	<i>Bambusa balcooa</i>	Poaceae	Barakbans	T	common	Cultivated
37.	<i>Barringtonia acutangula</i>	Lecythidaceae	Hijal	T	common	Cultivated
38.	<i>Bombax ceiba</i>	Bombaceae	Shimul Tula	T	common	Wild
39.	<i>Borassus flabellifer</i>	Palmae	Tal	T	common	Wild
40.	<i>Citrus grandis</i>	Rutaceae	Jambura	T	common	Cultivated
41.	<i>Cocos nucifera</i>	Arecaceae	Narikel	T	common	Cultivated
42.	<i>Feronia lemonia</i>	Rutaceae	Kadbel	T	common	Cultivated
43.	<i>Litchi chinensis</i>	Sapindaceae	Lichu	T	common	Cultivated
44.	<i>Litsea monopetala</i>	Lauraceae	Menda	T	common	Wild
45.	<i>Moringa oleifera.</i>	Moringaceae	Sajna	T	common	Wild
46.	<i>Neolamarckia cadamba.</i>	Rubiaceae	Kadam	T	common	Wild
47.	<i>Phoenix sylvestris.</i>	Arecaceae	Khejur	T	common	Cultivated
48.	<i>Phyllanthus embelica.</i>	Euphorbiaceae	Amloki	T	common	Cultivated
49.	<i>Samanea saman.</i>	Mimosaceae	Rain Tree, Meghsirish	T	common	Cultivated
50.	<i>Streblus asper</i>	Moraceae	Sheora	T	common	Wild
51.	<i>Switenia mahogani</i>	Meliaceae	Mahogani	T	Common	cultivated
52.	<i>Acacia nilotica</i>	Fabaceae	Acasia	T	Common	Wild
53.	<i>Casia siamea</i>	Fabaceae	Cassia tree	T	Common	Wild

Agricultural land

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

Aquatic Fauna

Macro-invertebrate Fauna

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

Fish

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

Table 3.3-12: A checklist of fish in the study area.

SL#	Local name	Common name	Scientific name	Family	IUCN Status
	Koi	Climbing perch	<i>Anabus testudines</i>	Anabantidae	LC
	Chela	Large Razorbelly Minnow	<i>Salmophasia bacaila</i>	Cyprinidae	LC
	Katol	Catla	<i>Catla catla</i>	Cyprinidae	LC
	Boal	Freshwater Shark	<i>Wallago attu</i>	Siluridae	VU
	Rui	Ruhu	<i>Labeo rohita</i>	Cyprinidae	LC
	Pangash	Yellowtail Catfish	<i>Pangasius pangasius</i>	Pangasiidae	EN
	Tengra	Striped Dwarf Catfish	<i>Mystus vittatus</i>	Bagridae	LC
	Shing	Stinging Catfish	<i>Heteropneustes fossilis</i>	Heteropneustidae	LC
	Shol	Snakehead Murre	<i>Channa striata</i>	Channidae	LC
	Taki	Spotted Snakehead	<i>Channa punctata</i>	Channidae	LC
	Bele	Bele	<i>Glossogobius giuris</i>	Gobiidae	LC
	Chital	Humped Featherback	<i>Chitala chitala</i>	Notopteridae	EN
	Gajar	Giant Snakehead	<i>Channa marulius</i>	Channidae	EN
	Pabda	Pabda catfish	<i>Ompok pabda</i>	Siluridae	EN
	Kakila	Silver Needle Fish	<i>Xenentodon cancila</i>	Belonidae	LC
	Mola	Mola Carplet	<i>Amblypharyngodon mola</i>	Cyprinidae	LC
	Chela	Large Razorbelly Minnow	<i>Salmophasia bacaila</i>	Cyprinidae	LC
	Bata	Bata Labeo	<i>Labeo bata</i>	Cyprinidae	LC
	Jat Punti	Spotfn Swamp Barb	<i>Puntius sophore</i>	Cyprinidae	LC
	Khailsha	Banded Gouram	<i>Trichogaster fasciata</i>	Osphronemidae	LC
	Gulsha Tengra	Bleeker's Mystus	<i>Mystus bleekeri</i>	Bagridae	LC
	Tengra	Striped Dwarf Catfish	<i>Mystus vittatus</i>	Bagridae	LC
	Magur	Walking Catfish	<i>Clarias batrachus</i>	Clariidae	LC
	Bacha	Batchwa Vacha	<i>Eutropiichthys vacha</i>	Schilbeidae	LC
	Potka	Ocellated Pufferfish	<i>Tetraodon cutcutia</i>	Tetraodontidae	LC
	Choto Tengra	Tengara Catfish	<i>Mystus tengara</i>	Bagridae	LC
	Mrigal	Mrigal Carp	<i>Cirrhinus cirrhosus</i>	Cyprinidae	NT
	Tatkini	Reba	<i>Cirrhinus reba</i>	Cyprinidae	NT
	Silver carp	Silver carp	<i>Hypophthalmichthys molitrix</i>	Cyprinidae	NT
	Grass carp	Grass carp	<i>Ctenopharyngodon idella</i>	Cyprinidae	DD
	Olive barb	Sar punti	<i>Systomus sarana</i>	Cyprinidae	LC

Data source: Study team using IUCN classification system

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



Fishing at Sonakahali canal



Fishing at Dhawrakhali canal

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

Terrestrial Fauna

Mammals

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

Table 3.3-13: A checklist of mammals found in the study area

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

Data source: Study team using IUCN classification system

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

Fauna

A total of 45 species belonging to 37 genera of 27 families were observed to be in the study area during field survey by ecology team in September, 2018. These species are present in variety of habitats from Grassland, homestead plantation, agriculture plantation and aquatic habitat. The list of species is included in Table 3.3-14. Out of these 45 species, Red Vented Bulbul (*Pycnonotus cafer*), Black Drongo (*Dicrurus macrocercus*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Black Kite (*Milvus migrans*), Large Billed Crow (*Corvus macrorhynchos*), Rufous Treepie (*Dendrocitta vagabunda*), Indian Roller (*Coracias benghalensis*), Common Hoopoe (*Upupa epops*), Black Rumped Flameback (*Dinopium benghalense*), White Throated Kingfisher (*Halcyon smyrnensis*), Pied Kingfisher (*Ceryle rudis*), Fulvous breasted Woodpecker (*Dendrocopos macei*), Shikra (*Accipiter badius*), White Wagtail (*Motacilla flava*), Red Wattled Lapwing (*Vanellus indicus*), Asian Koel (*Eudynamis scolopacea*), Rock Pigeon (*Columba livia*), Common Myna (*Acridotheres tristis*), Jungle Myna (*Acridotheres grandis*) and Green Bee eater (*Merops orientalis*) are reported to be listed in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capture. The proposed project site has many harbors species such as Red vented bulbul, Red Wattled Lapwing, Black Kite, Black Drongo, Rock Pigeon, Long-tailed Shrike and Common Myna. These species are common in the area and sufficient habitats are available within area once the construction and operation activities are commenced. None of the species were listed as threatened as per IUCN classification.

Table 3.3-14: A checklist of birds in the study area

SI	Local name	Common name	Scientific name	Family	IUCN status*
1	Bangla Kaththokra	Lesser Goldenback	<i>Dinopium benghalense</i>	Alcedinidae	LC
2	Shobuj Tia	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittacidae	LC
3	Halde Pakhi	Black-hooded Oriole	<i>Oriolus xanthornus</i>	Oriolidae	LC
4	Kala Fingey	Black Drongo	<i>Dicrurus macrocercus</i>	Dicruridae	LC
5	Pati Kak	House Crow	<i>Corvus splendens</i>	Corvidae	LC
6	Dar Kak	Jungle Crow	<i>Corvus leuillanti</i>	Corvidae	LC
7	Bangla Bulbul	Red-vented Bulbu	<i>Pycnonotus cafer</i>	Pycnonotidae	LC
8	Pati Tuntuni	Common Tailorbird	<i>Orthotomus sutorius</i>	Sylviidae	LC
9	Dhani Futki	Paddyfield Warbler	<i>Acrocephalus agricola</i>	Sylviidae	LC
10	Gobrey Shalik	Pied Myna	<i>Sturnus contra</i>	Sturnidae	LC
11	Jhuti Shalik	Jungle Myna	<i>Acridotheres fuscus</i>	Sturnidae	LC
12	Bhat Shalik	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	LC
13	Doel	Oriental Magpie Robin	<i>Copsychus saularis</i>	Muscicapidae	LC
14	Chorui	House Sparrow	<i>Passer domesticus</i>	Passeridae	LC
15	Gecho Chorui	Tree Sparrow	<i>Passer montanus</i>	Passeridae	LC
16	Dhani Tulika	Paddyfield Pipit	<i>Anthus rufulus</i>	Motacillidae	LC
17	Tila Ghughu	Eastern Spotted Dove	<i>Spilopelia chinensis</i>	Columbidae	LC
18	Nilmatha Hash	Mallard	<i>Anas platyrhynchos</i>	Anatidae	LC
19	Metey Rajhash,	Greylag goose	<i>Anser anser</i>	Anatidae	NT
20	Himaloe Kaththokra	Himalayan Flameback	<i>Dinopium shorii</i>	Picidae	DD
21	Bada Satarey	Marsh Babble	<i>Pellorneum palustre</i>	Timaliidae	DD
22	Holdebook Chotok	Yellow breasted Bunting	<i>Emberiza aureola</i>	Emberizidae	VU
23	Dhub Boga	Little Egret	<i>Egretta garzetta</i>	Ardeidae	LC
24	Boro Pankouri	Great Cormorant	<i>Phalacrocorax carbo</i>	Phalacrocoracidae	LC

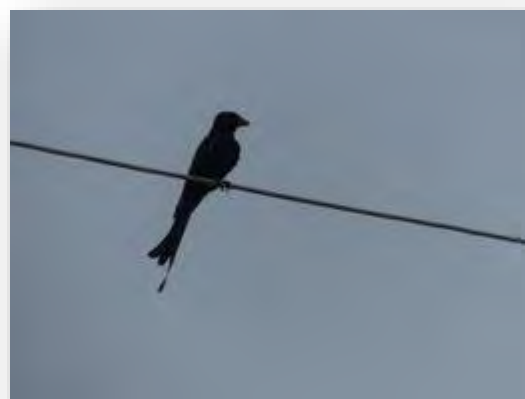
SI	Local name	Common name	Scientific name	Family	IUCN status*
25	Desi Pankouri	Indian Cormoran	Phalacrocorax fuscicollis	Ardeidae	LC
26	Chhoto pankouri	Little Cormorant	Microcarbo niger	Phalacrocoracidae	LC
27	Lal pa Dhenga	Black-winged Stilt	Himantopus himantopus	Recurvirostridae	LC
28	Proshanto Sonajiria	Pacific Golden Plover	Pluvialis fulva	Charadriidae	LC
29	Utturey Titi	Northern Lapwing	Vanellus vanellus	Charadriidae	LC
30	Pati Batan	Common Sandpiper	Actitis hypoleucos	Scolopacidae	LC
31	Bon Batan	Wood Sandpiper	Tringa glareola	Scolopacidae	LC
32	Khoiramatha Gangchil	Brown-headed Gull	Larus brunnicephalus	Laridae	LC
33	Choto Panchi	Little Tern	Sterna albifrons	Laridae	LC
34	Katua Chil	Black-winged Kite	Elanus caeruleus	Accipitridae	LC
35	Teela Eagle	Crested Serpent Eagle	Spilornis cheela	Accipitridae	LC
36	Pati Shikre	Shikra	Accipiter badius	Accipitridae	LC
37	Bhubon Chil	Black Kite	Milvus migrans	Accipitridae	LC
38	Shobuj Shuichora	Green Bee-eater	Merops orientalis	Meropidae	LC
39	Nilkan Machranga	Blue-eared Kingfisher	Alcedo meninting	Alcedinidae	LC
40	Chhoto Maachranga	Common Kingfisher	Alcedo atthis	Alcedinidae	LC
41	Lal Machranga	Ruddy Kingfisher	Halcyon coromanda	Alcedinidae	LC
42	Meghou Machranga	Stork-billed Kingfisher	Pelargopsis capensis	Halcyonida	LC
45	Dholagola Maachranga	White-throated Kingfisher	Halcyon smyrnensis	Halcyonidae	LC

Data source: Study team using IUCN classification system

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



Lesser Goldenback



Black Drongo



Red-vented Bulbul



Spotted Dove



Pied Myna



Yellow breasted Bunting

Herpeto-fauna

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

Table 3.3-15: A checklist of herpetofauna in the study area

SL#	Local name	Common name	Scientific name	Family	IUCN Status
1	Dhora Shap	Checkered Keelback	<i>Xenochrophis piscator</i>	Natricidae	LC
2	Shangkhini	Banded Krait	<i>Bungarus fasciatus</i>	Elapidae	LC
3	Paina Shap	Common Smooth-scaled Water Snake	<i>Enhydryis enhydryis</i>	Homalopsidae	LC
4	Baro Dumukha Shap	Diard's Blindsnake	<i>Argyrophis diardii</i>	Typhlopidae	LC
5	Laodoga Shap	Vine Snake	<i>Ahaetulla nasuta</i>	Colubridae	LC
6	Darash Shap	Indian Rat Snake	<i>Ptyas mucosa</i>	Colubridae	LC
7	Gui shap	Bengal Monitor	<i>Varanus bengalensis</i>	Varanidae	NT

SL#	Local name	Common name	Scientific name	Family	IUCN Status
8	Sona gui	Yellow Monitor	Varanusflavescens	Varanidae	NT
9	Roktochosa	Common Garden Lizard	Calotes versicolor	Agamidae	LC
10	Tiktiki	House Lizard	Hemidactylus flaviviridis	Gekkonidae	LC
11		Roofed Turtle	Pangshuratecta	Geoemydida	LC
12	Shundhi Kasim	Spotted Flapshell Turtle	Lissemyspunctata	Trionychidae	LC
13	Tokkhak	Tokay Gecko	Gekko gekko	Gekkonidae	LC
14	Dhum Kachchim	Brown Soft shell Turtle	Nilssoniahurum	Trionychidae	LC
15	Sona Bang	Indian Bullfrog	Hoplobatrachus tigerinus	Dicroglossidae	LC
16	Sobuj Dhani Bang	Two-striped Grass Frog	Hylarana taipehensis	Ranidae	LC
17	Shobuj Bang	Green Frog	Euphlyctis hexadactylus	Dicroglossidae	LC
18	Kuno Bang	Asian Common Toad	Duttaphrynus melanostictus	Bufonidae	LC
19	Kotkoti Bang	Skipper Frog	Euphlyctis cyanophlyctis	Dicroglossidae	LC

Data source: Study team using IUCN classification system

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

Ecosystem Services and Function

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

- The photosynthetic processes remove carbon dioxide in the air and supplies oxygen to the environment.
- Trees serve as sources of timber for housing construction, among others
- Animals supply the protein needs of humans, serve as pets or animal skin for making shoes, bags, and other derivatives
- The watershed provides fresh, clean water for human consumption
- Trees serve as buffer against storms preventing destruction of houses by strong winds
- Some species of plants can cure human ailments
- Humus from decomposition of organic matter serve as natural fertilizer in areas cleared for agriculture
- Major role of the ecosystem function are as follows

Gas Regulation

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

Climate Regulation

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

Water Regulation

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

Soil Retention

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

Nutrient Retention

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

Waste treatment and Assimilation

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

Biological Control

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

Barrier Effect of Vegetation

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

Protected Areas, Wildlife Sanctuaries, Game Reserves

Protected area (PA)

A Protected Area (PA) refers to an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means, i.e. PA is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources (IUCN, 1990). No PA exists at or near the project site (Figure 3.3-34 & Figure 3.3-35).

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

National Park (NP)

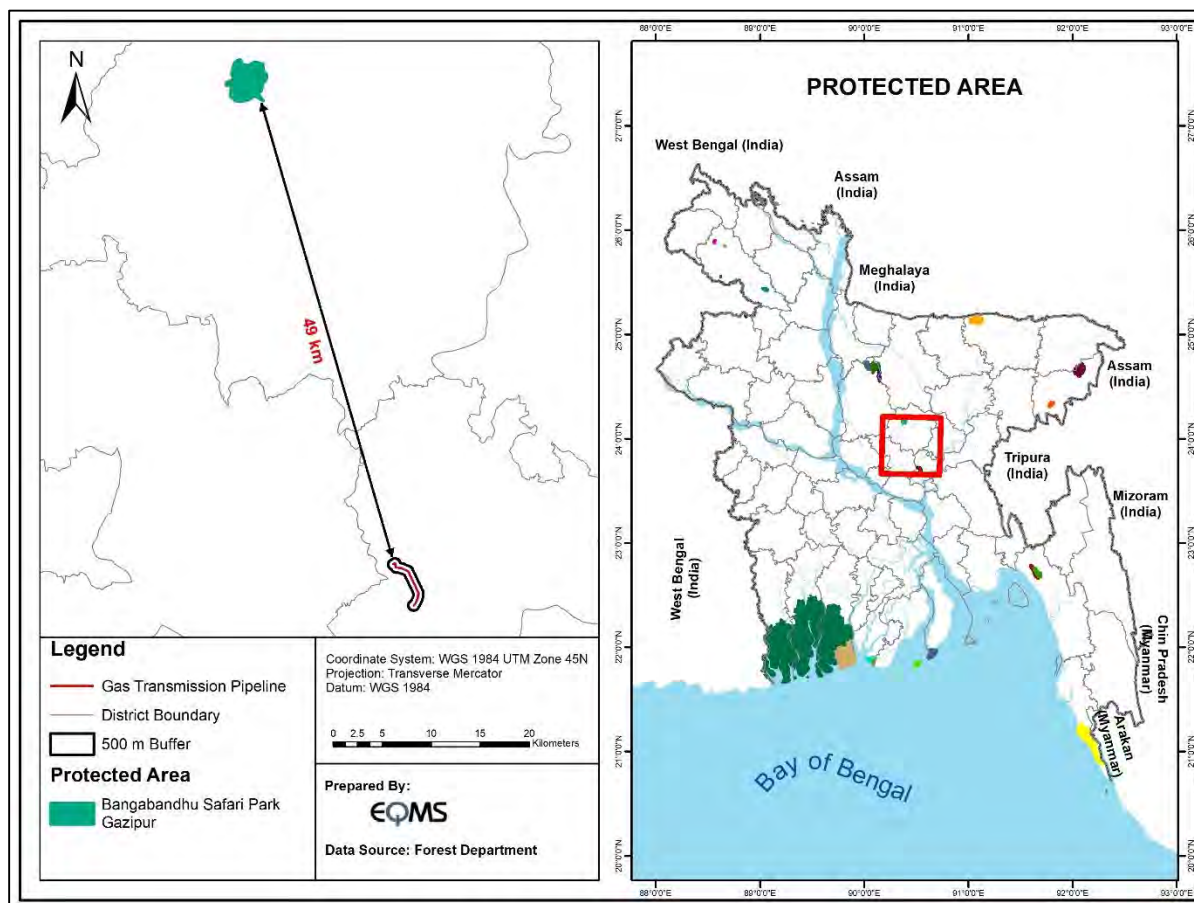
It is a reserved land, usually declared and owned by a national government, protected from most human development and pollution. No NP exists at or near the proposed project site (Figure 3.3-34 & Figure 3.3-35).

Game reserve (GR)

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

Wildlife Sanctuary (WS)

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



Source: Forest Department

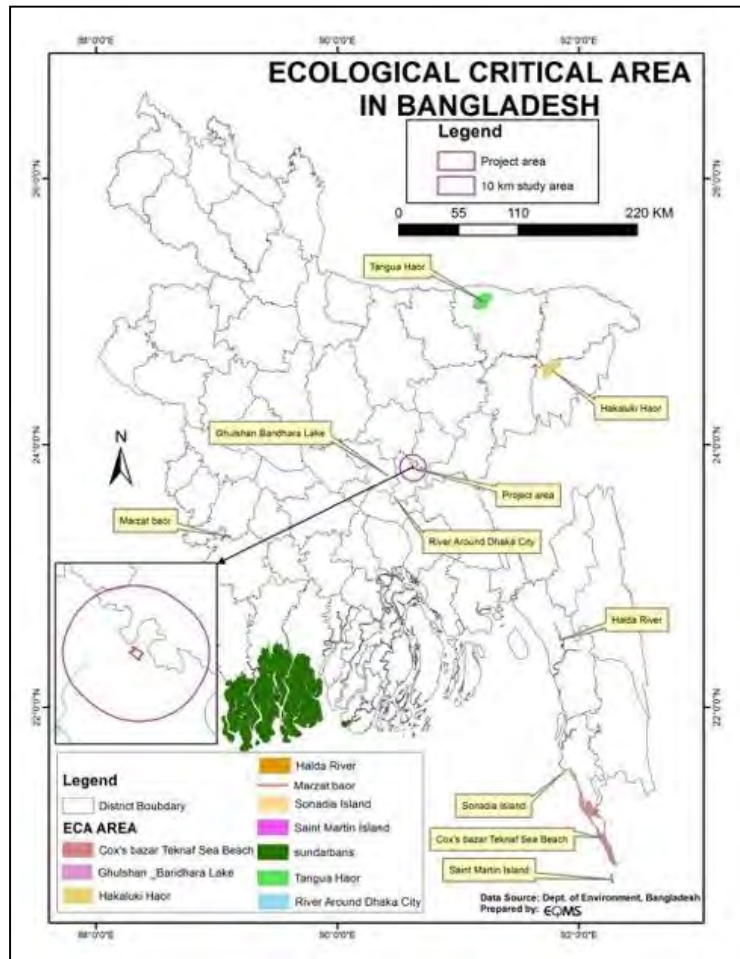
Figure 3.3-35: Protected Areas of 500 m buffer of Gas transmission Pipeline

Ecologically Critical Area (ECA)

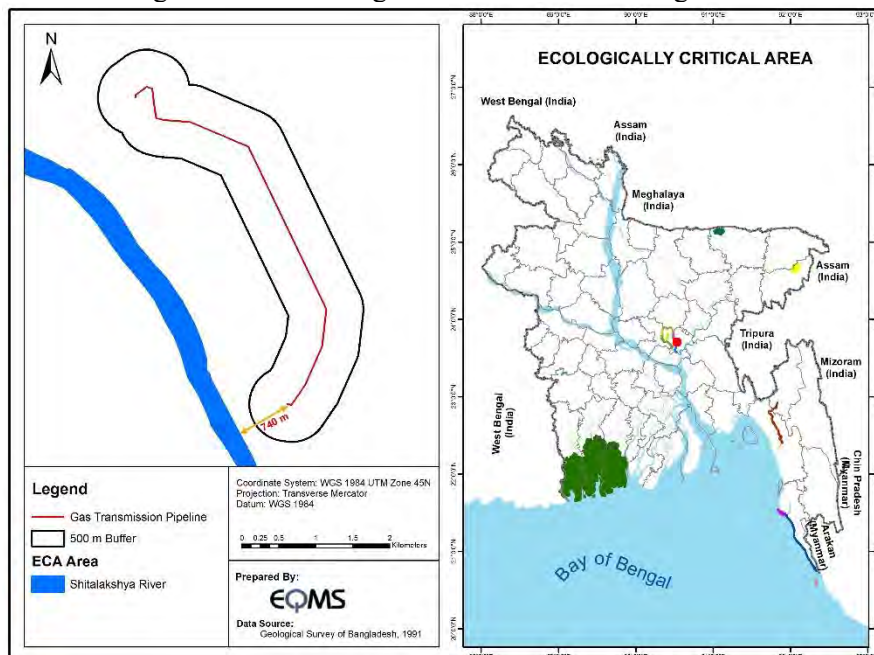
Bangladesh Environment Conservation Act, 1995, defines a Critical Area (ECA) where an ecosystem has been considered to be threatened and reaching a critical state (Figure 3.3-36) endangerment. In 2009, the Bangladesh Government declared the four rivers, such as Buriganga, Sitalakhaya, Turag and Balu around Dhaka city as ECAs. The Gazette notification to this effect imposes restrictions on a number of activities in these rivers and their associated riparian environs. These include all types of hunting, collection of all types of aquatic species living in the rivers, all activities that could result in the destruction of floral or faunal habitats, all activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste.

Cultural Heritage

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



Source: Department of Environment (DoE)
Figure 3.3-36: Ecological Critical Area in Bangladesh



Source: Department of Environment (DoE)
Figure 3.3-37: Ecological Critical Area in Bangladesh

Cultural Heritage

Nothing found in the development area would be affected by the development. No impact or impacts are negligible, no further study required.

Environmental Quality

Air Quality

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

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

Methodology of Air Quality Monitoring

The ambient air quality of the study area monitored at Five (5) locations for power plant and Three (3) locations for gas transmission pipeline during the monitoring period (September 2018). The monitoring parameters included Particulate Matter (SPM, PM10 and PM2.5), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours with the remaining parameters monitored on a 24-hourly basis during the study period.

Selection of sampling locations

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

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

The particulate and gaseous samples collected during the monitoring have been analysed as per the procedures specified in Table 3.3-16. The geographical locations and setting of the ambient air quality monitoring locations has been presenting in Table 3.3-17 & Table 3.3-18.

Table 3.3-16: Methodology for Analysis of Ambient Air Quality

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

Table 3.3-17: Ambient Air Quality Sampling Locations for Power Plant

Sl.	Sampling Station	Station Code	Geographic Location	Location Setting
	In front of Nurul Haque House; Vill: Maizpara, Union: Satgram, Upazila: Araihaazar	AQ1	23°49'45.8"N 90°36'45.3"E	Rural

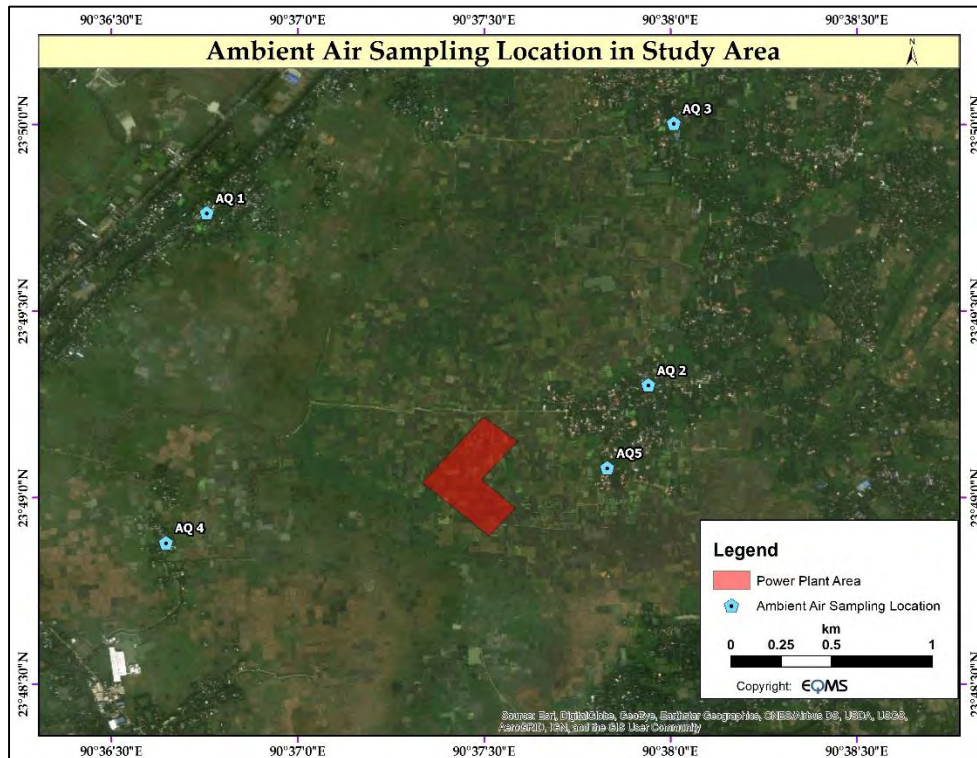
In front of Panchbaria Boro bari; Vill: Panchbaria, Union: Duptara, Upazila: Araihaazar	AQ2	23°49'18.1"N 90°37'56.4"E	Rural
In front of Tekpara govt. primary school; Vill: Tekpara, Union: Satgram, Upazila: Araihaazar	AQ3	23°50'00.4"N 90°38'00.5"E	Rural
In front of Rahim sekha house; Vill: Shingrati, Union: Duptara, Upazila: Araihaazar	AQ4	23°48'52.59"N 90°36'38.57"E	Rural
In front of Nasir Pradhan House; Vill: Dakhinpara, Union: Duptara, Upazila: Araihaazar	AQ5	23°49'4.00"N 90°37'49.83"E	Rural

Table 3.3-18: Ambient Air Quality Sampling Locations for Gas transmission Pipeline

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

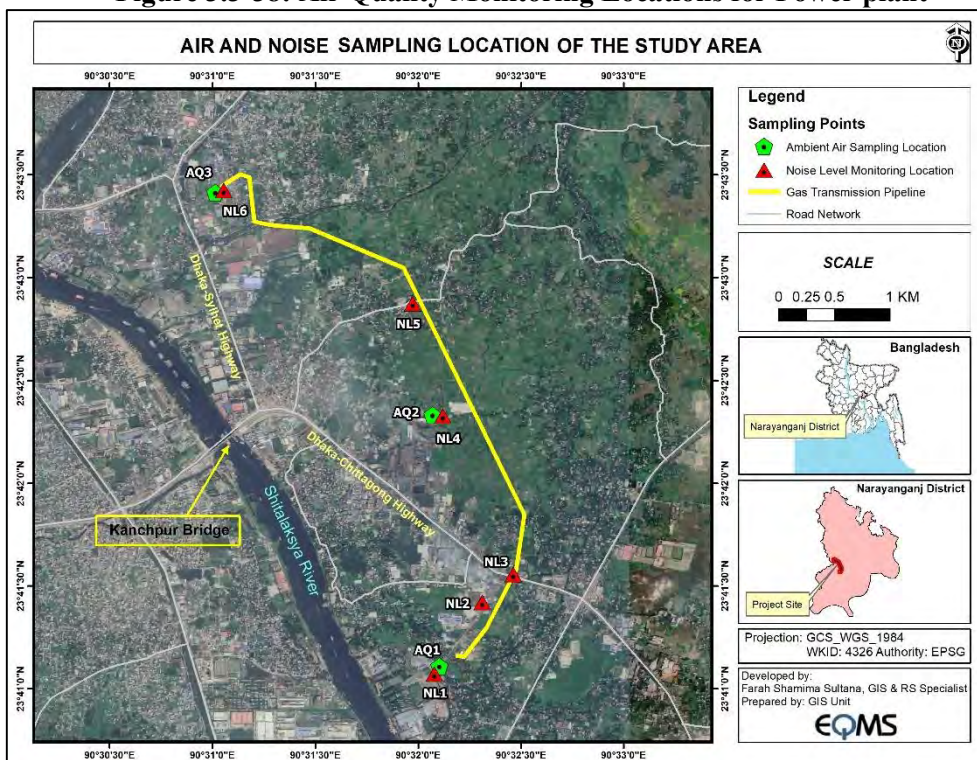
Air Quality Monitoring Pictures





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

Figure 3.3-38: Air Quality Monitoring Locations for Power plant



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

Figure 3.3-39: Air & Noise Quality Monitoring Locations for Gas Transmission Pipeline

Ambient Air Quality in the Study Area

The monitored ambient air qualities are summarized in Table 3.3-19.

Table 3.3-19: Ambient Air Quality in the Study Area

SL.	Sampling Station Code	Ambient air pollution concentration					
		PM _{2.5}	PM ₁₀	SPM	SO ₂	NO _x	CO
	Unit	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	ppm
Power Plant							
1.	AQ1	52.1	116.6	167.4	10.1	30.2	2.5
2.	AQ2	34.5	87.6	134.7	6.3	19.4	0.50
3.	AQ3	41.7	98.5	150.2	7.2	22.4	1
4.	AQ4	31.6	84.2	123.8	5.7	16.6	0.50
5.	AQ5	35.7	89.1	125.4	6.6	12.4	0.50
Gas Transmission pipeline							
1.	AQ1	37.1	97.2	138.2	5.2	15.5	1
2.	AQ2	40.5	85.9	141.5	6.3	14.9	0.50
3.	AQ3	50.1	110.9	165.3	9.5	25.4	1
Duration (hours)		24	24	8	24	24	8
Weather Condition		Sunny					
Bangladesh Standard (according to Environmental Conservation Rules’ 1997 and subsequent amendment in 2005)							
		65	150	200	365	65	9
IFC EHS Guideline (2007)		75 (24 hr) 35 (year)	150 (24 hr) 70 (year)	-	500(10 min)125 (24 hr)	200 (1 hr) 40 (year)	-
Method of analysis		Gravimetric	Gravimetri c	Gravimetri c	West- Geake	Jacob and Hochheise r	Indic ator tube

Note:

* CO concentrations and standards are 8-hourly only.

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

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

Analysis and Discussion of Result

PM_{2.5}

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

PM₁₀

The 24-hourly dry season average PM₁₀ concentration in ambient air in the study area was recorded in the range of 84.2 μg/m³–116.6 μg/m³. In addition, for Gas transmission line average PM₁₀ concentration was recorded in the range of 85.9 μg/m³ – 110.9 μg/m³. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh.

SPM

The 24-hourly average SPM concentration in ambient air in the study area was recorded in the range of 123.8 $\mu\text{g}/\text{m}^3$ –167.4 $\mu\text{g}/\text{m}^3$. In addition, for Gas transmission line average SPM concentration was recorded in the range of 138.2 $\mu\text{g}/\text{m}^3$ – 165.3 $\mu\text{g}/\text{m}^3$. the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh as well as IFC EHS Guidelines (2007).

SO₂

The 24-hourly average SO₂ concentration was recorded in the range of 5.7 $\mu\text{g}/\text{m}^3$ – 10.1 $\mu\text{g}/\text{m}^3$. In addition, for Gas transmission line average SO₂ concentration was recorded in the range of 5.2 $\mu\text{g}/\text{m}^3$ – 9.5 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh as well as IFC EHS Guidelines (2007).

NO_x

The 24-hourly average NO_x concentration was recorded in the range of 12.4 $\mu\text{g}/\text{m}^3$ – 30.2 $\mu\text{g}/\text{m}^3$. In addition, for Gas transmission line average SO₂ concentration was recorded in the range of 14.9 $\mu\text{g}/\text{m}^3$ – 25.4 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for PM_{2.5} in Bangladesh as well as IFC EHS Guidelines (2007).

CO

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

Noise Level

Noise levels were recorded at seven (7) locations for power plant and six(6) locations for Gas transmission line during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are shown in Table 3.3-20 and Table 3.3-21.

The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations were chosen in such a way that a representative data could be record all over the block. The sound level recorded in form of A-weighted equivalent continuous sound pressure level (Leq) values with the use of A-weighting filters in the noise-measuring instrument.

Table 3.3-20: Details of Ambient Noise Monitoring Locations for Power plant

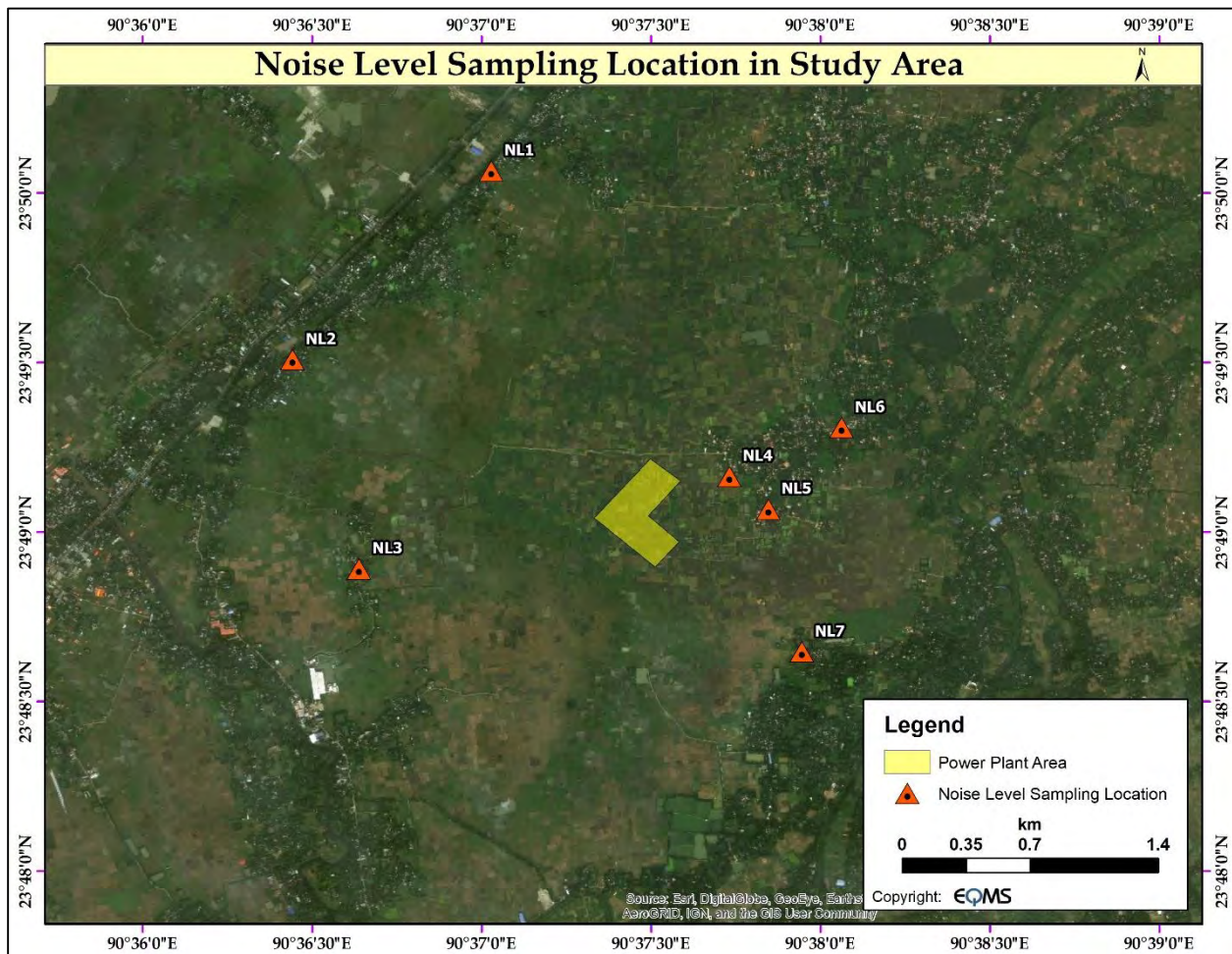
Sl.	Location	Location Code	Geographic location	Location setting
	In front of Sonpara govt. primary school; Vill: Sonpara, Union: Satgram	NL1	23°50'04.1"N 90°37'01.4"E	Silent
	In front of Naziruddin community clinic; Vill: Panchrukhi, Union: Satgram	NL2	23°49'26.8"N 90°36'26.6"E	Silent
	In front of Arju mia house; Vill: Shingrati, Union: Duptara	NL3	23°48'47.6"N 90°36'40.0"E	Residential
	In front of Hekim Prodhan House, Vill: Panchbaria Gram, Union: Duptara	NL4	23°49'10.54"N 90°37'43.47"E	Residential
	Dakkhin Para Jame Mosque, Vill: Panchbaria Gram, Union: Duptara	NL5	23°49'1.56"N 90°37'48.85"E	Silent
	In front of Danis Market; Vill: Panchbaria, Union: Duptara	NL6	23°49'18.2"N 90°38'04.5"E	Commercial
	In front of Uttar Dewan Para Mosque, Vill: Panchbaria Gram, Union: Duptara	NL7	23°48'37.45"N 90°37'59.23"E	Silent

Table 3.3-21: Details of Ambient Noise Monitoring Locations for Gas Transmission Pipeline

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

Noise Level Monitoring Pictures





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

Figure 3.3-40: Noise Monitoring Locations for Power plant

Recorded noise level can be seen in Table 3.3-22.

Table 3.3-22: Noise Level Parameter around the project site of the power plant and gas transmission line

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

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

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

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

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

Water Quality

Surface Water Quality

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

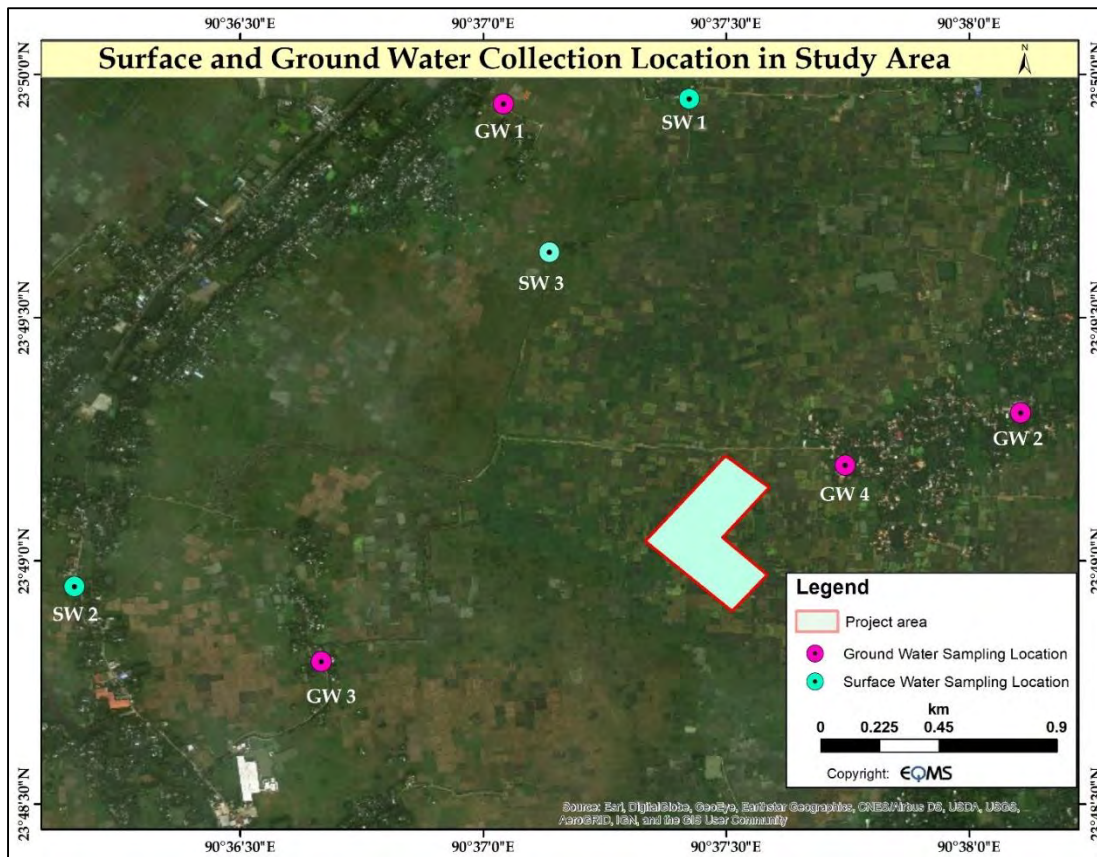
The surface water sampling collected from the Dhawrakhali canal to the project area. Surface water sampling locations were selected to obtain a representative water sample from various zones within the study area. Three (3) samples of surface water (SW1, SW2 & SW3) were collected from the canal near power plant site and another three (3) samples of surface water (SW1, SW2 & SW3) were collected from the pond near Gas transmission line alignment. Detail of the sampling location provided in Table 3.3-23 & Table 3.3-24.

Table 3.3-23: Details of Surface Water Sampling Locations for Power Plant

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

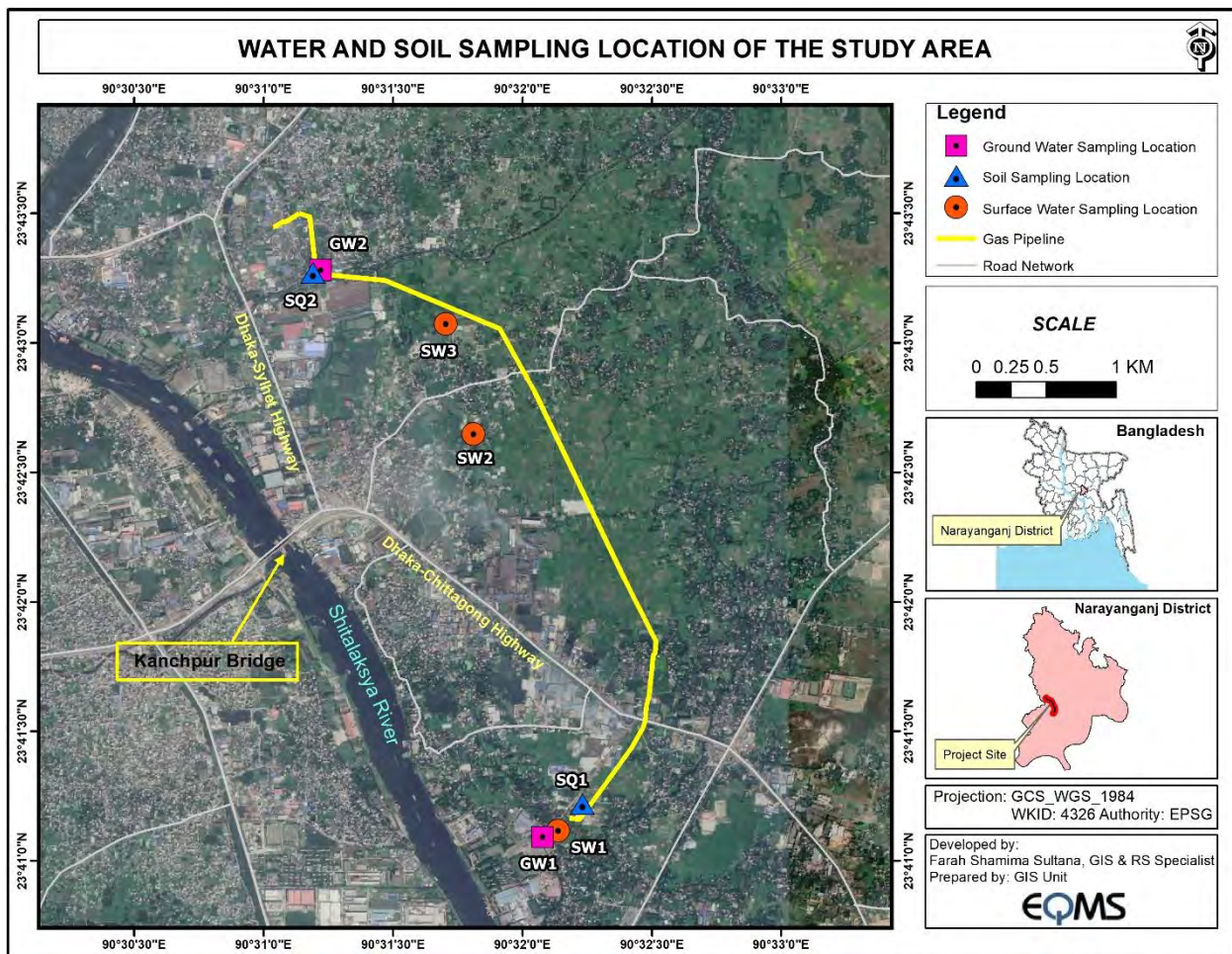
Table 3.3-24: Details of Surface Water Sampling Locations for Gas Transmission Pipeline

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



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

Figure 3.3-41: Surface Water & Ground Water Sample Collection Locations at Power Plant Site



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

Figure 3.3-42: Surface Water & Ground Water Sample Collection Locations at Gas Transmission Site

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

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

The samples were analyzed as per standard procedures/methods given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in Table 3.3-25.

Table 3.3-25: Methods for Water Analysis

Sl.	Parameter	Test method (APHA)
1	Temperature (°C)	Digital thermometer
2.	TDS (mg/l)	Digital TDS meter
3.	EC (µmhos/cm)	Digital EC meter
4.	DO (mg/l)	Digital DO meter
5.	pH	Digital pH meter
6.	Biochemical Oxygen Demand (BOD)	5 days incubation

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

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

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

The surface water quality compared with the Bangladesh ECR standard for best practice based classification criteria. Table 3.3-26Table 3.1-19 shows the analysis results. Some of the water analysis parameters discussed below in detail:

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

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

Table 3.3-26: Surface Water Quality Analysis

Characteristics	Unit	Concentration Present						Bangladesh Standard*					
		SW1	SW2	SW3	SW1	SW2	SW3	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
		Power Plant			Gas Pipeline		Transmission						
Temperature	°C	27.2	28.2	27.0	28.2	27.3	27.5	-	-	-	-	-	-
BOD	mg/L	9	17	23	2.0	1.1	3.1	2 or less	3 or less	3 or less	6 or less	10 or less	10 or less
COD	mg/L	32	56	88	72	40	80	-	-	-	-	-	-
EC	µS/cm	630	650	560	0.78	0.68	0.72	-	-	-	-	-	-
DO	mg/L	6.28	6.04	2.26	7.6	6.0	7.8	6 or above	5 or more	6 or more	5 or more	5 or more	5 or more
pH	-	7.70	7.8	7.52	8.69	8.70	8.76	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
TDS	ppt	0.32	0.33	0.35	0.39	0.34	0.36	-	-	-	-	-	-
Chloride	mg/L	73	76	81	19.7	16.2	18.9	-	-	-	-	-	-
Hardness	mg/L	265	275	270	178	183	202	-	-	-	-	-	-
Iron (Fe)	mg/L	0.12	0.05	0.30	0.03	0.08	0.06	-	-	-	-	-	-
Manganese (Mn)	mg/L	0.03	0.04	0.03	0.3	0.2	0.2	-	-	-	-	-	-
Sulphate	mg/L	5	4	1	18	21	20	-	-	-	-	-	-
Total Suspended Solid (TSS)	mg/L	22	14	20	13	16	15	-	-	-	-	-	-
Turbidity	NTU	21.2	2.2	6	4.4	10.5	8.9	-	-	-	-	-	-
Alkalinity	mg/L	185	183	243	130	132	128	-	-	-	-	-	-

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

(Source: Laboratory Analysis, DPHE and EQMS laboratory)

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

Ground Water Quality

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

The groundwater sampling locations were selected to obtain a representative water sample from various zones within the study area. The samples were collected from existing tube wells (hand-tube wells being use by the villagers). A total Four (4) ground water samples were collected from different locations of power plant area. In addition, total Two (2) ground water samples were collected from different locations of Gas transmission line area.

Details of the sampling locations provided in Table 3.3-27 and Table 3.3-28.

Table 3.3-27: Details of Ground Water Sampling Locations for Power Plant

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

Table 3.3-28: Details of Ground Water Sampling Locations for Gas transmission line Site

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

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

Water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can and 250 ml sterilized clean PET bottle and transported to the lab by using cool box at 4°C for complete physio-chemical and bacteriological tests respectively.

The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in Table 3.3-29.

Table 3.3-29: Methods for Water Analysis

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

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

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

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

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

In September 2017, JICA Study Team collected groundwater samples from tube wells in and around the project area. The result of the groundwater field samples and the GoB standards for potable water (ECR, 1997) is shown below in Table 3.3-30. The concentration levels of Manganese (Mn) & BOD of tube well found above the standard set by the DOE, GoB for drinking water. But the levels of pH, TDS, As, Ca, COD, Chloride, Fluoride, Fe, Pb, Phosphate, Sulphate, TSS and turbidity were found to be within the limit set by the DOE, GoB for drinking water. The average depths of deep tube wells for drinking water are at least 600-700 feet. After consultation with the DPHE officer of Araihaazar, according to the overall water quality data, practically good quality and quantity of ground water is available in and around the project site.

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

Table 3.3-30: Ground Water Quality Analysis Result

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

Source: Laboratory Analysis, DPHE and EQMS laboratory

Soil Quality

Sampling Methodology and Locations

The soil sampling strategy was designed to assess the existing soil quality over the study area. Two soil samples were collected from the study area at wet season. The details of the soil sampling locations at power plant site are presented in Table 3.3-31 & Table 3.3-32

. A composite sampling technique has used for soil sampling from each location.

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

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

Soil Sample Collection Pictures

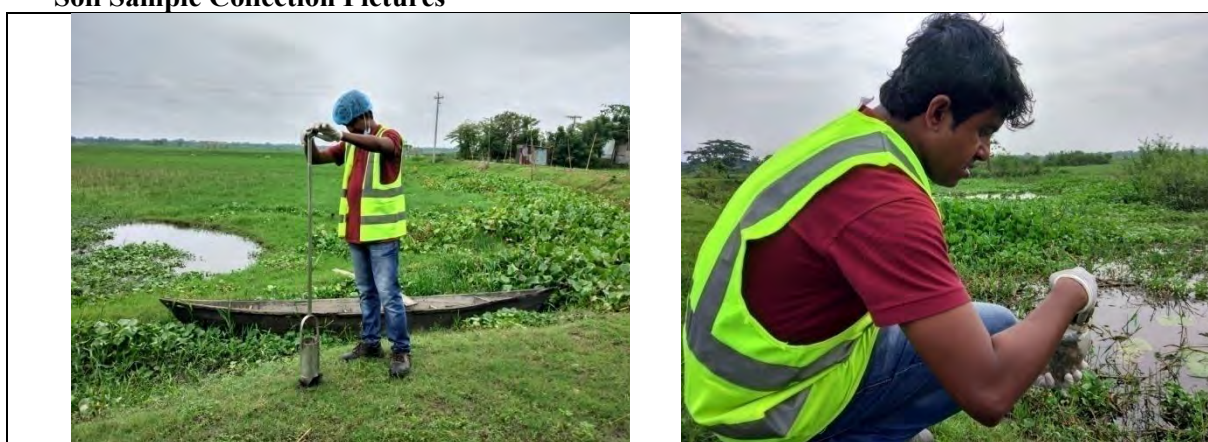
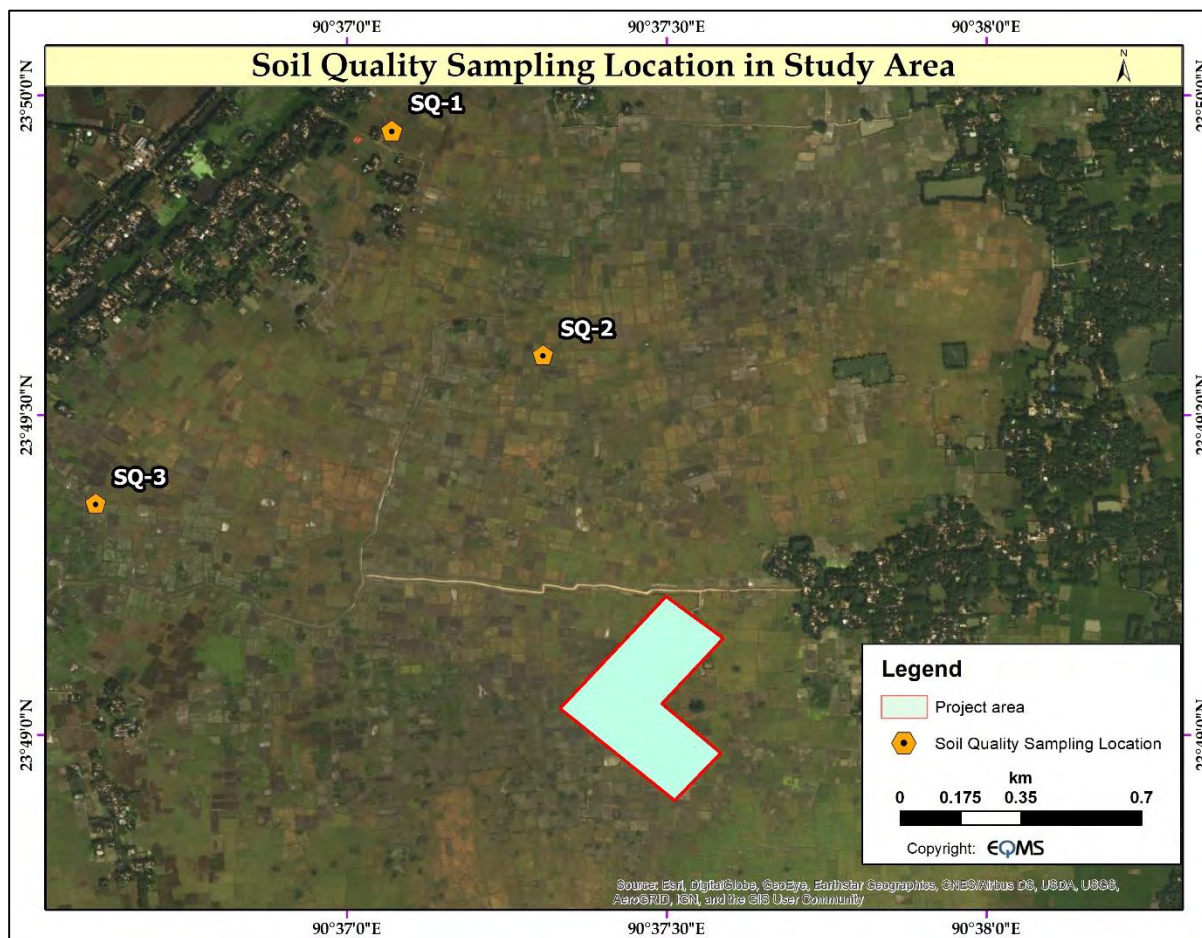


Table 3.3-31: Location of Soil Samples at Power Plant Site

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

Table 3.3-32: Location of Soil Samples at gas Transmission Pipeline Site

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



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

Figure 3.3-43: Soil Sampling Location Map at Power Plant site

Table 3.3-33: Soil Quality Results at Power Plant Site

Table 3-5 Soil Quality Results at Power Plant Site							
Location		Soil Quality					USEPA Guideline*
		Power Plant			Gas Transmission Pipeline		
Sample Code	-	SQ1	SQ2	SQ3	SQ1	SQ2	-
Parameter	Unit	Result	Result	Result	Result	Result	-
Grain Size Distribution	Sand	14	15	13	85	8	-
	Silt	66	58	51	10	47	-
	Clay	20	27	36	5	45	-
Textural Class	-	Silt loam	Silty clay loam	Silty clay loam	Loamy Sand	Silty Clay	-
pH	-	6.9	6.9	6.9	5.6	5.2	-
Organic Content	%	2.89	1.83	2.35	0.54	1.01	-
Potassium	meq/100g soil	0.09	0.12	0.14	0.20	0.15	-
Calcium	meq/100g	11.42	12.83	13.16	7.85	11.0	-

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

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

International guidelines are taken since there is no standard for soil pollution in Bangladesh. As shown in the Table 3.3-33, contamination by heavy metals, copper, Zinc, Lead and Chromium are within guidelines and considered as no polluted. However, Cadmium limit is 11.31 mg/kg- 27.62mg/kg that cross the limit at power plant area.

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

Demography

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

The table below shows the Demography profile of the project study area.

Table 3.3-34: Demography of the Proposed Power plant area

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

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

In the 5 km study area of Gas transmission pipeline, there are about 39622 households (HHs) including squatters with a total population of 115099 that will be influenced by the implementation of the proposed bridge. The average sex ratio is 111 and the average household size is 4.0. The demography of the study area is shown in the following Table 3.3-35.

Table 3.3-35: Demography of the Gas Transmission Pipeline Area

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

Source: Population and Housing Census, BBS, 2011

Ethnic Composition

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

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

Settlement and Housing

According to population and housing census (2011), total households of the project power plant study area is 111077. Predominant structure of this study area is kutcha (71.7%) followed by Semi-pukka (21.1%), Pukka (6.7%) and Jhupri (0.5%). Housing tenancy of the study area is owned by (49.6%), rented (46.6 %) and Rent free (3.8%). Table 3.3-36 show the type of structure and Housing tenancy in the project study area (Table 3.3-37).

Table 3.3-36: Type of structure in the proposed power plant area

Upazila	Union	Number of Households	Type of Structure (%)			
			Pukka	Semi-pukka	Kutcha	Jhupri
Narsingdi Sadar	Amdia	8608	1.8	11.0	86.9	0.3
	Meher Para	9300	6.2	25.8	67.3	0.6
	Madhabdi	10467	20.7	51.4	27.5	0.4
	Kanthalia	7979	1.6	8.9	88.8	0.6
Araihazar	Sadasardi	7916	6.2	15.7	77.9	0.2
	Duptara	7848	7.6	23.9	68.3	0.3
	Araihazar	5759	6.6	19.0	73.8	0.6
	Fatehpur	4333	4.5	17.7	77.7	0.1
	Brahmandi	10514	5.1	15.4	79.0	0.5
	Satgram	8342	3.8	15.5	79.9	0.8
Rupganj	Kanchan	10647	5.7	19.6	74.4	0.3
	Golakandail	12370	12.2	34.8	52.3	0.6
	Bholaba	6994	5.3	15.6	78.2	0.9
Project Study Area		111077	6.7	21.1	71.7	0.5

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

The predominant structure of this study area is Kutcha (40.5%) followed by Pukka (12.2%), Semi-pukka and jhupri (46.8% and 0.5%). Housing tenancy of the study area is owned by (40.1%), rented (56.7%) and rent free 3.2%). The following Table 3.3-37 shows the type of structure and housing tenancy in the project study area.

Table 3.3-37: Types of structure and housing tenancy in the Gas transmission pipeline area

Upazila	Union	Type of Structure (%)				Housing Tenancy (%)		
		Pukka	Semi-pukka	Kutcha	Jhupri	Owned	Rented	Rent free
Tarabo Paurashava	Word-8	10.3	68.2	21.3	0.2	20.1	75.9	4
Tarabo Paurashava	Word-9	8.4	63.8	27.6	0.2	20.2	75.6	4.1
Sonargaon	Kanchpur	19.2	43.9	36.5	0.3	37.4	59.5	3.2
Bandar	Madanpur	12.4	22.6	63.2	1.7	62	35.1	2.9
Kadam Rasul Paurashave	Word-9	10.6	35.4	54	0	60.7	37.5	1.8
Study Area		12.2	46.8	40.5	0.5	40.1	56.7	3.2

Source: Population and Housing Census, BBS, 2011

3.3.3. Environmental Legislation

National Policies and Laws Related to Power Generation

Power System Master Plan, 2016

The Power System Master Plan (PSMP) 2016, sponsored by Japan International Cooperation Agency (JICA) aims at assisting the Bangladesh in formulating an extensive energy and power development plan up to the year 2041, covering energy balance, power balance, and tariff strategies. Bangladesh has an aspiration to become a high-income country by 2041. The development of energy and power infrastructure, therefore, pursues not only the quantity but also the quality to realize the long-term economic development. Since Bangladesh is facing to the depletion of domestic gas supply, various issues such as sustainable development harmonizing with economic optimization, improvement of power quality for the forthcoming high-tech industries, and the discipline of operation and maintenance (O&M) for power plants need to be addressed holistically. Furthermore, energy subsidy is also a tough challenge, because there's always a concern that drastic increase of fuel and electricity prices may trigger another negative effect on the national economy. A meticulous analysis is required to find the best pathway to attain the sustainability of the energy and power sectors in balancing with the economic growth. The new PSMP study covers all the aforementioned challenges comprehensively, and come up with feasible proposals and action plans for Bangladesh to implement.

Power System Master Plan, 2010

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

Bangladesh Natural Gas Safety Rules (1991)

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

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

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

In section 31 of the rules stated for the Gas transmission line safety. The following safety distances from protected works shall be maintained for all high-pressure pipelines to be operated above 10 kg/cm².

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

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

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

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

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

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

- to ensure appropriate remedy for consumer disputes, dishonest business practices or monopoly;
- to ensure control of environmental standard of energy under existing laws; and
- to perform any incidental functions if considered appropriate by the Commission for the fulfillment of the objectives of this Act for electricity generation, quality of services, tariff fixation and safety improvement

Electricity (Amendment) Act, 2012

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

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

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

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

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

- The type of plant is open and the sponsor will be allowed to select plant of any configuration provided the electrical characteristics of the plant match that of the power system in Bangladesh.
- Where available, a subsidiary of Petrobangla may supply natural gas to the sponsor on a commercial basis at a price determined by the Energy Regulatory Commission. Alternatively, the sponsor may arrange his own fuel.

- It will be the responsibility of the sponsor to find customers for electricity. The distribution system required for the supply of electricity to the contracted customers may be built by the sponsors themselves or they can use the existing transmission and distribution systems if there is adequate capacity.
- In areas covered by BPDB/DESA/REB, the tariff announced by GoB from time to time shall apply.
- As per Electricity Act, 1910, the Sponsors will be required to obtain license from the GoB. The SPP will need to comply with all laws of Bangladesh including Environmental Standards.
- GoB support will be provided on “First Come First Serve” basis. Necessary advice and other assistance will be provided by the Power Cell for the establishment of SPPs.
- The sponsors under this policy including the Captive Independent Power Producer and the sponsors of Captive Power Generation who will set up power plants within a period of three years from the date of its statutory notification under this policy will enjoy the “Fiscal Incentives” and “Other Facilities and Incentives for Foreign Investors” provided under Section 5.0 and 6.0 respectively of the “Private Sector Power Generation Policy of Bangladesh”

3.3.4. Alternative Analysis

Alternative analysis for the Power plant

Location

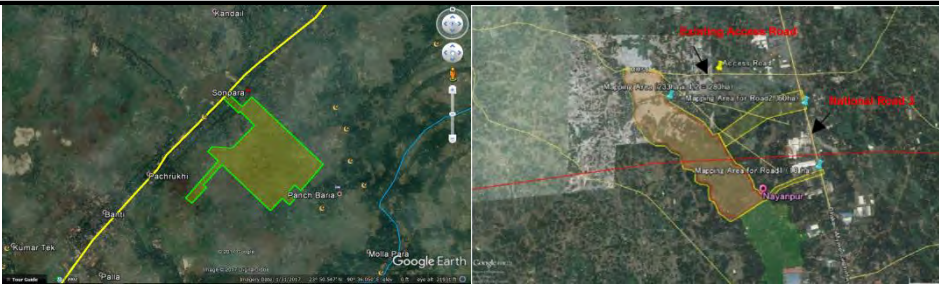
Since the proposed power plant is design to be a captive or a semi-captive power (excess power would be sold to the national grid) plant to Araihaazar EZ (AEZ), it is ideal to locate the power plant adjacent to AEZ in order to avoid unnecessary land acquisition and environmental and social impact. Thus the location of the power plant depends largely on the location of AEZ and location-wise alternatives can be analyzed collectively for the power plant and AEZ whose ECC has been already granted by DoE in May 2018.

In order to consider the project area and the shape of the Economic Zone, two alternatives were compared comprehensively from the viewpoint of technical aspect, economical aspect, safety, and social and environmental consideration.

As a result of the alternative study shown in Table 3.3-38. Araihaazar EZ was selected as the priority option because it has advantages from the viewpoint of technical aspect, economical aspect, safety, and environmental/social consideration as follows:

- Technical aspect: higher ground elevation
- Economic aspect: less construction cost
- Safety: less traffic volume during construction
- Environment/social consideration: less scale disruption of nature and less number of project-affected households (PAHs)

Table3.3-38: Result of Alternative location study

Araihazar Economic Zone		Nayanpur Economic Zone
Location Map		
Area	218.84 ha	233 ha
Location & District	20 km from Dhaka in direct distance, Araihazar Upazila, Narayanganj District	50 km from Dhaka in direct distance, Sreepur Upazila, Gazipur District
Highway access	Along Dhaka-Sylhet Highway	1.2 km Dhaka from Mymensingh Highway(National Highway No.3)
Distance from dhaka	26.0km from Dhaka in road distance(37 minutes)	60.9 km from Dhaka in road distance (1 hour 51 minutes)
Infrastructures	132kV/33kV substation, 2.5 km from site. 230kV transmission line passes nearby. Existing gas transmission line within AEZ – easy to connect. BEZA stated that Petrobangla has agreed for provision of 100MMCFD.	4 km away from 132kV/33kVsubstation (Sreepur Sub-Sta.1), 3.4km from site. 12 inches Gas transmission line along National Highway No. 3, 1.5km east away from site.
Land use	Farmland, single and double cropping	Farmland, single cropping
Site preparation	Embankment: 0.6- 2.6m (Avg.1.6m), Land elevation: Approx.6-8m above MSL, Flood water level due to rivers of Shitalakhya and Meghna: Approx.7.52m (1/100), Elevation of land preparation: 8.0m	Embankment: 0.5- 2.5m(avg. 1.5m),Land elevation: Approx. 14-16mabove MSL, Flooding: Not affected by Padma and Meghna Rivers, Avg. height of elevation: 16.5mabove MSL considering rain water gradient, Borrow pit in Barmi Bazar 17kmeast away from site
Natural environment	Rice paddy(Low risk for erosion and water logging)	Rice paddy (Low risk for erosion and water logging)
Environment /Social Consideration	- Since the traffic volumes resulting from the earthwork transportation during the construction phase are estimated to be smaller than in Nayanpur EZ, exhaust gas from the vehicular traffic will be less than in Nayanpur EZ. - According to the project description, the modification in the creek is not expected. Therefore, the negative impact on natural environment is forecasted as less than Nayanpur EZ. - Around 11 structures might be resettled in the Araihazar EZ area, which is less than in Nayanpur EZ area. Therefore, the social	- Since the traffic volumes resulting from the earthwork transportation during the construction phase are estimated to be larger than in Araihazar EZ, exhaust gas from the vehicle traffic will be more than in Araihazar EZ. - According to the project description, the modification in the creek is expected. Therefore, the negative impact on natural environment, Flora/Fauna and Ecosystem is expected. - More households will be resettled than Araihazar EZ area. Therefore, the social impact will be greater than that of

	Araihazar Economic Zone	Nayanpur Economic Zone
	impact will be lesser than that of Nayanpur EZ.	Araihazar EZ.
Flood Water Level	The result of the 100-year rough probability calculation shows that the water level is 7.21 m at Araihazar.	The result of the 100-year rough probability calculation shows that the water level is 10.72 m at Nayanpur.
Nearest River	Shitalakhya River, Brahmaputra River and Meghna River	Turag River and Shitalakhya River
Economic Aspect	- Since earthwork volume is smaller than Nayanpur EZ, construction cost is estimated to be less and construction period is estimated to be shorter than in Nayanpur EZ. - Since the number of PAHs will be less than in Nayanpur EZ as stated in the environmental/social consideration below, the compensation for resettlement will be reduced.	- Since earthwork volume is larger than in Araihazar EZ, construction cost is estimated to be higher and construction period is estimated to be longer than in Araihazar EZ. - Since the number of PAHs will be more than Araihazar EZ as stated in the environment/social consideration below, the compensation for resettlement will be increased
Evaluation	Compared with Nayanpur EZ, Araihazar EZ has advantages from the viewpoint of technical aspect, economical aspect, safety aspect, and environmental/social consideration. Therefore, Araihazar EZ is chosen as the preferred option.	

Selection of generation systems

The following generation systems were considered as options (Table 3.3-39) for the proposed power plant. Case 2 has been selected based on cost efficiency and also on minimizing environmental impact of power generation in accordance with the expected increase of power demand within AEZ.

Table 3.3-39: alternative generation systems

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

Alternative Fuel

Natural gas considers as a clean fuel for the generation of electricity. Other sources of energy could be coal, HFO, nuclear power, geothermal, wind power, hydropower and solar power that are used worldwide.

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

Zero option

The scenario should be based on the expected condition of AEZ “with” and “without” the proposed power plant. BEZA wishes to establish an economic zone that could meet international standards in all aspect. However, as per the study by JICA STUDY TEAM on the frequency and voltage of the 230kV of the existing electricity supply (the national grid) of the country, the power supply from the national grid apparently would fail to provide reliable and stable power to AEZ. Inability to provide reliable and stable power to the tenants of AEZ would jeopardize the value of AEZ because the fluctuation from the national grid will affect operation of factory facilities/equipment and their production quality.

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

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

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

Alternative analysis for the gas transmission line

Location

Preliminary survey was carried out in prior to the topographic survey of the gas transmission line in order to roughly examine the impact of 3 alternative route shown in Figure 3.3-44 and Table 3.3-40.

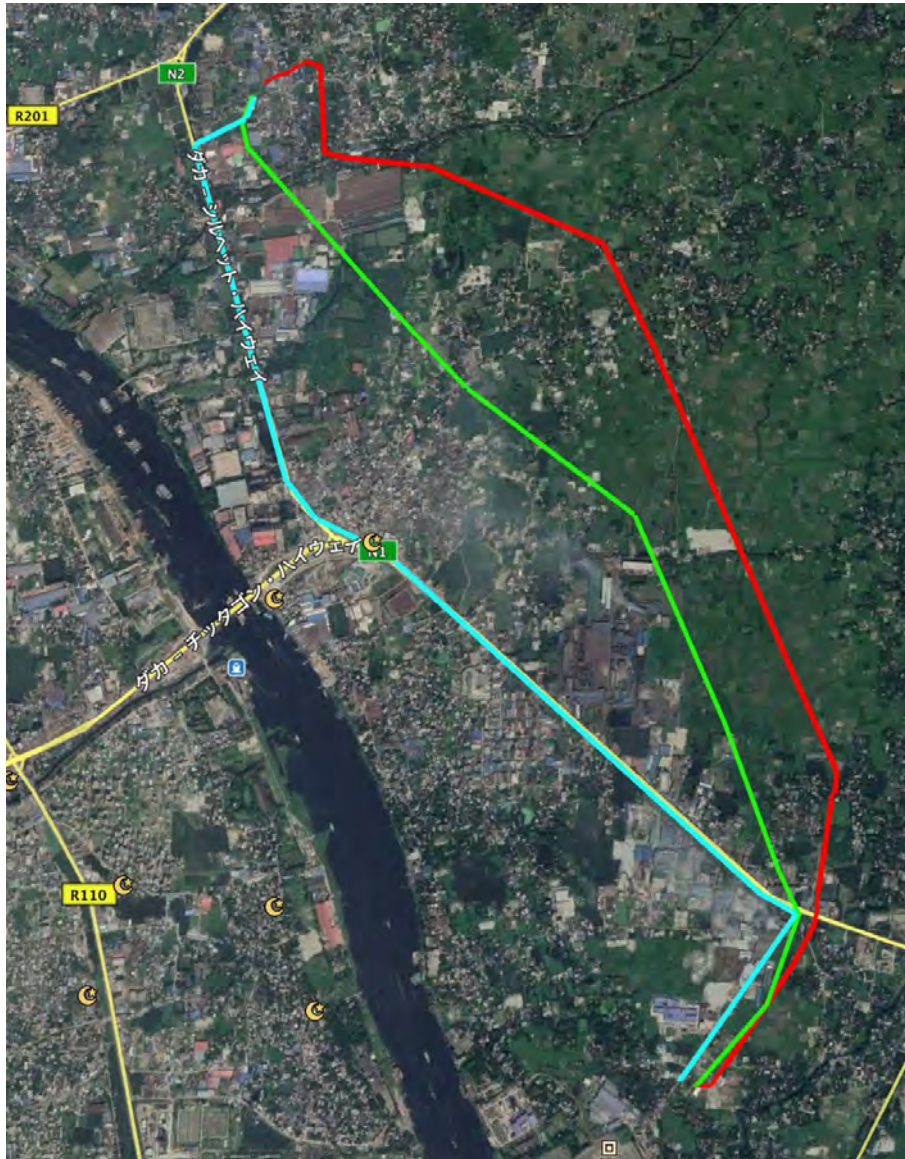


Figure 3.3-44: Map of 3 alternative routes of gas transmission line.

Table 3.3-40: comparison of 3 alternative alignments

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

Source: JICA STUDY TEAM.

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

Zero option

For the gas transmission line, "Zero option" refers to "no construction of the gas transmission line". Without the project, the impact described in this report can be avoided. However, the operation of AEZ and the proposed power plant would be hampered due to the shortage of gas supply and AEZ would lose its value as an economic zone. As a result, new job creation would be limited. Unlike the land acquisition at AEZ site, the acquired land for the gas transmission line can be restored and used by the previous owners as long as Natural Gas Safety Rules is conformed.

3.3.5. Scoping and Terms of Reference (TOR) for the Environmental Impact Assessment

Scoping

In order to assess the likely significant environmental and social impacts, potential environmental and social impacts of the power plant, including the substation and the transmission line, and the gas transmission line, scoping of impacts were carried out based on the project descriptions. The impacts of pollution, natural and social environment, health and safety, emergency risk, and others were classified as A to D, assuming no specific measures toward the impacts are taken:

Results of the scoping for environmental and social impact assessment are shown in Table 3.3-41 and Table 3.3-42. These impacts were evaluated in each of the three phases separately, namely: pre-construction, construction phase and operation phase. For the power plant, pre-construction (land development) has already been assessed in 3.1 of Chapter 3, pre-construction impact is omitted from the table.

Table 3.3-41: Scoping Matrix of the Power plant, substation and transmission line.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	C	CO: Construction machinery and transportation vehicles will be generated SOx, NOx, smoke, soot and earth, sand and dust particles will be scattered. This may cause air pollution. OP: Primarily natural gas will be used as the fuel for GT and GE for the primary operation, and diesel fuel will be used as the fuel for subsidiary operation. The exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution SOx or NOx without proper technologies and maintenance.
	2	Water pollution	B-	B-	CO: Effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from the washing of aggregate and sand. If these are inadequately handled, surface water and underground water will be contaminated. OP: Groundwater will be used in the cooling system and therefore, the thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, river water and underground water will be contaminated.
	3	Waste	B-	B-	CO: Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected. OP: The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated
	4	Soil pollution	B-	B-	CO: With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built, and earth and sand may flow out at the time of rainfall. Storage of raw material, fuel and construction debris may contaminate the soil. OP: Improper storage, handling, disposal of diesel fuel, lubricants, solid, and hazardous waste may lead to contamination of the soil.
	5	Noise	A-	A-	CO: Noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact OP: Without serious attention and countermeasures, the noise generation source during the operation includes the power plant operation, worker's commutation, traffic of vehicles for carrying the periodic inspection materials.
	6	Ground subsidence	D	C	CO/OP: There is no evidence or trace of ground surface subsidence around all the project sites. Degree and scope of impact are not clear thus more investigation required.
	7	Offensive Odours	D	D	CO: Odor may produce by domestic waste from the campsite. However, the impact will be very negligible. OP: No impacts are expected

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
	8	Sediment quality	B-	D	CO: Inadequate handling of domestic solid waste, hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds. OP: No impact is expected
Natural environment	9	Protected areas	D	D	CO/OP: Since no natural preservation area and national parks exist in and around the power plant area, an impact on protected areas is not expected.
	10	Ecosystems	B-	B-	CO: Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent water bodies. OP: The power plant site and its surrounding areas will have already been converted into commercial purposes. There is no natural forest in these areas. Plant's gaseous emission and excessive noise may disturb to the surrounding inhabiting floral and faunal species. Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.
	11	Hydrology	B-	B-	CO: During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds. OP: Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.
	12	Topography and geology	D	D	CO/OP: No impacts are expected
	13	Involuntary Resettlement	D	D	CO: The power plant will be established under the designated site of AEZ. No additional land will be acquired. OP: No impacts are expected
Social environment	14	Vulnerable group	B-/B+	B+	CO: Very minimum vulnerable people will be affected as per census survey. On the other hand, job opportunity and commercial opportunity would increase. OP: Non-technical skill job opportunities as workers of the power plant and commercial opportunity would improve.
	15	Indigenous and ethnic people	D	D	CO: No indigenous and ethnic persons were identified as per the census survey, and no such communities exist around the project site. OP: No impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B+	B+	CO: Increase of job opportunity as construction workers. OP: Increase of job opportunity as workers of the power plant or commercial opportunity targeted to these workers is expected.
	17	Land use and utilization of local	D	D	CO: There will be no significant change in land use. OP: During operation of the power plant, no further changes are expected.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
		resources			
	18	Water usage	B-	B-	CO: The surrounding wells may be affected by the reduction of underground water level resulting from underground water intake during the construction work and labor camps. OP: Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes. Excessive withdrawal of groundwater may lead to depletion of aquifers without proper assessment of the depth of the existing wells and installed groundwater wells with supply capacities.
	19	Existing social infrastructures and services	D	D	CO: Constructional activities of the power plant will not affect the access of the inhabitants to the social infrastructure and service facilities of the community. OP: no impacts are expected due to development of the power plant.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	CO: No impacts are expected. OP: No impacts are expected.
	21	Misdistribution of benefits and damages	D	D	CO: Employment opportunity will be increasing. Candidates of construction workers may experience some misdistribution between communities. However, the impacts will be very minimum. OP: No activity will cause misdistribution of benefits and damages
	22	Local conflicts of interest	D	D	CO: Due to an increase in employment opportunity will be increasing. Candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum. OP: There are people who would get job opportunity as workers of the power plant.
	23	Cultural heritage	D	D	CO/OP: Nothing found in the development area would be affected by the development.
	24	Landscape	D	D	CO/OP: There is no picturesque scenery in or around the site.
	25	Gender	B-	D	CO: Female laborers may be discriminated in wage at the construction site. OP: Project activities do not attract gender issues.
	26	Children rights	B-	D	CO: Underage employment may occur at the construction stage. OP: No impacts are expected.
	27	Infectious diseases	B-	B-	CO: Workers and Engineers coming from the outside area may carry an infectious disease, which may spread among other workers. OP: There is a possibility to increase the risks of infectious diseases due to the influx of workers of the power plant and the semi-urbanization of the project area and its surrounding area.
	28	Working	B-	B-	CO: Accidents and incidents during construction may occur. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapors, liquids

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			During Construction Phase	Operation Phase	
		conditions, including occupational safety			are the major hazards which are harmful to workers health. OP: Accidents or incidents are expected to occur due to electrical work, fire accident, gas leakage etc.
Others	29	Accidents	B-	B-	CO: Accidents may occur due to the operation and movement of heavy equipment, vehicle and machinery. OP: Road accidents may occur due to plant vehicles and motorbikes. Gas distribution line has risk due to the bursting of pipes or leakage.
	30	Transboundary impact and climate change	D	B-	CO: Emission from construction work is expected, but impacts are negligible. OP: Emissions of GHGs are generated from vehicle traffic and power plant operations.

Source: JICA Study Team

Table 3.3-42: Scoping Matrix of the gas transmission line.

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	D	PC/CO: During the clearing of RoW excavation and backfilling of pipelines, some dust distribution is expected. Also, the movement of vehicles and heavy equipment may emit a small amount of SO _x , NO _x and CO ₂ . OP: No impacts are expected.
	2	Water pollution	B-	D	CO: For installation of gas pipeline, land acquisition (20-feet strip) for the RoW is required and some water bodies will be affected. Additionally, for smooth implementation of the work, temporary roads would be constructed on one side of the RoW within the 20-Foot strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction stage as excavated soil from trench will be dumped beside RoW. OP: No impacts are expected
	3	Waste	B-	D	CO: Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected and typically managed by the appointed contractors; OP: No impacts are expected

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

Field	No	Impacts	Evaluation (Scoping)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	
	11	Hydrology	B-	D	CO: For smooth implementation of the work, temporary roads would be constructed on one side of the RoW and in the 20-foot strip requisitioned along the pipeline of the RoW. As a result, overland drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW. OP: After the backfilling, no impacts are expected.
	12	Topography and geology	D	D	CO/OP: No impacts are expected
Social environment	13	Involuntary Resettlement	A-	D	PC/CO: Acquisition of land for the project will affect them significantly. Because, (i) the land price of the land situated beside the acquired land will be decreased as construction of structures is prohibited within certain distance from the RoW, (ii) a remaining small piece of land has no use after acquiring larger portion of a plot but the project does not compensate for that small piece of land, (iii) some have no other properties than the affected one; Requisition of land for the project will also affect people of the project area. The soil becomes compacted, and this type of land is not good for cultivation, it takes time to make the land useful for cultivation. OP: No impacts are expected
	14	Vulnerable group	B-	D	CO: Very minimum vulnerable people will be affected. On the other hand, job opportunity as construction worker would increase. OP: The landowners can use the land for agricultural purpose after the pipeline installation.
	15	Indigenous and ethnic people	D	D	CO: no indigenous/ethnic people live in the project affected area. OP: no impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B-/B+	B-	CO: PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. Some industries' operation will be temporarily closed for the pipeline installation. Workers of the factories will lose their job temporary. On the other hand, an increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. OP: Productivity of the agricultural land will remain low for a certain period of time due to land work.
	17	Land use and utilization of local resources	B-	C	CO: Along the RoW, approximately 8.86 acres of agricultural land will be acquired for the construction. Therefore, agricultural productivity will be affected during and after the construction. The site is single cropped land, and the condition of land will be restored, so the impact is anticipated to be low. Several factories will need to suspend operation, and their factory will be partially demolished due to the construction. OP: No impact on agriculture resources is anticipated. In the RoW areas, agricultural land use practices will be restored.
	18	Water usage	D	D	CO: The water will be used only for drinking, so the impact is very negligible. No impacts are expected. OP: No impacts are expected.
	19	Existing social	D	D	CO: An increase in the number of vehicles for construction work may affect the access of the inhabitants to the

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

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

Term of References for EIA

JICA Study Team prepared a term of reference (TOR) for identified uncertain impacts summarized for the EIA study. A summary of survey methodologies is presented in Table 3.3-43 and Table 3.3-44.

Table 3.3-43: TOR for Impact Assessment of the power plant, substation and transmission line

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
Environmental pollution	1.	Air pollution	The existing ambient air quality of the study area monitored at Five (5) locations during the monitoring period. The monitoring parameters included Particulate Matter (SPM, PM ₁₀ and PM _{2.5}), Sulphur Dioxide (SO ₂), Oxides of Nitrogen (NO _x), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours, and the rest of the parameters monitored on 24-hourly basis during the duration of the study.	Industrial emissions and movement of vehicular access
	2.	Water pollution	Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Samples were taken from a selected surface water body's source representing different parts of the study area. Three surface water and Four groundwater sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area.	Estimated power plant's surface & groundwater quality
	3.	Waste	Review and summary of the previous survey	Study Estimated of power plant

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
	4.	Soil pollution	The soil sampling strategy was designed to assess the existing soil quality over the study area. The analysis results of physio-chemical parameters (metal content), pH level of samples is studied.	Estimated power plant's soil quality
	5.	Noise	Noise levels recorded at seven (7) locations in the study area during the monitoring period. Noise levels recorded in the form of sound pressure levels with the help of a digital sound level meter.	Increased traffic movement and power plant operations
	6.	Ground subsidence	Deep well boring survey and pump up test from Araihasar EZ site secondary documents	Secondary data/studies from AEZ
	7.	Sediment quality	Review and summary of the previous survey	Estimated power plant and treated wastewater from ETP
Natural environment	8.	Ecosystems	Field survey	Secondary data/studies for the sensitivity of the observed species
	9.	Hydrology	Review and summary of the JICA previous study on AEZ	Previous study
Social environment	10.	Vulnerable group	Focus group discussion	Comparison of the survey results and proposed entitlement matrix and stakeholder meetings, Estimated Power plant and their expected jobs
	11.	Water usage	Field survey, inventory of loss, census and socioeconomic survey	
	12.	Gender	Focus group discussion	
	13.	Children's rights	Census and socioeconomic survey	
	14.	Infectious diseases	Census survey of the project site and Secondary data	Secondary data
	15.	Working conditions including occupational safety	Focus group discussion	Secondary data
Others	16.	Accidents	Secondary data from LGED, RHD	Secondary data
	17.	Transboundary impact and climate change	Secondary data and air dispersion modelling	Secondary data

Source: JICA Study Team

Table 3.3-44: TOR for Impact Assessment of the gas transmission line

	No	Impacts	Methods of Surveys (The Content of supplemental EIA Survey and Social Impact Survey)	Methods of Predictions and other Considerations
Environmental pollution	1.	Air pollution	The existing ambient air quality of the study area monitored at Three (3) locations during the monitoring period. The monitoring parameters included Particulate Matter (SPM, PM ₁₀ and PM _{2.5}), Sulphur Dioxide (SO ₂), Oxides of Nitrogen (NO _x), and Carbon Monoxide (CO). SPM and CO monitored for 8 hours, and the rest of the parameters monitored on 24-hourly basis during the duration of the study.	Emissions from equipment and movement of vehicular access
	2.	Water pollution	Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water in the study area. Samples were taken from a selected surface water body's source representing different parts of the study area. Three surface water and two groundwater sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the groundwater in the study area.	Estimated project area's surface & groundwater quality
	3.	Waste	Review and summary of the previous survey	Study Estimated the project area
	4.	Soil pollution	The soil sampling strategy will design to assess the existing soil quality over the study area. The analysis results of physio-chemical parameters (metal content), pH level of samples is studied.	Estimated project area's soil quality
	5.	Noise	Noise levels baseline study at Six (6) locations in the study area. Noise levels will be recorded in the form of sound pressure levels with the help of a digital sound level meter.	Increased traffic movement and operation of constructional equipment and machinery
	6.	Offensive Odor	Review and summary of the previous survey near the project site	Study Estimated the project area
	7.	Sediment quality	Review and summary of the previous survey near the project site	Study Estimated the project area
Natural environment	8.	Ecosystems	Field survey	Secondary data/studies for the sensitivity of the observed species
	9.	Hydrology	Review and summary of the previous survey near the project site	Study Estimated the project area
Social environment	10.	Involuntary Resettlement	RAP study	RAP survey results and proposed entitlement matrix and stakeholder meetings, Estimated Gas transmission project and their
	11.	Vulnerable group	RAP study and Focus group discussion	
	12.	Local economies, such as employment, livelihood, etc.	Socio-economic census surveys for affected people will be conducted to identify income and livelihood of PAPs.	

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

Source: JICA Study Team

3.3.6. Result of Assessment

Environmental and social impact of Pre-construction Phase for the power plant has already been described in Section 3.1 thus it is omitted from this section in order to avoid repetition.

1) Air Pollution

Pre-construction Phase

Gas Pipeline

During the clearing of RoW, some earth activities are performed for this project. This is essential for the movement of vehicles and heavy equipment that create a small amount of dust and SO_x, NO_x and CO₂. However, this small amount of pollution has no significant impact on the overall pollution of the ambient air quality.

Construction Phase

Power Plant

All earthworks construction, site clearing, small structures demolition, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, hauling of materials, construction of access road will generate dust and affect the local airshed. Construction of access roads and its dust is likely to be the most significant direct potential impact on the local community. With the progress of construction work, SO_x, NO_x, smoke and soot will be generated from the construction machinery and transportation vehicles and earth, sand and dust particles will be scattered. This may cause air pollution.

Gas Pipeline

During Construction stage transportation of the pipeline, construction of earth road, digging of the earth for the trench, pressure regulating and metering stations, welding, cleaning and coating/ wrapping of the pipeline etc. could cause low atmospheric pollution in the air which may create health problem on workers and surroundings inhabitants. In addition, movement of vehicles and heavy equipment emit a small amount of SO_x, NO_x and CO₂. The emission of dust, gaseous pollutants (SO_x, NO_x and CO₂) and suspended particulates will be moderate.

Operation Phase

Power plant

The power plant will operate both diesel and natural gas. The 3 MW diesel engine will operate at the initial commencement of economic zone as the initial stage the economic zone will require less power. During the full-scale operation of the economic zone, the diesel engine will use as the backup power supply for starting GT during the blackout, the emergency power supply including the shortage of gas fuel supply and continuous power supply during low power demand of EZ. During the operation stage, the main source of air pollution is engine exhaust gas. Different gaseous emission, e.g. NO_x and CO will generate from the gas-based engine and gas turbine whereas SO₂, NO_x and CO will generate from diesel engine stack.

To know the intensity of impact is essential to predict air quality at receptor locations during operation of the proposed power plant. Modelling exercise has been performed to estimate the ground level concentration of SO₂, NO_x and CO around the project site. USEPA approved dispersion modelling

software AERMOD has been used to view the dispersion of the pollutants from the proposed power plant. Resultant results also calculated by adding emission of the proposed power plant. AERMOD is a modelling system consisting of three separate modules: AERMET, AERMAP, and AERMOD. AERMET is a meteorological pre-processor and uses hourly surface observations, cloud cover, and upper air parameters from a twice-daily vertical sampling of the atmosphere to create two output files consisting of surface and vertical profile data, respectively. The terrain pre-processor AERMAP uses Digital Elevation Model (DEM) maps as well as user-generated receptor grids. AERMAP's output file consists of the x, y locations of each receptor, mean sea level (MSL) elevation and hill profile parameters.

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

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

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

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

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

Receptors locations are shown in Table 3.3-45.

Table 3.3-45: Receptors Locations

Sl.	Sampling Station	Station Code	Geographic Location	Elevation (m)	Direction and Distance
1.	In front of Nurul Haque House;Vill: Maizpara, Union: Satgram, Upazila: Araihaazar	AQ1	23°49'45.80"N 90°36'45.30"E	11.0	NW Direction (1.6 kms)
2.	In front of Panchbaria Boro bari;Vill: Panchbaria, Union: Duptara,Upazila: Araihaazar	AQ2	23°49'18.10"N 90°37'56.40"E	11.74	ENE Direction (665 meters)
3.	In front of Tekpara govt. primary school; Vill: Tekpara, Union: Satgram, Upazila: Araihaazar	AQ3	23°50'0.20"N 90°38'0.48"E	11.04	East Direction (512 Meters)

Sl.	Sampling Station	Station Code	Geographic Location	Elevation (m)	Direction and Distance
4.	In front of Rahim Sekh house;Vill: Shingrati, Union: Duptara,Upazila: Araihaazar	AQ4	23°48'52.75"N 90°36'38.76"E	10.40	NNE Direction (1.71 km)
5.	Infront of Nasir Pradhan House; Vill: Dakhinpara, Union: Duptara,Upazila: Araihaazar	AQ5	23°49'4.00"N 90°37'49.83"E	9.43	NNE Direction (1.71 kms)

An assessment of the potential impacts has been undertaken through an air quality modelling exercise. This assessment is based on a power plant configuration consisting of one 25 MW capacity gas turbine, two sets of 6 MW gas engine and 1 set of 3 MW diesel engine. Discharge to the atmosphere from the plant occurs via four stacks, one stack for each engine. The diesel engine will use only emergency period during the economic zone will run in full scale. The model has been undertaken considering the worst-case scenario. The location of the power plant stacks is in Table 3.3-46.

Table 3.3-46: List of Stack Locations

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

The input parameters considered for the air dispersion modelling have been summarized in the table below

Table 3.3-47: Data Inputs Required for Modeling

No.	Scenario	Value
1	Control Pathway	
	Dispersion option	Non-Default Option
	Terrain	Flat
	Dispersion Coefficient	Rural
	Flagpole Receptor	No
2	Meteorological Input	
	Met Input Data	Meteorological data from 1 January 2016 to 31 December (Pre-processed Meteorological Data)
	Wind Speed Categories	A: 1.54 m/s B: 3.09 m/s C: 5.14 m/s

No.	Scenario	Value
		D: 8.23 m/s
		E: 10.8 m/s
		F: No upper bound
	Latitude	23°49'4.00"N
	Longitude	90°37'27.43"E
	Anemometer Height	14 m
	Base Elevation	9 m
3	Receptor Pathway	
	No. of X-axis Receptors	51
	No. of Y-axis Receptors	51
	Spacing for the X-axis	200
	Spacing for the Y-axis	200
	Sensitive Receptor	5
4	Source Pathway	Point Source
5	Output Pathway	Pollutants Ground Level Concentration
	SO ₂	1 Hourly, 24 Hourly and Annual
	NO _x	1 Hourly, 24 Hourly and Annual
	CO	1 Hourly, 8 Hourly, 24 Hourly and Annual

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

Incremental ground level concentrations obtained from modelling for air quality due to emissions of SO₂, NO_x, and CO are detailed below. SO₂ emission has been estimated only for the diesel engine as natural gas of Bangladesh contain a negligible amount of sulfur. The emission rate of SO₂ has been calculated based on the diesel requirement as 13.66 t/d and 2.5% sulfur content.

Nitrogen Oxide (NO_x)

The predicted 24-hour incremental ground level concentration of NO_x at all the monitored locations for ambient air quality is presented in Table 3.3-48 below.

Table 3.3-48: Predicted 24-hr Maximum Ground Level Concentration of NO_x

Receptor	Baseline NO _x level (24	Predicted NO _x level (24 hr	Total Concentration (Predicted+	Bangladesh Standard (24 Hours) (µg/m ³)	IFC, 2008 Limit

	hours) (µg/m ³)	Average) (µg/m ³)	Background) (µg/m ³)	ECR 97*	Draft ECR, 2017	(24 Hours) (µg/m ³)
AQ1	30.2	3.1	33.3			
AQ2	19.4	8.4	27.8			
AQ3	22.4	10.5	32.9	-	200	-
AQ4	16.6	3.1	19.7			
AQ5	12.4	8.9	21.3			

Source: JICA STUDY TEAM

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

The maximum concentration of NO_x was observed to 59.6 µg /m³ at coordinates of (257983.52m E 2636488.93m N) to the North of the stacks. The corresponding isopleth for NO_x emissions from the power plant operations is as given in Figure 3.3-45.

There is no stipulated 24-hourly standard for NO_x in ECR 97 (amendment in 2005). Ministry of Environment and Forest (MoEF) has prepared draft ECR 2017 including 24 hourly NO_x standards. It has been concluded that the ground level incremental concentration of NO_x in the ambient air quality monitored locations will be within the acceptable limit (Table 3.3-48).

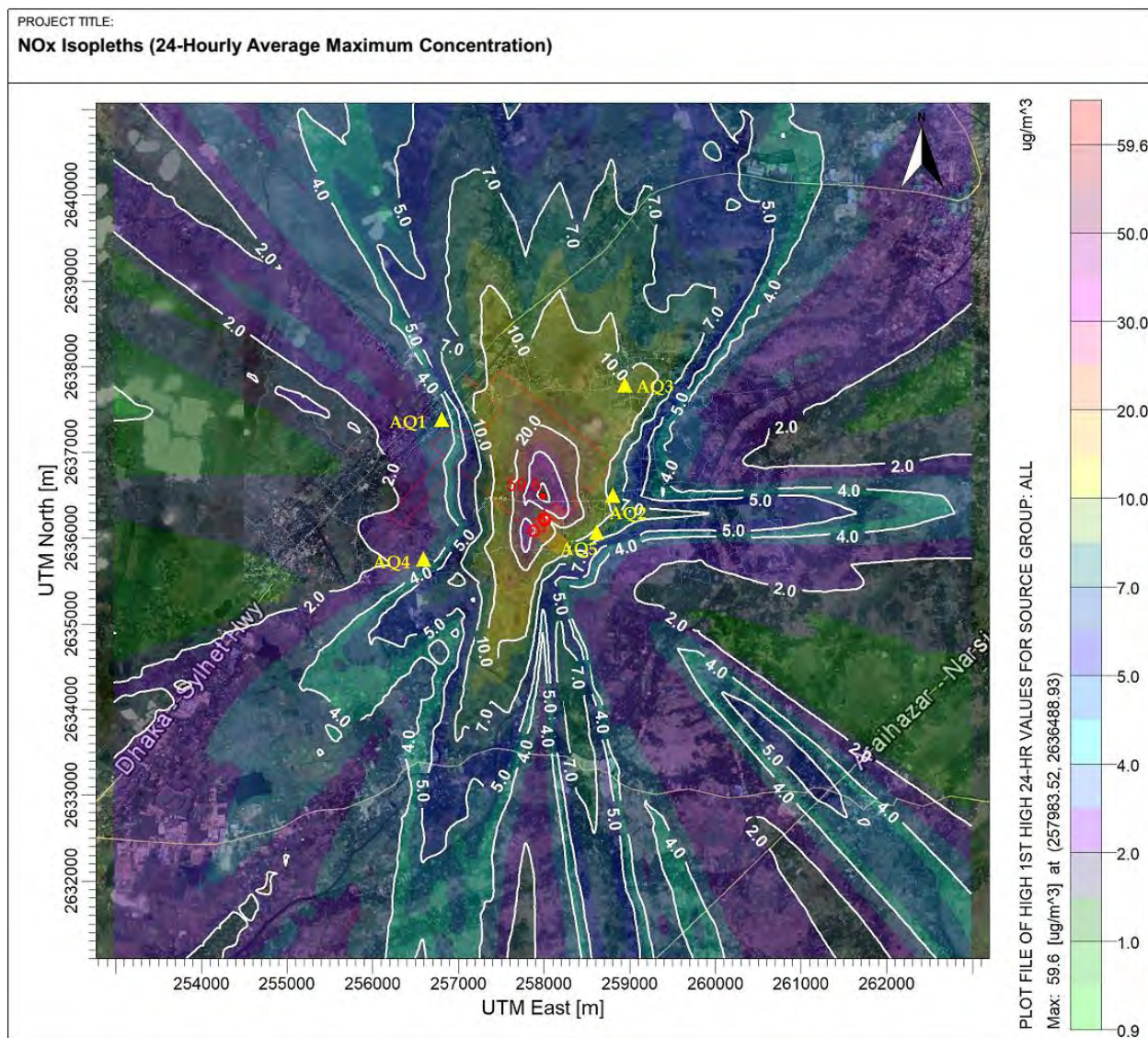


Figure 3.3-45: 24 Hourly Ground Level Incremental Concentration of NOx
Source: JICA STUDY TEAM

Carbon Monoxide

The predicted 8-hour incremental ground level concentration of CO due to the proposed power plant operations at all the monitored locations for ambient air quality is presented in Table 3.3-49.

Table 3.3-49: Predicted 8-hr Maximum Ground Level Concentration of CO

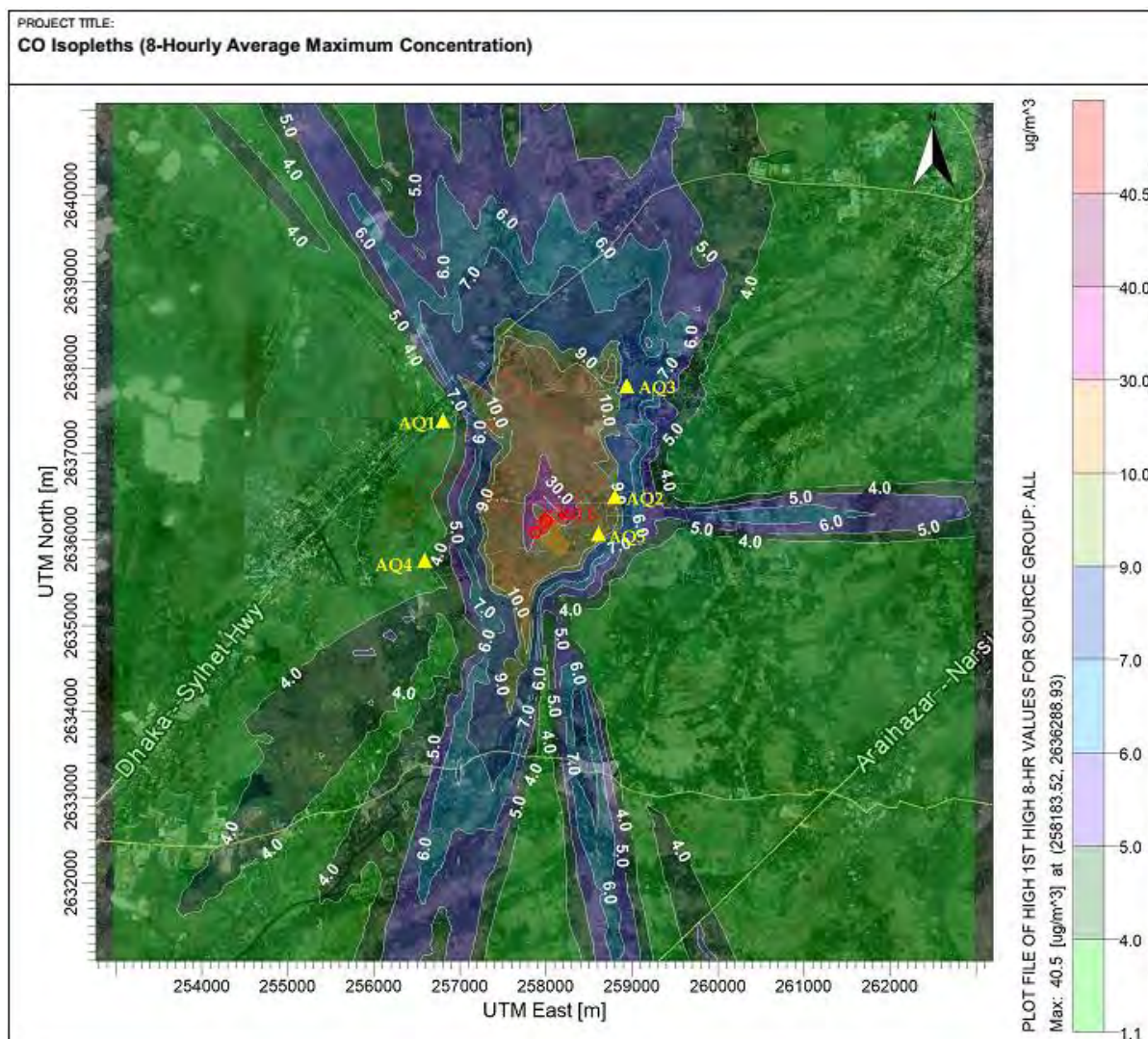
Receptor	Baseline CO level (8 hours) (ppm)	Predicted CO level (8 hr. Average) (ppm)	Total Concentration (Predicted+ Background) ($\mu\text{g}/\text{m}^3$)	Bangladesh Standard (8 Hours) (ppm)		IFC, 2008 Limit (24 Hours) (ppm)
				ECR 97*	Draft ECR, 2017	
AQ1	2.5	0.003	2.503	9	9	-

Receptor	Baseline CO level (8 hours) (ppm)	Predicted CO level (8 hr. Average) (ppm)	Total Concentration (Predicted+ Background) ($\mu\text{g}/\text{m}^3$)	Bangladesh Standard (8 Hours) (ppm)		IFC, 2008 Limit (24 Hours) (ppm)
				ECR 97*	Draft ECR, 2017	
AQ2	0.50	0.009	0.509			
AQ3	1	0.007	1.007			
AQ4	0.50	0.003	0.503			
AQ5	0.50	0.010	0.510			

Source: JICA STUDY TEAM

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

The maximum concentration of CO was observed to $40.5 \mu\text{g}/\text{m}^3$ (0.035 ppm) at coordinates of (258183.52m E 2636288.93m N) to the Northeast of the stack which will be within plant boundary. The corresponding isopleth for CO emissions from the power plant operations is as given in Figure 3.3-46.



Source: JICA STUDY TEAM

Figure 3.3-46: 8 Hourly Ground Level Incremental Concentration of CO

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

Sulphur Dioxide (SO₂)

Sulphur dioxide has been estimated only for diesel engine generator as natural has insignificant sulphur content. The predicted 24-hour incremental ground level concentration of SO₂ at all the monitored locations for ambient air quality is presented in Table 3.3-50 below.

Table 3.3-50: Predicted 24-hr Maximum Ground Level Concentration of SO₂

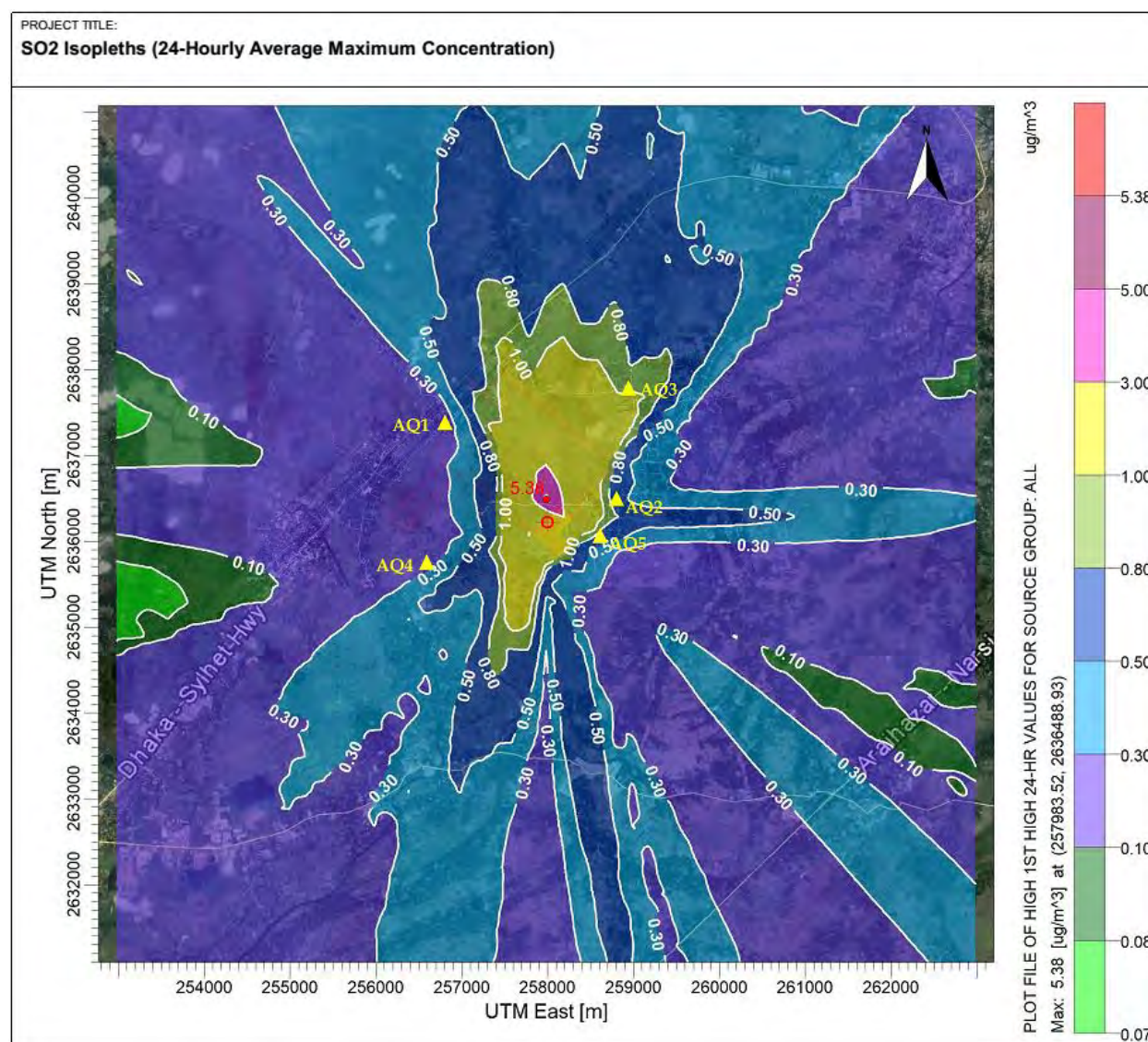
Receptor	Baseline SO ₂ level (24 hours) (µg/m³)	Predicted SO ₂ level (24 hr. Average)	Total Concentration (Predicted+ Background) (µg/m³)	Bangladesh Standard (24 Hours) (µg/m³)	IFC, 2008 Limit (24 Hours) (µg/m³)
				ECR 97* Draft ECR, 2017	

AQ1	10.1	0.23	10.3	365	85	125 (Interim Target-1)
AQ2	6.3	0.64	6.9			
AQ3	7.2	0.90	8.1			
AQ4	5.7	0.23	5.9			
AQ5	6.6	0.70	7.3			

Source: JICA STUDY TEAM

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

The maximum concentration of SO₂ was observed to 5.38 µg /m³ at coordinates of (257983.52 mE 2636488.93 mN) to the North of the stack, and the location is in the economic zone boundary. The corresponding isopleth for SO₂ emissions from the power plant operations is as given in Figure 3.3-47.



Source: JICA STUDY TEAM

Figure 3.3-47: 24 Hourly Ground Level Incremental Concentration of SO₂

Table 3.3-50 shows the total incremental ground level concentration of SO₂ due to the proposed power plant operations is well within the national standard as well as the IFC standard.

Gas Pipeline

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

2) Water Pollution

Construction Phase

- **Impact on Surface Water Quality**

Power Plant

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

Gas Pipeline

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

- **Impact on Ground Water Quality**

Power Plant

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

Gas Pipeline

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

Operation Phase

- **Impact on Surface Water Quality**

Power plant

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

• Impact on Ground Water Quality

Power plant

There will be very minimal chance of contaminating groundwater from wastewater and sewage during the operation phase. Pre-treated wastewater will be collected from the power plant through anti-corrosive pipes to the treatment plant and only be discharged to nature after meeting the national discharge standards. Following measures should be taken to minimize the groundwater pollution.

3) Waste

Construction Phase

Power plant/Gas transmission pipeline

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

Operation Phase

Power plant

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

Gas pipeline

No impact is expected for operating gas transmission pipeline.

4) Soil Pollution

Construction Phase

Power Plant

With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built, and earth and sand may

flow out at the time of rainfall. Storage of raw material, vehicles & equipment fuel and construction debris may contaminate the soil. Soil may be contaminated through spills and leaks of Fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.

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

Gas Pipeline

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

Operation Phase

Power Plant

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

Gas Pipeline

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

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

5) Noise and Vibration

Power Plant/Gas Pipeline

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

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

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

Operation Phase

Power Plant/Gas Pipeline

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

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

6) Ground Subsidence

Power Plant

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

Gas Pipeline

No impact is expected for operating gas transmission pipeline.

7) Offensive odors

Power plant/Gas Pipeline

No impacts are expected at the construction of power plant.

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

impacts or impacts are negligible

8) Sediment Quality

Construction Phase

Power plant

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

Gas Pipeline

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

Operation Phase

Power plant

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

Gas Pipeline

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

Natural Environment

9) Protected areas

Power Plant

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

Gas pipeline

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

The Haripur station by titas is very close to Sitalakhaya River which is 740m south-west direction from the station. The Gazette notification to this effect imposes restrictions on a number of activities in these rivers and their associated riparian environs. These include all types of hunting, collection of all types of aquatic species living in the rivers, all activities that could result in the destruction of floral or faunal habitats, all activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste. The project will not cause these impacts.

10) Ecosystems

Pre-construction Phase

Terrestrial Ecosystems

Gas pipeline

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

frightened easily by vehicle horns and may become distressed.

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

Aquatic Ecosystems

Gas pipeline

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

Construction Phase

Power Plant/Gas Pipeline

Terrestrial Ecosystems

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

Terrestrial Flora

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

i. Agricultural Land Flora

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

ii. Homestead Plantation Flora

The project activities have high potential to impact on homestead vegetation and agro-forestry by

offering increased disturbance and clearing. However, almost exclusively this vegetation is very close to the homestead buildings. The project authorities try to avoid acquiring existing homestead buildings. However, all vegetation will be cleared from the homesteads that are within the project area.

iii.]

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

Terrestrial Fauna

Relative impact on terrestrial fauna will be determined by their habitat preference, food source and sensitivity to human activities. Moreover, the species both vertebrates and invertebrates species found in the project sites, are highly adaptive to regular anthropogenic disturbance and so the impact from project activities will be short and non-severe. But, any overlap between the project activity and their breeding period will produce much greater impact.

i. Agricultural Land Fauna

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

ii. Homestead Plantation Fauna

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

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

iii. Roadside Vegetation Fauna

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

Aquatic ecosystem

With the progress of construction work, water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the water bodies. Contamination will occur due to civil construction work. This may have an adverse effect on many forms of life in the river, canal and ponds. Many seasonal and perennial water bodies will lose their characteristics. Run-off from a construction site may contain sediments or contaminant that may pollute water quality of canals, ponds and adjacent river that will affect the aquatic life. Impact on the habitat of aquatic and reverence fauna due to accidental spillage. The economic productivity of the wetlands will also

decrease with the reduction of seasonally flooded areas and subsequent loss of wetland-dependent species. The seasonal wetlands provide the basis for many fisheries production of the area. Wetland vegetation provides important shelter for many fish species.

i. Aquatic Flora

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

ii. Aquatic Fauna

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

iii. Fish Habitat Loss

Gas pipeline

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

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

Table 3.3-51: Number of Affected Trees (by Type and Size)

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

Source: JICA STUDY TEAM, November 2018

Operation Phase

Power Plant

The power plant site and its surrounding areas have already been converted into the agricultural land and are used for artificial purposes. There is no natural forest in these areas. The area to be used in the

power plant is comparatively small and will have some impact on plants and animals. Plant development will involve generation of emissions, effluents and increased vehicular movements may have the overall negative impact on the eco-system. Air pollutant will impact the existing vegetation and avifauna in the area. Likely impact on flora and fauna during the operation phase of the project will be mostly from Noise generation due to the operation of the power plant. The impact will be mainly on the terrestrial flora and fauna within the project site and its surrounding.

Gas Pipeline

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

11) Hydrology

Pre-construction Phase

Gas Pipeline

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

Construction Phase

Power Plant

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

Gas Pipeline

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

Operation Phase

Power Plant

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

Gas Pipeline

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

12) Topography and Geology

Construction Phase

Power Plant/Gas Pipeline

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

Operation Phase

Power Plant/Gas Pipeline

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

Social Environment

13) Involuntary Resettlement

Pre-construction

Power plant

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

Gas Pipeline

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

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

Table 3.3-52: Number of Land Losing Affected Households and Populations

SL	Name of Mouza	Quantum of	No. of Households Losing land	No. of

No.		Land		Populations
1	Bagnoyanogor	0.07	10	62
2	Behakoir	3.11	102	414
3	DighiBorabo	1.90	67	320
4	Kachpur	1.22	32	116
5	Monoharkharbag	2.55	42	180
Total		8.85	253	1092

Source: JICA STUDY TEAM, November 2018

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

Construction Phase & Operation Phase

The entire land was lower agricultural land in the project site. There was no cultural, historical and aesthetic interesting the project land and no loss of sensible place. There is no need to acquire any land at construction & operation stage. Therefore, no impacts or impacts are negligible.

14) Vulnerable Group

Pre-construction/Construction Phase

Power Plant

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

Gas Pipeline

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

Table 3.3-53: Affected Vulnerable AHs

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

JICA Study Team, November 2018

Operation Phase

Power Plant

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

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

Gas Pipeline

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

15) Indigenous and ethnic people

Power plant/Gas Pipeline

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

16) Local Economics, Such as Employment, Livelihood

Pre-construction& Construction Phase

Power plant

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

Gas pipeline

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

In Bangladesh landowners leased out their land to intending farmers on a temporary basis and for a certain period of time on verbal and mutual understanding. Through this informal arrangement, the sharecropper sometimes has to pay money to owners and sometimes share the harvested crops. In most cases, there is no written agreement between the landowners and sharecroppers. To identify the

sharecroppers, the landowners are the main source as there is no written agreement or contract between them. Impact on indirectly affected person was assessed through census and SES. Only one (1) persons were identified as sharecroppers in the project area. A list of sharecroppers is annexed with this document. Mouza-wise sharecroppers are presented in the table below:

Table 3.3-54 Mouza-wise Sharecroppers

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

Source: JICA STUDY TEAM, November 2018

In the process of census and impact assessment in the project alignment, three small industrial units and one restaurant were identified. The Sayeed Textile Mills at Dighiborabo is found closed since long ago. No persons or worker except one security personnel involved with this industry. The employed security guard will not lose his job. Other two small industries are operating with its full capacity. Sayeed Textile mills don't require relocation as the pipeline goes through its open space. But other two factories need to be relocated temporarily. Workers involved with these factories will lose their job due to the construction of the gas transmission line. A total of 52 workers will lose their livelihood earning source. The number of wage loser person is presented in the table below.

Table 3.3-55: Number of Wage Loser in the Gas Pipeline Project

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

Source: JICA STUDY TEAM, November 2018

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

Operation Phase

Power plant/Gas Pipeline

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

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

In the RoW areas, agricultural land use practices will be suspended for a temporary basis. After installation of pipeline, Farmers can use this land again for agricultural activities.

17) Land Use and Utilization of local resources

Pre-construction Phase / Construction Phase

Power Plant

The 9.28 ha or 22.93 acres of agricultural land will be altered by the industrial purpose. Therefore, the annual agricultural production rate of that upazila will be decreased. In the project site, the land is single cropped agricultural land, so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development.

Gas pipeline

If the TBS and CGS are installed on the agricultural lands, then the land use practice will be changed partially from the agricultural to non-agricultural use for those areas. The Gas Pipeline requires approximately 8.86 acres of land. The entire land for the project identified as privately owned land and need to be acquired. A large portion (8.17 acres) of land selected for gas pipeline project is found as the agricultural category, though at many places the owners of land developed the land for homestead purposes. But the classification of land is not recorded in the respective land office. The gas pipeline project covers five mouzas in three Upazila in Narayanganj districts. Category-wise quantum of acquired land is presented in the table below.

Table 3.3-56: Quantum of Acquired Land

SL No.	Name of Mouza	Number of Plots	Amount of Acquired Land (in acres)					Total
			Doba (Waterbody)	Agri land	Pond	Viti	Fallow	
1	Bagnoyanogor	1	0	0.07	0.00	0.00	0.00	0.07
2	Behakoir	74	0	3.11	0.00	0.00	0.00	3.11
3	DighiBorabo	40	0	1.31	0.36	0.07	0.16	1.90
4	Kachpur	21	0	1.22	0.00	0.00	0.00	1.22

SL No.	Name of Mouza	Number of Plots	Amount of Acquired Land (in acres)					Total
			Doba (Waterbody)	Agri land	Pond	Viti	Fallow	
5	Monoharkharbag	67	0.0468	2.45	0.01	0.04	0.01	2.55
Total		203	0.0468	8.17	0.36	0.11	0.17	8.86

Source: JICA STUDY TEAM, November 2018

Therefore, the annual agricultural production rate of that upazila will diminish. In the project site, the land is single cropped agricultural land, so the impact on agriculture activities/ resources is anticipated to have a low significant impact from the project development.

Operation Phase

Power Plant/Gas Pipeline

No impact on agriculture resources is anticipated from power plant development during the operation phase. In the RoW areas of gas transmission pipeline, land use practices will be restored.

18) Water Usage

Construction Phase

Power Plant

Groundwater will be used in the during the construction phase of the power plant. Therefore, Excessive withdrawal of groundwater may lead to depletion of aquifers. Source of water of these activities will be the groundwater from own borehole. The water source will be approximate 260-300m deep wells. A past survey estimated the arsenic contamination concentration to be low enough to not be a problem. Measures should be taken to minimize water extraction by reducing water consumption and wastage. Adoption of the advanced technologies and machinery which helps in minimizing water requirement for construction;

Operation Phase

Power Plant

Total water consumption is 160 m³/day of which 80 m³/day will be used for gas turbine cooling, and rest 80 m³/day will use for gas booster compressor. However, the groundwater will be taken from deep wells (260m to 300m) so that it will a considerable reduction of the underground water level. Excessive withdrawal of groundwater may lead to depletion of aquifers.

Moreover, it is necessary to prevent excessive depletion of wells due to excess water usage and the subsidence of surrounding ground.

19) Existing Social Infrastructures and Services

Construction Phase

Power plant/Gas Pipeline

An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community. However, the impact is very negligible. So, No impacts are expected.

Operation Phase

Power plant/Gas pipeline

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area. No impact is expected.

20) Social Institutions Such as Social Infrastructure and Local Decision making institutions

Construction Phase

Power plant/Gas Pipeline

Regulations of Bangladesh stipulate that public consultation must be held in the land acquisition process. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office.

Operation Phase

Power plant/Gas Pipeline

No impact on social institutions such as social infrastructure and the local decision is anticipated from the power plant and Gas pipeline development during the operation phase.

21) Misdistribution of Benefits and Damages

Pre-construction Phase

Gas Pipeline

Only landowner and property owners and affected labors will be eligible for the compensation and rehabilitation. Equality of compensation shall be assured as there is a possibility of unequal compensation between local residents.

Construction Phase

Power plant/Gas Pipeline

Not everybody could benefit from the construction work due to limited requirements and preferences of the contractors.

Operation Phase

Power plant/Gas Pipeline

Misdistribution of benefits and damages would occur since there are PAHs who lose their income source for power plant and gas pipeline development, while there are people who would get job opportunity as workers of the power plant. Therefore, in the operation phase, the impact will be negligible. Therefore, no further study is required.

22) Local Conflict of Interest

Pre-construction& Construction Phase

Power plant/Gas Pipeline

Due to an increase in employment opportunity will be increasing during preconstruction and construction; candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum.

Operation Phase

Power plant/Gas Pipeline

There are people who would get job opportunity as workers of the power plant and those who would not. However, the impact will be negligible.

23) Cultural Heritage/Asset

Nothing found in the development area would be affectedly the development. Therefore, no impact is expected on cultural heritage due to proposed project implementation.

24) Landscape

Pre-construction& Construction Phase

There is no picturesque scenery in or around the site. All construction activities for the administration building, boundary wall will be carried out within the power plant site, and gas transmission line installation will not cause any impact on the landscape and scenic beauty. A green buffer of 3.5 m only one row of trees will be developed all around the project site which will enhance the scenic beauty of the area.

Operation Phase

The landscape of power plant site is the naturally depressed area which will be changed to industrial land

use after the development of power plant site. No major change in landscape is associated with the development of the power plant.

Plantation area which will be tentatively occupied during pre-construction/construction phase will be restored to the original state and returned to the landowner after construction.

25) Gender

Pre-construction& Construction Phase

Employment opportunities as well as wage difference may occur between male and female. It is anticipated that most of constuction work will require male workers and there will be less opportunity for females.

Operation Phase

Project activities do not attract gender issues. Job opportunities will be open to women according to their qualification.

26) Children's Right

Pre-construction& Construction Phase

The following item was examined to forecast the impact:

- May impact on educational opportunity of school going children in PAHs of the Project;
- May impact on educational opportunity of school going children in local community;
- Impact of the project on increase of child labor;

Operation Phase

There are many affected households who have school going children's. They must be relocating to other places, and these children's educational opportunity will be temporarily disrupted due to the relocation. Currently, the majority of the children of PAHs in the project area go to school in and around power plant area and gas pipeline alignment.

27) Infectious Diseases

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

Power plan

The entire construction phase for the power plant is expected to continue for about 3 years. This will require labour of unskilled, semi-skilled, skilled and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly of skilled labourers and workers. During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility with HIV/AIDS and the disease can spread among local people.

Operation Phase

This is a possibility to increase the risks of infectious diseases due to influx of workers of the industries and the semi-urbanization of the project area and its surroundings area.

Working Conditions, Including Occupational Safety

28) Occupational Health and Safety

Construction Phase

Power Plant

There would be a possibility to occur accidents and incident during construction works for the implementation of the Project. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapours,

liquids are the major hazards which are harmful to workers health. In order to prevent accidents and incidents, the project proponent regulates to install security and maintain safety prevention measures and devices suitable for use in each plot for construction in the internal regulation. Therefore, the construction contractor based on the international guidelines should manage the working condition during the construction.

Gas pipeline

During the construction period producing so much noise and vibration cause of the movement of vehicles, heavy equipment and Lorries will impact on workers health as well as surrounding people. The produced welding sparks and radiation from radioisotopes, which are harmful to the human body, will impact on the health of the workers; local people and wildlife.

It is anticipated that there are high possibilities of fire due to the negligence of the responsible personnel for handling, storing and using of primer and condensate.

Operation Phase

Power Plant

During the operation phase power plant will start their operation, accidents or incidents are expected to occur more or less during the operation phase. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dust, fumes, vapours, liquids are the major hazards which are harmful to workers health. Based on the rules, the power plant should prepare and implement appropriate mitigation measure under the respective impact assessment based on the international guidelines. The accommodation for workers will be arranged according to the project proponent of logistics, residential and commercial area in order to provide a dwelling place for them. The mitigation measure should be prepared for the respective occupational risk based on the operation plan and working condition of the power plant.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment. Further, various forms of operation or manoeuvring errors may occur during the operation. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project. The Disaster Emergency Response Plan is to be prepared and actions to be taken by the implementing agency to cope with any of the emergency periods.

Community Health and Safety

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

Power Plant/Gas Pipeline

It is envisaged that during the construction phase activities, a lot of the material and heavy equipment is scheduled to be brought to the site in vehicles via the inner access roads. Some of these impacts associated specifically with roadways are:

- Traffic congestions on roads and possible disruption to the community usage during peak movement hours;
- Increased risks with respect to safety associated with traffic movement;
- Inconvenience to the community in terms of air and noise pollution caused by the movement of vehicles;
- Structural and surface damage to the road due to movement of heavy vehicles and equipment; and
- The proposed gas transmission pipeline would cross Highway road, many other rural roads. Only feeder and village roads will face temporary communication disruption as major roads will be constructed through the underpass. Smooth transportation of passengers and goods using the village roads will be impacted negatively in this regard;

Apart from the traffic, other community health and safety impacts resulting from the construction phase of activities would typically include (but not be limited to):

- Generation of dust, noise and odour from the construction site which may have health-related impacts on the local community;
- Fire Safety from the ongoing construction activities which may include handling and storage of flammable chemicals and materials;
- Improper disposal and migration of sewage into the surroundings;
- Improper disposal of sewage and waste may lead to contamination of groundwater, as the water table in the project area is very high.
- Any waste disposal in the canal from the project would affect the population in downstream of water flow
- It is also anticipated that the construction of the gas pipeline has risk due to the bursting of pipes or leakage and conflagration. All these significantly impact the health of the working personnel and the people living in the neighbouring.

Potential impacts during the construction period on existing infrastructure and community health and safety are expected to be moderate.

Operation Phase

Power Plant

The health and safety risks in the plant during operations include the potential for respiratory diseases, burns, allergies and operational accidents among the employees and immediate neighbouring communities if adequate mitigation measures to prevent the above are not implemented. In addition, local public health centres may report an increase in cases involving respiratory ailments like coughing, phlegm; eye irritation etc. due to the dust and particulate matter from operations.

Traffic: The impacts envisaged from the project activities on with respect to community usage of access roads are mostly confined to the operation phase when the resource movement in and out of the site is higher. In addition, the local people would be benefitted from the strengthening of the road connecting the access road to the Project site.

Influx: Apart from the operation phase, skilled technicians and operators are also likely to be sourced for operating the plants once it goes into operation. It is envisaged that during that phase these technicians would be housed in rented accommodation in and around Araihaazar.

Health and Safety: The key health & safety impacts on the local community during operation phase include:

- Emission & Noise generated from the operation of the power plant. These emissions may include compounds of Nitrogen and Carbon which may be harmful to the surrounding community;
- Fire & Explosion Hazards;
- Improper sewage and waste disposal;

Risk of Fire

Pre-construction Phase

No impact or impacts are negligible, no further study required.

Construction Phase

Power plant/Gas Pipeline

Risk of fire might increase due to the implementation of the construction work for the project. Labor's camp will face the high risk of fire at construction period. Faulty electrics are the biggest cause of workplace fires, loose wires, plugs that are overloaded and old equipment can all make for a potential death trap. Discarded cigarettes can cause fires if not put out and disposed of properly in the project area. Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present. It has to be said that one of the most common causes of fires in the workplace is human error. Fires can occur as a result of negligence in a variety of different ways including improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended.

Operation Phase

Power plant

Risk of fire would increase due to the operational activities of the power plant and population growth in and around the project area. Electrical systems that are overloaded, resulting in hotwiring or connections or failed components might occur at operation phase.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment.

Others

29) Accidents

Construction Phase

Power Plant/Gas Pipeline

It is anticipated that the risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machinery. It is also anticipated that the construction of the gas pipeline has risk due to the bursting of pipes or leakage. All these would have a potential impact upon the health of the working personnel and the people living in the neighbouring areas.

Operation Phase

Power Plant

Road accidents would be increased due to industrial vehicles, commuter buses, and motor lines.

Gas Pipeline

During operation and maintenance period, the leakage of gas from the high-pressure pipeline is anticipated, which may occur fire and other disasters to the life, property and environment. Severe flood, cyclone, tornado, lightning, earthquake etc. may occur at any time during the operation and maintenance of the project.

30) Transboundary impact and climate change

Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming.

Construction Phase

Power Plant

Although construction machines and vehicles generate greenhouse gases, quantities of generated gases do not give serious impact and negligible on this item. To minimize GHG emission during the construction phase, mitigation measures shall be taken by the contractor, such as management of operation time of construction machinery, avoidance of excessive loading operation, and education of construction workers/drivers about the idling stop practice for construction machinery and vehicles.

Operation Phase

Power Plant

Amount of emission of Carbon Dioxides (CO₂) based on the increase of vehicles. However, Emission from construction vehicles/equipment is negligible compared to the number of passing vehicles daily. In addition, energy-saving equipment and fuels that emit less GHG will be recommended to be installed to the power plant for their operations as much as possible. Besides, the power plant authority will initiate the utilization of commuter bus for workers to reduce traffic GHG emission.

3.3.7. Environmental Impact Assessment

In connection with the scoping matrix described in Table 3.3-57, the rating was reevaluated based on the survey and findings. Revised evaluation (rating) is presented in the table below.

Table 3.3-57: Environmental Impact Assessment for the power plant based on survey

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Construction Phase	Operation Phase	Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	C	B-	B-	CO: All earthworks construction, site clearing, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, hauling of materials, construction of internal road will generate dust and affect the local air shed. Construction machinery and transportation vehicles will be generated SO_x, NO_x, smoke, soot and earth, sand and dust particles will be scattered. This may cause air pollution. OP: Primarily natural gas will be used as the fuel for GT and GE for the primary operation and diesel fuel will be used as the fuel for subsidiary operation. It has been confirmed through air dispersion modeling that the exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution such as SO_x or NO_x without proper technologies and maintenance.
	2	Water pollution	B-	B-	B-	B-	CO: Effluent resulting from washing the equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from washing of aggregate and sand. If these are inadequately handle, surface water and underground water may be contaminated. Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality. OP: Ground water will be used in the cooling system and therefore, thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, surface water and underground water will be contaminated.
	3	Waste	B-	B-	B-	B-	CO: Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected. OP: The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated.
	4	Soil pollution	B-	B-	B-	B-	CO: With the progress of excavation work for structures, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. The unloading yard will be built and earth and sand may flow out at the time of rainfall. Storage of raw material, fuel and construction debris may contaminate the soil. Soil may also contaminate through spills and leaks of fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.

							OP: Improper storage, handling, disposal of diesel fuel, lubricants, solid and hazardous waste may lead to contamination of the soil.
	5	Noise	A-	A-	B-	A-	CO: Noise will be generated from the construction machinery, equipment and transportation vehicles. However, the construction site is far from the residential area. Therefore, the impacts are moderate. OP: Without serious attentions and counter measures, the noise generation source during the operation includes the power plant operation, worker's commutation and traffic of vehicles for carrying the periodic inspection materials. The inhabitants of the surrounding area may have noise problem.
	6	Ground subsidence	D	C	N/A	D	CO/OP: There is no evidence or trace of ground surface subsidence around all the project sites.
	7	Offensive odors	D	D	N/A	N/A	CO: Odor may produce by domestic waste from campsite. However, the impact will be very negligible. OP: No impacts are expected.
	8	Sediment quality	B-	D	B-	N/A	CO: Inadequate handling of domestic solid waste, raw material, hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds. OP: No impact is expected
Natural environment	9	Protected areas	D	D	N/A	N/A	CO/OP: Since no natural preservation area and national parks exist in and around the power plant area, an impact on protected areas is not expected.
	10	Ecosystems	B-	B-	B-	B-	CO: Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent waterbodies. OP: The power plant site and its surrounding areas will have already been converted into the commercial purposes. There is no natural forest in these areas. Plant's gaseous emission and excessive noise may disturb the surrounding inhabiting floral and faunal species. Water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal.
	11	Hydrology	B-	B-	B-	B-	CO: During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds. OP: Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.
	12	Topography and geology	D	D	N/A	N/A	CO/OP: No impacts are expected
Social environment	13	Involuntary resettlement	D	D	N/A	N/A	CO: The power plant will be established under the designated site of AEZ. No additional land will be acquired. OP: No impacts are expected.
	14	Vulnerable group	B-/B+	B+	B-/B+	B+	CO: The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities. Very minimum vulnerable people will be affected as per census survey. On the other hand, job opportunity and commercial opportunity would increase. OP: Non-technical skill job opportunities as workers of the power plant and commercial opportunity would improve.

	15	Indigenous and ethnic people	D	D	N/A	N/A	CO: No indigenous and ethnic persons were identified as per the census survey and no such communities exist around the project site. OP: No impacts are expected
	16	Local economies, such as employment, livelihood, etc.	B+	B+	B+	B+	CO: Increase of job opportunity as construction workers. OP: Increase of job opportunity as workers of the power plant or commercial opportunity targeted to these workers is expected.
	17	Land use and utilization of local resources	D	D	N/A	N/A	CO: There will be no significant change of land use. OP: During operation of power plant, no further changes are expected.
	18	Water usage	B-	B-	B-	B-	CO: The surrounding wells may be affected by reduction of underground water level resulting from underground water intake during the construction work and labor camps. OP: Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes. Excessive withdrawal of ground water may lead to depletion of aquifers without proper monitoring/ assessment of the depth of the existing wells and installed deep ground water wells with supply capacities. The deep-well water within the AEZ will utilize different water layer so that significant impact is not expected to the surrounding wells near the project site.
	19	Existing social infrastructures and services	D	D	N/A	N/A	CO: Constructional activities of power plant will not affect the access of the inhabitants to the social infrastructure and service facilities of the community. OP: No impacts are expected due to development of the power plant.
	20	Social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	CO: No impacts are expected. OP: No impacts are expected.
	21	Misdistribution of	D	D	N/A	N/A	CO: Employment opportunity will be increasing. Those who are not hired as construction workers may experience some misdistribution between communities. However, the impacts will be very minimum.

		benefits and damages					OP: No activity will cause misdistribution of benefits and damages.
	22	Local conflicts of interest	D	D	N/A	N/A	CO: Due to an increase in employment opportunity will be increasing. Those who are not hired as construction workers may experience some conflicts between communities. However, the impacts will be very minimum. OP: There are people who would get job opportunity as workers of the power plant.
	23	Cultural heritage	D	D	N/A	N/A	CO/OP: Nothing found in the development area would be affected by the development.
	24	Landscape	D	D	N/A	N/A	CO/OP: There is no picturesque scenery in or around the site.
	25	Gender	B-	D	B-	N/A	CO: Female laborers may be discriminated in wage at construction site. OP: Project activities do not attract gender issues.
	26	Children rights	B-	D	B-	N/A	CO: Underage employment may occur at construction stage. OP: No impacts are expected.
	27	Infectious diseases	B-	B-	B-	B-	CO: Workers and Engineers coming from the outside area may carry infectious disease, which may spread among other workers. OP: There is a possibility to increase the risks of infectious diseases due to influx of workers of the power plant and the semi-urbanization of the project area and its surroundings area.
	28	Working conditions, including occupational safety	B-	B-	B-	B-	CO: Accidents and incidents during construction may occur. Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, chemical, gases, dusts, fumes, vapours, liquids are the major hazards which are harmful to workers health. OP: Accidents or incidents are expected to occur due to electrical work, fire accident, gas leakage etc.
Others	29	Accidents	B-	B-	B-	B-	CO: Accidents may occur due to the operation and movement of heavy equipment, vehicle and machineries. OP: Road accidents may occur due to plant vehicles and motor bikes. Gas distribution line has risk due to bursting of pipes or leakage.
	30	Transboundary impact and climate change	D	B-	N/A	B-	CO: Emission from construction work is expected but impacts are negligible. OP: Emissions of GHGs are generated from vehicle traffic and power plant operations.

Source: JICA Study Team

Table 3.3-58: Environmental Impact Assessment of the gas transmission line

Pre-construction phase refers to Land acquisition and requisition process before construction.

Field	No	Impacts	Evaluation (Scoping)		Evaluation (After Survey)		Description of the Rating
			Pre/During Construction Phase	Operation Phase	Pre/During Construction Phase	Operation Phase	
Environmental pollution	1	Air pollution	B-	D	B-	N/A	PC/CO: During clearing of RoW excavation and backfilling of pipelines, some dust distribution is expected. Also movement of vehicles and heavy equipment emit small amount of SO _x , NO _x and CO ₂ . OP: No impacts are expected
	2	Water pollution	B-	D	B-	N/A	CO: For installation of Gas transmission line, land acquisition (20-feet strip) for the RoW is required and some water bodies will be affected. Additionally, for smooth implementation of the work, temporary roads would be constructed on one sides of the RoW within the 20-Feet strip requisitioned along the pipeline of the RoW. As a result, over land drainage would be hampered during the construction stage as excavated soil from trench will be dumped beside RoW. Waste will also be produced from washing of aggregate and sand. If these are inadequately handle, surface water and underground water may be contaminated. Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality. OP: No impacts are expected
	3	Waste	B-	D	B-	N/A	CO: Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the domestic solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and surface water will be contaminated, and sanitation problems will arise. General construction waste is expected and typically managed by the appointed contractors. OP: No impacts are expected
	4	Soil pollution	B-	B-	B-	B-	PC: It is likely that the soils of the project sites will not be polluted. CO: The soils of the canal crossing sites may be polluted with the liquid wastes (mud) generated from the canal crossing activities. Vehicular oil and lubricants also pollute the soil quality. The waste lubricants will not only pollute the soils, but also contaminate the ground water in the long run.. OP: Pigging of the pipe for cleaning purposes may generate hazardous pollutants from TBS/CGS etc, which are likely to be spread over the soils. If these pollutants are not safety disposed off, then the soils of the project areas will be polluted.
	5	Noise	B-	D	B-	N/A	PC/CO: With the progress of construction work, noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact OP: No impacts are expected
	6	Ground subsidence	D	D	N/A	N/A	CO/OP: There is no evidence or trace of ground surface subsidence around all the project sites. No impacts or impacts are negligible, no further study is required.

	7	Offensive odors	B-	D	B-	N/A	CO: The amount of domestic solid waste will increase due to inflow of a great number of workers. If such waste is inadequately handled, odor may be produced by putrefaction; OP: No impacts are expected
	8	Sediment quality	B-	D	B-	N/A	CO: The bottom sediment of the canal/pond may be polluted with the liquid wastes (mud) generated from the crossing activities. The waste lubricants will not only pollute the sediments of waterbodies, but also contaminate the ground water in the long run. OP: No physical activities are expected during operation and no impacts are expected.
Natural environment	9	Protected areas	D	D	N/A	N/A	PC/CO/OP: No direct connection with protected area involves the project despite the Sitalakhya River which is considered as ECA under the government notification. No surface water will be disturbed with underground pipelining technologies utilized by the authorized agencies as per the applicable laws and regulation of natural gas utilization and safety.
	10	Ecosystems	B-	D	B-	N/A	PC: The habitat types and ecosystem found in the non-forested agricultural and homestead areas are not considered to be significant from a biodiversity perspective. Extensive use of vehicle horns has the potential to cause disruption to the surrounding inhabiting wildlife. Similar to terrestrial ecosystems, aquatic ecosystems are also not likely to be affected. CO: Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Many species of flora and fauna would frighten easily by vehicle horns and civil works that may become distressed. With the progress of construction work, canal water pollution will occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent waterbodies. Contamination will occur due to civil construction work. OP: No impacts are expected
	11	Hydrology	B-	D	B-	N/A	CO: For smooth implementation of the work, temporary roads would be constructed on one sides of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, over land drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW. OP: After the backfilling, no impacts are expected.
	12	Topography and geology	D	D	N/A	N/A	CO/OP: No impacts are expected
Social environment	13	Involuntary resettlement	A-	D	A-	N/A	PC: 255 land owners will lose land due to land acquisition for the RoW. Additionally, value of surrounding land that are not acquired will decrease as construction of structures is prohibited within certain distance from the RoW. The project does not compensate for the small piece of land which can only be used as agricultural land. Some PAPs have no other properties than the affected properties. Requisition of land for the project will also affect people of the project area. The soil becomes compacted and will not be suitable for cultivation at least for one crop season. CO /OP: No impacts are expected
	14	Vulnerable group	B-	D	B-	N/A	CO: Very minimum vulnerable people will be affected. On the other hand, job opportunity and commercial opportunity would increase. OP: The landowners can use the land for agricultural purpose after the pipeline installation.
	15	Indigenous and ethnic	D	D	N/A	N/A	CO: no indigenous/ethnic people live in the project affected area. OP: no impacts are expected

	people					
16	Local economies, such as employment, livelihood, etc.	B-/B+	B-	B-/A+	D	PC/CO: PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. Some industries' operation will be temporary closed for the pipeline installation. Workers of the factories may lose salary temporary. On the other hand, increase of job opportunity as construction workers or commercial opportunity targeting workers is expected. OP: In the RoW areas, agricultural land use practices will be suspended for temporary basis. After installation of pipeline, Farmers can use this land again for agricultural activities.
17	Land use and utilization of local resources	B-	C	B-	D	CO: The 9 acres of agricultural land will be altered by the construction activities. Therefore, the annual agricultural production rate of that upazila will diminish. In the project site, land is single cropped agricultural land so the impact on agriculture activities/ resources is anticipated to have a low impact from the project development. OP: No impact on agriculture resources is anticipated. In the RoW areas, agricultural land use practices will be restored.
18	Water usage	D	D	N/A	N/A	CO: The water will be used only for drinking so the impact is very negligible. No impacts are expected. OP: No impacts are expected.
19	Existing social infrastructures and services	D	D	N/A	N/A	CO: An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community. However, the construction period is short so that impacts is very minimum. OP: No impacts are expected.
20	Social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	CO: Construction may disturb access to social or public institutions and services temporarily but construction period is short and impact will be minimum. OP: No impacts are expected.
21	Misdistribution of benefits and damages	B-	D	B-	N/A	PC: Only landowner and property owners and affected labours will be eligible for the compensation and rehabilitation. CO: Affected Land owners, factory workers may not find same income source. OP: No impact is expected.
22	Local conflicts of interest	D	D	N/A	N/A	CO: Due to an increase in employment opportunity will be increasing during construction; candidates of construction workers may experience some conflicts between communities. However, the impacts will be very minimum. OP: No impact is expected.
23	Cultural heritage	D	D	N/A	N/A	PC/CO/OP: No cultural heritage is found
24	Landscape	D	D	N/A	N/A	PC/CO/OP: There is no picturesque scenery in or around the site.

	25	Gender	B-	D	B-	N/A	CO: Wives of those men who lose their land or jobs may suffer from adverse effects on their household economy. Female laborers may be discriminated in wage at construction site. OP: Project activities do not attract gender issues.
	26	Children rights	B-	D	B-	N/A	CO: Access to school may be disturbed and underage employment may occur at construction stage. OP: No impact is expected.
	27	Infectious diseases	B-	D	B-	N/A	CO: It is envisaged that outsourced personnel will comprise mostly of skilled labourers and workers. During Construction, in general, a lot of migrant workers flow into the sites, who may have the possibility with HIV/AIDS and infectious diseases can spread among other workers and local peoples. OP: No impact is expected.
	28	Working conditions, including occupational safety	B-	B-	B-	B-	CO: Noise and vibration due to movement of vehicles, heavy equipment and Lorries will have impact workers health as well as surrounding people. The produced welding sparks and radiation from radioisotopes, which are harmful for the human body will impact health of the workers; local people and wild life. It is anticipated that there is high possibilities of fire due to negligence of the responsible personnel for handling, storing and using of primer and condensate. OP: During operation and maintenance period, the leakage of gas from high-pressure pipeline may occur. Further, various forms of operation or maneuvering errors may occur during the operation. Severe flood and earthquake may damage the Gas transmission line period as a result it may cause severe injury of the workers.
Others	29	Accidents	B-	B-	B-	B-	CO: It is anticipated that the risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machineries. OP: During operation and maintenance period, the leakage of gas from high-pressure pipeline is anticipated which may cause fire and other disaster to the life, property and environment. Severe flood and earthquake may damage the Gas transmission line period as a result it may cause severe injury of the workers.
	30	Transboundary impact and climate change	D	D	N/A	N/A	CO/OP: Impacts are negligible.

Source: JICA Study Team

3.3.8. Environmental Management Plan and Cost.

The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and management actions, set to a time frame with specific responsibility assigned and follow-up actions defined. EMP is a plan of actions for avoidance, mitigation and management of the negative impacts of the project. All offsite facilities shall be constructed under supervision of BEZA. EMP implementation shall also be BEZA who will intern implement it through contractors.

Mitigation Plan for Pre-Construction (only applies to Gas transmission line), Construction Phase& Operation Phase.

A summary of mitigation measures identified for the pre-construction, construction& operation phases of the Project is presented in Table 3.3-59. This also identifies lead responsibility for implementing the mitigation measures and sources of funds for such implementation.

Table 3.3-59: Environmental Mitigation and Management Plan for Power plant (Construction & Operation Phase)

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
Construction Phase							
Environmental Pollution	Air Pollution	B-	Earthworks construction, site clearing, civil construction, mechanical construction, handling and stocking of construction materials, dry materials stockpiling, and hauling of materials will generate dust Construction machinery and transportation vehicles will be generated SO _x , NO _x , smoke, soot and earth, sand and dust particles	Periodic inspection and maintenance control will be conducted to reduce exhaust discharged from construction machines and vehicles. Sprinkling of water on haul roads Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; Raw materials, excavated soil and other debris should be stored under covered sheds Generators, compressors, and other equipment to be shut down when not in use; Provision of face mask to workers to minimize inhalation of dust particles; Low sulphur diesel should be used for running construction equipment and vehicles; Air emission monitoring programme to be undertaken quarterly by the contractor, according to the design specified in the EMP and the contract specifications. The programme must include, as a minimum monitoring of SPM, CO, NO ₂ , SO ₂ , PM _{2.5} and PM ₁₀ ; Strict fuel/chemical inventory and minimization of spillages to reduce fugitive vapor emissions.	Appointed Contactor	BEZA	Contractor Cost
	Water Pollution	B-	Effluent resulting from washing	Avoid excavation activities during rains;	Appointed	BEZA	Contractor

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
			the equipment, sewage and sanitary wastewater will be generated during the work; Waste will also be produced from washing of aggregate and sand; Leaks and spills of oil, lubricants and improper handling of sewage or chemical may pollute the surface water quality.	Prevent piling up of excavated soil, raw material and construction debris at site by proper management and disposal; Minimize run-off by using sprays for curing; Maintaining appropriate flow of water sprinklers at site; Construction of storm water drains along with sedimentation tanks with sand bags as partition as barrier for direct flow of run off to canal; Collection & Reusing of curing over flow, tire wash water etc within the site; Construction of adequate nos. of toilets and proper sanitation system to prevent open defecation along the canals/rivers/water supply lines; Construction of soak pits/septic tanks to dispose-off the domestic waste water generated from labour camps to prevent disposal of sewage in surface water bodies; Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies; No debris/construction material should enter water body in the area. No sewage or waste water should be accumulated in any unlined structure; Timely disposal of the construction/chemical/hazardous waste so as to prevent leaching of any pollutant to ground; The ground water quality should comply Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines;	Contactor		Cost
	Waste	B-	Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. The household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If such waste is inadequately	Segregate waste to minimize waste material; Waste should be segregated and disposed in the separate place; Reuse as much as possible with consideration of soil property;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
			handle, underground water and surface water will be contaminated, and sanitation problems will arise.				
	Soil Pollution	B-	Excavation work for structures, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall. Storage of raw material, fuel and construction debris may contaminate the soil. Soil may also contaminate through spills and leaks of fueling and operation of heavy machinery and transport vehicles, Unloading and loading activities.	Raw material will be stored under covered sheds and paved surface; Fuel storage area should be proper containment; Adoption of best management practices to prevent any spillage of raw materials; Construction debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites; Waste from labour camps can be segregated at site. Food waste/wet waste should be composted in pits within the campsite; Recyclable waste should be sold to the authorized dealers ensuring environmental friendly and the remaining should be disposed off at designated sites through local agencies responsible for waste management in the area;	Appointed Contactor	BEZA	Contractor Cost
	Noise	B-	Noise will be generated from the construction machinery, equipment and transportation vehicles;	Vehicles and machinery should be regularly serviced and check for pollution control; Worker who will be work high noise area should provide ear plug; No noise generating activity shall be carried out in the night; Use low noise generating equipment; Temporary noise barriers should be provided near the high noise generating areas like metal or tiles cutting sites, generator room etc; Any employee who may complain about ear related pain and or complication while at work to access medical attention at the expense of the contractor or project proponent; Regular noise monitoring, especially at the school and residential area located close to the project site should be carried out; Machinery to be used should comply with the noise standards prescribed by DoE as well as EHS IFC Guideline 2007;	Appointed Contactor	BEZA	Contractor Cost
	Sediment Quality	B-	Inadequate handling of domestic solid waste, raw material,	Raw material will be stored under covered sheds and paved surface; Fuel storage area should be proper containment;	Appointed	BEZA	Contractor

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
			hazardous waste and lubricants may pollute the adjacent topsoil and characteristics of the adjacent streambeds.	Adoption of best management practices to prevent any spillage of raw materials; Construction debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites; Recyclable waste should be sold to the authorized dealers ensuring environmental friendly and the remaining should be disposed off at designated sites through local agencies responsible for waste management in the area;	Contactor		Cost
Natural Environment	Ecosystems	B-	Extensive use of vehicle horns, civil construction and dust creation has the potential to cause disruption to the surrounding inhabiting floral and faunal species. Canal water pollution may occur due to inadequate handling of wastewater and may have an adverse effect on many forms of life in the canal and adjacent waterbodies. Birds in the homestead vegetation will be disturbed	No solid or liquid waste shall be discharged in water bodies; Septic tanks/soak pit should be provided to treat sewage to be generated from labour camps and prevent its disposal in water body; Toilets should be provided at site to prevent contamination of water due to open defecation in nearby areas; Vehicle washing/equipment cleaning should not be allowed near canal/drain; Wastewater from the washing area should be collected and should be used for curing purpose or wheel washing purpose; Temporary storm water drainage system should be developed at site to channelize the storm water away from debris storage area and raw material storage area; All the raw material and debris should be stored in covered sheds on paved surfaces to minimize the contamination of rainfall run-off; Diesel, paints, cements etc should not be stored near the water bodies and drain;	Appointed Contactor	BEZA	Contractor Cost
	Hydrology	B-	During rain, drainage water may cause flash flooding in the surrounding lower land without drainage system and retaining ponds.	Natural drainage pattern should be maintained. Run-off assessment shall be made of catchment area and peripheral/garland drains shall be constructed around power plant based on the assessment of catchment area (frequency, and storage area); Storm water drain shall have the provision of de-siltation before discharge to canal/waterbody;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
Social Environment	Vulnerable Group	B-	The vulnerable groups identified for the Project are those old and aged, physically handicapped and destitute individuals that are potentially affected by the project activities The vulnerable people who involved in agricultural work will be affected mostly by this project;	Provide unskilled jobs and employment opportunities for vulnerable that may increase their participation and support them with income and livelihood. Organising women in self-help group to operate canteens in the construction camp site; Implementation of social welfare programs targeted at vulnerable groups including old aged, physically handicapped etc.	Appointed Contactor	BEZA	Contractor Cost
	Water Usage	B-	The surrounding wells may be affected by reduction of underground water level resulting from underground water intake during the construction work and labor camps.	Water for curing can be saved by carrying out curing in early morning or late evening and covering structures with gunny bag so as the moisture can be restored for longer time; Regular inspections at site to monitor leakages in water storage tanks; Creating awareness among construction workers about the importance of water conservation; Adoption of the advance technologies and machinery which helps in minimizing water requirement for construction; Storing the curing run-off and waste water from other construction activity and using the same for sprinkling;	Appointed Contactor	BEZA	Contractor Cost
	Gender	B-	Female laborers may be discriminated in wage at construction site	Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female	Appointed Contactor	BEZA	Contractor Cost
	Children's Right	B-	Underage employment may occur at construction stage.	Child labor at the construction site during the project implementation shall be strictly prohibited since such practices are banned by both Bangladesh laws and JICA guidelines; BEZA shall regularly monitor project sites to guide contactors and their related firms to discourage child labor; Introducing them to assistance organizations such as NGO and so forth	Appointed Contactor	BEZA	Contractor Cost
	Infectious Diseases	B-	Workers and Engineers coming from the outside area may carry infectious disease, which may spread among other workers.	To provide surveillance for worker's health; Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
				To provide treatment through standard case management in on-site and community health care facilities as necessary; Educating project personnel and residents on risks, prevention and available treatment; Promoting collaboration with local authorities to enhance access of worker's families and the community to public health services and promote immunization as necessary; Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites;			
	Working conditions, including occupational safety	B-	Occupational Health & Safety Physical trouble, noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful for workers health; May insect and snake bite in the labour camp; Road Accident	To provide adequate health care facilities and first aid within construction sites; To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; To provide adequate lavatory facilities for the number of people expected to work in the facility; To provide adequate supplies and easy access of drinking water with a sanitary; To provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labelling of equipment, communicate Hazard codes, electrical; To establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
				To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			
			Community Health & Safety Traffic congestions on roads and possible disruption to the community usage during peak movement hours; Inconvenience to community in terms of air and noise pollution caused by the movement of vehicles; Generation of dust and odor from the construction site which may have health related impacts on the local community; Fire Safety from the ongoing construction activities which may include handling and storage of flammable chemicals and materials; Improper disposal and migration of sewage into the surroundings;	Provision of infrastructure for migrant labour such as water supply, electricity, sanitary facilities, medical aid and other basic amenities to avoid dependence on limited local resources; Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area; Creating awareness among the drivers about speed, traffic safety, use of horns etc while driving through settlement areas; Covering of trucks while carrying soil, sand, cement, aggregates etc to minimise spread of dust and spill over; Avoiding unnecessary movement of vehicle through settlement area to minimise disturbance and traffic safety related issues; Creating awareness among children, women, and old age people in particular and the community in general on traffic safety by using existing mediums such as school, women self help groups, village union and religious occasions; Sprinkling of water to suppress dust generation in the construction zone; Provide training and create awareness about fire and safety among workers at site; Disposal of wastes at pre identified waste dumping site to avoid unauthorized dumping;	Appointed Contactor	BEZA	Contractor Cost
			Risk of Fire Risk of fire might increase due to the implementation of the construction work Faulty electrics are the biggest cause of workplace fires, loose wires, plugs that are over loaded Old equipment can all make for a potential death trap	To minimize the impact, the rule and the internal regulation for the power plant of Araihaazar will be applied appropriate security and safety system for their implementation; Maintain safe housekeeping practices that reduce the risk of fire danger; Implement a program that includes preparation, prevention, and recognition of fire Risk; Proper handling of combustible and flammable material; Keep all fires and heaters well guarded, especially open fires; Keep portable heaters and candles away from furniture and curtains;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
			Discarded cigarettes can cause fires Smoking can be especially hazardous if it is allowed to take place near areas where flammable materials are present Improper use of equipment, accidents, drinks being spilt over electrical equipment and leaving cooking unattended The most common causes of fires in the workplace is human error.	Don't dry or air clothes over or near the fire or the cooker; Do not smoke in the project site;			
Others	Accidents	B-	Accidents may occur due to the operation and movement of heavy equipment, vehicle and machineries.	Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; Provision of traffic sings, road mark, bump, zebra mark, guard rail and pole, and curb stones etc;	Appointed Contactor	BEZA	Contractor Cost
Operational Phase							
Environmental Pollution	Air Pollution	B-	The exhaust gas due to combustion of gas and diesel fuel during the operation may lead to air pollution SOx or NOx without proper technologies and maintenance.	Latest technology, methodology, and machinery involving minimal air emissions should be adopted by Power Plant; Process emission if any shall be control with the installation of adequate air pollution control systems; Complete combustion of the fuel occurs in the gas turbine. Almost no CO or SPM is produced; A low-NOx burner/ water injection is used to minimize generation of the nitrogen oxides; It is suggested to install a high stack to minimize the impact. Air pollution monitoring should be carried out by power plant to check the air pollution level; Check leakage and reduce fugitive emission of gas from the distribution pipeline system. Exercise careful and minimum venting & purging of gas; Maintain generator and other machine and equipment in good	EHS team of Plant Operation Company	BEZA	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
				condition to operate with low exhaust particularly at the regulating & metering Station locations. Power Plant should obtain clearance from DoE, Bangladesh. Periodic renewal of ECC should be obtained by the Power Plant;			
	Water Pollution	B-	Plant effluent and domestic wastewater will be generated, and waste will also be produced. If inadequately handled, surface water and ground water will be contaminated.	Power plant has to arrange pre-treatment facility to treat their processed effluent and sewage they generate to meet certain level of pollution load set by the operator; Pre-treated wastewater will be treated in CETP/STP to meet national waste water discharge standards as well as international standard set forth by BEZA; Storm and industrial wastewater will be collected in separate pipe networks to prevent contamination of storm water draining to natural wetlands; Power plant should treat the effluent and sewage generated by them so as to achieve zero discharge and no untreated effluent should be discharged into any water body; Storm water system should be inspected & cleaned before monsoon every year; River/canal water quality shall be monitored periodically; Ground water quality shall be monitored periodically; The ground water quality should comply Schedule 3 of ECR, 1997 of the GOB and the WHO Guidelines;	EHS team of Plant Operation Company	BEZA	O&M Cost
	Waste	B-	The plant waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. The office solid waste such as papers, cans, bottles and food remnants discarded by employees is also generated;	For the waste produced in the process of operation of the power plant, the waste management program including the reduction, reuse and recycling of the waste will be worked out; Site drainage controls to isolate potentially contaminated areas from discharge to the environment; Environmental training and awareness programs for plant workers should be required;	EHS team of Plant Operation Company	BEZA	O&M Cost
	Soil Pollution	B-	Improper storage, handling, disposal of diesel fuel, lubricants,	Treatment of the effluents and sewage and ensuring proper disposal; Water Treatment Plant (WTP) shall be installed before operation; Segregate non-hazardous solid waste from hazardous one and dispose	EHS team of Plant Operation	BEZA	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
Natural Environment			solid and hazardous waste may lead to contamination of the soil.	properly; Plant waste generated should be stored in impervious storage tanks; Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; Common waste storage areas shall be designated for plant domestic waste; Recyclable waste should be sent to authorize vendors for recycling and rejected waste should be disposed off as per the norms specified by DoE for the particular waste; Reduction or total elimination of effluent from the manufacturing process;	Company		
	Noise	A-	The noise generation source during the operation includes the power plant operation, worker's commutation and traffic of vehicles for carrying the periodic inspection materials. Vehicles movement will create noise pollution; The inhabitants of the surrounding area may have noise problem.	Need regular maintenance; In the field of more detailed designing for future, efforts must be made to achieve the estimated noise level resulting from the operation of the power generation facility. Pumps should be fitted in acoustic enclosure to reduce the noise generation; Noise barriers will be mandatory for the factories generating a lot of noise during operations; Plantation should be developed along the roads and boundary to form continuous barrier that will reduce the noise level significantly; Regular noise monitoring, especially at the school and residential area; Use of ear-muffs and ear-plugs by power plant personnel working in the generator and turbine facilities of the power plant. Building, Noise enclosure, Silencer and/or insulation lagging for Gas Turbine.	EHS team of Plant Operation Company	BEZA	O&M Cost
	Ecosystems	B-	Plant's gaseous emission and excessive noise may disturb to the surrounding inhabiting floral and faunal species. Water pollution may occur due to inadequate handling of wastewater and may have an	Periodic monitoring shall be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact; No waste shall be discharged in water bodies, i.e. canal and agricultural land etc. WTP should be installed to treat the effluent generated and to re-use and recycle. Native tree species will only be planted in the region;	EHS team of Plant Operation Company	BEZA	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
			adverse effect on many forms of life in the canal.				
	Hydrology	B-	Without drainage and its retaining systems, excess drainage water from power plant area could cause flash flooding in the surrounding lower land.	Natural drainage pattern should be maintained; Run-off assessment shall be made of catchment area and peripheral/garland drains shall be constructed around power plant site based on the assessment of catchment area. Storm water drain shall have the provision of de-siltation before discharge to retention canal/river; Install of additional earth drain line around the boundary of the project area if a flood were to occur.	EHS team of Plant Operation Company	BEZA	O&M Cost
Social Environment	Water Usage	B-	Groundwater abstraction at the Plant will be undertaken for plant cooling and domestic purposes Excessive withdrawal of ground water may lead to depletion of aquifers without proper assessment of the depth of the existing wells and installed ground water wells with supply capacities. Total water consumption is 160 m ³ /day of which 80 m ³ /day will be used for gas turbine cooling and rest 80 m ³ /day will use for gas booster compressor;	Water efficient technologies will be adopted in central utility service divisions and also at the plant process level; Adoption of best management practices to prevent water wastage and minimize water loss; Usage of water conservation fixtures to minimize water consumption; Installation of leakage detection system to minimize the water loss; Regular monitoring of ground water level in the area should be carried out. Estimated should be made to calculate the draught and recharge of the ground water aquifers. More green space will planted to foster aquifer recharge; Ground water aquifer assessment studies may be undertaken to assess the ground water potential. Treated effluent will be recycled;	EHS team of Plant Operation Company	BEZA	O&M Cost
	Infectious Disease	B-	There is a possibility to increase the risks of infectious diseases due to influx of workers of the power plant and the semi-urbanization of the project area and its surroundings area.	Conduct mitigation measures stipulated in the international guidelines such as EHS Guidelines of IFC To conduct Information, Education and Consultation Communication (IEC) campaign periodically to staff, employees, and immediate local communication concerning the risks, dangers and impact and appropriate avoidance behavior with respect to, of Sexually Transmitted Disease (STD) or Sexually Transmitted Infection (STI) in general and HIV/AIDS in particular,	EHS team of Plant Operation Company	BEZA	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
				To provide for STI and HIV/AIDS screening, diagnosis, counseling and referral to dedicated national STI and HIV/AIDS program.			
	Working Conditions, including occupational Safety	B-	Occupational Health and Safety Physical trouble, Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space, Chemical, Gases, dusts, fumes, vapours, liquids are the major hazards which are harmful for workers health.	To provide adequate health care facilities and first aid within operation sites of power plant; To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; To provide adequate laboratory facilities for the number of people expected to work in the facility; To provide adequate supplies and easy access of drinking water with a sanitary means to provide temporary shelters to protect against heat stroke during working activities or for use as rest areas as needed; To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances where there is potential for exposure to substances poisonous by ingestion of food as necessary; Adequate preventive measures from negative factors such as fire precautions, lighting, safe access, work environment temperature, area signage, labeling of equipment, communicate hazard codes, electrical; To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;	EHS team of Plant Operation Company	BEZA	O&M Cost
			Community Health and Safety The health and safety risks in the plant during operations include potential for respiratory diseases, burns, allergies and industrial accidents among the employees and immediate neighboring communities Emission & Noise generated from the operation of the power plant activities. These emissions may	Adequate provision for suppression of dust and particulate matter originating at source; Developing a disaster management plan and community health and safety plan to deal with emergency situations; Regular training of plant personnel on health and safety aspects; Creating awareness among the general public around the plant about possible emergency situations and way to respond to them; Develop an influx management plan to address the influx related issue; Release of nitrogen and carbon compounds within permissible limit so that human health is not affected;	EHS team of Plant Operation Company	BEZA	O&M Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	supervision	Mitigation Cost Source
Others			include compounds of Nitrogen and Carbon which may be harmful to the surrounding community; Fire & Explosion Hazards;				
			Risk of fire Risk of fire would increase due to the activities of the power plants. Overloaded electrical systems could result in hot wiring or connections or failed components might occur at operation phase. Old equipment can all make for a potential death trap Discarded cigarettes can cause fires Human errors.	The power plant shall install and maintain an effective fire alarm system and firefighting system for each building in the plot, and implement emergency drill with reference to the rule and regulation; Implement a program that includes preparation, prevention, and recognition of fire Risk; Proper handling of combustible and flammable material; Prohibit smoking in the project site; Install approved smoke detectors on each floor.	EHS team of Plant Operation Company	BEZA	O&M Cost
	Accident	B-	Road accidents may occur due to plant vehicles and motor bikes. Gas distribution line has risk due to bursting of pipes or leakage.	Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors; Provision of traffic sings, road mark, bump, zebra mark, guard rail and pole, and curb stones etc	EHS team of Plant Operation Company	BEZA	O&M Cost
	Transboundary impact and climate change	B-	Emissions of GHGs are generated from vehicle traffic and power plant operations.	Control of GHGs emission by energy use efficiency, process modification, selection of fuels or other materials, the processing of which may result in less emission, application of emission control techniques, if possible;	EHS team of Plant Operation Company	BEZA	O&M Cost

Table 3.3-60: Environmental Mitigation and Management Plan for Gas Transmission Pipeline (Pre-construction, Construction & Operation Phase)

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Preconstruction Phase							
Environmental Pollution	Air Pollution	B-	- During clearing of RoW removal of existing structure will create some dust. - Movement of heavy vehicles may generate dust and gas emission	- Selecting short and direct routes for all traffic; - Wetting onsite areas - Vegetation clearance during dry weather periods; - Maintaining generator engines and other heavy-duty engines in proper condition;	Appointed Contactor	BEZA	Contractor Cost
	Noise	B-	- With the progress of construction work, noise will be generated from the construction machinery and transportation vehicles. - Disturbance to religious performance	- Traffic to and from the site to be controlled with respect to routing of vehicles and timing of vehicle movements (i.e. working hours); - Site activities during preconstruction works will to the extent practicable be limited to day time working - Equipment will be maintained in good working order where appropriate; - Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc.) to minimize noise levels at offsite receptor locations.	Appointed Contactor	BEZA	Contractor Cost
Social Environment	Involuntary resettlement	A-	255 land owners will lose land due to land acquisition for the RoW. - Value of surrounding land that are not acquired will decrease as construction of structures is prohibited within the RoW. - Requisition of land for the project will also affect people of the project area. - The soil becomes compacted and will not be suitable for cultivation	- Proper implement of resettlement action Plan (RAP); - Provide adequate compensation in time to PAPs; - The authority should be careful and take necessary measures that every displaced people can be resettled as per law of the land; - Backfill the land properly; - Need proper action to restore the agricultural land in previous condition;	DC office/BEZA	DC office/ BEZA	DC office /BEZA

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			at least one crop season.				
	Local economies, such as employment, livelihood, etc.	B-	- PAHs who earn income from paddy fields and/or vegetable fields might lose their income source. - Some industries' operation will be temporary closed for the pipeline installation. Workers of the factories will lose their job temporary.	- Income and livelihood restoration program can be provided to those who need different job. - Compensation should be provided to the employees of the affected factory if they will lose income. - Standing crop should be compensated as per RAP	BEZA	BEZA	BEZA
	Misdistribution of Benefits and Damages	B-	Only landowner and property owners and affected labours will be eligible for the compensation and rehabilitation.	- Establish GRC. - Establish external monitoring committee or assign external monitoring consultant.	BEZA	BEZA	BEZA
Construction Phase							
Environmental Pollution	Air Pollution	B-	- Emission of dust - Movement of heavy vehicles will emit small amount of SOx, NOx and CO2	- Sprinkling of water at construction site and haul roads - Trucks transporting fine materials, soil and waste to and from the Project site will be covered to reduce the release of dust; - Provision of face mask to workers to minimize inhalation of dust particles - Maintaining generator engines and other heavy duty engines in good condition, to reduce exhaust emissions; - Good housekeeping (i.e., strict fuel/chemical inventory and minimization of spillages, to reduce fugitive vapor emissions).	Appointed Contactor	BEZA	Contractor Cost
	Water Pollution	B-	- Surface water will be contaminated - Leaks and spills of oil, lubricants,	- To avoid excavation and backfilling activities during rains; - Construction of storm water drains along with	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			fuel may impact on surface water • Improper handling of sewage and chemical	sedimentation tanks with sand bags as partition as barrier for direct flow of run off to canal or river; • Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the water bodies; • The facilities shall be designed and operated to ensure that the risks of accidental releases and spills of environmentally hazardous compounds are minimized;			
	Waste	B-	• Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil • The domestic solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. • Hazardous waste may contaminated surface and ground water as well as soil quality	• Segregate waste to minimize waste material • Waste should be disposed in the designated dumping site; • Recycled as possible with consideration of soil property; • Use bean at camp site;	Appointed Contactor	BEZA	Contractor Cost
	Soil Pollution	B-	• Vehicular oil and lubricants also pollute the soil quality. • Soil stability and compactness • Temporary loss of soil fertility • Storage of raw material, equipment fuel and construction debris may contaminate the soil.	• Restoration of disturbed soil to its original use or to an approved use; • Installing adequate runoff drainage channels to prevent flooding, inundation and silting; • Provision of a test separator and flare system sufficient to prevent accidental releases from equipment and vehicles during construction activities; • Raw material will be stored under covered sheds and paved surface;	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				Construction debris should be stored under covered sheds and paved surface and should be disposed off regularly to designated sites;			
	Noise	B-	- Noise from generators - noise will be generated from the construction machinery and transportation vehicles. - Disturbance to religious performance - Exposure of employees to high noise level (above 85dB) continuous for 8 hours per day may result in noise induced hearing loss;	- Vehicles and machinery should be regularly serviced and check for pollution control; - Equipment will be maintained in good working order where appropriate acoustic hoods will be provided; - Taking maximum advantage of shielding provided by onsite structures and offsite natural features (trees, etc) to minimize noise levels at offsite receptor locations. - Worker who will be work high noise area should provide ear plug; - No noise generating activity shall be carried out in the night; - No construction activities to be undertaken during night hours to prevent any disturbance to nearby residents and labours in labour camps; - Regular noise monitoring, especially at the school and residential area. - Machinery to be used should comply with the noise standards prescribed by DoE as well as EHS IFC Guideline 2007;	Appointed Contactor	BEZA	Contractor Cost
	Offensive Odors	B-	The amount of domestic solid waste will increase due to inflow of a great number of workers. If such waste is inadequately handled, odor may be produced by putrefaction;	- Before starting the construction work, the workers will be instructed to classify and collect garbage; - Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction;	Appointed Contactor	BEZA	Contractor Cost
	Sediment	B-	The bottom sediment of the	Construction of storm water drains along with	Appointed	BEZA	Contractor

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

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
				raw material storage area;			
	Hydrology	B-	- For smooth implementation of the work, temporary roads would be constructed on one sides of the RoW and in the 20-feet strip requisitioned along the pipeline of the RoW. As a result, over land drainage would be hampered during the construction phase as excavated soil from trench will be dumped beside the RoW. - Damage of irrigation networks	- Ensure completion of pipeline construction and back filling work during dry season. - Keep provision of bypass drainage system, if the major streams are obstructed by the alignment during Gas transmission line installation. - Construction of new culvert/pipe connection on temporary road to drain out the overland flow in the critical crossing point. - Removal of spoiled earth of the RoW - If any irrigation canals are damaged or disrupted during project work, immediately the canals should be repaired or re-established. Loss of existing source of irrigation should be replaced by another source. - The interventions in the ponds should be completed within the shortest possible time;	Appointed Contactor	BEZA	Contractor Cost
Social Environment	Vulnerable Group	B-	- The vulnerable groups have been identified in the Project area and extent of impact may be larger than others (non-vulnerable group). - The vulnerable people who involved in agricultural and fishing work may be affected by this project;	- Provide unskilled jobs and employment opportunities for vulnerable group. - Giving preference in physically less demanding jobs in the worker camp/ construction such as cleaning, office assistant etc.; - Ensure non-exploitation of women in terms of equal wage, opportunity, participation in decision-making etc. - Implementation of social welfare programs including ILRP targeted at vulnerable groups including women-headed households, old aged, physically handicapped etc. - Provide special allowance to support livelihood.	Appointed Contactor	BEZA	Contractor Cost
	Local	B-	PAHs who earn income from	Income and livelihood restoration program can be	BEZA/	BEZA	BEZA/

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
	Economics, such as employment, livelihood		paddy fields and/or vegetable fields might lose their income source. - Some industries' operation will be temporary closed for the pipeline installation. Workers of the factories will lose their job temporary. - On the other hand, increase of job opportunity as construction workers or commercial opportunity to the workers is expected.	provided to those who need different job. - Compensation should be provided to the employees of the affected factory if they will lose income. - Income loss can be mitigated by providing alternative job opportunities for PAPs; - All direct income loss must be adequately compensated as per RAP; - Provision of proper training to all workers for handling the construction activities;	Appointed Contactor		Contractor Cost
	Land Use and Utilization of local resources	B-	- The 9 acres of agricultural land will be altered by the commercial purpose; - Impact on agriculture activities/ resources is anticipated; - Factory building will be damaged.	- Agricultural area which will be tentatively occupied during construction will be restored to original state and returned to the land owner after construction. - Backfilling of soil should be done properly. - Soil should be kept clear from contamination during construction work. - Proper compensation for loss of structure should be ensured.	Appointed Contactor	BEZA	Contractor Cost
	Misdistribution of Benefits and Damages	B-	Affected Land owners, factory workers may not find same income source.	- Give proper compensation to PAPs. - Establish GRC to support PAPs. - Provide ILRP to help PAPs to restore source of income - Assign external monitoring committee or consultant. - Provide job opportunity for PAPs during construction.	BEZA/ Appointed Contactor	BEZA	BEZA/ Contractor Cost
	Gender	B-	Wives of those men who lose their land or jobs may suffer from adverse effects on their household	Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			economy. Female laborers may be discriminated in wage at construction site.	Monitoring of gender equality should be conducted.			
	Children's Right	B-	- Impact on educational opportunity on school children in PAHs of the Project; - Underage employment may occur at construction stage.	- Child labor at the construction site shall be strictly prohibited - BEZA shall regularly monitor project sites to guide contractors and their related firms to discourage child labor; - Social Support of sending children to school; - Introducing them to assistance organizations such as NGO and so forth	BEZA/ Appointed Contactor	BEZA	Contractor Cost
	Infectious Diseases	B-	Workers and Engineers coming from the outside area may carry infectious disease, which may spread among other workers or neighboring community.	- Separate arrangement of accommodation for local workers with direction of necessary 'code of conduct' is recommended. - To provide surveillance for worker's health; - Prevention of illness among workers by undertaking health awareness and education initiatives and by conducting immunization programs for workers; - To provide treatment through standard case management in on-site and community health care facilities as necessary; - Educating project personnel and area residents on risks, prevention, and available treatment about infectious diseases;	Appointed Contactor	BEZA	Contractor Cost
	Working conditions, including occupational safety	B-	- Noise and vibration cause of movement of vehicles, heavy equipment and Lorries will impact on workers health as well as surrounding people. - Welding sparks and radiation from radioisotopes which are	- Care should be taken to move/ operate and maintenance of vehicles, lorries and heavy construction equipment to minimize the level of noise and vibration; - The welding activities should be done in a restricted area. - Arrangement of adequate firefighting equipment,	Appointed Contactor	BEZA	Contractor Cost

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			harmful for the human body will impact on health of the workers; • Fire and explosion will impact the project personnel, neighbors; • Improper arrangement of sanitation and drinking water will impact on health of the project personnel and workers. • May insect and snake bite in the labour camp; • Road Accident may occur	accessories. • Ensure all precautionary measures i.e., proper storing and other flammable materials to reduce the possibility and risk of fire and explosion. • Enhance regular monitoring to the work site. • Adequate sanitation facilities and supply of pure drinking water will need to be ensured at the site and camps. • To provide adequate health care facilities and first aid within construction sites; • To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure; • To arrange for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances; • To promote the use of repellents, clothing, netting, and other barriers to prevent insect bites and snake bite; • Establish rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures, and control of traffic patterns or direction; • To identify and provide appropriate PPE that offers adequate protection to the worker, co-workers, and occasional visitors;			

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
Others	Accidents	B-	- Risk of accidents during the construction period is moderate due to the operation and movement of heavy equipment, vehicle and machineries. - Road accident may occur	- Need contingency fund for affected neighboring people to address accidental issues during implementation period, - Need proper danger signs/ posters, road mark, poles, fences etc to avoid accident at pipeline installation site, - Proper awareness program about possible accidents should be ensured for the neighboring people; - Follow Health and Safety Management Plan (HSMP) rules and regulations designated by contractors;	Appointed Contactor	BEZA	Contractor Cost
Operational Phase							
	Soil Pollution	B-	- Pigging of the pipe for cleaning purposes may generate hazardous pollutants from TBS/CGS etc, If these pollutants are not safely disposed off, then the soils of the project areas will be polluted. - During maintenance, vehicles and machineries lubricant will be spilled over the soils - Handling, storage, transport and disposal of all hazardous materials have impact to soils	- Solid and liquid wastes should not be spread over the project site. These are to be kept in containers for safe disposal elsewhere. - Segregate non-hazardous solid waste from hazardous one and dispose properly; - Ensure proper storage for chemical and hazardous materials to prevent accidental spillage; - Some chemicals like odorants, battery fluids etc. at control station plants and the radioactive isotopes which are occasionally used/ hired for NDT in pipeline O&M purposes are to be carefully handled, transported only in properly signed vehicles	TITAS	TITAS/BEZA	O&M
Social Environment	Working Conditions, including occupational Safety	B-	- Leakage of high pressure gas may create fire and other disaster during the operation phase - Human Safety - Handling, storage, transport and disposal of all hazardous materials have impact to soils or	- Sharing information related possible risk and hazard; - Establish network of information dissemination; - Organize training sessions for local people to train them in emergency response against possible disaster. - To provide adequate health care facilities and first	TITAS TITAS	TITAS/BEZA TITAS/BEZA	O&M O&M

	Item	Scoping	Expected Environmental and Social Impacts	Proposed Environmental Mitigation Measures and Environmental Management	Implementing Organization	Responsibility for supervision	Mitigation Cost Source
			ground/ surface water as a result as a result of leakages or spills during use Fugitive emission of gas from the pipeline system	aid within operation site; To provide OHS training program and information of basic site rules of work, basic hazard awareness, site specific hazards, safe work practices, and emergency procedure;			
Others	Accident	B-	- Possible accidents may include leakage of light oil as a standby fuel or breakage of the Gas transmission line in terms of equipment. - Possible accident may be breakage of the transmission line due to earthquake and others natural disasters.	- Creating and implementing a safety education program - Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities - Management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program - Installation of fire prevention equipment and facilities; - Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning and facilities; - Working out safety regulations.	TITAS	TITAS/BEZA	O&M

Cost estimation for environmental mitigation measures

BEZA will allocate a separate budget in order to ensure environmental management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment etc. need to be included in the contract cost estimation and/or operating cost estimation. The environmental management budget estimation for construction and operation phase of the Project e prepared separately for the gas transmission line and the power plant as shown in Table 3.3-61, Table 3.3-62, Table 3.3-63, and Table 3.3-64.

The Power plant and Gas transmission pipeline Project authority will have to enforce the instructions from EMP and secure a budget to monitor instructed environmental parameters accordingly. The following table shows the overall cost for the power plant and Gas transmission pipeline project.

Environmental Management Budget for Power Plant:

Table 3.3-61: Environmental Management Cost (A) in BDT for Power Plant

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
01	Dust management by water sprayer	LS	-	-	300,000
02	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	50,000
03	Campsite waste disposal facilities	Nos.	-	-	200,000
04	First aid box for treatment of injuries in emergency situations	Nos.	-	-	50,000
05	Water Supply	Nos.	-	-	100,000
06	Sanitary facilities	Nos.	-	-	50,000
08	Water quality protection measures: soil pollution and sedimentation control at the construction site and prevention of spillages, leakages of polluting materials, etc. to be at the satisfaction of the engineer.	LS	-	-	100,000
09	Rehabilitation of ancillary sites including stockpile sites, brick crushing sites, borrow areas, work force camps/ site office, etc and turfing to the entire satisfaction of the engineer.	Sq.m	-	-	100,000
10	Orientation to the technical personnel/ Construction worker associated with the power plant about the key issues of EMP	LS	-	-	Included in the construction cost
11	Ecology (Visible flora and fauna monitoring)	LS			Included in the construction cost
Total Environmental Management Cost (A)					950,000

Table 3.3-62: Environmental Management Cost (B) in BDT for Power Plant

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Operation Stage (Yearly)					
01	Campsite waste disposal facilities	Nos.	-	-	100,000
02	First aid box for treatment of injuries in emergency situations	Nos.	-	-	50,000
03	Water Supply	Nos.	-	-	Included in Operation & Maintenance Cost
04	Sanitary facilities	Nos.	-	-	Included in Operation & Maintenance Cost
05	Tree plantation and green area development plan	LS	-	-	200,000
06	Orientation to the technical personnel/ Operation worker associated with the power plant about the key issues of EMP	LS	-	-	Included in the Operation & Maintenance Cost
Total Environmental Management Cost (B)					350,000

Environmental Management Budget for Gas Transmission Pipeline:

Table 3.3-63: Environmental Management Cost (A) in BDT for Gas Transmission Pipeline

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
01	Dust management by water sprayer	LS	-	-	200,000
02	Maintenance and protection of traffic including construction of diversion road, warning signs, and posting of signboard detaining project activities	LS	-	-	50,000
03	Campsite waste disposal facilities	Nos.	-	-	200,000
04	First aid box for treatment of injuries in emergency situations	Nos.	-	-	100,000
05	Water Supply	Nos.	-	-	150,000
06	Sanitary facilities	Nos.	-	-	100,000
08	Water quality protection measures: soil pollution and sedimentation control at the construction site and prevention of spillages, leakages of polluting materials, etc. to be at the satisfaction of the engineer.	LS	-	-	100,000
09	Orientation to the technical personnel/ Construction worker associated with the Gas transmission Pipeline project about	LS	-	-	Included in the construction

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Construction Stage					
	the key issues of EMP				cost
10	Ecology (Visible flora and fauna monitoring)	LS			Included in the construction cost
Total Environmental Management Cost (A)					900,000

Table 3.3-64: Environmental Management Cost (B) in BDT for Gas Transmission Pipeline

No.	Description of Item	Unit	Quantity	Unit Rate	Item Total
Operation Stage (Yearly)					
01	Accidents and Occupational Health & Safety and Community Health & Safety	LS	-	-	100,000
02	Orientation to the technical personnel/ Operation worker associated with the Gas transmission Pipeline project about the key issues of EMP	LS	-	-	Included in the Operation & Maintenance Cost
Total Environmental Management Cost (B)					100,000

3.3.9. Monitoring Plan

Table 3.3-65: Environmental monitoring plan for the power plant

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project Activity areas and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of Contractor	Contractor Cost
Ambient Air Quality	Dust generation GHG emission	SPM, PM 2.5, PM10, CO, SO _x , NO _x	At 4 Locations	24-hour	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq _{day} , Leq _{night} and hourly Leq	At 5 Locations (Important Sensitive Receptors)	24-hour Once every fortnight	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Water	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	At 2 locations	Standard Analytical methods	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR 1997	At 2 locations	Standard Analytical methods	Quarterly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Waste and Odor	Internal domestic/ kitchen waste	Solid waste, liquid waste, Hazardous waste	Waste disposable point	Waste a quality	Daily	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Soil	Soil Quality	pH, salinity, NH ₄ ⁺ , total-	Project Location	Standard	Quarterly	Contractor/	Contractor

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
		P, heavy metals, oil & grease		analytical methods		3rd Party Environmental Consultant	Cost
Hydrology	Groundwater level Ground elevation level Consumption of groundwater amount	Compliance with mitigation measures presented in the EMP	Well near the construction site	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Social Environment	Vulnerable Group Local economies, such as employment, livelihood, etc. Misdistribution of Benefit and Damage Gender Children's Right	Monitoring of the implementation status of Resettlement works such as provision of assistance package for project affected persons, and common assets; Monitoring of the implementation status for CSR activities such as community support program	Around project site	Visual inspection of all active work areas	Once/year	BEZA	BEZA
Occupational Health and Safety	Accidents or incidents due to construction activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by contractor	As defined in H&S Plan	Contractor/ EHS Team of Contractor	Contractor Cost
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Approach Road	Incidents, accidents and community complaints	Based on occurrence	Contractor/ EHS and/or Community Liaison Officer of Contractor	Contractor Cost
Operation Phase							
General	Inspection of mitigation	General compliance with mitigation measures	Project activity areas and construction	Visual inspection of all active work	Daily	EHS Team of BEZA	Included in operation

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
	compliance	presented in the EMP and as specified in Contractor Manual	workers camp	areas			and maintenance (O&M) cost
Air Pollution	Stack emissions concentrations	NOx, SOx, CO, SPM	3 Stack for exhaust emission	Standard methods	Half yearly	3rd Party Environmental Consultant	O&M cost
	Ambient air quality	PM10, PM2.5, SOx, NOx, CO	At 2 Locations	Standard methods	Quarterly	3rd Party Environmental Consultant	O&M cost
Noise	Noise generation by Gas turbine & other operational activities	Sound Pressure Level	1 m from the noise generating equipment	Noise monitor	Quarterly	EHS Team or 3 rd Party Environmental Consultant	O&M cost
	Ambient noise	Ambient noise levels	At 5 locations (Important Sensitive Receptors)	Noise monitor with data logger	Quarterly	3rd Party Environmental Consultant	O&M cost
Water	Ground water quality	Drinking water quality parameters as per Schedule 3 of ECR1997	Bore well water to be used for domestic purposes and treated water quality to be used for drinking	Standard analytical methods	Quarterly	3rd Party Environmental Consultant	O&M cost
	Wastewater	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	Treated water from ETP	Standard analytical methods	Quarterly	3rd Party Environmental Consultant	O&M cost
	Surface water quality	Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals	At 2 locations	Standard analytical methods	Quarterly	EHS Team/3rd Party Environmental Consultant	O&M cost
Solid &	Internal domestic/	Solid waste	Waste disposable point	Waste a quality	Daily	Third Party	O&M Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
hazardous waste	kitchen waste, and medical center waste					Agency/BEZA	
Aquatic Ecology	Fisheries	Visible fish kills	Outlet of the discharge	Visual inspection	Fortnightly	Plant EHS Team	O&M Cost
Terrestrial Ecology	Ecology	Visible flora and fauna monitoring	Plant surrounding area of 2 km radius	Abundance, species composition	Half yearly initial 2 years of operations. Any further monitoring based on the analysis of results	3rd Party Environmental Consultant	O&M cost
Works health and safety Monitoring	Accidents or incidents due to operation and maintenance activities, workers health	Near-misses, incidents, occupational diseases, dangerous occurrence etc.	Project activities areas	As to be defined in the H&S plan to be prepared BEZA	As defined in H&S plan	Plant Authority and monitored by BEZA	O&M Cost
Health Monitoring	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complains	Access Road	Accidents, incidents and complains	Based on occurrence	Plant Authority and monitored by BEZA	O&M Cost
	Public Concern	Complains	Neighboring communities	As to be defined in the H&S plan to be prepared by BEZA	Continuous	Plant Authority and monitored by BEZA	O&M Cost
Disaster Management Plan (DMP) Monitoring	Earthquake	Structure Design	Project Area	As to be defined in the DMP to be prepared by BEZA	Continuous	Plant Authority and monitored by BEZA	O&M Cost
CSR Activities	Community Development	Activities/Programmes and No. of beneficiaries	Neighboring communities around the Project	No. of beneficiaries and outcome of the	Periodic and need based	Admin/ HR Manager and	CSR Budget

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
			activity areas	activities		Station Manager	

Table 3.3-66: Environmental Monitoring Plan for Gas Transmission Pipeline Project

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
Preconstruction & construction Phase							
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the EMP and as specified in Contractor Manual	Project site and construction workers camp	Visual inspection of all active work areas	Daily	EHS Team of Contractor	Contractor Cost
Ambient Air Quality	Dust generation	Check dust suppression activity	Project site	Visual Monitoring	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq _{day} , Leq _{night} and hourly Leq	At construction and nearest settlement and Important Sensitive Receptors (5 Locations)	24-hour	Monthly	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Soil & Sediment	Soil pollution due to onsite pipeline installation	Check excavated soil is properly maintained and reuse	Construction site	Visual Monitoring	Regularly	Contractor	Contractor Cost
Water	Surface Water Quality	pH, TDS, EC, TSS, Fe, NH ₃ - N, DO, COD, Turbidity, BOD ₅ , Oil and Greases	Adjacent water body (4 location)	Standard Analytical methods	Monthly	Contractor/ 3rd Party Environmental	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
						Consultant	
Waste and Odor	Internal domestic/ kitchen waste	Solid waste, liquid waste, Hazardous waste	Waste disposable point	Waste a quality	Daily	Contractor/ 3rd Party Environmental Consultant	Contractor Cost
Hydrology	Groundwater level Ground elevation level Drainage system	Compliance with mitigation measures presented in the EMP	Well near the construction site	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Social Environment	Involuntary Resettlement Vulnerable Group Local economies, such as employment, livelihood, etc. Misdistribution of Benefit and Damage	Monitoring of the implementation status of Resettlement works such as provision of assistance package for project affected persons, and common assets; Monitoring of the implementation status for CSR activities such as community support program	Around project site	Visual inspection of all active work areas	Once/month	BEZA	BEZA
	Gender	Monitoring of payment to workers by the contractor shall be implemented not to allow payment gaps between male and female	Construction Site	Visual inspection of all active work areas	Regularly	Contractor	Contractor Cost
	Children Right	Check Child Labour	Construction Site	Visual inspection of all active work areas	Regularly	Contractor	Contractor Cost
Infectious Diseases	Risk of HIV/AIDS	Ensuring that contractor's personnel and local	Project site	Consultation with workers and	Quarterly Monthly	Contractor/ EHS Team of	Contractor Cost

Project Stage/ Affected Component	Environmental Issue	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility	Cost
		community understand HIV-AIDS awareness campaign		community		Contractor	
Occupational Health and Safety	Accidents or incidents due to Gas transmission pipeline construction	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas and construction workers camp	As defined in construction phase Health & Safety Plan to be prepared by contractor	Monthly	Contractor/ EHS Team of Contractor	Contractor Cost
Operation Phase							
Soil and Sediment	Soil pollution due to Gas transmission line installation	Check excavated soil is properly compacted	RoW of Gas transmission line	Visual Monitoring	Regularly	Contractor	Contractor Cost
Hydrology	Drainage system	Compliance with mitigation measures presented in the EMP	Well near the project activity area	Visual inspection of all active work areas	Once/ months	Contractor	Contractor Cost
Accidents and Occupational Health and Safety	Accidents or incidents due to transmission pipeline construction	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas	As defined in operation phase Health & Safety Plan to be prepared by contractor	Quarterly	Contractor/ EHS Team of Contractor	Contractor Cost

Cost Estimation for Environmental Monitoring

BEZA will allocate a separate budget for environmental monitoring plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building described in the EMoP. It should be noted that cost for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment etc. need to be included in the contract cost estimation and/or operating cost estimation. The environmental monitoring budget estimation for the power plant and the gas transmission line provided below in Table 3.3-67 and Table 3.3-68. The Power plant and Gas transmission pipeline Project authority will have to enforce the instructions in accordance with the EMP.

Environmental Monitoring Budget for Power Plant:

Table 3.3-67: Environmental Monitoring Cost (C) in BDT/yr for Power Plant

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Air pollution	During Construction	Measurement of SPM, PM 2.5, PM10, CO, SOx, NOx	30,000	48	1,440,000
	During Operation	3 Stack Emissions	30,000	6	180,000
		2 Ambient Air Quality Measurement of PM10, PM2.5, SOx, NOx, CO	30,000	8	240,000
Water pollution (Surface & Ground Water)	During Construction	Surface Water Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals Ground Water Drinking water quality parameters as per Schedule 3 of ECR 1997	30,000	16	480,000
	During Operation	Surface Water Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals Waste Water Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals Ground Water Drinking water quality parameters as per Schedule 3 of ECR 1997	30,000	16	480,000
Noise	During Construction	Periodical maintenance of construction vehicles and installation of sound insulation cover(Noise levels)	5,000	20	100,000
	During Operation	Power Plant Site and 2 closest receptor from power plant	5,000	12	60,000
Occupational Health & Safety	During Construction	Accident or incidents due to construction activities,	-	-	Included in EMP Cost

Component	Stage	Item	Unit Cost	Quantity	Total Costs
and Community Health& Safety	on	dangerous occurrences			
	During Operation	Hazard due to road traffic	-	-	Included in EMP Cost
Ecology	Aquatic and Terrestrial Ecology	Visible flora and fauna monitoring	-	-	Included in EMP Cost
Total Environmental Monitoring Cost (C)					3,180,000
Environmental Training	During Operation	Orientation Workshop and follow up training program for capacity building/ institutional development program	-	LS	200,000
Environmental Training Costs (D)					200,000
Grand Total (A+B+C+D)					4,680,000

Environmental Monitoring Budget for Gas Transmission Pipeline:

Table 3.3-68: Monthly Environmental Monitoring Cost (C) in BDT for Gas Transmission Pipeline

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Involuntary Resettlement	Pre-Constructi on & During Construction	Monitoring Compensation of for impact	-	-	Included in RAP Cost
Air pollution	During Construction	Check dust suppression activity	LS		Included in EMP Cost
Water pollution (Surface Water)	During Construction	Surface Water pH, TDS, EC, TSS, Fe, NH ₃ - N, DO, COD, Turbidity, BOD5, Oil and Greases	30,000	4	120,000
Noise	During Construction	At construction and nearest settlement and Important Sensitive Receptors (5 locations) Noise levels in Leq, Leq _{day} , Leq _{night} and hourly Leq	5,000	5	25,000
Soil and Sediment	During Construction	Visual Monitoring	-	-	Included in EMP Cost
Waste	During Construction	Waste disposal	--		Included in EMP Cost
Occupational Health & Safety and	During Construction	Accident or incidents due to construction activities, dangerous occurrences	-	-	Included in EMP Cost

Component	Stage	Item	Unit Cost	Quantity	Total Costs
Community Health& Safety	During Operation	Hazard due to road traffic	-	-	Included in EMP Cost
Ecology	Aquatic and Terrestrial Ecology	Visible flora and fauna monitoring	-	-	Included in EMP Cost
Total Environmental Monitoring Cost (C)					145,000
Environmental Training	During construction	Orientation Workshop and follow up training program for capacity building/ institutional development program	-	LS	100,000
Environmental Training Costs (D)					100,000
Grand Total (A+B+C+D)					1,245,000

3.3.10. Institutional arrangement for EMP and EMoP

During Construction Phase of the power plant

The organizational structure for the operation and management of EMP and EMoP for the proposed power plant is shown in the figure below. The Contractor contracted by BEZA will assign an Environmental Manager for implementation of EMP and EMoP for construction of the power plant (including the substation and the transmission line) construction activities and will submit the environmental monitoring report to BEZA who acts as supervising entity. BEZA will submit the monitoring report to JICA on quarterly basis. BEZA will submit the monitoring report to JICA on quarterly basis.

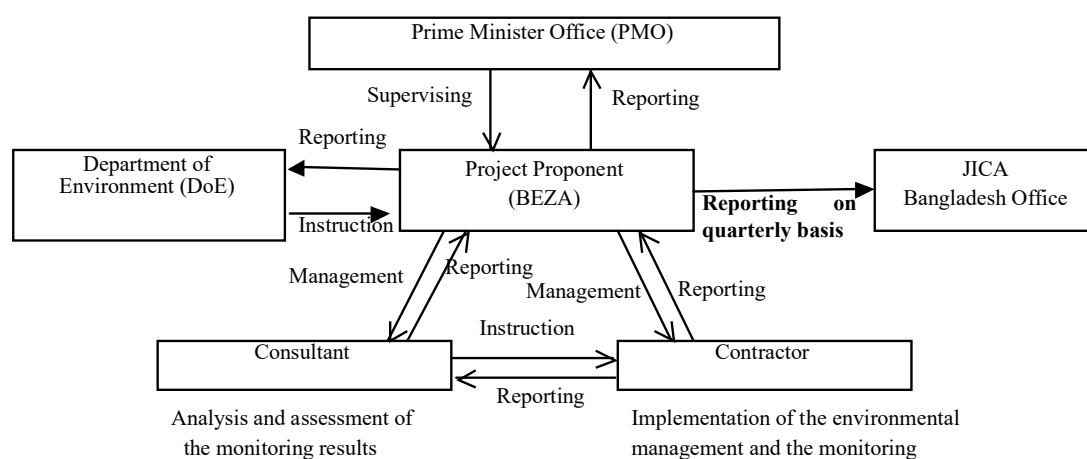


Figure 3.3-48: Implementation Structure / Mechanism of EMP and EMoP during Construction Phase of the power plant

During Operation Phase of the power plant

The organizational structure for the operation and management of EMP and EMoP for the proposed power plant is shown in Figure 3.3-49. The operator contracted by or forms a joint venture with BEZA will assign an Environmental Manager for implementation of EMP and EMoP during operation of the

power plant (including the substation and the transmission line) and will submit environmental monitoring report to BEZA who acts as supervisor. BEZA will submit monitoring report to JICA on quarterly basis.

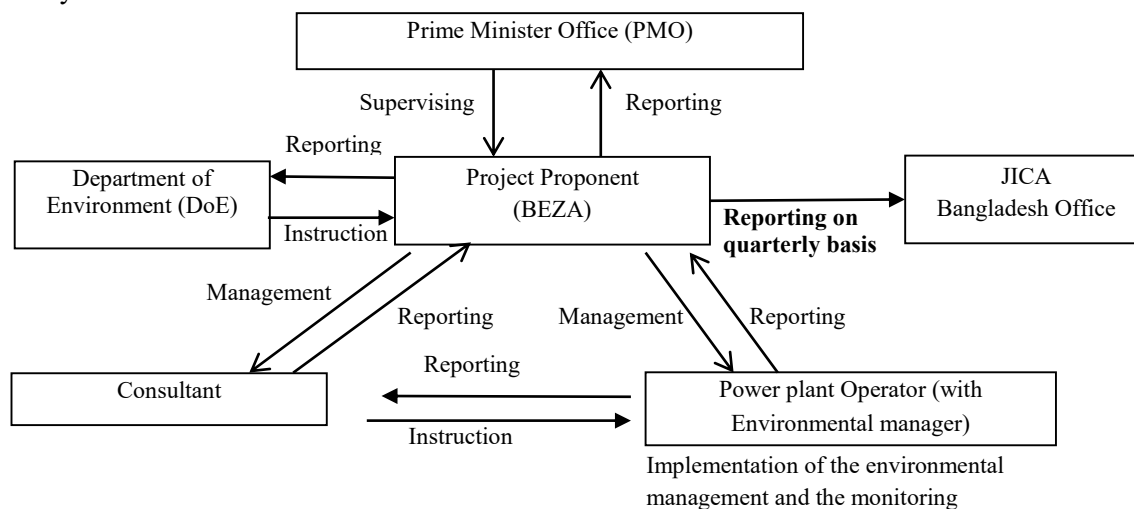


Figure 3.3-49: Implementation Structure / Mechanism of EMP and EMoP during Operation Phase of the power plant

Pre-Construction and Construction phase of the gas transmission line

The organizational structure for the operation and management of EMP and EMoP for Pre-construction and construction phase of the proposed Gas transmission line is shown in 3.3-64. The Contractor contracted by TITAS, who will procure and manage the contractor for the gas transmission line construction, will assign an Environmental Manager for implementation of EMP and EMoP. TITAS will submit the environmental monitoring report to BEZA who acts as supervisor. BEZA will submit the monitoring report to JICA on quarterly basis.

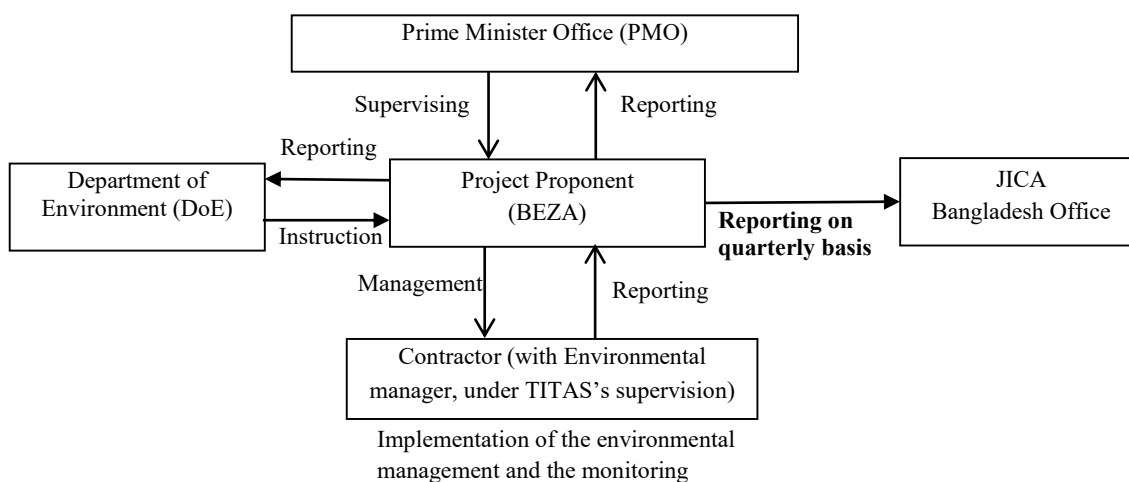


Figure 3.3-50: Implementation Structure / Mechanism of EMP and EMoP during Pre-construction Phase and Construction Phase of the Gas transmission line.

During Operation Phase of the gas transmission line

The organizational structure for the operation and management of EMP and EMoP for operation phase of the proposed Gas transmission line is shown in Figure 3.3-51 below. TITAS will be the operator of the gas transmission line, thus TITAS will submit the environmental monitoring report to BEZA who acts as supervisor. BEZA will submit the monitoring report to JICA on quarterly basis.

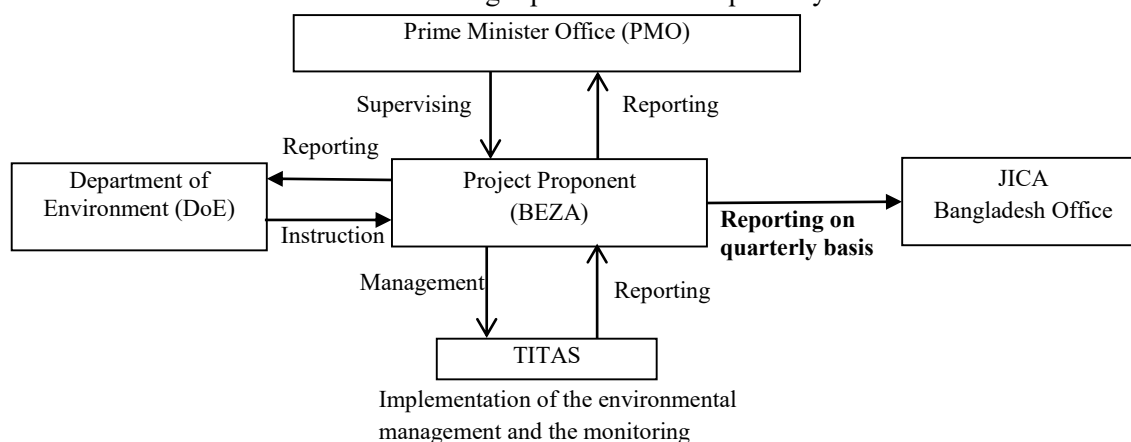


Figure 3.3-51: Implementation Structure / Mechanism of EMP and EMoP during Pre-construction Phase and Construction Phase of the Gas transmission line.

3.3.11. Public Consultation Meetings

PCM - Scoping phase - for the Gas Transmission Pipeline

Public consultation meetings for the Gas transmission pipeline EIA preparation were held at 2 locations adjacent to the project site. PCM at 1st location was held on 24th October 2018 at the Paurashava office of one of the major project impacted communities (Tarabo Paurashava, Tarabo). PCM at 2nd location for the Gas transmission pipeline EIA preparation was held on 30th October 2018 in front of Kazibari mosque of one of the major project impacted communities (Madanganj, Bandar). PCM at 3rd location for the Power plant EIA preparation was held on 16th November 2018 at Panchbaria of one of the major project impacted communities (Panchbaria, Duptara). Prior to the notice, BEZA consulted with the local leader and was requested to conduct the consultation/meeting where there is enough space for more than 100 persons under the shadow. The venue was selected in terms of easy accessibility from villages in and around Gas transmission project site and Power plant the meeting place capacity of the building. The project proponent prepared the invitation letter together with the notice of the meeting in Bengali language and announced to the invitees, who are residents in Ward-9 under Tarabo Paurashava, residents of Madanpur union, residents of Duptara union and relevant governmental organizations, non-governmental organizations (NGOs), community- based organizations (CBOs) and anyone who are interested.

Information on the meeting was announced to the invitees one week in advance before the meeting by sending invitation letters to the respective invitees.

As per the JICA Environmental Guidelines, advanced newspaper notice (see Appendix 6) of the consultation was published on 18th October,18 for PCM at Location-1, 23th October,18 for PCM at Location-2 & 11th November,18 for PCM at Location-3.

The presentation and handouts were prepared and explained in Bengali language. The opinions from the participants were received in the question and answer session. Additionally, separately talked with participants so that those who are hesitant to speak out in public could share their views and comments. Furthermore, female assistants were also available for the female participants who need any help.

Summarized Outcomes of PCMs (Scoping phase)

PCM for 1st location for the Gas transmission pipeline EIA preparation was held on 24th October 2018 at the Paurashava office of one of the major project impacted communities (Tarabo Paurashava, Tarabo). The joint consultation/meeting was participated by roughly 39 persons

PCM for 2nd location for the Gas transmission pipeline EIA preparation was held on 30th October 2018 in front of Kazibari Mosque of one of the major project impacted communities (Madanpur, Bandar). The joint consultation/meeting was participated by roughly 33 persons

In the consultation meeting, after the explanation on the project outline planned in Gas transmission pipeline project, which pass through the industrial area, residential and commercial areas and the expected key environmental and social benefits as well as potential negative impacts were explained during the preconstruction, construction and operation stage. In addition, survey items of the baseline EIA study and future schedule for the EIA were presented to the participants. At the end, a question and answer session was organized in all the meetings. As a whole, seven questions were raised from the participants and discussed with the project proponent and coordinating organization.

Time and Date	1st Location: Gas transmission line site Date: 24 October, 2018 Day: Wednesday Time: 11:00 AM to 12:00 AM 2nd Location: Gas transmission line site Date: 30 October, 2018 Day: Friday Time: 11:00 AM to 12:00 AM 3rd Location: Power plant site Date: 16 November, 2018 Day: Friday Time: 03:00 PM to 05:00 PM
Venue	1st Location: Paurashava Auditorium Room, Tarabo Paurashava, Rupganj, Narayanganj 2nd Location: Kazibari Mosque, Madanganj, Bandar, Narayanganj 3rd Location: Panchbaria Village, Duptara, Araihasar, Narayanganj
Invitees	1st Location: Deputy Commissioner (DC), Narayanganj Mayor, Tarabo Paurashava, Rupganj, Narayanganj Upazila Nirbahi Officer, Rupganj, Narayanganj Social Specialist, EQMS (JICA consultant) Environmental Specialist, EQMS(JICA consultant) Counselor, Ward no-9, Tarabo paurashava Local residents in and around Gas Transmission Pipeline area

	Other organizations and individuals who are interested in the Project 2nd Location: Deputy Commissioner (DC), Narayanganj Upazila Nirbahi Officer, Bandar, Narayanganj Chairman, Madanpur, Bandar, Narayanganj Social Specialist, EQMS(JICA consultant) Environmental Specialist, EQMS(JICA consultant) Member, Ward no-3, Madanpur, Bandar Local residents in and around Gas Transmission Pipeline area Other organizations and individuals who are interested in the Project 3rd Location: Chairman, Dupatara, Araihaazar, Narayanganj Member, Panchbaria, Union: Duptara, Araihaazar, Narayanganj Environmental Specialist, EQMS (JICA consultant) Local residents in and around Power Plant area Other organizations and individuals who are interested in the Project
Attendee	1st Location: 44 people (men: 39, women: 5) Age range: 22-70 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons Some participants including the 5 women refused to sign in the participant list. They did not want to disclose their identity. 2nd Location: 33 people (men: 33, women: 0) Age range: 22-70 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons 3rd Location: 54 people (men: 46, women: 8) Age range: 28-85 Category of participants: Project affected people, local community and relevant stakeholders including both governmental and private sector representatives irrespective of gender; Occupation: Women, Farmer, Businessman, Service holder, Teacher, Student & Unemployed Persons
Agenda	Brief explanation on the past EIA-related studies Project description on layout plan, construction process and land acquisition process. Major positive and negative findings on the draft scoping results Scope of the EIA study Further schedule of EIA
Language Used	In local language: Bangali language

Photos of the PCMs are available in Appendices. List of participants of PCMs are presented in Appendices. Comments raised by the participants and response by BEZA (consultants) during the PCMs are summarized in the table below;

Key Points Raised by the Participants at Public Consultation Meeting (1st Location)

Participants	Comment/Question	Response
Md. Shariful Islam Land Owner, Dighiborabo	We are very positive in any kind of government development. Landowners like us have to pay for it for the better future and we are ready for it. However, if we get proper land value as compensation compared to market price, we may survive. Otherwise, we will be marginalized or landless. We heard that new law on land acquisition has been updated in 2017. Where, the DC's payment rate has been mended 1.5 times to 3 times. What would be the DC's rate in the proposed project? How will the legal landowners be paid?	Consultant: We are working on revised gazetted act. We have already approached our administrative procedure. All the Landowners will be compensated as per new gazette. Consultant: After reviewing all land ownership deeds, R.S. allocation holders' name and the relevant documents, an actual legal owner will be identified and compensated;
Md. Anowar Resident, Dighiborabo	Some structures need to be demolish at Dighiborabo site. Is they compensated for the structure?	Consultant: At the scoping stage, we tried to minimize the adverse impact as much as possible and design this project. We redesigned our project for not affecting the residential settlements. But some structures will be affected by this project. They will be compensated for their structural loss.
Md. Ashiqur Rahman Resident, Dighiborabo	When the construction work starts, land excavation will occur. Surface drainage system will be affected by this project. Consequently, adjacent low lands will be inundated during wet season. Is BEZA aware of this situation?	Consultant: The contractor will work excavation work at dry season. In addition, they will not block any kind of drainage system.
Shakil Resident, Dighiborabo	He suggest that to identify the best possible route to minimize structure loss and advised the consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during Preconstruction and construction stages of the project.	Consultant: The contractor should be follow the Environmental Management Plan (EMP) & Environmental Monitoring Plan (EMoP) and the proponent will be supervised the progress

Key Points Raised by the Participants at Public Consultation Meeting (2nd Location)

Participants	Comment/Question	Response
Md. Solayman Resident, Ward-3, Madanpur	Should be reduce Air Pollution Job facilities should be available for local people Gas transmission line transmission should be done considering possible impacts on nature, environment and local people's livelihood	Consultant: Employment opportunities will be created at construction stage; Proper mitigation measures will be applied for minimizing the possible impacts on Environment & Ecology.
Kazi Rabiul Resident, Ward-3, Madanpur	Project area stands in agricultural land. So proper plan should be taken to minimize the impact on agriculture. Improve drainage system beside agricultural land otherwise in rainy season lower land will be gone under water	Consultant: The proponent will be minimized environmental pollution and reduce minimum pollution on soil quality; The landowners will be compensated as per govt. land acquisition rules.

Participants	Comment/Question	Response
	Will give proper compensation to the affected people and land loser? Improve irrigation system	Should be improve irrigation canal and drainage system at construction period
Nuru Mia Resident, Ward-3, Madanpur	Gas transmission line will bring economic growth of our area. Need to mitigate environmental pollution like air, water, noise etc.	Consultant: The Air, Noise, Water quality will be monitored as per DoE standard; Proper mitigation measures will be applied as per EMP
Md. Khalik Businessman, Ward-3, Madanpur	Strictly discourage child labor. Limit migrate workers' employment opportunity	Consultant: The contractor will be strictly discouraged on child labor. The contractor will be hired local people for construction work.

Key Points Raised by the Participants at Public Consultation Meeting (3rd Location)

Participants	Comment/Question	Response
Md. Jillur Rahman, Businessman, Panchbaria	He raised that nothing has been specifically mentioned about the female workers in regard to the employment of local people. He mentioned that he would be in favour of establishing power plant at Araihaazar EZ if the local people are in favour of the power plant at AEZ.	Consultant: In regard to the employment of female workers, he mentioned that there will be no discrimination with female workers. Workers of all genders will have equal opportunity.
Mubarak Mia, Farmer, Panchbaria	He also raised that no power plant shall be constructed unless the local people are fully motivated in terms of their job opportunity and assurance of no negative impacts on environment.	Consultant: He also assured that people of both genders will enjoy equal opportunity in terms of employment and compensation etc.
Mobarak Hossain, Local resident, Panchbaria	We want a gate in Panchbaria village side so that the workers can easily enter in the power plant.	Consultant: BEZA will take necessary steps to easy entrance and exit in the power plant for workers.
Dulal Mia, Farmer, Panchbaria	For filling the power plant area, the adjacent lower land may go under water through heavy rain. If agricultural land affected by the land filling & construction work. Then BEZA should give us proper compensation on our damages.	Consultant: Around the boundary wall, BEZA will construct drainage line to pass the storm water. Contractor will give proper restitution based on the damages.
Kiron, Member, Panchbaria	Civil construction, vehicle movement, operation of equipment, construction of internal road may generate dust, noise and water pollution. Please take proper mitigation measures to reduce the impact	Consultant: The contractor/BEZA will apply proper mitigation measures as per EMP and EMoP at construction and operation stage.
Shahida Mosarrafa, Chairman, Duaptara	We expect that this company will enhance it's helping hand as a part of social responsibility for developing this locality by contributing in development of school, college and hospital etc.	Consultant: BEZA has plan to implement some social welfare programs for neighbour communities.

Participants	Comment/Question	Response

2nd Public Consultation Meetings (Draft Final Phase / information disclosure stage)

2nd PCM is to expected be held in January 2019 at same locations as the 1st PCM. 2nd PCM aims to disclose findings of EIA for the proposed gas pipeline and the power plant and to provide PAPs with opportunities to present their views and concerns toward the project.

Any concerns or issues raised shall be taken into consideration and BEZA is obligated to incorporate take necessary measures and reflect them into the EMP and EMoP..

Focus Group Discussion (FGD)

Focus group Discussion (FGD) is a small, but demographically diverse group of people and whose reactions are studied especially in guided or open discussions about a proposed project to determine reactions that can be expected from a particular group such as women group, vulnerable group, special group who may experience different degree of impact by the project. It is a form of qualitative research consisting of interviews in which groups of people are asked about their perceptions, opinions, beliefs, and attitudes towards the project, service, concept, advertisement, idea or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members.

Discussion was held with the local people at near the proposed Gas transmission line site. Date, location and the number of participants of each discussion is listed in Table 3.3-69

. Different categories of local people were grouped and discussed with many issues to capture their perceptions. The summary of focus group discussions (FGDs) is shown in Table 3.3-70.

Table 3.3-69: Details of Focus Group Discussions (FGDs)

Sl.	Date	Location of the FGD	Participants			Category of participants
			Total	Male	Female	
	24.10.2018	Dighiborabo near the gas station	7	7	0	Land Owners, Factory Owners, Structure loser and Farmers
	16.11.2018	Panchbaria at Duptara union near the power plant	15	0	15	Woman

Table 3.3-70: Summary of Focus Group Discussion with Local Community

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are very positive of this project. Still they do not get any kind of letters from Govt./DC's. Many survey works have already been started such as route survey and environmental baseline survey.	Consultants made a clear description on location, pipeline alignment, acquiring process about the proposed project. People are aware about the project in the study area.
Support of local people for the proposed project	Almost everyone suggested that to identify the best possible route and advised the consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during different stages of the project.	The consultants informed that during the design stage of the Gas transmission line different alternative options have been considered;
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. However, this land acquisition will create landlessness for the limited affected peoples but for the growth of the country, it can be acceptable if properly compensated.	All development projects require land acquisition which causes land loss. In compared to national development, this loss is very negligible. However, the land owners can be used this land for agricultural purpose after installation of pipeline.
What are the characteristics of the lands those are going to be taken for the proposed project?	Proposed land is low in nature. Therefore, during wet season no agricultural activities can be done. Thus most of the land is used for single cropping production especially in winter season. Most of the lands are used for paddy production and production rate is very high in these lands. Paddy produced approximately 25kg per decimal.	In this project, government will require land acquisition that may causes agricultural loss. However, the land owners can be used this land for agricultural purpose after installation of pipeline.
How do the land owners and farmers depend on the lands those are going to be taken for the proposed project?	Most of the landowners and farmers are involved in agriculture and other jobs too. Agricultural production contributes to enhance the food availability and solvency for these affected households. However, there are some affected persons too who only depend on agricultural production for their livelihood.	Detailed RAP along with proper compensation packages and livelihood assistance will be proposed to prepare for all affected persons respective to all dependencies so that all affected persons can restore their livelihood after the land acquisition.
How does this dependency contribute to the livelihood?		The land will be backfilled properly and restored its previous condition.
How do other people who are not landowners depend on the acquired land?	Some people do sharecropping production. These people are usually landless. They do not have land but they rent this land for specific time duration to produce crop for their livelihood. Almost everyone suggested that to identify the sharecroppers list and advised the consultants to consider them under compensation.	During PCM consultant explain that sharecroppers will be compensated according to RAP.
What are the common practices for renting lands to the sharecroppers?		
What should be done to minimize the Environmental impacts?	Everyone said that proponent should take precautions in the environmental mitigations to minimize air pollution, noise pollution, water pollution, Soil pollution,	The proponent will be monitored/supervised the project site periodically as per EMP and EMoP.

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
	sediment pollution etc.	

Table 3.3-71: Summary of Focus Group Meeting with Women

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are very positive of this project. Still they do not get any kind of letters from Govt./DC's. Many survey works have already been started such as route survey and environmental baseline survey.	Consultants made a clear description on location, pipeline alignment, acquiring process about the proposed project. People are aware about the project in the study area.
Support of local people for the proposed project	Almost everyone suggested that to identify the best possible route and advised the consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during different stages of the project.	The consultants informed that during the design stage of the Gas transmission line different alternative options have been considered;
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. However, this land acquisition will create landlessness for the limited affected peoples but for the growth of the country, it can be acceptable if properly compensated.	All development projects require land acquisition which causes land loss. In compared to national development, this loss is very negligible. However, the land owners can be used this land for agricultural purpose after installation of pipeline.
What are the characteristics of the lands those are going to be taken for the proposed project?	Proposed land is low in nature. Therefore, during wet season no agricultural activities can be done. Thus most of the land is used for single cropping production especially in winter season. Most of the lands are used for paddy production and production rate is very high in these lands. Paddy produced approximately 25kg per decimal.	In this project, government will require land acquisition that may causes agricultural loss. However, the land owners can be used this land for agricultural purpose after installation of pipeline.
How do the land owners and farmers depend on the lands those are going to be taken for the proposed project?	Most of the landowners and farmers are involved in agriculture and other jobs too. Agricultural production contributes to enhance the food availability and solvency for these affected households. However, there are some affected persons too who only depend on agricultural production for their livelihood.	Detailed RAP along with proper compensation packages and livelihood assistance will be proposed to prepare for all affected persons respective to all dependencies so that all affected persons can restore their livelihood after the land acquisition.
How does this dependency contribute to the livelihood?		The land will be backfilled properly and restored its previous condition.
How do other people who are not landowners depend on the acquired land?	Some people do sharecropping production. These people are usually landless. They do not have land but they rent this land for specific time duration to produce crop for their livelihood. Almost everyone suggested that to identify the sharecroppers list and advised the consultants to consider	During PCM consultant explain that sharecroppers will be compensated according to RAP.
What are the common practices for renting lands		

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
to the sharecroppers?	them under compensation.	
What should be done to minimize the Environmental impacts?	Everyone said that proponent should take precautions in the environmental mitigations to minimize air pollution, noise pollution, water pollution, Soil pollution, sediment pollution etc.	The proponent will be monitored/ supervised the project site periodically as per EMP and EMoP.

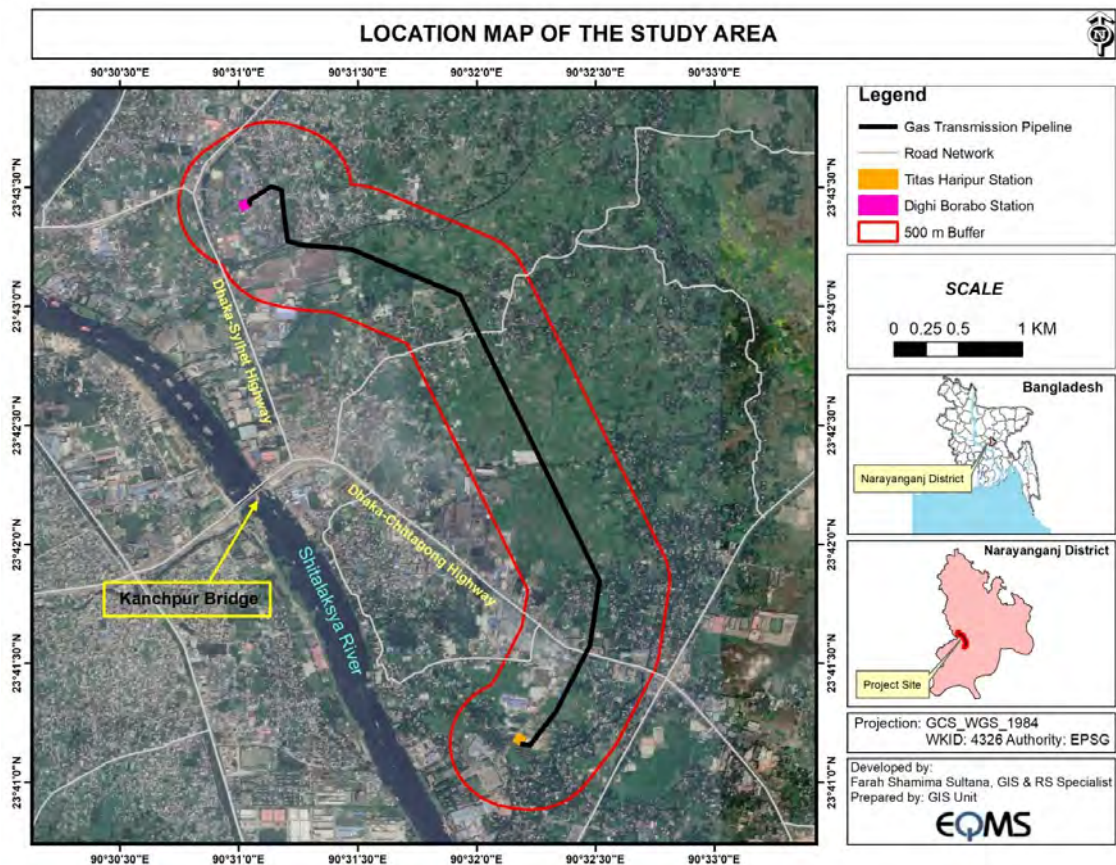
3.4 Social Impact Assessment for Gas Transmission line (RAP 2)

Project Objective

Apart from AEZ development site, AEZ requires sufficient, uninterrupted and sustainable power and gas supply for all industrial units to be established in the EZ. Existing gas pipeline across the EZ has no capacity to supply sufficient gas to the Power Plant and other industrial units. That is why, AEZ requires to install a new booster pipeline for enhancing capacity of existing gas pipeline from Haripur TBS to Dighiborabo CGS to provide gas to the power plant and industries within AEZ. Thus, this report has been prepared by JICA's consultants to examine social impact assessment and to prepare Resettlement Action Plan which will be utilized for land acquisition and impact mitigation process for the proposed Gas transmission line.

Location

The proposed project for gas transmission line from Haripur TBS to Dighiborabo CGS is located in Narayanganj district and crosses 3 Upazila namely Rupganj, Sonargaon and Bandar and one ward of Narayanganj City Corporation (Figure 3.4-1).



source: Google map - partially modified by JICA Study Team

Figure 3.4-1: Location map of the project

Geographical relationship and gas transmission connection between the proposed gas transmission line and AEZ is shown in **Figure 3.4-2**. The pink line in the figure indicates the alignment of the proposed gas transmission line. The green line indicates the existing pipeline that would connect Dighiborabo CGS and AEZ. Additionally, a broader gas transmission line connectivity map is illustrated in Figure 3.4-3.

Source: JICA Study Team

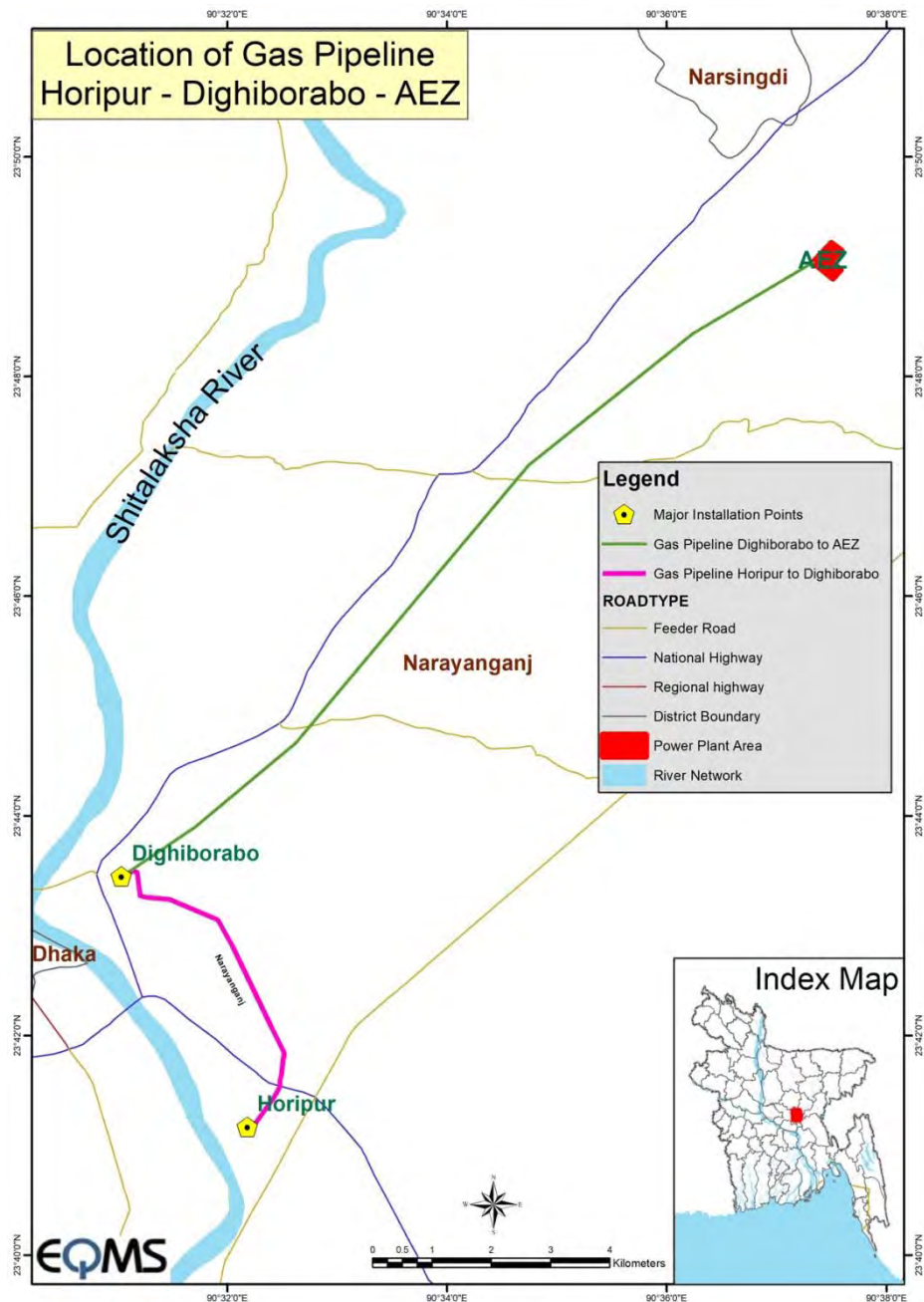
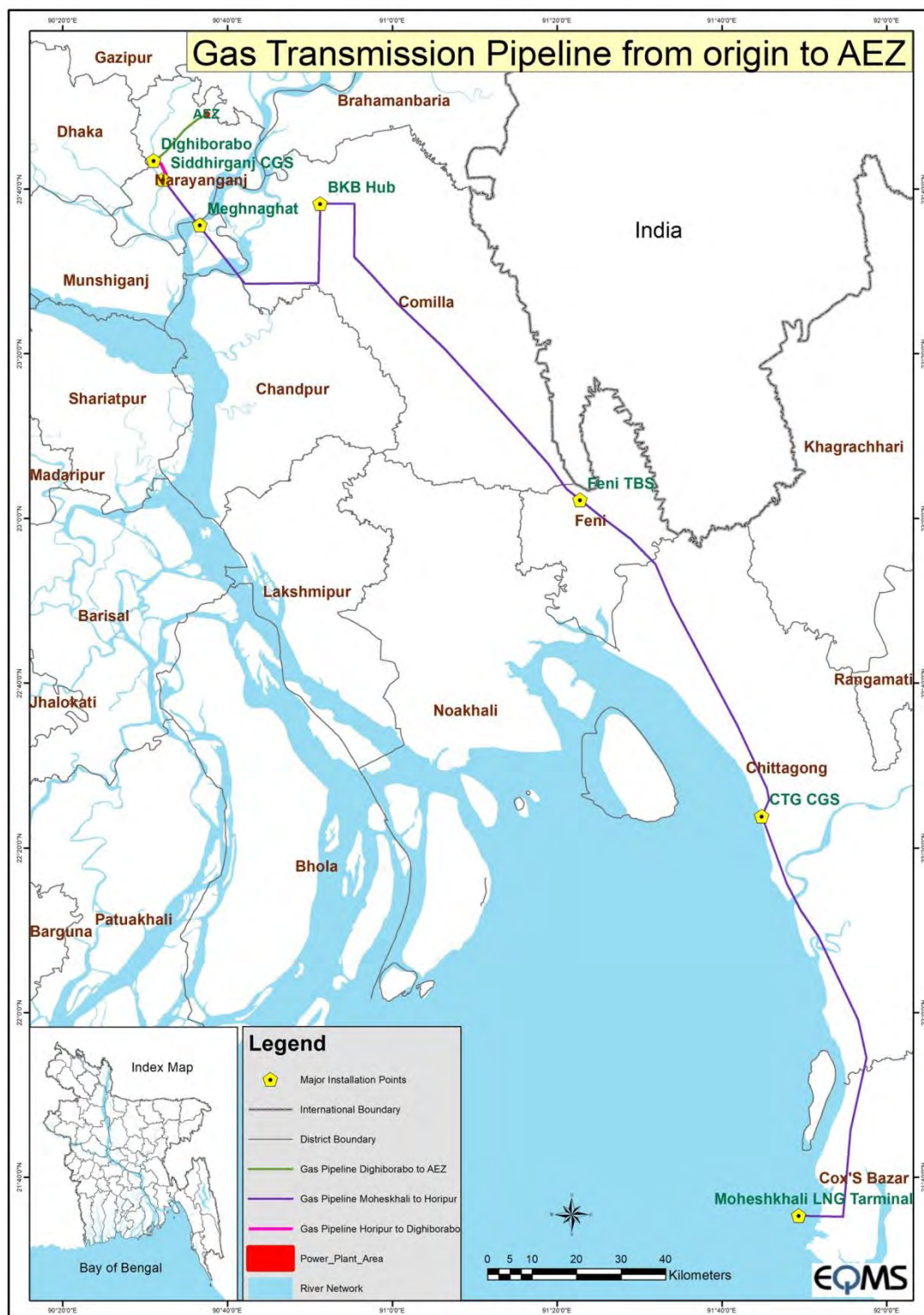


Figure 3.4-2: Gas transmission connection from the proposed gas transmission line and AEZ.



Source: JICA Study Team

Figure 3.4-3: Gas transmission connectivity from Moheshkhali and the proposed gas transmission line and AEZ.

Summary of Land Acquisition and Resettlement Impact:

The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. Entire land is privately owned and need to be acquired. Land acquisition process is yet to start and it will take few months. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition (Table 3.4-1).

The number of involuntary resettlement would be 12 households who are included in 253 affected households. Some of those household may return to their current location and build a new house.

Additionally, non-title holders have been identified through the survey: 1 sharecropper, 52 wage losers. All of them are eligible to receive allowance for the loss of their income even though they do not own land in the affected area.

Detailed social impact assessment was carried out in November 2018 for the Gas Transmission Line from Haripur TBS to Dighiborabo CGS. Expected project impact on social aspect has been discussed in this document.

Table 3.4-1: summary table of project impact

SL No.	Assessed and Type of Impact		Unit	Total
1	Amount of Land to be Acquired		Acre	8.86
2	Amount of land to be requisitioned		Acre	8.11
3	Households to be Affected		Nos.	253
4	Households to be resettled among the affected HHs		Nos	12
5	Populations to be Affected		Nos.	1,092
6	Male	609		
	Female	483		
7	Structures to be Affected		sft	15,251
	Pucca	4,711		
	Semi-Pucca	10,082		
	Tin-made	458		
8	Secondary/Associated Structures		Nos.	18
9	Trees to be Affected		Nos.	225
10	Vulnerable Households		Nos.	58
11	Share Croppers	Non-Title Holders	Nos.	1
12	Wage Loser		Nos.	52
13	Business/Enterprise Affected		Nos.	3
14	Impact on renting Opportunity		Nos.	3

3.4.1. Social Conditions of Project Area and Identification of Potential Impacts

Census and Socio-economic survey

The census and socio-economic survey was carried out in November 2018 in the project area. The main objective of the census survey is to obtain details of project affected households i.e. demography of populations, access to education, health and sanitations, occupations and income earning sources and overall social dimensions. The census and socio-economic survey collected a wide range of data, for example, demography, age/sex distribution, education, occupation, income/poverty data, types of businesses, types and ownership status of affected structures and other assets.

The Gas Transmission Line project requires a total of 8.86 acres of land in five mouza. Entire land is privately owned and need to be acquired. Land acquisition process is yet to start and it will take few

months. A total of 253 households with populations of 1092 will be affected by the project due to the land acquisition. Impact on land and populations by the gas transmission line is presented in Table 3.4-2

Table 3.4-2: Number of Land Losing Affected Households and Populations

SL No.	Name of Mouza	Quantum of Land	No. of Households Losing land	No. of Populations
1	Bagnoyanogor	0.07	10	62
2	Behakoir	3.11	102	414
3	Dighiborabo	1.90	67	320
4	Kachpur	1.22	32	116
5	Monoharkharbag	2.55	42	180
Total		8.86 (rounded up)	253	1092

Source: JICA STUDY TEAM, November 2018

General Demography

100% census and socio-economic survey was carried out in the project surroundings area. A total of 253 households with a Project Affected Persons (PAPs) of 1092 were identified and surveyed in Gas Pipeline Project area as shown in below. The average household size is 4.3 which is more or less similar to the national average. The national average household size is 4.42.

Table 3.4-3: General/Demographic Profile of Affected Population

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

Source: JICA STUDY TEAM

Age and Sex Distribution of Affected Populations

The demographic information of the affected populations has been analyzed as a part of the socio-economic profile of the populations of project area. This comprises of gender profile and age-sex distribution of the affected populations in project area. The survey result clearly indicates that there is gender disparity in regards to male-female ratio. The affected populations comprised of 55.8% of males and 44.2% females. More than one-fourth (29.9%) of total populations were identified children and adolescents. Majority (60.8%) of the total affected populations belongs to 20-59 years age group, which also means that the majority of affected populations are in productive age. About 9.27% persons of affected population belong to the retiring and elderly age category. Age group-wise sex segregated total affected population is presented in Table 3.4-4.

Table 3.4-4: Age and Sex Distribution of Affected Population

AGE GROUP	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
0-4	20	1.8	28	2.6	48	4.4
5-9	37	3.4	44	4.0	81	7.4
10-14	52	4.8	39	3.6	91	8.3
15-19	50	4.6	57	5.2	107	9.8
20-24	68	6.2	46	4.2	114	10.4
25-29	55	5.0	47	4.3	102	9.3
30-34	52	4.8	38	3.5	90	8.2
35-39	58	5.3	58	5.3	116	10.6

40-44	52	4.8	32	2.9	84	7.7
45-49	31	2.8	22	2.0	53	4.9
50-54	37	3.4	23	2.1	60	5.5
55-59	29	2.7	17	1.6	46	4.2
60-64	19	1.7	12	1.1	31	2.8
65-69	15	1.4	8	0.7	23	2.1
70+	34	3.1	12	1.1	46	4.2
TOTAL	609	55.8	483	44.2	1092	100.0

Marital Status of Affected Populations

Almost two-third (58.2%) of total affected population was found married while 40.2% of them unmarried. A total of 18 persons were identified as widow/widower. Marital status of affected population is presented in Table 3.4-5:

Table 3.4-5: Marital Status of Affected Populations

Marital Status	Gender				Total	
	Male	%	Female	%	N	%
Married	339	31.0	296	27.1	635	58.2
Unmarried	266	24.4	173	15.8	439	40.2
Widow/widower	4	0.4	14	1.3	18	1.6
	609	55.8	483	44.2	1092	100

Source: JICA STUDY TEAM

Educational Profile of Affected Populations

Based on census and socio-economic data (Table 3.4-6), it was revealed that majority (63.8%) of affected persons have completed primary level education. About 175 (16%) and 78 (7.1%) have passed secondary and higher secondary level education respectively while only 50 (4.5%) identified as privileged of having tertiary level education. Fifty seven affected people were found illiterate. Survey result also revealed that illiteracy rate is comparatively similar between male and female population.

Table 3.4-6: Level of Education of Affected Household Head

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

Source: JICA STUDY TEAM

Occupation Distribution of Affected Populations

According to the census and SES findings, most of the affected household head (49.8%) are engaged with commercial/business activities as the project location considered one of the major business and industrial hub. A detail of occupation distribution of affected household head is presented in Table 3.4-7:

Table 3.4-7: Distribution of Occupation of Affected Household Head

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

Source: JICA STUDY TEAM

Annual Income of Affected Households

The project is located in the major industrial and business hub of the country. Annual income levels of the Affected Household Heads are shown in Table 3.4-8. The 1st and lowest income category is up to BDT 101500/year pertaining to the income vulnerability calculated on Cost of Basic Need (CBN) approach. Among the 253, a total of 25 (9.9%) AHs fall into the vulnerable group. Survey result depicted that 64 AHs (25.3%) live below the poverty line. Census reveals that a substantial number of AHs has higher income and belong to middle-class and upper middle-class strata of the society as the project location are a prominent business area in the country. Lowest income pertaining to the vulnerability assessment is calculated by adding annual inflation rate up to the 2018 since 2010.

Table 3.4-8: Annual Income of Affected HHs

Level of Income (BDT)	Number	Percentage (%)
Up to 101500	25	9.9
101500-150000	39	15.4
150000-200000	42	16.6
200000-250000	66	26.1
250000-300000	14	5.5
300000-350000	6	2.4
350000-400000	15	5.9
Above 400000	46	18.2
Total	253	100.0

Land Holding by Affected Households outside the Project Area

Census and socio-economic survey shows that 38 (15.0%) affected households will become landless while 132 (52.2%) AHs own only 0.05 acres of land. First two categories of affected households will

become virtually landless due to land acquisition for the project. About 72 (28.5%) of the affected household have land outside of the project amounting from 0.06 to 0.35 acres, which is very small considering their dependency on land for livelihood. Details of land holding status by affected household outside of project area is shown in Table 3.4-9.

Table 3.4-9: Ownership of Land by AH outside of the Project Location

Sl. No.	Land Amount (own land)	No. of AH	%
1	Land Less	38	15.0
2	Up to 0.05 Acre	132	52.2
3	0.06 to 0.20 Acre	68	26.9
4	0.21 to 0.35Acre	4	1.6
5	0.36 to .50 Acre	6	2.4
6	0.51 acres to Above	5	2.0
Total		253	100.0

Source: JICA STUDY TEAM

Involvement with NGO/Financial Institutions

Census and SES revealed that a total of 24 affected household are engaged with either NGOs or financial institutions i.e. commercial private or public bank for their regular financial assistance. Involvement with NGOs and financial institutions of projected affected households is presented below Table.

Table 3.4-10: Involvement with NGO and Financial Institutions

SL No.	Name of NGO	No. of HH have Loan	Average Loan Size
1	NGO	19	78,421
2	BANK	5	38,880,000

Source: JICA STUDY TEAM

Accessibilities

Access to Water

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

Table 3.4-11: Access to Water

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

Source: JICA STUDY TEAM

Access to Sanitation

Survey results shows that only 0.29% (5 nos.) not a single affected households are using kutchra i.e. unhygienic latrine. All affected households have sanitary latrine i.e. hygienic sanitation facilities. Available sanitation facilities using by project affected households is presented in Table 3.4-12.

Table 3.4-12: Access to Sanitation

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

Source: JICA STUDY TEAM

Fuel and Energy Sources

A total of 234 (92.5%) affected households are using natural gas for cooking while 19 (7.5%) households using firewood or cow dung cake for cooking. 100% affected households are connected to the National power grid for electricity. Fuel and energy sources and consumption intensity is presented in Table 3.4-13.

Table 3.4-13: Fuel and Energy Sources of AHH

SL No.	Sources of Fuel for Cooking	No. HH	%	Sources of Fuel/Power for HHs Lightening	No. of HH	%
1	Gas	234	92.5	Electricity	253	100
2	Wood/Cow dung Cake	19	7.5	Solar Energy	0	0
3	Kerosene/Diesel	0	0	Kerosene/Diesel	0	0
4	BIO Gas	0	0		0	0
Total		253	100.0	Total	253	100.0

Source: JICA STUDY TEAM

Accessibility to other Social Services

The project is located in the central zone of Bangladesh and very close to the capital city of Dhaka. The project area also regarded as business hub of the country. As a result, the project location has comparatively improved connectivity networks and has adequate opportunity to get services from various Government Department. All of AHs have easy access to health services, educational facilities and religious institutions. Table 3.4-14 shows the distance of basic social services available to the project affected persons.

Table 3.4-14: Accessibility to Other Social Services

SL No	Name of Services	Distance			Total
		< 1 km	>1 < 3km	>3km	
1	Access to Health Services	130	69	54	253
2	Access to Bazar	245	8	-	253
3	Access to Religious Institution	248	5	-	253

Source: JICA STUDY TEAM

Gender Impact

Gender Segregated Education Status and Sex Ratio of Affected Populations

The census covered 100% of affected household in the project area. The survey result clearly indicated that there is gender disparity among populations. The survey identified a total of 1092 persons of which 609 are males and 483 are females respectively. Sex ratio of total affected populations is 1:0.79, which is

significantly less than the national sex ratio. More or less a equitable trend of having education of female PAPs is observed through the survey. About 1.8% of male PAPs completed post-graduation level education while female's share is only 0.3%. Gender segregated education status of affected population is presented in below Table:

Table 3.4-15: Gender Segregated Education Status of Affected Populations

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

Source: JICA Study Team

3.4.2. Land Acquisition and Social Safeguard Legal Frameworks

This section reviews the legal framework for land acquisition and resettlement experience in Bangladesh within the purview of the JICA's safeguard policies and requirements. A policy framework in accordance with JICA's policy, gap analysis and gap-filling measures has been adopted for compensation and resettlement of the affected households/persons. The policy framework is fully aligned with the JICA guidelines for Environmental and Social Considerations.

Cut-off-Date

Eligibility for compensation and resettlement assistance is limited by establishing legal or social cut-off-date in gas pipeline project. As per land acquisition process, serving date of notice u/s-4 is considered as legal cut-off-date for compensation. But the land acquisition process is yet to start for gas pipeline project. In the course of RAP preparation, the census and SES, and Inventory of Loses (IoL) started on 8th November 2018. Thus, the RAP for gas pipeline declared 8th November as the social Cut-off-Date, which necessarily means that, after this date no compensation for new structures or other assets built on the area will be considered.

According to "Natural Gas Safety Rules 1991" decreed by Ministry of Power, Energy and Mineral Resources, section 31 states that the "safe distance" must be maintained to secure Right of Way for gas transmission line. It is also confirmed by TITAS that land acquisition of 20 feet (10feet on both sides) along the transmission line is mandatory. Similarly, additional 20 feet on one side of RoW must be needed for land requisition which will be used temporarily during construction phase and will be returned to the land owners after construction and restoration to the original condition. In some areas where structures or houses already exist, land requisition can be avoided in order to minimize impact.

Any illegal settlement will not be allowed after the social cut-off date. TITAS possesses topography maps which clearly presents all the structures and assets at the time of social cut-off date. Any structures that are not included in the topography map is considered invalid and TITAS holds right to displace those illegal settlements. Additionally, TITAS is coordinating the project with local government offices who manage settlements at the project site so that no illegal settlement should occur.

Legal and Policy Instruments

The project i.e. Gas Transmission Pipe line will be constructed on approximately 10.00 acres) of private land. The RAP is prepared in accordance with two legal and policy framework.

- i. The Government of Bangladesh's Acquisition and Requisition of Immovable Property Act-2017 (ARIPA-2017).
- ii. JICA Guidelines for Environmental and Social Considerations (April 2010).

Gap between Bangladeshi Legal Frameworks and JICA Policies

Table 3.4-16: Summary of gaps between Bangladeshi Legal Framework and JICA Environmental Guidelines

SL No.	Aspects/Issues	ARIPA-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted for the project.
1	Avoid Involuntary resettlement	Avoidance of resettlement is not specifically mentioned in the 2017 Act.	Involuntary resettlement and loss of means of livelihood should be avoided by exploring all viable alternatives.	Gaps with regard to this principle to avoid resettlement impact thru alternative options.	Gas Pipeline ARAP adheres to this principle - i.e., avoid resettlement impacts where feasible.
2	Minimize involuntary resettlement	The law only implicitly discourages unnecessary and excess land acquisition, as excess land remains idle and unused and lands acquired for one purpose cannot be used for a different purpose. Land that remains unused should be returned to the original owner(s).	When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.	Notice u/s-4 under 2017 Act requires notification only; no consultation is required.	-Minimize displacement of people as much as possible by exploring all viable design alternatives. -If unavoidable, provide for prompt payment of just compensation, replacement cost (for lost assets and income) and rehabilitation and livelihood assistance, towards better condition than before relocation for all displaced households, regardless of (land) tenure. Unused land will be returned back to the original owners through de-acquisition.
3	Mitigate adverse social impact	The mitigation measures are cash compensation only for lost assets. The complexities of resettlement are not addressed by the ARIPA-2017. .	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner.	Only cash-based compensation for acquired assets. The impacts of income and livelihood and the need for resettlement are not considered.	Provision for replacement value/cost for lost assets (i.e., land, structures, trees etc.) at replacement cost. Separate Livelihood and Income Restoration Plan be prepared. Mitigation measures/RAPs to be disclosed to the community and available in <i>Bangla</i> .
4	Identify, assess and address the potential social and economic impacts	The 2017 Act requires preparation of a Land Acquisition Plan (LAP) for land acquisition and compensation purposes. However GOB environmental rules/guidelines (1997) synchronize	The impacts to be assessed with regard to environmental and social considerations. These also include social impacts including migration of population and involuntary	Impact assessments are typically done in the case of externally funded projects; otherwise, a land acquisition plan is	ARAP requires identification of impacts caused by displacement whether or not through land acquisition (maintaining the principle that lack of formal title to

SL No.	Aspects/Issues	ARIPA-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted for the project.
		various applicable laws and policy frameworks of the country for early identification of impacts on biophysical, socioeconomic and cultural environment of a project intervention and their mitigation. Requires the assessment of technical alternatives, including the no action alternative to minimize adverse environmental impacts, include impact on human health and safety. EIA identifies measures to minimize the problems and recommends ways to improve the projects.	resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.	prepared for acquisition purposes. Project impacts on properties, livelihoods and employment, health and environment are discussed in IEE/ESIA reports, but do not provide enough information to determine losses and basis for compensation. Existing laws do not have provision for identification of indigenous people to recognize their particular problem and inconveniences due to the project.	land should not be a bar to get compensation and resettlement assistance), including number of affected persons. The Resettlement Framework also addresses both direct and indirect impacts.
5	Prepare mitigation plans for affected persons	The Deputy Commissioners (DCs) has the mandate in their respective jurisdiction as per law to acquire land for any requiring person (public agency or private person). The requiring body requests the Deputy Commissioners for acquisition of land for their project/scheme. DCs investigate physically the requirement of land and carry out Joint Verifications of assets and type of land for assessing the quantity of losses (u/s 9 (1) of the law). The Affected titled holders receive compensation the assessed and determined by DC according to the <i>mouza</i> rates plus 200% additional for land and 100% additional for Structures, Trees and crops. The	People who will be displaced must be resettled and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner.	Existing law and methods of assessment do not ensure Replacement Cost of property at current market price. The ARIPA-2017 has provision for resettlement of displaced households but don't have provision for rehabilitation of affected persons or their loss of income or livelihood resources. "Market value" of property is often found low in respect of current market price, it can be raised, if appealed, by a	ARAP for gas pipeline requires full census and/or updating, where possible, for up-to date database. ARAP will be developed on the updated survey data Provide guidelines to ensure compensation for lost assets at full Replacement Costs and other assistance to help them improve or at least restore their standard of living at pre-project level. Includes special attention to gender and preparation of gender action plan.

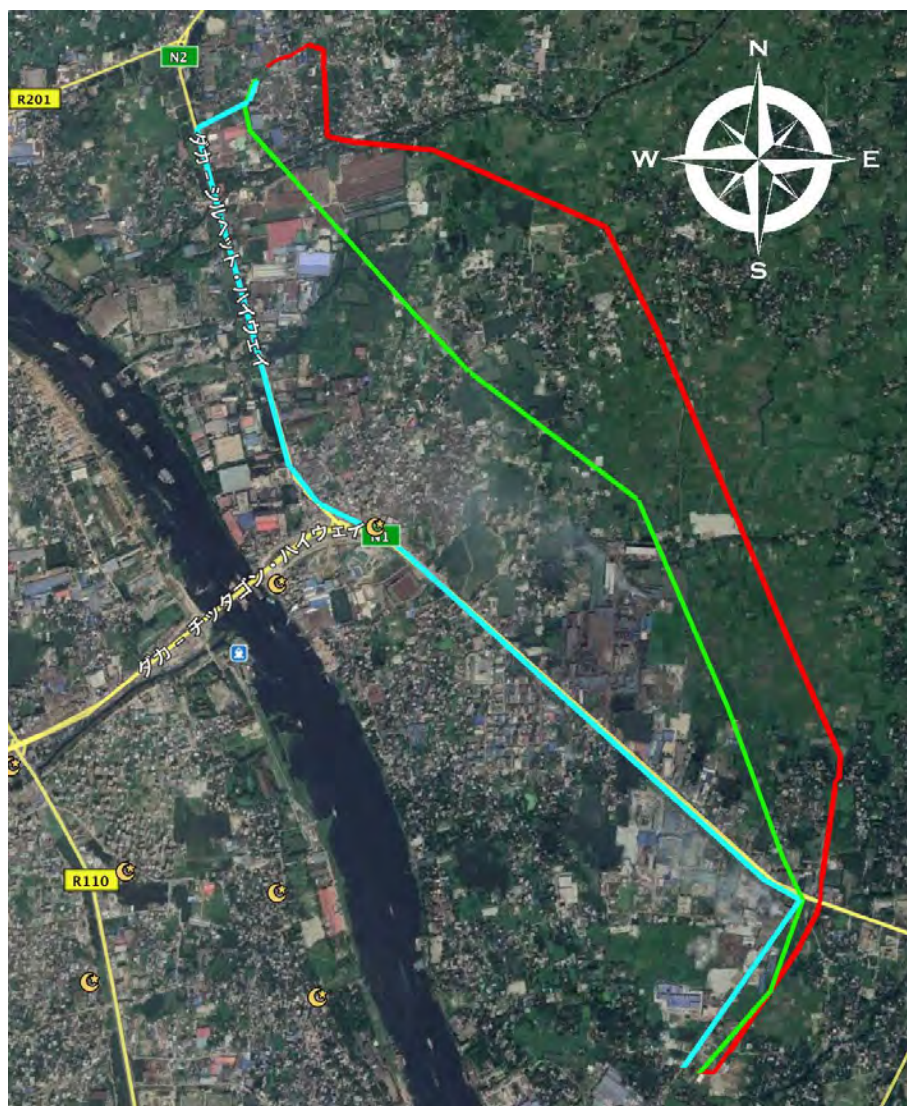
SL No.	Aspects/Issues	ARIPA-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted for the project.
		Deputy Commissioner follows the rate of PWD for structure, DAE for crops, DoF for trees, etc.). Affected owners have the right to appeal on acquisition or on the compensation amounts determined as per law.		maximum of 10 percent each time which in most case is not sufficient to match with real market price.	
6	Consider alternative project design	Feasibility studies including social, political, cultural and environmental impact assessments, detailed engineering surveys as basis for acquisition of private property or rights.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	No specific laws for considering project design to avoid or minimize involuntary resettlement. Feasibility study considers cost benefit more from technical than socio cultural considerations	ARAP for gas pipeline considers feasible alternative project design to avoid or at least minimize physical or economic displacement, while balancing environmental, social, technical and financial costs and benefits.
7	Involve and consult with stakeholders	The ARIPA-2017 have provisions (Section 4 and 4/1) to notify the owners of property to be acquired. Any party having any objections can appear to DC for a hearing with 15 days of notification	Appropriate participation by affected people and their communities must be integrated in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood.	There is no provision in the law for consulting the stakeholders but the land allocation committees at district, division and central government level. People have limited scope to negotiate with the government on the price of land, but have no right to refuse acquisition	ARAP for Gas Pipeline has provisions for community consultation and public disclosure of impacts as well as mitigation measures, including disclosure of Resettlement Action Plan. Further, grievances redress procedures involving cross-section of people, including representative of affected persons, have been established for accountability and transparency.
8	Disclose and inform APs of RP and mitigation measures	The ARIPA-2017 requires serving a "notice" to be published at convenient places on or near the property in a prescribed form and manner stating that the property is proposed to be acquired (u/section 3).	In preparation of a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	Disclosure takes place in case of donor-funded projects.	ARAP for Gas Pipeline requires disclosure of Draft ARAPs to the affected communities in a form or language(s) that are understandable to key stakeholders, civil society, particularly affected groups and the general public in open gathering.

SL No.	Aspects/Issues	ARIPA-2017	JICA Policy/Guidelines (April 2010)	Gaps Between Gob and JICA Policy/guidelines.	Safeguard Measures Adopted for the project.
					Further, updated RAPs will be disclosed based on material changes as a result of the concerns of affected families.
9	Support existing social and cultural institutions of the affected persons	Generally, any social and cultural institutions should be avoided.	The impacts to be assessed with regard to environmental and social considerations. These also include social impacts, including social institutions such as social capital and local decision-making institutions, existing social infrastructures and services.	If avoidance is not possible, the Government shall acquire, but will reconstruct or rebuild the social and cultural institutions.	Affected households were given options for relocation in accordance with their choices and support available forms existing social networks. Host-resettlers' relation was enhanced by providing civic amenities and infrastructure services to the host villages.
10	Build capacity of the borrower(s) in IR implementation	No provision in the ARIPA-2017.	JICA makes efforts to enhance the comprehensive capacity of organizations and operations in order for project proponents etc., to have consideration for environmental and social factors, appropriately and effectively, at all times.	There is a gap in regards to build capacity of borrower or clients of managing resettlement action plan implementation.	ARAP for Gas Pipeline could follow other projects implemented by RHD, BWDB, BBA and the Railway. Special scope could be made for enhancing BEZA's capacity to manage Resettlement Action Plan implementation.

3.4.3. Assessment of Socio-economic Impacts

Alternative analysis - Selection of the project location

The route survey was conducted by JICA consultants under supervision of TITAS in order to identify an alignment that would have least impact possible to the environment and the society. At first, TITAS proposed BEZA to utilize the existing RoW from old existing gas pipeline. However, this idea soon found to be unfeasible because the initial route survey found that it would cause a significant number of resettlements and removals of businesses, loss of jobs, replacement of residential houses. After a series of discussion and assessment among the consultants and TITAS engineers, an alternative route was proposed by JICA's consultant in order to minimize impact and the number of resettlements. Other alternative routes were also compared in terms of impact as well as of time and cost-wise feasibility. The comparison of the alternative routes were shown in Figure 3.4-4 and Table 3.4-2.



Source: Google map – partially modified by JICA Study Team

Figure 3.4-4: Alternative routes

Table 3.4-2: Comparison with alternative routes

	Color of the alignment	Characteristics	Impacts
1		Along the National Hwy. Use of the existing RoW	30-50 Shops (tin Shed and Semi Paca), 4 storied building, 1 CNG pump, 6-8 Tin shed Buildings Disturbance to the national Hwy. Land acquisition could be minimum, however, the construction will disturb the traffic of the national Hwy and will cause significant economic loss and permission from other ministries may be required. Construction would be time-taking and costly due to the traffic. Many shops and small businesses along the national Hwy exists and they would be disturbed or displaced.
2		Avoid structures but also consider the shortest length	20-25 tin shed houses, 1-2 storied buildings, BARM iron rolling factory, himaloy CNG station, Ekhlas spinning mill 1 multi-storied buildings and another small garments. Land acquisition could be less than alignment 3, but the number of displacement of houses, industries will be much higher. Negotiation with large factories and factory workers could take long time. Cost for removing the large structure and compensation for the businesses would be very large.
3		Focused on minimizing structure loss and resettlement.	Tin shed 15-20. 6 small factories (some are not fully operational or are only seasonal). Slightly more land acquisition required than other alignments due to extra bends to avoid structures but the number of resettlement (displacement) and impact to businesses and loss of jobs (temporal) would be minimum. Construction would be faster and less costly.

In accordance with the alternative comparison/analysis above and findings from the consultations with the local businesses and land owners, JICA consultants confirmed that the alignment 3 would be the most feasible and to have least number of resettlement and displacement of the people and businesses.

At the joint meeting at TITAS office on 11 September 2018 with the presence of BEZA's project manager and TITAS's general manager of planning and development, JICA consultants presented the alternative analysis result and both parties agreed to proceed with the alignment 3.

Following the confirmation of the route by TITAS and BEZA, a topographic survey was conducted by JICA consultants in order to acquire detailed information of the structures and surrounding terrains of the RoW. TITAS and JICA's consultants further assessed and modified the RoW in order to minimize the impact as much as possible.

Impact on Land by Type

The Gas Pipeline requires approximately 8.86 acres of land. The entire land for the project identified as privately-owned land and need to be acquired. Large portion (8.17 acres) of land selected for gas pipeline project is found as agricultural category, though at many places the owners of land developed the land for

homestead purposes. But the classification of land is not recorded in the respective land office. The gas pipeline project covers five mouzas in three Upazila in Narayanganj districts. Category-wise quantum of acquired land is presented in Table 3.4-17:

Table 3.4-17: Quantum of Acquired Land

SL No.	Name of Mouza	Number of Plots	Amount of Acquired Land (in acres)					Total	
			Doba body)	(Water	Agri land	Pond	Viti		Fallow
1	Bagnoyanogor	1	0		0.07	0.00	0.00	0.00	0.07
2	Behakoir	74	0		3.11	0.00	0.00	0.00	3.11
3	Dighiborabo	40	0		1.31	0.36	0.07	0.16	1.90
4	Kachpur	21	0		1.22	0.00	0.00	0.00	1.22
5	Monoharkharbag	67	0.0468		2.45	0.01	0.04	0.01	2.55
Total		203	0.0468		8.17	0.36	0.11	0.17	8.86

Source: JICA STUDY TEAM, November 2018

Impact on Structures

Structures Losing Households by Type

Through census and preparation of inventory of losses, a total of 18 households and one religious institution were identified having residential, commercial, industrial and secondary structures in the project alignment. Two industrial units at Dighiborabo were identified in the project alignment. One is a weaving factory and other one is textile mills. Ablution place (Ozu Khana) of Dighiborabo bazaar Mosque will be affected and need to be relocated temporarily. Structures losing households and type of structures will be affected is presented in Table 3.4-18

Table 3.4-18: Structures Losing Households by Type

SL No	Name of Mouza	Type of Structures				Total
		Residential	Commercial	Industry	Secondary/Associate	
1	Dighiborabo	4	1	2	1	8
2	Behakoir	5				5
3	Monohorkharbag	3	1		2	6
	Total	12	2	2	3	19

Source: JICA STUDY TEAM, November 2018

Amount of Affected Structures by Construction Materials

The Gas Pipeline project has very limited impact on structures. A total of 15,251 sft of residential and commercial structures will be affected by the project of which 4,711 sft is pucca, 10082 sft semi-pucca and 458 sft is tin-made and need to be relocated. One weaving factory and one closed textile mills were identified in the project alignment. The weaving factory will be affected partially and needs to be relocated temporarily. The gas pipelines cross the textile mill through its open space; so relocation is not required. Category of structures by construction materials in gas pipeline project is given Table 3.4-19

Table 3.4-19: Amount of Structures by Construction Materials

SL No.	Name of Mouza	Type of Structures			Total
		Pucca	Semi-Pucca	Tin-made	
1	Dighiborabo	916	8,427	248	9,591
2	Behakair	3,795	---	210	4,005
3	Monoharkharbag	---	1,655	---	1,655
		4,711	10,082	458	15,251

Source: JICA STUDY TEAM, November 2018

Impact of Secondary/Associated Structures

The project has very limited impact on secondary or associated structures. A total of 3 deep tube-well (water lifting pump) were identified in the project boundary. Six (6) gas distribution lines, 6 electric

meters, one electric pole with transmitter and one chemical pressure treatment plant need to be relocated. Impact on secondary or associated structures is shown in below Table:

Table 3.4-20: Quantity of Affected Secondary/Associated Structures (sft.)

Types of Movable Structures	Unit	Total
Gas line	Nos.	6
Electric meter	Nos.	6
Deep Tube well	Nos.	3
Electric pole with transmitter	Nos.	1
Chemical pressure treatment Plant	Nos.	1
Wood Seasoning Chamber	Nos.	2
Boundary wall	rft	60

Source: JICA STUDY TEAM, November 2018

Impact on Trees

In addition to impact on land and structures, the Gas Pipeline project has very limited impact on trees. A total of 225 fruits trees were identified of which 147 were large, 37 were medium and 2 were and saplings. There were 29 large size timber trees and only 10 banana trees to be cut down due to the project. Impact on trees is presented in Table 3.4-21:

Table 3.4-21: Number of Affected Trees (by Type and Size)

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

Source: JICA STUDY TEAM, November 2018

Impact on Vulnerable Households

Certain groups of population by virtue of their socio-economic realities are considered socially vulnerable and thus in need of special consideration so that they can benefit from the development activities of the project. These groups include: (a) headed by single men or women with dependents with low income ; (b) headed by old/disabled people without means of livelihood support; (c) households that fall on or below the national poverty line ; (d) elderly headed households and (e) disabled headed households and (f) households belong to indigenous or ethnic minority population . The above groups have been recognized as “vulnerable groups” under the Project. The Cost of Basic Need (CBN)³ method was followed to determine the poverty-line income.

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

Table 3.4-22: Affected vulnerable AHs.

Vulnerable Category	Total	%
Female Headed AH without male income earner	20	34.5
Elderly Headed Households (70+)	13	22.4
Households belonging below poverty line (96000 BDT yearly income)	25	43.1

³Household income and expenditure Survey (HIES)-2010 and adding inflation rate up to 2017

Total	58	100.0

Source: JICA STUDY TEAM, November 2018

Impact on Sharecroppers

In Bangladesh land owners leased out their land to intending farmers on temporary basis and for a certain period of time on verbal and mutual understanding. Through this informal arrangement, the sharecropper sometimes has to pay money to owners and sometimes share the harvested crops. In most cases there is no written agreement between the land owners and sharecroppers. To identify the sharecroppers, the land owners are the main source as there is no written agreement or contract between them. Impact on indirectly affected person was assessed through census and SES. Only one (1) persons were identified as sharecroppers in the project area. A list of sharecroppers is annexed with this document. Mouza-wise sharecroppers are presented in Table 3.4-23:

Table 3.4-23: Mouza-wise Sharecroppers

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

Source: JICA STUDY TEAM, November 2018

Impact on Wage Earner/Factory Workers

In the process of census and impact assessment in the project alignment, three small industrial units and one restaurant were identified. The Sayeed Textile Mills at Dighiborabo is found closed since long ago. No persons or worker except one security personnel involve with this industry. The employed security guard will not lose his job. Other two small industries are operating with its full capacity. Sayeed Textile mills don't require relocation as the pipeline goes through its open space. But other two factories need to be relocated temporarily. Workers involved with these factories will lose their job due to construction of the gas transmission line. A total of 52 workers will lose their livelihood earning source. Number of wage loser person is presented in Table 3.4-24.

Table 3.4-24: Number of Wage Loser in the Gas Pipeline Project

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

Source: JICA STUDY TEAM, November 2018

Impact on Income from Business

There are 3 business enterprise identified in the project alignment. The owners of the enterprises will lose their income from business due to the construction of the gas pipeline. Khan Garments will be affected and need to be relocated partially. The owner will lose income source-base partially. Tea Stall and Restaurant owner will lose income earning opportunity due to construction of and installation of gas pipeline. All of them are running their enterprise/business on rental premises and they will have to pay monthly rent to the owner until the termination of rental agreement. Impact on income from business is presented in Table 3.4-25.

Table 3.4-25: Impact on Income from Business

Name of industry/ business	Affected	Monthly rent	Advance Paid	Yearly net Income

	households			
Khan Garments	1	100,000	500,000	-----
Tea Stall	1	6,000	30,000	180,000
Restaurant	1	27,000	50,000	360,000

Source: JICA STUDY TEAM, November 2018

Impact on Income from House Rent

During census and impact assessment, three landlords were identified who rent their living/housing structures. The identified structures will be demolished due to construction of gas pipeline. They will lose their income from house rent and thus their livelihood will be interrupted. There were 16 small housing units and the owner got average BDT 6000/month for each unit. Actually income from house rent is their main and principle livelihood means. Impact on income and livelihood from house rent should be mitigated. Summary of impact on income from house rent is presented in *Table 3.4-26*.

Table 3.4-26: Impact on Income from House Rent

No. of Affected households (Landlord)	No. of Renter	Average Monthly rent	Total Monthly Loss
3	16	6000	96000

Source: JICA STUDY TEAM, November 2018

Impact on Indigenous Populations and Ethnicity

According census and SES in 2018 conducted by JICA STUDY TEAM, no indigenous or ethnic minority populations were identified in the project area.

Impact on Land for Requisition

The proposed Gas Transmission Line Project requires additional land along with the RoW for construction purpose. This is known as “Land requisition”. The is required for temporary period up to the completion of the construction works. The project requires a total of 8.11 acres of additional land in six mouza to be requisitioned. The land selected for requisitioned is identified as flat agricultural land. However, no structures were identified in the “Requisition Area”. A total of 243 households will be affected due to requisition. Almost all of them would also be affected in the “Acquisition Area”. The Deputy Commissioner will inform the respective land owners in written form regarding the purpose and necessity of requisition and compensation assessment process. The Deputy Commissioner required land initially for two years’ period as per ARIPA-2107, so compensation should cover for the land value of 2 years. The summary and quantum of requisitioned land in presented in *Table 3.4-27*.

Table 3.4-27: Summary of Estimated Land Requisition Area:

Sl. No.	Mouza Name	Number of Plots	Requisition Land in Acres	Number of Owners
1	Dighiborabo	33	1.61	60
2	Monoharkharbag	77	2.33	79
3	Chengail	1	0.01	1
4	Kachpur	22	0.96	35
5	Behakoir	73	3.12	66
6	Bagnoyanogor	2	0.07	2
Total		208	8.11	243

Summary of Impact

Detailed social impact assessment has been carried out in November 2018 for the Gas Transmission Line from Haripur TBS to Dighiborabo CGS. Probable project impact on social aspect has already been discussed in this document. A summary of impact is presented in the Table 3.4-28

Table 3.4-28: Summary of Project Impact

SL No.	Assessed and Type of Impact		Unit	Total
1	Amount of Land to be Acquired		Acre	8.86
2	Amount of Land to be requisitioned		Acre	8.11
3	Households to be Affected		Nos.	253
4	Populations to be Affected		Nos.	1092
5	Male	609		
	Female	483		
6	Structures to be Affected		sft	1361.97
	Pucca	4,711		
	Semi-Pucca	10,082		
	Timade	458		
7	Secondary/Associated Structures		Nos.	18
8	Trees to be Affected		Nos.	225
9	Vulnerable Households		Nos.	58
10	Share Croppers		Nos.	1
11	Wage Loser		Nos.	52
12	Business/Enterprise Affected		Nos.	3
13	Impact on renting Opportunity		Nos.	3

3.4.4. Eligibility and Entitlements

Eligibility for compensation and resettlement assistance is limited by Cut-off-Date. The cut-off-date for compensation under law for those identified on project Right of Way (RoW) is considered to be the date of serving notice under section-4 according to the ARIPA of 2017.

The legal cut-off-date will be established following land acquisition process for gas pipeline project. The land acquisition process is yet to start for the project. Identified legal owner will get compensation for land and other properties on the acquired land. However, person without legal titled to the land is not eligible for compulsory compensation.

Persons have no title to the land, but living in the project alignment, sharecroppers, factory workers, shop vendors, vulnerable women headed households identified through census will get resettlement assistance. The census starting date i.e. 8th November 2018 is the social cut-off-date for non-title affected person. Any persons moving into the area after the cut-off-dates will not be entitled for compensation either from DC or BEZA.

Valuation of Assets

The Deputy Commissioner follows the principles/rules of written down in the ARIPA-2017 to determine the market prices of assets like land, structures and trees on acquired land. The Deputy Commissioner determined market price of land as per mouza rate of the same year prepared by the Land Registry Office for each mouza for each land category for the 8.86 acres. The Deputy Commissioner shall calculate Cash Compensation under Law (CCL) for land by adding 200% with the mouza rate according to ARIPA-2017. In determination of market price structures, trees and crops the DC will follow the rates and rules of

Public Works Department (PWD), Department of Forest (DoF) and Department of Agriculture Extension (DAE) respectively. The Deputy Commissioner shall calculate the Cash Compensation under Law (CCL) by adding 100% with the determined price for structures, trees and crops.

The mouza rate basically prepared by averaging transaction value of corresponding year for each category of land for each mouza and the Land Registry office update it in the month of July in every year. The determined value is invariably less than the “market price” as owners customarily report undervalued land transaction prices in order to pay lower stamp duty and registration fees. As a result, the mouza rate of land is always found lower than the actual market price.

The Acquisition and Requisition of Immovable Property Act promulgated and enacted in 2017 and have provision for additional 200% of mouza rate to ensure “market price” of acquired land. The provisions for calculating CCL is fair enough to match with market price as the ARIPA-2017 promulgated and enacted very recently. The affected persons demanded compensation at the rate of 3 times higher than mouza rate in public consultation meeting. However, compensation for acquired assets/property assessed through legal procedures i.e. in accordance of ARIPA-2017 ensures fair and commensurate with the existing market price. For gas pipeline project, there is no need to consider replacement value (Top-up) for acquired land, structures and trees.

Requisition of Land for Construction Works

The gas pipeline project requires temporarily 8.11 acres of land along the project right of way for construction works. According to the Acquisition and Requisition of Immovable Property Act-2017, the Deputy Commissioner has the authority and mandate to take possession of land in public interest by imposing section 20(2) for two years tenure. The rationale, procedures and compensation assessment methods has been laid down in the third (3) chapter of the ARIPA-2017.

The Deputy Commissioner will inform the land owners in written form of to explain why and what purpose the land will be requisitioned. The Deputy Commissioner or the project authority can't use the requisitioned land for other purpose except the declared one. The Deputy Commissioner or the project authority could not change the type of requisitioned land. If any damage will occur during the project construction, the Deputy Commissioner shall pay proper compensation for restoration of the damages and make the land as it was before the requisition.

Through requisition the government shall established land use right by imposing its domain authority. However, the land owner will get proper compensation for requisitioned land. After taking possession, the DC could hand over the land to the respective project proponent. After two years of issuing date of notice under section 20(2), the validity of the requisition order will be terminated automatically.

The requisitioned land is found necessary for more than two years; the Deputy Commissioner will review the award and inform the land owners in writing. The Deputy Commissioner could not issue requisition order on land using for homestead, religious and educational institutions, orphanage, hospital, public library and grave yard. The Deputy Commissioner will pay compensation following requisition procedures and take possession of required land for two years. Should the construction be completed before the two year period, the land can be returned to the owner without waiting for the two year period.

Eligibility for Compensation and Entitlement Matrix

Table 3.4-29: Entitlement Matrix for the gas transmission line

Loss Item 1: Loss of Agricultural Land			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Legal owner/ titleholders as identified by Deputy Commissioner (DC) in the process of CCL payment.	- Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. - BDT 650/decimal as one-year crop compensation. - The cultivators will be allowed to harvest the standing crops free of cost.	DC will pay Cash Compensation under Law (CCL) for the land.	- Persons entitled will be informed of the details about the land acquisition and compensation policy, process, resettlement package and payment procedures. - DC will determine and pay the price of acquired land with 200% enhancement of mouza rate as CCL.
Loss Item 2: Loss of Homestead , Commercial Land and Common Property Land			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Legal owner/ title holders as identified by DC in the process of CCL payment.	- Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. - Affected person will get opportunity to construct houses on land after completion of construction.	DC will pay Cash Compensation under Law (CCL) for the land	Persons entitled will be informed of the details about the land acquisition and compensation process, resettlement package and payment procedures.
Loss Item 3: Loss of Water Bodies (Ponds, Both Cultivated and Non-Cultivated)			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Legal owner/ titleholders as identified by (DC) in the process of CCL payment.	- Cash Compensation as replacement cost (RC) of agricultural land at 3 times higher of mouza rate. - BDT 400/decimal to be considered as one-year compensation for fish cultivation. - The fish cultivators will be allowed to catch/harvest all the fishes free of cost before taking possession.	DC will pay CCL (Cash Compensation under Law) for the pond.	Persons entitled will be informed of the details about the land acquisition and compensation policy, process, resettlement package and payment procedures.
Loss Item 4: Loss of All Types of Structures With or Without Title to Land			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Legal owner/ titleholders as identified by DC Or as identified through the JVC and census/IoL.	- Cash Compensation as Replacement Cost (RC) for structures with additional 100% of assessed value determined by the DC with the assistance of PWD. - BDT 1699/sft for Pucca structures+100% additional with the rate. - BDT 886/sft for Semi-Pucca structures+100% additional with the rate. - BDT 410/sft for Tin-made structures+100% additional with the rate.	- Applicable to all structures located within the project RoW at the cut-off date. - DC with the assistance of the PWD will assess and finalize the rate of CCL for affected structures. - DC will disburse CCL. - BEZA will provide other	- Firm will identify the structures loser EPs according to Joint Verification Survey and assess and calculate structures type and amount of structures to be displaced. - DC will determine the value for structures with assistance of PWD and pay the value for structures with 100% enhancement as CCL.

	• BDT 20/sft, but not exceeding BDT 15000 as Transfer Grant (TG) for shifting affected structures. • BDT 30/sft, but not exceeding BDT 20000 as Reconstruction Grant (RG) for reconstruction of affected structures • BDT 20000 for each HH as Re-installation Grant of utility services (electricity, gas, tube-well and latrine). • BDT 1,000,000/deep tube-well re-installation. • As structure demolition grants, the owners will be allowed to take away all the salvageable materials free of cost within the declared date of BEZA/TITAS.	resettlement benefits directly or through the TITAS.	
Loss Item 5: Loss of Trees With or Without Title to Land			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
• Legal owner/ titleholders as identified by DC • Socially recognized owners of trees grown on public or other land, as identified through census. • Owners of trees such as Forest Department, Cooperatives society, Zilla Parishad, City Corporation, Lessee on public land	• BDT 10000 for each large, BDT 8000 for each medium, BDT 1500 for each small of fruits trees respectively. • BDT 15000 for each large timber trees respectively. • BDT 300 for each banana tree. • Owners of the trees will be allowed to take away the salvageable materials free of cost within the BEZA declared date.	• Applicable to all trees and plants located within the project RoW at the cut-off date. • DC will pay CCL as applicable for trees/plants.	• Standard rates for trees and fruits of different species available with the Department of Forestry/Horticulture will be considered by DC in calculating the CCL. • DC will finalize the market price of trees and fruits with assistance from Department of Forest/Horticulture and enhance it by 100% to fix up under Cash Compensation under Law (CCL) • Forest Department, Cooperatives society, Zilla Parishad, City Corporation will not be considered for resettlement benefits.
Loss Item 6: Loss of Income from sharecropping			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
• Sharecroppers cultivating land within the project RoW, as identified through census and SES.	• Transitional allowance of BDT 8000/month for 3 months.	• BEZA will pay the entitlement to the EPs with the help of GRC. • The net income per month assessed through CBN methods and to be finalized by the BEZA/TITAS.	▪ Census will identify (records, Nos. and category) ▪ Eligibility to be based on businessmen identified by the census • Compensation must be paid one month before EP dismantles and removes the structures as per works requirements.
Loss Item 7: Loss of Wage (Factory and Shop workers)			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues

• Factory Workers, shop worker within the project RoW, as identified through census and SES	• Transitional allowance of BDT 12,250/month for 6 months. The rate presented (12,250 BDT) is subject to change by proper valuation of the actual salaries of the workers. Any excess cost incurred by this can be covered by contingency budget of BEZA.	• BEZA will pay the entitlement to the EPs with the help of GRC. • Compensation rate is at actual monthly salary of identified wage loser.	▪ Census will identify (records, Nos. and category) ▪ Eligibility to be based on businesspersons identified by the census.
Item 8: Loss of Income from Business			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
• Business owner, within the project RoW, as identified through census and SES	• Transitional allowance of BDT 20,000/month for 6 months. The rate presented (20,000 BDT) is subject to change by proper valuation of the affected business. Any excess cost incurred by this can be covered by contingency budget of BEZA.	• BEZA will pay the entitlement to the EPs with the help of GRC. • The net income per month assessed through CBN methods and to be finalized by the BEZA/TITAS.	▪ Census will identify (records, Nos. and category) ▪ Eligibility to be based on businessmen identified by the census ▪ Compensation must be paid one month before EP dismantles and removal of the structures as per works requirements.
Item 9: Loss of Income from House Rent			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
• Landlord or the house owner, within the project RoW, as identified through census and SES	• Transitional allowance of BDT 6000/month for 6 months.	• BEZA will pay the entitlement to the EPs with the help of GRC. • The net income per month assessed through CBN methods and to be finalized by the BEZA/TITAS.	▪ Census will identify (records, Nos. and category) ▪ Eligibility to be based on businessmen identified by the census ▪ Compensation must be paid one month before EP dismantles and removes the structures as per works requirements.
Loss Item 10: Temporary Loss of Land in Requisition Process			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Legal owner/ titleholders as identified by Deputy Commissioner (DC) in the process of Compensation payment.	• Cash Compensation for temporary use of at mouza rate. • BDT 650/decimal as two-year crop compensation. • The owners will retain the land upon completion of construction works.	• DC will assess and pay Compensation. • Requisition order shall remain valid initially for two years. • If the requisitioned land is further required by the project, the DC will inform the owners in written and review the compensation package.	• Persons entitled will be informed of the details about the land acquisition and compensation policy, process and payment procedures. • The compensation ceiling or rate is subject to decision of the concerned Deputy Commissioner.
Item 11: Grants to Vulnerable AHs			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues

Vulnerable households (Poor, female headed HHs, Elderly headed HHs, disabled/physically challenged, Indigenous, and Homeless) will be considered as vulnerable HHs.	• BDT 15000 for each HHs as Vulnerability Allowance (VA)	• The EPs will be identified as per the census. • The entitlement will be provided to the identified EPs by BEZA.	• Vulnerable households losing income from business, employment and livelihood resources will be assessed through census.
Item 12: Unforeseen Adverse Impacts			
Persons Entitled	Entitlements	Application Guidelines	Implementation Issues
Households/Business, Structures, persons affected by any unforeseen impact identified during RAP implementation.	• Entitlements will be determined as per the Entitlement Matrix	• The unforeseen impacts will be identified through special survey by the Firm as directed by BEZA • BEZA will take necessary action based on GRC decision • The entitlements will be approved by BEZA • The payment will be made by BEZA with the help of Firm	• The unforeseen impacts and displaced persons will be identified with due care as per policy of the project

In addition to the entitlement matrix above, it should be noted that if any damage should occur to the land requisition area during the project construction, the Deputy Commissioner shall bear land restoration cost and the land must be returned to the land owner(s) in original and satisfactory condition.

Compensation and Payment Mechanism

BEZA will ensure that the properties (land, structures and other assets) to be displaced for the Gas Transmission Line project will be compensated at full replacement cost, determined by the Deputy Commissioner. The principle for determining value and compensation for assets, incomes, and livelihoods is replacing the loss of affected assets and restoring the loss of income and workdays experienced by the displaced households. Income Restoration and Livelihood Assistance will be provided to vulnerable households and business enterprises.

This RAP ensures Replacement Cost for land will be paid by the DC. PAPs will receive compensation from the DC for acquired properties and resettlement and other assistance, as indicated in the RAP (entitlement matrix) will be provided by the BEZA.

Compensation and Resettlement Procedures for Titled Holders.

Deputy Commissioner's (DC) Compensation to Titled Holders (TH)

1. BEZA produced and prepared Land Acquisition Plan (LAP) and submit to the Deputy Commissioner (DC).
2. The DC will carry out a feasibility study of the acquisition and submit the report to the Ministry of Land (if the land is more than 16.67 acres) or to the divisional commissioner (if the land is less than 16.67 acres) for approval.
3. Upon approval of the LAP from Ministry of Land (MOL) or from Divisional Commissioner, the DC will issue notice under section 4 of ARIPA to the recorded owner of the affected property
4. Representative from the acquiring body (DC) and requiring body (BEZA) will conduct a joint verification survey of the affected property within 3 days of serving notice u/s-3 and wait 15 days to receive any complain from land owners.
5. The DC will issue notice u/s 6 to entertaining claims from affected persons.
6. On the basis of the joint verification survey data, the DC will request valuation of structures, trees and crops from the Public Works Department (PWD), the Forest Department and Agriculture Department, respectively.
7. The DC will collect recorded land price from the concerned Sub- register's office from the last 12 months previous to the date of notice under section 3.
8. After receiving the rates from PWD, Forest and Agriculture Departments, the DC will prepare an estimate, adding 50% premium where applicable and send it to the requiring body (BEZA) for placement of fund within 60 days.
9. The DC will prepare the award for compensation in the name of recorded owner.
10. Upon placement of fund, the deputy commissioner will issue notice u/s 11 to the titled owners for receiving cash compensation under law (CCL) within 15 days from the date of issuing notice u/s 11.
11. The affected persons will need to produce record of rights to the property with updated tax receipt of land, declaration on non-judicial stamp; photograph etc. to the DC office with the claim.
12. Upon fulfillment of documentation requirements, the DC office disburses CCL in the office or at field level issuing prior notice to the landowners.

3.4.5. Income and Livelihood Restoration Program

The Gas Pipeline for AEZ will be constructed and installed on private land. A moderate but not few numbers of populations will lose their income resource base. Restoration of income and livelihood of the affected to pre-project level is thus one of the most important tasks in resettlement management. This RAP has provision for interim support to mainstream alternative income generating scheme or

enhancement of existing livelihood resources so that AHs can either continue their previous occupation or can start new venture or undertake an alternative occupation. The basic objective of income and livelihood restoration and rehabilitation measures is to restore the economic status of the AHs at least at the level they have prior to the project.

Livelihood Impact and Risk

Affected Person experienced loss of livelihood sources mainly due to loss of agricultural land and agricultural productive base. The Affected Persons compel to surrender their land due to the project and they may experience temporary disturbance in their income and working habit. A small number (38) out of 253 Affected Households will become landless due to the land acquisition for the project. They can't purchase replacement land with the compulsory compensation and other resettlement assistance as there is acute land scarcity in the project area and price of land is sky-rocketing every day. They might be going for other enterprise or business activities for their livelihood.

It was revealed through census and SES, only 6.3% of affected households engaged with agricultural activities for their livelihood. Majority portion of affected household heads (49.8%) are involved with business. Level of annual income of affected households has been assessed and only 58 households fall under vulnerable category. The project located in one of the major industrial hub of the country and peoples living in the area are involved with different types of activities. Only one women headed households was found unemployed.

Measures of ILRP

Provisions for Income and Livelihood Restoration program focused on improvement or at least restoration of livelihood and income of all APs. The measures consider diminishing of income and disruption of livelihood earning due to the project. In addition to provided compensation at mouza rate with additional 200% of mouza rate ensured mitigation of impact on livelihood due to the land acquisition. With the given compensation and other resettlement assistance, the affected household may able to enhance and improve their living conditions having engaged with multiple livelihood activities. The project requires only 8.86 acres of land in a strip of about nearly six kilometers stretch. It was found during the census survey that the land acquisition does not have significant livelihood impact on affected person or households. On the other hand, the RAP produces suitable and appropriate provision for transitional allowances for wage loser, business loser and house owner to address their needs during construction period. Due to very insignificant and unrecognizable impact due to land acquisition, unlike to the RAP for the AEZ, this gas transmission line project does not sponsor separate income and livelihood restoration program.

3.4.6. Grievance Mechanism

Grievance Redress Committee (general description is given in 3.2.6)

BEZA will form Grievance Redress Committees at Union and project level to resolve complaints or grievances formally through community participation. The GRC at union level will be composed off five members who include representative from BEZA, Union Parishad Chairperson, Two representatives including one woman from PAPs and TITAS representative. Representative of BEZA chaired the committee while TITAS representative will act as member secretary of the committee.

The project level GRC will be composed of 3 member who include the Project Director and Social Safeguard Specialist of BEZA. The project director will chair the committee while Safeguard Specialist will act as member secretary of the committee.

Scope and Jurisdiction of GRC

The GRC will be activated with the responsibilities to resolve resettlement and compensation related grievances/issues not to be addressed under legal suits in the courts. Scope of work and jurisdiction of GRC is as follows:

- The GRC will receive grievances, complaints or disputes through TITAS field office from affected persons in writing.
- The field official of TITAS will assist Affected Person to lodge/register any resettlement grievance, complaints or disputes over ownership title of acquired land/assets to the GRC.
- The GRC will review, consider and resolve grievances related to social/resettlement and environmental mitigation during RAP implementation.
- Any grievance, complaints and problems should ideally be resolved on the first day of hearing or within a period of one month, in case of any complicated one requiring additional and field investigation.
- Grievance of Indirectly affected persons will also be reviewed by GRC.
- GRC decisions should ideally be arrived at through consensus, failing which resolutions will be based on majority vote.
- Any decision made by GRC must be within the purview of social, resettlement, and environmental policy framework.
- The GRC will not deal with any issues/matters pending in the court of law. But if the parties agree on through written appeal, then GRC can only mediate for withdrawing of litigation.
- Other than disputes relating to ownership right under the court of law, GRC will review grievances involving all resettlement benefits, relocation and other assistance. However, the major grievances that might require mitigation include:
 - Dispute over APs not enlisted in the original IOL or census.
 - Losses not identified correctly.
 - Compensation/assistance not as per entitlement matrix.
 - Delay in disbursement of compensation/assistance.
 - Disputes over ownership
 - Improper distribution of compensation/assistance in case of joint ownership

A minimum three (3) members shall form the quorum for the meeting of GRC.

Disclosure and Procedures

Upon taking possession of acquired land, BEZA will form Grievance Redress Committee. Prior to the start of construction works, BEZA and its representative will make sure to the PAPs about the establishment of grievance redress mechanism and the process. All relevant contact information and the grievance redress steps posted at every UP office involved as well as TITAS field office. The poster will be in local language and posted as soon as possible. The BEZA representative will check at least every month to ensure that the posters are properly displayed and contact instructions and numbers are clearly provided.

GRC meeting will be held in the respective field office of BEZA or TITAS or any other location as agreed by the Committee and also convenient to the Project Affected Persons (PAPs). If needed, GRC members may take field visits to verify and review the issues at dispute, including ownership/shares, reasons for any delay in payments or other relevant matters.

Documentation and record keeping

All GRC documents will be maintained by TITAS field officials for review and verification by supervision consultants of BEZA. TITAS or BEZA field offices will act as secretariat to the GRCs. As a result, the record will be up-to-date and easily accessible on-site.

3.4.7. Institutional Framework

Deputy Commissioner's Office

The Deputy Commissioner (DC) has the key role in the RAP implementation process. The DC has the legal responsibility of acquiring land and paying compensation directly to the AHs as per the Acquisition and Requisition of Immovable Property Act-2017 (Act-21 of 2017). DC has access to official record and the Legal/Administrative authority for determining market price of acquired and updating ownership title of land for Cash Compensation under Law (CCL). The District Land Acquisition Officer (DLAO) will assist and support Deputy Commissioner in land acquisition process. The Deputy Commissioner will conduct joint verification to assess quantum of acquired property and estimate cost for acquisition. The DC offices will receive funds from BEZA for payment of compensation to the directly affected persons. Participation of DC is necessary in project area meeting to avoid any unwanted circumstances related to law and order. Similarly DC's interventions/assurances will be required in matters such as disposal of land ownerships disputes, allotment of surplus land for construction of common properties.

Project Director Office

BEZA has established a Project Management Unit (PMU), headed by a Project Director (PD) who is responsible for the overall execution of the Araihaazar Economic Zone Project. The Project Director of AEZ will perform as Chief Resettlement Officer (CRO) assisted and supported by an Assistant Manager and Social Development Specialist. The Project Director of AEZ will be the responsible officials for Gas Pipeline Project.

The PD/CRO will responsible for:

- Overall resettlement and rehabilitation work.
- Call and chair regular coordination meeting between PMO-SIU and TITAS.
- Coordinate the implementation of Resettlement & Rehabilitation activities with Head Office and Field office.
- Approve micro plan prepared by TITAS.
- Monitor monthly progress of RAP implementation.

- Guide staff of BEZA, M&E agency on policy related issues during implementation; and
- Ensure timely release of fund for Resettlement & Rehabilitation activities.

Safeguard Implementation Unit

The executing agency (here is BEZA) will implement the RAP through setting a Safeguard Implementation Unit (SIU), headed by the Assistant Manager as Resettlement Officer under the PMU. The concerned Resettlement Officer (RO) with the status of Assistant Manager at the SIU, will act as the Convener of the Grievance Redress Committee (GRC) and the Resettlement Advisory Committee (RAC).

The SIU will carry out the following specific tasks relating to RAP finalization and its implementation:

- Coordinate necessary arrangement to support RAP finalization and implementation activities, *i.e.* appointing GRC.
- Submit updated RAP to JICA, prepared by the consultant for review, endorsement, and disclosure before RAP implementation;
- Ensure meaningful consultations and stakeholder participations during RAP updating and its implementation;
- Perform the overall responsibility of planning, management, monitoring, and implementation of the program;
- Ensure availability of necessary budget for complying with all necessary activities;
- Synchronize compensation payment activity and handover required land to the contractor;
- Develop RAP implementation tools and forms, including necessary Committees; and
- Monitor the effectiveness of entitlement packages and payment modality.

Resettlement Management Committee

To arrive at a fair compensation sufficient to cover replacement value of the lost properties and assets, formation of a Property Valuation Advisory Committee is considered for each Upazila. Again, to redress a mechanism to dispose of the complaint out of the court as per RAP, for setting up a Grievance Redress Committee (GRC) for each union is also felt indispensable.

Grievance Redress Committee (GRC)

A mechanism to dispose of the complaints out of the court, a Grievance Redress Committee for each union has been very useful in Bangladesh. The GRC in BEZA will be composed of:

1. Representative of BEZA : Convener
2. Representative of TITAS : Member
3. Chairman/Mayor : Member
4. Two Representative of DPs (one male or one female) : Member

Institutional Responsibilities for Providing Resettlement Assistances

Table 3.4-30: Institutional Responsibilities in Compensation Providing Process

Related Activities and Responsibilities	Responsibility
A. Finalization of RAP	
Design and reproduction of RAP information materials	BEZA
Disclosure and public consultations	BEZA
Selection of members and establishment of Resettlement Advisory Committee	BEZA
Design and carry out joint verification survey	DC/BEZA
Processing the census survey data of AHs	BEZA
Assessing AHs and vulnerable AHs to be relocated	BEZA

Related Activities and Responsibilities	Responsibility
Determination of entitlements and consultations with individual AHs	BEZA
Disclosure of RAP to BEZA, APs, and concerned stakeholders	SIU-BEZA
Review and concurrence of final RAP	JICA
Approval of RAP	BEZA
B. RAP Implementation	
Preparation and Issuance of ID cards to AP	BEZA
Formation and Mobilization of GRC	BEZA
Appointment of External Monitoring Agency (EMA)	BEZA
Establishment of internal monitoring unit/team	BEZA
Budget approval for compensation and other benefits	BEZA/TITAS
Release of funds for payment of compensation/resettlement benefits	BEZA/TITAS
Payment of compensation and other benefits	BEZA/TITAS
Filing and resolution of complaints of APs	BEZA/TITAS
Confirmation of “no objection” for the award of civil works contract	JICA
Relocation and livelihood restoration assistance	BEZA/TITAS
C. Monitoring, Evaluation and Reporting	
Internal monitoring and evaluation	BEZA
External monitoring and evaluation	External Monitor
Biannual safeguard monitoring report	BEZA/TITAS

3.4.8. Monitoring and Evaluation

Monitoring and Evaluation are the key apparatus of RP implementation. Monitoring is a periodical checking of planned activities and provides midway inputs, facilities changes, if necessary, then provides feedback for project management to keep the program on schedule. Evaluation on the other hand assesses the resettlement effectiveness, impact and sustainability of Resettlement and Rehabilitation program. BEZA will establish a monitoring and evaluation system under the jurisdiction of Project Director at PMO office. Monitoring will continue till the end of RP implementation. Components will include performance monitoring i.e., physical progress of work and impact monitoring and external evaluation.

BEZA is going to form 1) an internal monitoring to confirm the progress of the RAP implementation and adequacy of the entitlements and to plan necessary additional safeguard measures if it is necessary, and 2) independent evaluations to evaluate the effectiveness of the proposed entitlements, monitor the recovery of the living standards for the PAPs, and recommend BEZA to enforce necessary additional measures if it is necessary.

Monitoring and evaluation will be accomplished by collecting, analyzing, reporting and using information, about resettlement progress as per the scope of the RAP. A standard database will be developed for the purpose of constant monitoring and post evaluation of the RAP targets.

The BEZA will conduct the daily operation of land acquisition, payment of compensation, identification of entitled persons physically, and processing their entitlements, relocation and resettlement, those field level monitoring and assessment.

Approach and Methodology

The SIU will monitor and measure the progress of implementation of the resettlement action plan. The scope of monitoring activities will be proportionated to the projects' risks and impacts. As well as recording the progress in compensation payment and other resettlement activities, BEZA or its external social consultant are responsible for preparing and submitting quarterly report to JICA and must respond for information disclosure for monitoring and evaluation or RAP anytime should there be request from JICA to ensure that the implementation of the resettlement plan has produced the desired outcomes. To assess the changes and variations the M&E approach will identify and select a set of appropriate indicators and gathering information on them. The M&E process will ensure participation of stakeholders, especially the affected persons, women and vulnerable groups. The process will also undertake different formal and informal surveys for impact analysis. M&E processes assess the resettlement efficiency, effectiveness, impact and sustainability will carry out through the identification of lessons from the project for building upon future remedy.

Stages of M & E

Monitoring and evaluation process will be focused on indicators specific to process by PIU and outcomes at three consecutive stages of RP implementation: RP preparatory stage, relocation stage and rehabilitation stage. Viewpoint of M&E at these stages will be as follows:

Preparatory Stage

Monitoring is concerned with administrative issues for the period of the pre-relocation phase of the resettlement process such as, establishment of resettlement unit, budget management, and consultation with AHs in the preparation of resettlement plan and their participation in the implementation process, information dissemination on payments of entitlement due, grievance redress, and so on. The major issues for monitoring will be to:

- Conduct additional baseline survey, if required;
- Consultations;
- Identify AHs and their numbers;
- Identification of different categories of AHs and entitlements of individuals;
- Collection of sex disaggregated data and preferences of women;
- Establish Inventory of Losses;
- Ascertain Entitlements;
- Budget delivery;
- Information dissemination;
- Institutional capacity assessment;

Implementation Stage

Once the AHs have resettled at new self-relocated sites, the focus of monitoring will shift to issues of livelihood restoration. The key issue of monitoring will be:

- Initiation of livelihood restoration activities;
- Provisions for basic civic amenities and essential facilities in the host area.
- Consultations;
- Assistance to enhance the livelihood and quality of life

M & E Indicators

As per compliance requirements of JICA's social consideration on involuntary resettlement, RAP policy and targets, the RAP implementation process will be monitored and evaluated through setting up indicators. These indicators have been mentioned below.

1: Process Indicators	
Project input, public participation and monitoring	- Setting up an RAP implementation organization - Deployment of implementing agencies - Training of concerned staff - Census, inventory of losses, baseline socio-economic survey - Expenditure of implementing agencies - Procedure of identification of eligible affected HHs/persons - Procedure of determining loss and entitlements - Development of livelihood and income restoration program - Preparation of disclosure instruments - Disclosure and consultation events - Formation of GRC, PVAC and RAC - Grievance redresses procedures in-place and functioning - Level of public awareness on RP policy and provisions Cost of compensation collection by Ahs - Monitoring reports submitted
2: Output Indicators	
Delivery of entitlements, Relocation and Rehabilitation	- Number of households self-relocated in and around the areas - Number of households compensated and assisted - Number of businesses relocated in and around the areas - Number of affected persons purchased agricultural land - Amount of compensation disbursed - Amount of other benefits disbursed - Number of eligible persons identified and provided training on IGA - Number of vulnerable households assisted for re-location - Number of vulnerable households brought under livelihood program
3: Impact Indicators	
Longer Term Impact	- Changes in housing in another place - Changes in drinking water and sanitation - Changes in land holding - Changes in occupation - Changes in income and expenditure - Pace of income against change in expenditure - Changes in attending health problems - Nutrition of women and children - Gender balance and women empowerment - Changes in vulnerable households and women headed households.

Institutional Arrangement for M & E

BEZA will carry out internal monitoring of the RAP implementation involving BEZA-SIU offices, TITAS and the Consultants. An independent external monitoring agency will carry out M&E independently of the BEZA. The social development consultant will oversee and monitor safeguard compliance of the project while JICA will conduct periodic missions for the compliance monitoring. The project affected persons, their community and local level NGO will also participate in the M&E process

Office of the Project Director

The project Director is responsible to oversee proper and timely implementation of all activities in RAP. The monitoring will be carried out with support from the BEZA-SIU offices and the TITAS. BEZA/TITAS will collect appropriate data from the field and provide feedback to SIU on progress of RAP implementation and the day to day problems arising out of the process.

TITAS prepared monthly/quarterly reports on the progress of RAP implementation. SIU have to be collect information from the project site and assimilate in the form of monthly progress of RAP implementation and adjust work program where necessary, in case of delays or problems.

External Monitoring

An External Monitoring Agency (EMA), independent of the project, with prior experience in resettlement and rehabilitation of development induced displacement engaged to carry out external M&E and reporting of the implementation of the RAP. The EMA will carried out quarterly, annual, mid-term and final evaluation and recommend necessary changes to the SIU and the Social and Environment Circle (SEC) for consideration. The scope of external monitoring will cover compliance monitoring and social impact evaluation of RAP implementation.

The EMA covered compliance issues such as: (i) compensation and entitlement policies, (ii) adequacy of organizational mechanism for implementing the RAP, (iii) restoration of APs income, (iv) settling complain and grievances and (v) provisions of adequate budgetary support by SIU for implementation of the RAP. The EMA will assess if the APs: (i) have been provided with alternative place to relocation, (ii) have re-established their structures, (iii) re-established their business and (iv) were extended assistance to restore their incomes at pre-project level. It also appraised accounting documents used in recording the payments of compensation to APs by BEZA. In addition to this at least once a year and annual impact evaluation to assess the effectiveness of the work being undertaken and level of result achieved.

Reporting Requirement

The Assistant Manager at SIU is responsible for supervision and implementation of the RAP for the project. The Assistant Manager at SIU prepared monthly progress reports on resettlement activities to PD. The External Monitoring Agency (EMA) submitted “**quarterly report**” to the PD through review and determine whether resettlement goals have been achieved, more importantly whether livelihoods and living standard have been restored/enhanced and suggest suitable recommendations for improvement. Monitoring reports will be submitted at regular interval as specified. Both monitoring and evaluation undertaken as a part of regular activities and reporting on this extremely important in order to take corrective measures. Following table provides details on the content and timing for various report associated with M&E.

Table 3.4-31: Reporting cycle /frequency

Activity/ Reportin g	Contents	Timeline	Responsibil ity
Monthly Progress Report	Narrative as per Monitoring Plan format giving details on activity, results, issues affecting performance and variance if any and reason for same and corrections recommended	To be submitted within 10 days of the following month	BEZA/TITAS
Quarterly Report	Progress, issues, with regard to payments of compensation, and other assistance, review of expenditure vs. budgeted	To be submitted within 30 days of end of every	BEZA/TITAS

	amount by budget heads and sub heads; recommendations	6 th month	
Final Report	Project achievement and impacts	To be submitted within 90 days of end of the Project	BEZA/TITAS

3.4.9. Cost and Financial Source of Mitigation Measures

Calculation of Replacement Cost

The costs for land acquisition and resettlement for the project has been estimated at the current market price for the year 2018, with necessary supplements for replacement value, dislocation allowances with assessed replacement value for the same year, and additional assistance for income & livelihood restoration and vulnerabilities as per the resettlement policy framework.. This budget is an estimate of financial outlays for meeting different expenditure. The rules laid down in ARIPA-2017 to determine value of acquired properties and assets ensures Current Market Price *i.e.* additional 200% of mouza rate for land and additional 100% for structures, trees and crops will be determined by Deputy Commissioner. This estimated cost calculated as per rules of ARIPA-2017.

Valuation of Land

Price of land in Bangladesh varies substantially depending on productivity, commercial utility, and proximity to urban centers and access to communications. Therefore land price also varies within a given geographical boundary like the smallest land administration unit called “Mouza”. The Deputy Commissioner determined mouza-wise price by “Land Category” which differs from mouza to mouza. The land types in the project area recognized by DCs are as follows:

- Null (Agricultural/crops Land)
- Homestead (viti)
- Doba (waterbody)
- Fallow land etc.

The land Losers, whether purchasing or not will be provided with replacement cost of land that include titling cost and Current Market Price. Replacement Cost of all categories of land has been established as per mouza rate plus additional 200% of mouza rate. The cost for acquired land has been calculated at mouza for each category of land of each mouza. The value of acquired land is estimated as BDT 692,650,436 (Sixty nine crores twenty six lac fifty thousand four hundred and thirty six only). Details estimated Replacement Cost for land is presented in Table 3.4-32.

Table 3.4-32: Estimated Cost for Compensation of Acquired Land

Name of Mouza	Type of land	Quantum of Land (In deci.)	Mouza Rate	Estimated additional 200% of Mouza rate
Dighiborabo	Null	131.4698	312,600	123,292,378
	Pond	35.68411	40,000	4,282,093
	Viti	6.68961	68,400	1,372,708
	Fallow	16.15245	30,000	1,453,721
Sub Total		189.99597		130,400,900
Behakoir	Null	311.28574	306,148	285,898,520

Name of Mouza	Type of land	Quantum of Land (In deci.)	Mouza Rate	Estimated additional 200% of Mouza rate
Sub Total		311.28574		285,898,520
Kanchpur	Null	122.04316	244,253	89,428,224
Sub Total		122.04316		89,428,224
Monoharkharbag	Null	244.58162	244,000	179,033,746
	Pond	0.59229	61,600	109,455
	Viti	4.49495	379,900	5,122,895
	Doba	4.67861	127,000	1,782,550
	Fallow	1.07438	16,000	51,570
Sub Total		255.42185		186,100,216
Bagnoyanogor	Null	7.21219	38,000	822,190
	Fallow	0.03214	4,000	386
Sub Total		7.24433		822,575
Total Compensation for Land		885.99105		692,650,436

Calculation: Land amount multiplied by mouza rate, then multiplied by 300%.

Valuation of Structures

The Deputy Commissioner of Narayanganj assessed Cash Compensation under Law (CCL) for structures in accordance with the ARIPA-2017. The Deputy Commissioner will assess value of affected structures at the rate of Public Works Department (PWD). As per ARIPA-2017, the affected structures loser person to be compensated with 100% additional of assessed value for structures. The acquisition process is yet to start by the Deputy Commissioner. The indicative value of affected structures has been calculated at rate of PWD. The total estimated value of affected structures stood at **BDT 35,020,346** (Thirty five lac twenty thousand three hundred and forty six only). Estimated cost for structures is presented in below Table:

Table 3.4-33: Estimated Cost of Acquired Structures

SL No.	Type of Structures	Quantum of Structures	200 % of Units Rates	Estimated Cost
1	Pucca	4,711	3,398	16,007,978
2	Semi-Pucca	10,082	1,772	17,865,304
3	Tin-made	458	820	375,560
4	Boundary Wall	60	100	6,000
5	Septic Tank	432	1,772	765,504
Total				35,020,346

Valuation of Trees

The Deputy Commissioner has not assessed and budgeted compensation for trees. In the project right-of way, trees were identified during census. PAPs will be compensated for affected trees according to the acquisition laws in Bangladesh. As per ARIPA-2017, the Deputy Commissioner will assess compensation for trees according to the rate of Department of Forestry with additional 100% of assessed value. JICA Guideline for Environmental and Social Consideration confirms Replacement Cost for trees. In compliance with acquisition law and JICA policy, an estimated budget for trees is calculated in this RAP. Valuation of trees is assessed in line with the methods and rates of the Department of Forestry. The value of affected trees

estimated as **BDT 4,414,000** (Forty four lac fourteen thousand only). The details of cost estimation of affected trees is given in Table 3.4-34.

Table 3.4-34: Estimated Cost of Affected Trees

SL No	Type. of Trees	Nos. of Trees	200% of Units Rate	Estimated Cost
1	Large Fruit Trees	147	20,000	2,940,000
2	Medium Fruit Trees	37	16,000	592,000
3	Fruit Saplings	2	3,000	6,000
4	Large Timber Trees	29	30,000	870,000
5	Banana Plant	10	600	6,000
Total				4,414,000

Estimated Cost of Crops/Fish stock

As per ARIPA-2017, the land owners will get compensation for standing crops/fish stock of acquired land. The acquisition process is yet start by the Deputy Commissioner. The RAP for Gas Transmission Line proposes compensation for produce of acquired land for one year. The net production value calculated according to the methods followed by Department of Agricultural Extension (DAE). The estimated cost for crops/fish stock is stood at BDT 545,296 (Five lac forty five thousand two hundred and ninety six only) and presented in Table 3.4-35

Table 3.4-35 Estimated Cost for Crops/Fish stock

SL No.	Type of loses	Quantum of Land (in decimal)	Unit rate	Estimated Cost
1	1 year crop compensation	816.59	650	530,784
2	Compensation for fish stock in the pond/water body	36.28	400	14,512
Total				545,296

Transfer and Reconstruction/Re-installation Grants

The RAP prescribes for relocation allowances for affected persons lost residential and commercial/industrial structures in the project area to elsewhere suitable for them. The relocation allowances include transfer and reconstruction grants of the structures and also include re-installation of utility services. The rates of relocation allowances fixed as per guidelines of PWD and in consideration of other Resettlement Action Plan/Resettlement Plan (RAP/RP) currently under implementation in Bangladesh and also describe in the entitlement matrix. There is 3 deep tube-well identified in the project alignment. If possible, try to avoid relocation of 3 deep tube-well and other major structures during construction and installation of gas pipeline. In that case no relocation assistance/grants will be paid. A total of 19 households and 3 deep tube-wells will be affected by the project. The RAP has provision for transfer and reconstruction grants at calculated on total lost amount with a highest ceiling to be paid for residential and commercial/industrial structures. Re-installation cost calculated as per PWD rate. A detail the relocation allowances is presented in Table 3.4-36

Table 3.4-36: Transfer and Reconstruction/Re-installation Grants

SL No.	Type of Resettlement Grants	Units	Rate	Estimated Cost
1	Transfer Grant	19	15,000	285,000

2	reconstruction Grant	19	20,000	380,000
3	Re-installation of Utility Services	19	20,000	380,000
4	Deep Tube-well reinstallation	3	1,000,000	3,000,000
Total				4,045,000

Livelihood Allowances

During census and SES, details social assessment has been carried out to identify and assess impact on income and livelihood of affected persons. A total of 58 households identified as vulnerable based on their annual income. There are one sharecropper, 52 factory workers identified in project alignment will lose their income earning opportunity due to the construction of gas pipeline. There are 3 businessmen and 3 landlords who will lose their income from business and house rent respectively. The RAP has provision to mitigate the impact on income and livelihood and prescribe transitional allowances to restore income and livelihood. These allowances provided as subsistence until the completion of pipeline installation. Several Resettlement Action Plans/Resettlement Plans (RAPs/RPs) in compliance of the World Bank, ADB and JICA policy on involuntary resettlement is currently under implementation in Bangladesh. The RAP for Gas Transmission Line prescribes transitional allowances in light of that RAPs/RPs. Estimated cost for transitional allowances stood at BDT **5,184,000** and presented in Table 3.4-37.

Table 3.4-37: Estimated Cost for Livelihood Allowances

SL No.	Type/Category of Allowances	Units	Rate	Quantity	Estimated Cost (BDT)
1	Special Allowance for VH	58	15,000	1 time	870,000
2	Allowance for Sharecropper	1	8,000	3 months	24,000
3	Wage Loser	52	12,250	6 months	3,822,000
4	Allowance for business loser	3	20,000	6 months	360,000
5	Allowance for rental houses	3	6,000	6 months	108,000
Total					5,184,000

Estimated Cost for Requisitioned Land

The project requires a total of 8.11 acres of additional land to be requisitioned temporarily to facilitate construction works. Necessary rules and instruction for requisition is laid down in the ARIPA-2017. The Deputy Commissioner will assess compensation for requisitioned land. However, there is no specific ceiling or fixed rate to apply for assessing compensation. In Bangladesh, compensation assessment for requisitioned land depends on the Deputy Commissioner discretionary authority. In Padma Multipurpose Bridge Project, The Deputy Commissioner followed similar rate as it is for acquired properties. Later the Deputy Commissioner has brought the requisition land under acquisition process, as it seems unrealistic and complex procedures. As for this project, this RAP calculated compensation for requisition land at mouza rate without additional value. However, this cost estimation remains subject to the decision of respective Deputy Commissioner. The estimated cost for requisitioned land is very much indicative and tentative. The RAP also recommends crops compensation of requisitioned land for two years. The estimated cost for requisitioned land is presented in table below.

Table 3.4-38: Estimated cost for land requisition

SL No.	Name of Mouza	Quantum of Land (in decimal)	Unit rate/decimal	Total Cost
1	Dighiborabo	161	312,600	50,328,600
2	Monoharkharbag	233	244,000	56,852,000
3	Chengail	1	155,925	155,925

4	Kachpur	96	244,253	23,448,288
5	Behakoir	313	306,148	95,824,324
6	Bagnoyanogor	7	159,800	1,118,600
Crops compensation for requisitioned land for two years (650x2=1,300)				
7		811	1,300	1,054,300
Sub Total				228,782,037

Budget and Financing Plan

Necessary fund needed for meeting the compensations and other benefits will be provided by BEZA, based on the financing plan agreed by the Government of Bangladesh and JICA. BEZA will also ensure that the RAP is submitted to JICA for concurrence, and that funds for entitlements under the RAP is fully provided to AHs prior to the award of the civil work contract. BEZA will transfer the necessary fund for compensation of acquired properties to TITAS and then TITAS will place the fund to the Deputy Commissioner account. The Deputy Commissioner will disburse the compensation to the affected persons.

The total estimated cost to be incurred for acquisition and implementation of the RAP is about BDT **1,067,705,226** (One hundred-six crores seventy-seven lac five thousand two hundred and twenty-six taka only) including administrative cost of the DC and contingency; which is equivalent to approximately US\$ **13,020,795** (One crore thirty lac twenty thousands seven hundred nine-five only). Detailed estimated budget is given in Table 3.4-40. Summary of estimated cost of acquisition and resettlement budget is given in Table 3.4-39.

Table 3.4-39: Summary of Estimated Cost for Compensation and Resettlement Assistance

SL No	Description of Cost	Estimated Cost in BDT	Estimated Cost In US\$
1	Estimated Cost for Compensation of Acquired Land	692,650,436	8,446,957
2	Estimated Cost for Compensation of Acquired Structures	35,020,346	427,077
3	Estimated Cost for Compensation of Acquired Trees	4,414,000	53,829
4	Estimated Cost for Compensation for crops/fish stock	545,296	6,650
5	Estimated Cost for Transfer and reconstruction Grant	4,045,000	49,329
6	Estimated Cost for transitional Allowances	5,184,000	63,220
7	Estimated cost Land Requisition	228,782,037	2,790,025
	Total Estimated Cost	970,641,114	11,837,087
Administrative Cost of DC and Contingency at 10% of total budget		97,064,111	1,183,709
Grand Total		1,067,705,226	13,020,795

Management of Resettlement Budget

Upon request and requisition of TITAS, BEZA will transfer required fund to the TITAS account and the TITAS will place the same amount to the Deputy Commissioner's account for disbursing compensation to the affected persons.

The Project Director will prepare and place the budget according to Entitlement Matrix to Chairman of BEZA to get approval. Upon getting approval from the chairman, The Project Director will approve the administrative guideline and payment modalities. There will be a bank account in any commercial bank with appropriate signatories at SIU. The account may be operated by two signatories with compulsory of PD.

The payment debit voucher will be quadruplicate, of which one will be original with revenue stamp, and remaining will be photocopies of the original one. The original one will be submitted and kept at the SIU. The second copy will be retained by the GRC, and remaining two will be preserved at the Project Director office and other one is for EP.

Table 3.4-40: Estimated detailed compensation cost for the gas transmission line

Sl. No.	Category of loss	Unit /Quantity in decimal/No./sft/rft	Mouza Rate/decimal/No./sft	CCL Rate (Mouza rate+200%) per decimal	CCL To be paid By DC (Mouza rate + 200%)	Estimated budget in BDT	In USD (USD 1=82 BDT)
A: Compensation at Mouza rate for land (in decimal)							
A-1	Dighiborabo						
	Null	131.4698	312,600	123,292,378	123,292,378	123,292,378	1503,566
	Pond	35.68411	40,000	4,282,093	4,282,093	4,282,093	52,221
	Viti	6.68961	68,400	1,372,708	1,372,708	1,372,708	16,740
	Fallow	16.15245	30,000	1,453,721	1,453,721	1,453,721	17,728
Sub Total		189.99597		130,400,900	130,400,900	130,400,900	1,590,255
A-2	Behakoir						
	Null	311.28574	306,148	285,898,520	285,898,520	285,898,520	3486,567
Sub Total		311.28574		285,898,520	285,898,520	285,898,520	3,486,567
A-3	Kachpur						
	Null	122.04316	244,253	89,428,224	89,428,224	89,428,224	1090,588
Sub Total		122.04316		89,428,224	89,428,224	89,428,224	1,090,588
A-4	Monoharkhabad						
	Null	244.58162	244,000	179,033,746	179,033,746	179,033,746	2183,338
	Pond	0.59229	61,600	109,455	109,455	109,455	1,335
	Viti	4.49495	379,900	5,122,895	5,122,895	5,122,895	62,474
	Doba	4.67861	127,000	1,782,550	1,782,550	1,782,550	21,738
	Fallow	1.07438	16,000	51,570	51,570	51,570	629
Sub Total		255.42185		186,100,216	186,100,216	186,100,216	2,269,515
A-5	Bagnoyanogor						
	Null	7.21219	38,000	822,190	822,190	822,190	10,027
	Fallow	0.03214	4,000	386	386	386	5
Sub Total		7.24433			822,575	822,575	10,031
Total Compensation for Land		885.99105		692,650,436	692,650,436	692,650,436	8,446,957
B: Compensation for Crops and fishstock							

1	1 year crop compensation	816.59	650	530,784	530,784	530,784	6,473
2	Compensation for fishstock in the pond/waterbody	36.28	400	14,512	14,512	14,512	177
Sub Total				545,296	545,296	545,296	6,650
C: Compensation for Structures							
1	Pucca	4,711	1,699	16,007,978	16,007,978	16,007,978	195,219
2	Semi-Pucca	10,082	886	17,865,304	17,865,304	17,865,304	217,870
3	Tin-made	458	410	375,560	375,560	375,560	4,580
4	Boundary Wall	60	50	6,000	6,000	6,000	73
5	Septic Tank	432	886	765,504	765,504	765,504	9,335
Sub Total				35,020,346	35,020,346	35,020,346	427,077
D: Compensation for Trees							
1	Large Fruit Trees	147	10,000	2,940,000	2,940,000	2,940,000	35,854
2	Medium Fruit Trees	37	8,000	592,000	592,000	592,000	7,220
3	Fruit Saplings	2	1,500	6,000	6,000	6,000	73
4	Large Timber Trees	29	15,000	870,000	870,000	870,000	10,610
5	Banana Plant	10	300	6,000	6,000	6,000	73
Sub Total				4,414,000	4,414,000	4,414,000	53,829
E: Resettlement cost for Structures							
1	Transfer Grant	19	15,000	285,000	285,000	285,000	3,476
2	reconstruction Grant	19	20,000	380,000	380,000	380,000	4,634
3	Re-installation of Utility Services	19	20,000	380,000	380,000	380,000	4,634
4	Deep Tube-well reinstallation	3	1,000,000	3,000,000	3,000,000	3,000,000	36,585
Sub Total				4,045,000	4,045,000	4,045,000	49,329
F: Resettlement Allowances							
1	Special Allowance for VH	58	15,000	870,000	870,000	870,000	10,610

2	Allowance for Sharecropper	1	8,000	24,000	24,000	24,000	293
3	Wage Loser	52	12,250	3,822,000	3,822,000	3,822,000	46,610
4	Allowance for business loser	3	20,000	360,000	360,000	360,000	4,390
5	Allowance for rental houses	3	6,000	108,000	108,000	108,000	1,317
Sub Total				5,184,000	5,184,000	5,184,000	63,220
G: Estimated Cost for Land requisition							
1	Dighiborabo	161	312,600		50,328,600		
2	Monoharkharbag	233	244,000		56,852,000		
3	Chengail	1	155,925		155,925		
4	Kachpur	96	244,253		23,448,288		
5	Behakoir	313	306,148		95,824,324		
6	Bagnoyanogor	7	159,800		1,118,600		
Crops compensation for requisitioned land for two years (650x2=1300)							
7		811	1,300		1,054,300		
Sub Total					228,782,037	228,782,037	2,790,025
Total					970,641,114	970,641,114	11,837,087
Administrative Cost of DC office at 5% of total budget					48,532,056	48,532,056	591,854
Contingency at 5% of total budget					48,532,056	48,532,056	591,854
Grand Total						BDT 1,067,705,226	USD 13,020,795

Management of Resettlement Budget

The BEZA does not have any set codified rules for payment of grants to AHs eligible for resettlement assistance from the project. BEZA also does not have separate specialized wing in its organogram for implementing Resettlement Action Plan (RAP). BEZA could disburse compensation and resettlement assistance payment mechanism by establishing Safeguard Implementation Unit (SIU) under the jurisdiction of Project Director. With support from SIU, the Project Director will prepare and place the budget according to Entitlement Matrix to Chairman of BEZA to get approval. Upon getting approval from the chairman, The Project Director will approve the administrative guideline and payment modalities. There will be a bank account in any commercial bank with appropriate signatories at SIU. The account may be operated by two signatories with compulsory of PD.

BEZA will appoint and engage an experience NGO/Firm for implementing the Resettlement Action Plan of Japanese Economic Zone in Araihasar. Implementing NGO/Firm will assist SIU in disbursement of compensation and resettlement assistance. NGO/Firm will prepare necessary documents, maintain vouchers and register and operate MIS to keep disbursement related information up to date.

The payment debit voucher will be quadruplicate, of which one will be original with revenue stamp, and remaining three will be photocopies of the original one. The original one will be submitted to the SIU on a monthly basis by the NGO/Firm. The second copy will be retained by the NGO/Firm head office, and remaining two will be preserved at the Project Director office and other one is for EP.

3.4.10. Implementation Schedule

The overall schedule of RAP implementation will be based on the principle that (i) all displaced persons, households and businesses are paid their due compensation and other resettlement benefits/allowances prior to relocation; and (ii) relocation of the families/businesses should be synchronized with the schedule. At the beginning of the RAP implementation work, designated personnel for entertaining and resolving claims /grievances of the EPs regarding social safeguard and environmental issues will be appointed. Once RAP implementation is complete, then project infrastructure construction work will start. A tentative RAP implementation schedule is presented below.

Activities	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
LAND ACQUISITION & REQUISITION												
Preparation of LAP and Submit DC												
Land AcquisitionProcessing LA Estimate and Fund Placement with DC												
Notice u/s-4, JVS and u/s-8 for acquisition notice u/s-20 (i), and u/s-8 for requisition Award of Compensation, u/s-11 Possession and Handing over Land												
SOCIAL PREPARATION												
Disclosure of RAP												
Determination of Entitlement												
PAYMENT OF COMPENSATION												
Coordinate with DC office on Land Assist PAP's in the Process of CCL												
Prepare Application for CCLCollection Opening Bank Accounts by the PAP's Apply and Receive CCL EP/PAPs Approach for Resettlement Assistance												
RELOCATION												
Payment of Transfer and Reconstruction												
Payment of Other Resettlement PAP's Mobilization and Relocation Monitoring of Relocated Households												
GRIEVANCE REDRESS												
Complaints receive from aggrieved PAPs Review, approval and actions MIS AND MONITORING												
Design, Develop and Operate Automated Internal Monitoring												
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Figure 3.4-4: Tentative schedule of RAP implementation

3.4.11. Accountability, Community Participation and Stakeholder Meeting

Public Consultation with relevant stakeholders

1st Public Consultation Meetings (Scoping phase)

Outline and objectives of the project have been disclosed to the affected people and their communities through open public consultation meetings and FGDs. The main objective of the Public consultation meeting and FGDs is to obtain and reflect stakeholders input in project planning and implementation.

To ensure stakeholders' participation, a rigorous publicity was undertaken through local newspaper. Attendance sheet and the newspaper advertisement are attached in the Appendices. The project proponent (BEZA) issued invitation letters to the concerned stakeholders to participate in public consultation meetings and request to have any comments, suggestion and recommendation on land acquisition and in preparation of RAP.

For scoping phase of RAP and EIA study, two consultation meeting locations were selected in order to ensure easy access for the PAPs since the project affected area stretches up to 5 km. One was organized on 24th at Tarabo Municipality office and the other was held on 30th October 2018 at Dewabag Mosque premises. The consultation meeting intensely focused on the project description, land acquisition, requisition and compensation procedures. Public Consultation Meeting minute was prepared in this RAP. More details are given in the previous section, 3.3.11, since these PCMs were jointly held with EIA PCMs.

Name & Address of Participant	Issues Raised	Response
Mosharrof Hossain Jubo League Leader Roopganj, Narayanganj.	People will lose their land due to gas pipe line, so what will be the compensation process.	BEZA representative said that there will be a compensation package of new Acquisition and Requisition of Immovable Property Ordinance 2017 making provision of additional 200% of land value.
Showkat Ali Affected Person Business Man Dighiborabo Narayanganj	- Demanding change of the alignment of gas pipe line. As an existing 42ft acquired land already occupied by the government besides the Ekhlash Uddin High school, he suggests to use that acquired land for gas pipe line. - They don't get the proper compensation during previous land acquisition by WAPDA. - Could we use the land after construction? - What will be the way to mitigate construction period environmental problem?	- The gas pipe line alignment is finalized by various analysis to ensure minimal loss of property and structure. - If the gas pipeline alignment has change, the objectives of this project will not full fill. - BEZA confirms that affected person will get compensation according to their loss of property. - After construction period the farmer can use their land as same as previous. - Representative from BEZA assured that all necessary mitigating measure will be undertaken to avoid any negative impact whether it is environmental or social. The project doesn't obstruct natural flow of water. The project will follow standard of DoE and JICA environmental and Social Consideration to mitigate any negative impact. About protection bund, BEZA will consult with Bangladesh Water Development Board (BWDB).
Babul Misra Affected Person Business man Dighiborabo Narayanganj	Going to lose his household and business shop as the alignment of pipe line lies into his house.	He will be compensated for shifting his house to another place during construction period.
Md. Aslam Affected person, Sayeed Market, Dighiborabo	- His household, textile factory, Ice cream factory will be affected due to alignment of gas pipeline. - If the production of Textile mills impede how could he pay the existing workers ?	- He will be compensated for shifting his house and machinery to another place during construction period. - A compensation package will be available for the salary of workers during construction period.
Fakhrul Islam Project Affected Person Retired DGFI official	Demanding the change of gas line alignment.	Answer to the question regarding alignment changes is the same as mentioned above.
Al Amin Project Affected Person Dighiborabo	To use the previous 42ft acquired area rather new one.	Answer to the question regarding alignment changes is the same as mentioned above.

Roma Rani Project Affected Person Dighiborabo	To use the previous 42ft acquired area rather new one.	Answer to the question regarding alignment changes is the same as mentioned above.
Mohi Uddin Khondokar Affected person Dewanbag	- Already 2 gas pipe line and two electric line gone through his land and home stead, will be vulnerable if another one is established, demanding the change of current alignment of gas pipe line. - People will lose their land due to gas pipe line, so what will be the compensation process.	- The gas pipe line alignment is finalized by various analysis to ensure minimal loss of property and structure. - BEZA representative said that there will be a compensation package of new Acquisition and Requisition of Immovable Property Ordinance 2017 making provision of additional 200% of land value.
KaziRobiul Affected Person Business man Dewanbag Narayanganj	- Litigation is on process for the household which has been lying at current gas pipe line alignment, who will get the compensation? - Is it possible to acquired when litigation is running? - What will be the compensation package of fixed asset like as water pipe line?	- Acquisition process will not be bogged down due to litigation, but before the final review of the litigation they will not get compensation, but after final review the compensation will be provided to legal owner. - Affected person will be compensated for shifting his house and asset to another place during construction period.
Biplob Hossain Project Affected Person Dewanbag Narayanganj	Job opportunity for affected person and their relatives needs to be ensured according to their skill and educational qualification	Job opportunity for affected person according to their skill and educational qualification will be recommended.
Abdul Kadir Project Affected Person Dewanbag Narayanganj	Needs to ensure to get proper compensation with in due time. Priority for job opportunity who are losing their land. Demanding the change of gas line alignment. Being aware of middle man when compensation is given.	Answer to the question regarding job opportunity is the same as mentioned above Answer to the question regarding alignment changes is the same as mentioned above.
Mojibur Rahman Project Affected Person Dewanbag Narayanganj	Construction work must be log off during prayer time. What will be the environmental pollution mitigation measure?	Construction work for sensitive zone e.g., mosque, school will take into an action to prevent any kind of problem. The project will follow standard of DoE and JICA environmental and Social Consideration to mitigate any negative impact.

2nd Public Consultation Meetings (Information disclosure)

In prior to the implementation of RAP, an additional round of consultation meetings are expecting to be held by the end of February, 2019 to disclose the detail of the project and procedures of compensation for PAPs after this RAP by BEZA and JICA.

RAP report will be made available at BEZA and TITAS field offices and at local union and Upazila Parishads. RAP report will also be translated into Bengali language and made available for public viewing at website of BEZA. For continued consultations, the following steps are envisaged in project design and implementation:

- BEZA will organize public meeting and will apprise the communities about the progress in the implementation of resettlement, social activities, the compensation and assistance to be paid. Regular update of the progress of the resettlement component of the project will be placed for public display at the local level BEZA and TITAS office and local Union Parishads.
- All monitoring and evaluation reports of the RAP components of the project will be disclosed in the same manner as that of RAP.
- Key features of RAP, particularly entitlement and institutional arrangement for grievance redress will be summarized in a booklet and distributed among the AHs and their communities along the project corridor.
- BEZA will conduct information dissemination session at major intersection and solicit the help of the local community leader to encourage the participation of the AHs in RAP implementation.
- Attempts will be made to ensure that vulnerable groups, non-title holders and all the entitled persons described in this RAP understand the process and to take their specific needs into account.

Focus Group Discussion (RAP study)

A total of 10 Focus Group Discussions were held with the different group of populations during field visits and census survey by JICA study team. The gas pipe line alignment will go through the total of 5.8 km area from Horipur TBS to Dighborabo CGS, and it will need total 20 feet land for acquisition and requisition. The land acquisition and implementation of the project has significant impact on PAPs and surrounding populations in both negative and positive form. Persons who would lose land and other assets due to the project identified as directly affected person. Persons having no title to the land, but lose livelihood resource base are identified as indirectly (sharecroppers) affected persons. Persons who are working in the affected structure for livelihood purpose e.g., Textile and garments workers, timber workers are also identified as project affected person. As the proposed gas pipe line alignment will have gone through various structure and industry so the household members and industry worker also be affected due to implementation of project. Focus Group Discussion was conducted to obtain views and perception about the project from different groups of peoples in and around the project. General norms and procedures for holding a FGD followed to ensure spontaneous participation of affected populations. The responses or explanations by consultants were provided to the inquiries and opinions of PAPs during FGDs and PAPs have understood and accepted the responses. Summary of Focus Group Discussion is presented in Table 3.4-41:

Table 3.4-41: Summary of FGD

Date & Place	Target Group	Participant			Issues/Topic Discussed	Opinions of APs	Project Responses
		M	F	T			
8/11/2018 Khan Spinning Mill Sayeed Market Dighiborabo Narayanganj	Worker (Male and Female group)	6	4	10	Gas pipe line alignments, Project objective and goals Job opportunities land acquisition and requisition, livelihood and income restoration, current salary of the employee, compensation	Total of 35 workers along with male and female currently working at this factory. Women works only day shift, and male works both day and night shift, so there is a gap between the male and female in case of salary. As the alignment will have gone through the factory they will severely affected during construction period. Their work station either shift or removed due to the construction of gas pipe line through this factory. They demanded work day loss salary and others restoration plan for their livelihood. They also demanded to change the alignment of gas pipe line.	Compensations for work day loss will be provided. And with several types of analysis the gas pipe line alignment has designed to ensure minimal loss of household structures and lands.

Date & Place	Target Group	Participant			Issues/Topic Discussed	Opinions of APs	Project Responses
		M	F	T			
1/11/2018 Dewanbag Akaba Timber	Male Worker of the Timber Factory	8	0	8	resettlement benefits, Improvement of service facilities etc.	Total of 150 workers both male and female work at this Timber industry. As the gas pipe line will go through their structure and they demanded their salary as compensation for the construction period work.	Compensations for work day loss will be provided.
1/11/2018 Dewanbag Akaba Timber	Female Worker of the Timber Factory	0	7	7			
3/11/18 Kazi Bari Dewanbag	Affected Household members of Home and structure.	5	4	9		Total 5 Household along with 33 members lives in this address. By the alignment of proposed gas pipe lines, they will lose their household and agricultural land. They demanded proper compensation for their house shifting and loss of agricultural land. They are also concerned about the construction period pollution problem.	Compensations for house shifting will be provided. And environmental pollution mitigation measure will be taken on construction period.
4/11/2018 Behakoir Kanchpur Narayanganj	Land Owners And Sharecroppers	8	0	8		The gas pipe line will go through their agricultural land, the demanded proper compensation for their land. And if possible then change the alignment of gas pipeline to save their agricultural land.	Compensations will be provided three times of mouja rate of their lands. And with several types of analysis the gas pipe line alignment has designed to ensure minimal loss of household structures and lands.
4/11/2018 Behakoir, Kachpur, Narayanganj	Affected person of Garments (Zamdani Shari)	6	1	7		It is a small garment who are making Zamdani Shari with 8 employees. As their working site will be affected due to construction period they demanded the compensation for shifting their machineries and work day loss salary for their livelihood.	Compensations for work day loss will be provided or shift themselves into other place and shifting compensation will be provided.

Date & Place	Target Group	Participant			Issues/Topic Discussed	Opinions of APs	Project Responses
		M	F	T			
5/11/2018 Dighiborabo Tarabo Narayanganj	Affected Person of Dighi Owners	7		7		Total 35 Households are related with this dighi, they are claiming that they are the legal owners of this dighi which was the philanthropic approach of ZaminderIsha khan. As the gas pipe line will go through the dighi they demanded compensation for the loss of fallow land.	As litigation is running for the ownership of the dighi, they will get compensation after the final review of litigation.
1/11/2018 Dewanbag Narayanganj	Land Owners (Farmers & Business man)	9		9		The gas pipe line will go through their agricultural land, they demanded proper compensation for their land. And if possible then change the alignment of gas pipeline to save their agricultural land.	Compensations will be provided three times of mouja rate of their lands. And with several types of analysis the gas pipe line alignment has designed to ensure minimal loss of household structures and lands.
4/11/2018 Kachpur Narayanganj	Land Owners (Female group)	2	5	7		They will lose their land due to the establishment of gas pipeline. So they demanded proper compensation and services e.g., road network developments, job opportunity of construction period.	They will compensate as per the existing land acquisition law.
8/11/2018 Sayeed Market	Land and Structure Owner	5	2	7		They are going to lose their part of home, garments industry, ice cream factory as well as home which have been rented to others people. They demanded either change the pipe line alignment or proper compensations for losing their home, machineries etc.	Proper compensation will be provided as well as shifting charge of machineries.

Chapter 4 Other Remarks and Studies

4.1. Solid waste management plan

4.1.1 Current situation survey

(1) Laws, Standards, and Rules

Bangladesh government has enacted a series of legislative measures related to industrial wastes since 1992 as shown in the table below.

Table 4.1-1: Regulatory Framework for Industrial Waste Management

Instrument	Date	Content	Implication
Policy			
National Environmental Policy, 1992 (NEP) (MOEF, 1994).	1992	Protection and sustainable management of the environment. Objectives: Maintaining the ecological balance and overall development through protection and improvement of the environment; Identifying and regulate polluting and environmentally degrading activities; Ensuring environmentally sound development; Ensuring sustainable and environmentally sound use of all natural resources	MOEF to remain actively remain associated with all international environmental initiatives (e.g. Basel Convention).
National Environmental Management Plan, 1995	1995	Framework of programmes and interventions to manage resources, reduce environmental degradation, improve the natural and manmade environment, conserving habitats and biodiversity, promote sustainable development and improve quality of human life.	MOEF to implement NEP. Actions and interventions also for government, NGOs and wider civil society.
Laws			
Environmental Conservation Act (ECA)	1995	Important legislative control on industrial water pollution. Dedicated to the "conservation, improvement of quality standards, and control through mitigation of pollution of the environment".	
Environmental Conservation Rules (ECR)	1997	Rules under ECA 1995 provide additional guidance for specific components of the Act that is to be enforced by the DoE, which has responsibility for: 1. Coordinating with other authorities or agencies. 2. Adopting safety and abatement measures to prevent environmental degradation. 3. Advising persons on environmentally sound use, storage, transportation, import and export of hazardous material or its components. 4. Conducting research and assisting in conservation and improvement of the environment.	Standards set for liquid effluents and gaseous emissions with some legal authority and powers given to DOE. IEE/EIA studies have been made mandatory For new industries. Penalties for failure to comply with ECA rules and
Regulations			
		5. Investigating locations, equipment, processes, materials, to ensure improvement of the environment, and control and mitigate pollution. 6. Collect, publish and disseminate environmental information on pollution. 7. Advising Government on processes and materials that cause pollution. 8. Ensuring potable water quality.	regulations. Essential powers for HWM in line with international requirements are in place
The Environmental Court Act 2000	2000	Supports ECA & ECR by establishment of environmental courts for offences relating to environmental pollution. Protocols for the establishment of court, defines the court's jurisdiction, penalties, powers of search and entry, and procedures for investigation, trial and appeal.	Confirms powers for HWM and lines of enforcement in line with international requirements

Source: Managing Hazardous Wastes: Country Inventory Report for Bangladesh (ADB/DOE: 2010)

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

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

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

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

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

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

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

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

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

3) Recent Development of Act, Standards and Rules related to Industrial Waste Management

The past 10 years has seen several important improvements in the legislation related to industrial waste management as shown in the table below.

Recent Development of Act, Standard and Rules related to Industrial Waste

	Year
Environmental Conservation Act (Amendment)	2010
Hazardous Waste and Ship Breaking Waste Management Rules	2011
Bangladesh Standards and Guidelines for Sludge Management	2015
Draft Rule for Environmental Conservation Rule	2017

In 2011, “Hazardous Waste and Ship Breaking Waste Management Rules” was newly established. Although this rule is mainly addressed for the ship-breaking industry, it explains the role of National Technical Committee, basic rules on handling hazardous waste and detailed lists of types of hazardous waste.

Another important development was “Bangladesh Standards and Guidelines for Sludge Management” in 2015. According to a survey report “Managing Hazardous Waste: Country Inventory Report for Bangladesh (ADB/DOE: 2010)”, 62% of 48 surveyed factories in the textile industry did not have effluent treatment plants (ETPs) and 94% did not have sludge management.

According to DOE, a comprehensive waste management rule is currently being considered.

(2) Industrial Waste Generation in Bangladesh

There is no regularly published official statistics on industrial waste in Bangladesh. The latest comprehensive data on this subject can be found in the above survey (Managing Hazardous Waste: Country Inventory Report for Bangladesh (ADB/DOE: 2010)). The table below shows the general situation of waste generation in Bangladesh including the total volumes of hazardous and non-hazardous waste (as of 2005, 2007 or 2008) and their future projection (2012 and 2025).

Table 4.1-2: Situation of Waste Generation in Bangladesh

Category	Statistics	Data Source
TOTAL VOLUME OF WASTES (tons/year)		
Total volume of municipal solid wastes in urban areas	4,866,505 (2005) = 13,332.89tons/day x 365 3,000 tons/day in Dhaka (2005)	Waste Concern (2005) JICA (2005)
Agricultural Waste	65 million metric ton per year	Waste Concern and Swiss Contact 2007
Industrial waste (hazardous) from seven selected sectors*	109.47 million/cubic meter/year (waste water) 0.113 million ton/year (sludge) and 26, 884 tons/year (solid waste)	Waste Concern and ADB (2008)
Hazardous Medical Waste	12,271 metric ton per year (2007)	Waste Concern and ADB (2008)
WASTE PER CAPITA (kg/per/day)		
	Urban: 0.41 (2005) Dhaka City: 0.56 (2005) Agricultural:1.68 (based on 2008 rural population)	Waste Concern (2008) JICA (2005)
FUTURE WASTE PROJECTIONS (Total Waste Generation)		
By 2025 (solid waste) 2012 (hazardous waste)	17,155,000 tons/year = 47,000tons/day x 365 0.60 kg/per/day in Urban Areas 2472.07 million/cubic meter/year (waste water), 2.81 million metric ton/year (sludge) and 53,874 metric ton/year (solid waste)	UMP (1999), as cited by Waste Concern (2008) Waste Concern and ADB (2008)

Source: Managing Hazardous Wastes: Country Inventory Report for Bangladesh (ADB/DOE: 2010)

The above survey report identified 21 industries/products which generated hazardous waste. The number of business entities generating hazardous waste increased drastically between 1994 and 2007.

Table 4.1-3: Number of Business Entities Discharging Hazardous Waste in Bangladesh

SI	Trade/industry	Chemicals	1994	2007
1	Acid Handlers And Suppliers	Nitric acid, Sulfuric acid, Olum, Hydrochloric acid	6	
2	Adhesive & Glue Makers	Methylethyl, Ketones, Toluene, Acetone,	5	
3	Bleaching Powder	Chlorine	3	
4	Battery Manufacturer	Lead, Sulfuric Acid	36	38
5	Chlor Alkali (Caustic Soda)	Chlorine, Mercury, Hydrogen gas	1	
6	Fertilizer N.P.	Amonia, Carbon monoxide, Phosphoric acid, Sulfuric acid	7	8
7	Paints and Varnishes	Solvents, Metalic oxides of Pb, Ti	20	63
8	Pesticides	Benzene, Toluene, Butane, Organo Phosphorous materials	16	100
9	Pharmaceutical	Organic Chemicals	185	337
10	Industrial Chemicals	Sulfuric acid, Sodium Silicate	21	41
11	Plastics	PVC Solvents	80	260
12	Rayon Manufacture	Mercury, Chlorine	1	
13	Synthetic Foam	Cyanides, Solvents	3	
14	Vegetable Oils, Vanashpati Ghee	Hydrogen	8	23
15	Textile,	Dying & Printing Toxic Dyes	85	357
16	No. of clinic & hospitals	Hazardous waste	-	2004
17	Ship breaking & Dismantling		-	20
18	Petroleum Refinary - 1			
19	Tannery		-	183
20	E-Waste		-	
21	Paper & Pulp		-	80

Source: Data for 1994 and 2007 are respectively from WHO-DoE (1994) and BBS (2007).

Source: Managing Hazardous Waste: Country Inventory Report for Bangladesh (ADB/DOE: 2010)

The next table shows the industrial waste generation by selected seven industries (textile, hospital & clinics, tannery, pesticides, fertilizers, oil refinery and paper & pulp) in Bangladesh.

Table 4.1-4: Industrial Waste Generation by Selected Seven Industries in Bangladesh

Sl.	Sectors	Classification of waste		Year					
		Basel	WHO	Wastewater		Sludge		Solid	
				2007	2012	2007	2012	2007	2012
1	TEXTILE SECTOR Annual Growth: 90% Sludge Generation: -17.14 M3/1000 meter -1.14 Kg./ M3 of waste water generated	Y12 Y34 H12		99.75 mil M3/yr	2470.4 mil M3/yr	0.113 Mil MT/yr	2.81 Mil MT/yr	-	-
2	HOSPITAL & CLINICS Annual Growth: 8.18% Waste Generation: 2.29 kg/patient/day	Y1 Y3 H6.2						12,271 MT/yr	*19,578 MT/yr *for 2013
3	TANNERY Annual Growth: 5% Waste Water Generation: 4 liter/ Sq.ft of hide processed Solid Waste Generation: 350 kg/ton of hide processed	Y21 Y35		1.3 mil M3/yr	1.66 mil M3/yr	-	-	26,250 MT/yr	33,502 MT/yr
4	PESTICIDES Annual Growth: 5.2% Waste Water Generation : 0.85 M3/MT of finished product Solid Waste Generation: 30 MT of Finished product		Class IB Class II Class III	10,920 M3/yr	14,070 M3/yr	-	-	357.18 MT/yr	460.22 MT/yr
5	FERTILIZER Annual Growth: 4% Waste Generation: Total 1246 MT of solid waste (spent catalyst) existing today. Every 5-12 years on average it needs to be disposed. Waste Water: 2.66 M3/MT (average rate of waste water (effluent) generation from the surveyed fertilizer (Urea only) manufacturing industries)	Y23 Y21 Y22		7.8 mil M3/yr	-	-	-	277 MT/yr	334 MT/yr
6	OIL REFINERY Maximum production capacity: 1.38 million MT/year	Y34 Y35		0.61 mil M3/yr	No change expected	4000 liters/yr.	No change expected	-	-
7	PAPER AND PULP	-	-	-	-	-	-	-	-

Source: Managing Hazardous Waste: Country Inventory Report for Bangladesh (ADB/DOE: 2010)

(3) Current Situation of Industrial Waste Management in Existing Export Processing Zones

There are currently 8 Export Processing Zones (EPZs) in Bangladesh. Bangladesh Export Processing Zones Authority (BEPZA) has its own building code as requirements for self-constructed buildings inside EPZs, which includes anti-pollution measures as described below.

G.1. Proper measures for disposal of industrial wastes, both solid and liquid, are to be taken. BEPZA reserves the right to issue instruction on this issue from time to time.

G.2. Liquid wastes are to be pre-treated within the premises before these are discharged into the EPZ drains.

With a support of the Department for International Development (DFID) and International Development Association (IDA), BEPZA has employed national environment counselors as shown in the table below.

Table 4.1-5: Number of Appointed Environment Counselors of BEPZA

	Number of national environment counselors	Years of appointment
Year 2012	30	2 years
Year 2015	6	2 years
Year 2017	2	Temporary (not fixed)

The national environment counselor has the following duties.

- i. Review the status of regulatory compliance of the EPZ and the individual enterprises and advise on necessary steps to ensure compliance
- ii. Monitor the performance of the Central Effluent Treatment Plant (CETP) and its related activities.
- iii. Monitor the performance of ETPs of individual enterprises that have not joined CETP for round the clock in shifting duties and ensure compliance towards the terms and condition and/or DoE's Discharge Standard.
- iv. Monitor the environmental management issues including effluent discharge, sludge management, air emissions, noise, chemical and hazardous materials management, solid and hazardous waste management, emergency response and cleaner production of the enterprises of EPZs as appropriate and report to the Zone Authority

Official quantitative data on industrial waste generation is not available from Bangladesh Export Processing Zones Authority (BEPZA). Therefore, an interview survey is conducted with tenant factories in selected EPZs as shown in the table below.

Table 4.1-6: Current Practice of Industrial Waste Management in Existing EPZs

	Dhaka EPZ	Adamjee EPZ	Comilla EPZ
Solid Waste	Collected by waste collectors after inspection and permit by BEPZA		
Wastewater	Treated by CETP (Flagship Dhaka CETP (BD) Ltd.)	CETP is partially operating (according to an interview with a factory inside EPZ)	Treated by CETP (Sigma Group)
Sludge from CETP	Sent to outside place (Not disclosed)	Unknown	Sent to local landfill site outside EPZ

Source: Interview and telephone survey with tenant factories in each EPZ

Based on the survey so far, currently most of the solid industrial waste was sold to waste recycling companies in Dhaka EPZ. BEPZA officials check the loading and transportation of waste for each factory.



Waste Collector for Garment Waste



Waste Storing Place of a Dyeing Factory

(Plastic, Thread, Carton box: 5–6ton/month)

Dhaka EPZ has a central effluent treatment plant (CETP) inside the zone, operated by a Singapore company. Currently out of 102 factories in the zone, 27 factories discharge wastewater to the CETP. The CETP generates 2 ton of de-watered sludge per day.



CETP at Dhaka EPZ (Owned and Operated by



4.1.2 Recommendations

(1) Projection of Industrial Waste Generation at AEZ

In this sub-section, the generation of industrial waste at AEZ is projected. This projection is based on the estimated industry mix data derived from “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority (JICA: 2017)”. The land use plan for the 200ha is summarized in the table below.

Table 4.1-7: Land Use Plan Allocation of Araihaazar EZ Development

	LAND USE PLAN	Phase-1		Phase-2		Total (Phase 1 + 2)	
		Area (ha)	Ratio (%)	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
A.	Factory Lots	57.84	58.44%	81.60	81.60%	139.44	70.08%
B.	Service Facilities	2.00	2.02%	–	0.00%	2.00	1.01%
C.	Road/Bus Bay/Parking	16.06	16.23%	15.40	15.40%	31.46	15.81%
D.	Retention Pond	3.14	3.17%	–	0.00%	3.14	1.58%
E.	Other Infrastructures	3.60	3.64%	–	0.00%	3.60	1.81%
F.	Green Area	12.27	12.40%	3.00	3.00%	15.27	7.67%
G.	Future Development	4.07	4.11%	–	0.00%	4.07	2.05%
	TOTAL	98.98	100.00%	100.00	100.00%	198.98	100.00%

Source: “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority (JICA: 2017)”

The factory lots area (139.44ha) is to be occupied by the following industries. The industry mix in terms of percentage are shown in the tables below.

Table 4.1-8: Estimated Industry Mix in Percentage for 100 ha (left) and 200 ha (right) of Araihaazar EZ

Industry	Ratio	Industry	Ratio
Textile, Garment	15%	Textile, Garment	5%
Textile, Accessory	26%	Textile, Accessory	0%
Motorcycle Assembly	9%	Motorcycle Assembly	10%
Automobile Assembly	5%	Automobile Assembly	10%
Metal, Nonferrous Metal	10%	Metal, Nonferrous Metal	15%
Electronics	10%	Electronics	15%
Machinery Parts	5%	Machinery Parts	10%
General Assembly	5%	General Assembly	10%
Plastic Processing	5%	Plastic Processing	10%
Agriculture Processing, Food	5%	Agriculture Processing, Food	5%
Pharmaceuticals	5%	Others	10%
Total	100%	Total	100%

Source: “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority (JICA: 2017)”

The industry mix in terms of “ha” is shown in the tables below.

Table 4.1-9: Estimated Area-wise Industry Mix for 100 ha (left) and 200 ha (right) of Araihaazar EZ

Industry	Araihaazar Phase I Area (ha)	Araihaazar Phase I+II Area (ha)
Textile, Garment	8.17	12.10
Textile, Accessary	14.16	14.16
Motorcycle Assembly	4.90	12.76
Automobile Assembly	2.72	10.58
Metal, Nonferrous Metal	5.45	17.24
Electronics	5.45	17.24
Machinery Parts	2.72	10.58
General Assembly	2.72	10.58
Plastic Processing	2.72	10.58
Agriculture Processing, Food	2.72	6.65
Pharmaceuticals	2.72	2.72
Others	0.00	7.86
Total	54.46	133.06

Source: “The People’s Republic of Bangladesh Project for Development of Economic Zones and Capacity Enhancement of Bangladesh Economic Zones Authority (JICA: 2017)”

Our estimation also employs industry-wise waste generation data from “The study on master plan on industrial waste management in the Bangkok metropolitan area and its vicinity in the Kingdom of Thailand (JICA: 2002)”. This data provides the generated waste quantity per ha for each industry in Thailand in the early 2000s as shown in the table below. Assuming that the industrial waste content of AEZ is similar to that of Thailand in the early 2000s, the waste generation quantity can be estimated by multiplying the land use area by the unit rate of waste generation for each industry.

Table 4.1-10: Industry-wise waste generation data in Thailand (2002)

Factory Study Code	Descriptions	Non-HW (ton/year)	HW (ton/year)	Total (ton/year)
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	295,015	9	295,024
G02	Food (flour, sugar, tea, ice etc.)	11,881	1,218	13,099
G03	Drink, Beverage	47,208	30,079	77,287
G04	Textile, Thread, Fibre	64,299	1,562	65,861
G05	Textile product (Clothes, mats etc.)	53,513	153	53,666
G06	Wearing Apparel	54,835	19	54,854
G07	Hide, Fur, Footwear	42,163	243	42,406
G08	Woodwork (any or many items)	143,705	2,264	145,969
G09	Woodwork (bamboo, rattan, straw, cork etc.)	61,848	48	61,896
G10	Furniture	159,222	5,820	165,042
G11	Paper, Cardboard	48,735	227	48,962
G12	Printed matter	36,232	9,156	45,388
G13	Chemical matter, Petroleum	5,107	45,395	50,502
G14	Rubber	44,213	1,357	45,570
G15	Plastic product	93,787	43,559	137,346
G16	Glassware, Ceramics, non-Metallic Matter	105,949	284	106,233
G17	Steel basic industries, non-ferrous metal basic industries	668,620	124,484	793,104
G18	Metal product (tools, appliances, household furniture, building interior etc.)	60,446	1,024	61,470
G19	Metal product (construction, installation)	47,439	1,848	49,287
G20	Metal product (others)	74,770	78,984	153,754
G21	Machines (Engines, Turbines, Machinery)	35,982	2,248	38,230
G22	Machines (for producing metal or wood products)	2,346	1,298	3,644
G23	Machines (for paper, chemical, food, textile etc.)	2,985	283	3,268
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	6,086	5,954	12,040
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)	72,951	147,919	220,870
G26	Electric product (Electric Equipment)	35,599	6,247	41,846
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	6,986	17,663	24,649
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	30,774	5,997	36,771
G29	Precision machinery	1,426	2,878	4,304
G30	Others (Musical instruments, Sport, Toys etc.)	13,929	98	14,027
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	35,605	15	35,620
G32	Others (Engine-driven for vehicles or motorcycles etc.)	963	18,114	19,077
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	163	1,009	1,172
Total	—	2,364,782	557,456	2,922,238

Source: The study on master plan on industrial waste management in the Bangkok metropolitan area and its vicinity in the Kingdom of Thailand (JICA: 2002)

The result of the waste generation estimation for AEZ is shown in the table below. The total industrial generation is 5,128 ton/year.

Table 4.1-11: Result of Waste Generation Estimation for AEZ

	Area (ha)	%	Factory No.	Non-HW (ton/year)	HW (ton/year)	Total Generation (ton/year)	Recycling Non-HW (ton/year)	Recycling HW (ton/year)	Non- Recycling Non-HW (ton/year)	Non- Recycling HW (ton/year)
Textile, Garment	12.1	9.09	4.78	124	0	124	97	0	27	0
Textile, Accessory	14.16	10.64	5.60	324	8	332	254	0	70	8
Motorcycle Assembly	12.76	9.59	5.04	517	101	618	406	1	112	100
Automobile Assembly	10.58	7.95	4.18	26	67	93	21	0	6	67
Metal, Nonferrous Metal	17.24	12.96	6.82	873	15	888	684	0	189	15
Electronics	17.24	12.96	6.82	562	798	1,361	441	6	121	793
Machinery Parts	10.58	7.95	4.18	98	20	118	77	0	21	20
General Assembly	10.58	7.95	4.18	98	20	118	77	0	21	20
Plastic Processing	10.58	7.95	4.18	133	62	194	104	0	29	61
Agriculture Processing, Food	6.65	5.00	2.63	806	0	806	632	0	174	0
Pharmaceuticals	2.72	2.04	1.08	5	43	48	4	0	1	43
Others	7.86	5.91	3.11	324	103	427	254	1	70	102
Total	133.06	100.00	52.60	3,891	1,237	5,128	3,050	9	840	1,229

Source: calculated by JICA Study Team

The breakdown of the waste generation estimation is summarized in the table below. Since the possibility of recycling hazardous waste is uncertain in Bangladesh, the non-recyclable hazardous waste is assumed to be 1,237 ton.

Table 4.1-12: Summary of Waste Generation Estimation for AEZ (ton and percentage)

	Non HW (ton/year)	HW (ton/year)	Total (ton/year)
Generation	3,891	1,237	5,128
Recycling	3,050	9	3,059
Non-recycling	840	1,229	2,069

	Non HW	HW	Total
Generation	76%	24%	100%
Recycling	78%	1%	60%
Non-recycling	22%	99%	40%

Source: calculated by JICA Study Team

It should be noted that the data of Thailand on waste generation per factory (company) is the national average of each industry including small, medium and large companies. As the majority of the companies are small and medium companies, their waste generation volume may be smaller than that of tenant factories of AEZ, which include foreign companies. According to an interview survey, the waste generation volume of some Japanese textile companies in EPZs in Bangladesh is twice larger than the waste generation volume estimated above for textile industry. There is a possibility that the above estimate could be doubled.

It is assumed that the sludge from the CETP of AEZ is included in the above estimation. However, the sludge quantity is separately estimated below as a reference purpose, based on the data from the CETP of Dhaka EPZ. The wastewater of the CETP of Dhaka EPZ is currently 20,000m³/day while the generated sludge after de-watering is 2ton/day. In case of AEZ, the expected wastewater quantity for the 200ha is 5,656m³/day, which could generate sludge of about 0.5ton/day (183ton/year). The details of the estimation by industry is shown in the table below.

Table 4.1-13: Summary of Sludge Generation Estimation for AEZ

Industry	Area	Unit rate	Water demand	Wastewater demand
	ha	m3/ha/d	m3/d	m3/d
Textile, Garment	12.1	60	726	580.8
Textile, Accessary	14.16	60	849.6	679.68
Motorcycle Assembly	12.76	60	765.6	612.48
Automobile Assembly	10.58	50	529	423.2
Metal, Nonferrous Metal	17.24	50	862	689.6
Electronics	17.24	50	862	689.6
Machinery Parts	10.58	50	529	423.2
General Assembly	10.58	50	529	423.2
Plastic Processing	10.58	50	529	423.2
Agriculture Processing, Food	6.65	50	332.5	266
Pharmaceuticals	2.72	60	163.2	130.56
Others	7.86	50	393	314.4
Total	133.06		7,070	5,656

Source: calculated by JICA Study Team

Lastly the validity of applying Thailand's 2001 data to Bangladesh's present situation is discussed. For comparing the manufacturing sector between Thailand in early 2000s and present Bangladesh, we use the data from "Survey of Manufacturing Industries (SMI) 2012" of Bangladesh and "The 2001 Manufacturing Industry Survey Whole Kingdom" of Thailand. Based on these data, we calculate the gross output value per factory for each sub-sector of the two countries as shown in the table below. On the average of the whole manufacturing sector, the gross output per factory is roughly 4 times larger in Thailand of 2001 than that of Bangladesh of 2012. Therefore, the industrial waste generation of Thailand of 2001 may be larger than that of Bangladesh in 2012. Likewise, our above estimation for AEZ's waste generation (5,128ton/year) may be much larger than the actual generation. Assuming the growth rate of 9% for the manufacturing sector of Bangladesh after 2012, the gross output per factory of Bangladesh may become around half of that of "2001 Thailand" in early 2020s, when AEZ becomes operational.

Table 4.1-14: Comparison of Manufacturing Sector in Thailand and Bangladesh (000 US\$)

	Division of Industry	Gross output per factory in Thailand (2001)	Gross output per factory in Bangladesh (2012)
1	Manufacture of food products and beverages	6,760	939
2	Manufacture of tobacco products	6,954	2,238
3	Manufacture of textiles	8,082	814
4	Manufacture of wearing apparel	1,575	3,257
5	Manufacture of leather and related products	2,247	1,024
6	Manufacture of wood and products of wood and cork, except furniture	1,498	286
7	Manufacture of paper and paper products	6,754	793
8	Printing and reproduction of recorded media	1,687	150

9	Manufacture of coke and refined petroleum products	191,856	2,424
10	Manufacture of chemicals and chemical products	11,703	2,995
11	Manufacture of rubber and plastics products	4,207	617
12	Manufacture of other non-metallic mineral products	2,737	945
13	Manufacture of basic metals	9,740	9,397
14	Manufacture of fabricated metal products except machinery and equipment	1,838	616
15	Manufacture of machinery and equipment n.e.c	5,281	842
16	Manufacture of office, accounting and computing machinery and Manufacture of medical, precision and optical instrument	43,416	3,324
17	Manufacture of electrical machinery and apparatus n.e.c; Manufacture of radio, television and communication equipment	19,219	2,053
18	Manufacture of motor vehicles, trailers and semi-trailers	16,829	3,356
19	Manufacture of other transport equipment	4,797	1,644
20	Manufacture of furniture and manufacture n.e.c	1,921	462
21	Recycling	3,160	77
	Total	6,217	1,576

* The exchange rates of 1USD=80BDT and 1USD=30THB are applied in the calculation.

As a conclusion, the actual generation may be between our above estimation of AEZ's waste generation (5,128ton/year) and half of it (2,564ton/year).

Options of Industrial Waste Management for AEZ

1) Option 1: Waste Co-processing at Clinker (Cement) Factory

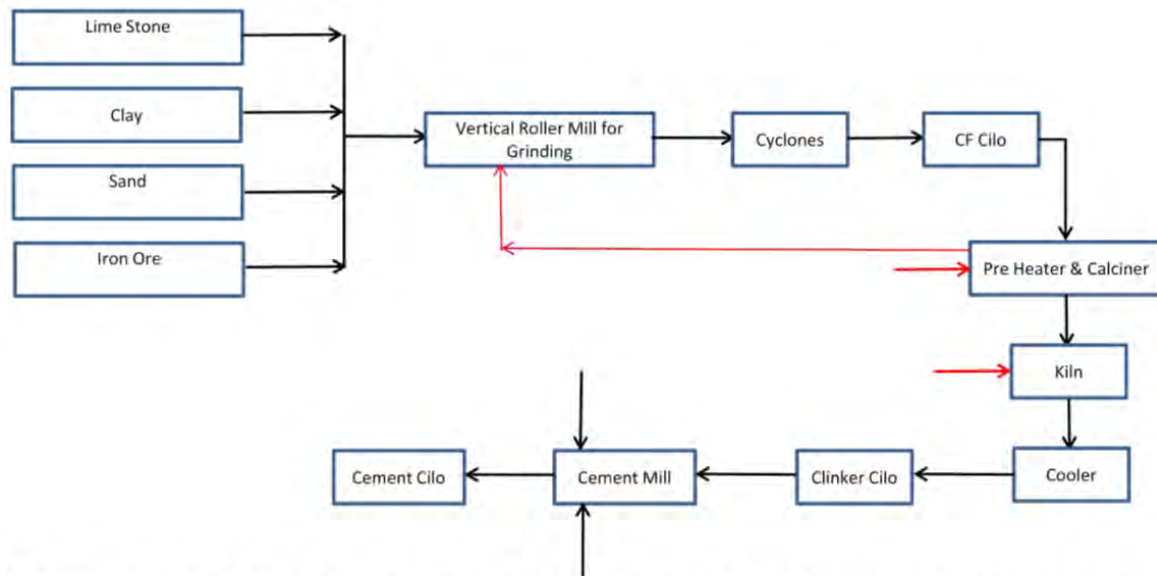
LafargeHolcim Bangladesh Limited, which is one of the two integrated cement production facilities operating in Bangladesh, currently provides Waste Co-processing Service. Their cement (clinker) factory in Chattak, Sunamganj district has a closed cycle process without residual or waste/byproduct as shown in Figure 4.1-1below.



Source: LafargeHolcim Bangladesh Limited

Figure 4.1-1: A Closed Cycle Process Without Residual or Waste/Byproduct

Through co-processing facility, the industrial waste is fed with the raw materials in the kiln where due to high temperature and high residence time, the complete combustion is ensured with no residual waste as cement process generates neither ash nor other waste/by product. Combustion ashes, made up mainly of the same elements as Cement (CaO , SiO_2 , Al_2O_3 , Fe_2O_3) are used in its composition. Currently natural gas is used as fuel for combustion in the Chattak factory. Current waste delivered to the factory does not have enough energy and therefore is not used as a fuel. Feeding of waste is shown by red arrows in the material flow below. The fed waste is burned and the resulting ash is mixed with the other materials to produce cement.



*Waste material is fed through the locations indicated by the red arrow lines depending upon the type
Source: LafargeHolcim Bangladesh Limited

Figure 4.1-2: Material Flow at LafargeHolcim Co-processing Plant



Figure 4.1-3: Location of Lafarge-Holcimfactory in Chattak, Sunamganj District

The location of the cement factory is Chattak, Sunamganj district, which is about 235km from AEZ. The co-processing capacity is currently 1,000ton/year, which is low due to its relatively manual operation. The capacity shall be increased up to 5,000ton/year from late 2018 by automation. The indicative treatment charge in 2017 ranged from \$150/ton to \$1,000/ton. Some of the examples are listed below.

- Non-Hazardous Waste (Non-HW) from the food industry: 150\$/ton
- Hazardous Waste (HW) from the pharmaceutical industry: 550\$/ton
- HW from Agrochemical industry: 600\$/ton
- HW from Petro:500\$/ton

The average transportation cost is 21-25\$/ton (250\$/10-12ton truck) from Dhaka district to Chattak factory. It receives untreated waste water from agro chemical industry as well as sludge from textile, pharmaceutical and oil & gas exploration industries. The company's global guideline permits receiving waste containing Cr less than 1000 ppm and other metals (As, Ni, Co, Mn, Zn, Pb, Sb, V, Be) less than 10,000 ppm. The unacceptable waste for the company is as follows.

- Radioactive waste
- Asbestos-containing waste
- Explosives and ammunition/weapons
- Self-reactive/thermally unstable compounds/organic peroxides exhibiting explosive properties
- Anatomical and infectious health care waste
- Electronic fraction of electrical and electronic waste (e-waste)
- Whole batteries as a targeted material stream
- Waste of unknown or unpredictable composition

The company currently has such customers as Syngenta Bangladesh, Chevron, Nestle Bangladesh, Novartis Bangladesh, SanofiAventis, GSK, Renata, Bayer CropScience, Unilever, P&G, CocaCola etc.

Generally, the waste co-processing capacity of a clinker factory is at least 1 percent of the clinker production capacity, which is 1.4 million ton in case of LafargeHolcim's Chattak factory. Therefore, they could eventually expand their co-processing capacity up to 14,000 ton or more. This is large enough for AEZ. Besides, there is another clinker factory, Chattak Cement Factory Ltd., which is a subsidiary of Bangladesh Chemical Industries Corporation. This company has the clinker production capacity of 230,000 ton per year. Therefore, their potential co-processing capacity is 2,300 ton per year or more.

In Southeast Asia countries, it is normal to transport hazardous waste for a long distance, due to the limited number of treatment facilities. It is sometimes more than 1,000km in the case of Indonesia. Current indicative treatment costs of co-processing are relatively high in Indonesia. There should be the possibility of reducing the treatment cost if a waste treatment company undertakes the pre-treatment process, such as consolidating, sorting, blending, etc.

2) Option for Non-Hazardous Waste: Matuail Landfill Expansion Site of Dhaka South City Corporation

For non-hazardous waste of AEZ, it is desirable for tenant factories to dispose the waste at a nearby waste treatment site as it can save the transportation cost. However, there is no public waste treatment facility in Narayanganj district. The nearest waste treatment site is the Matuail Landfill Site of Dhaka South City Corporation (DSCC), located in the east of Dhaka city as shown in the map and photos below. The distance from AEZ to the Matual Landfill Site is about 23km by trucks.

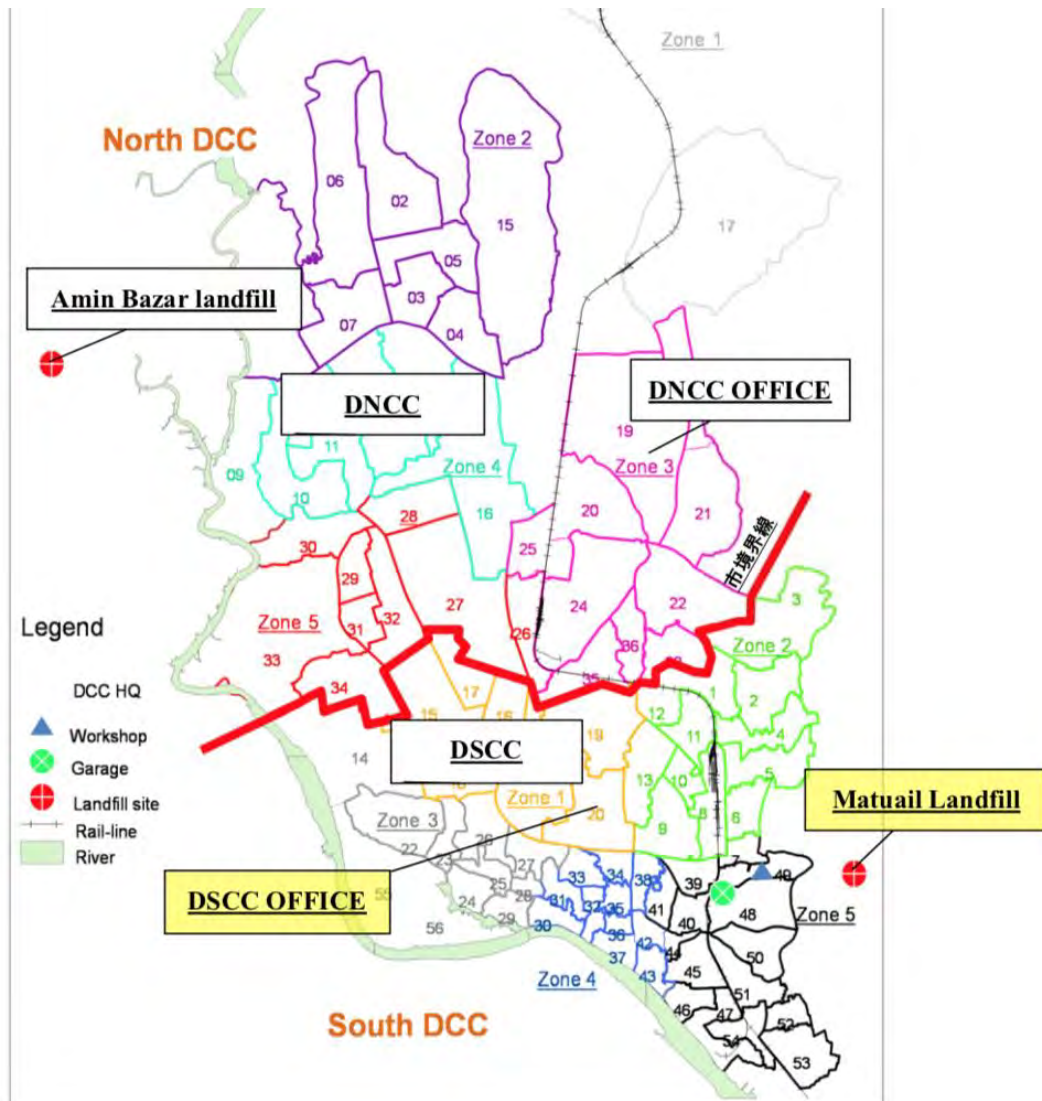


Figure 4.1-4: Locations of Matuail Landfill Site in Dhaka City

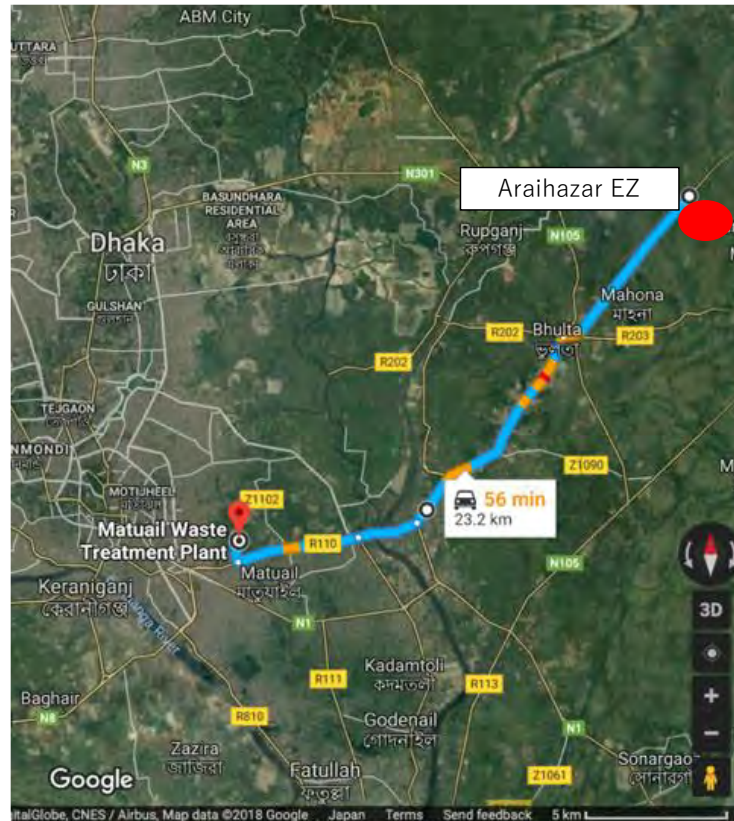
Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City” and Google map



Photo: Matuail Landfill Site



Photo: Waste Collection Truck



The existing area of the Matuail Landfill Site is 36 ha. For the Matuail Landfill Site, DSCC has an expansion plan (18ha) in the adjacent land. The construction work of the expansion takes about 2 years, starting from the mid of 2018. The budget for the expansion plan has already been approved. Details of the expansion plan are illustrated in the following figure and table.

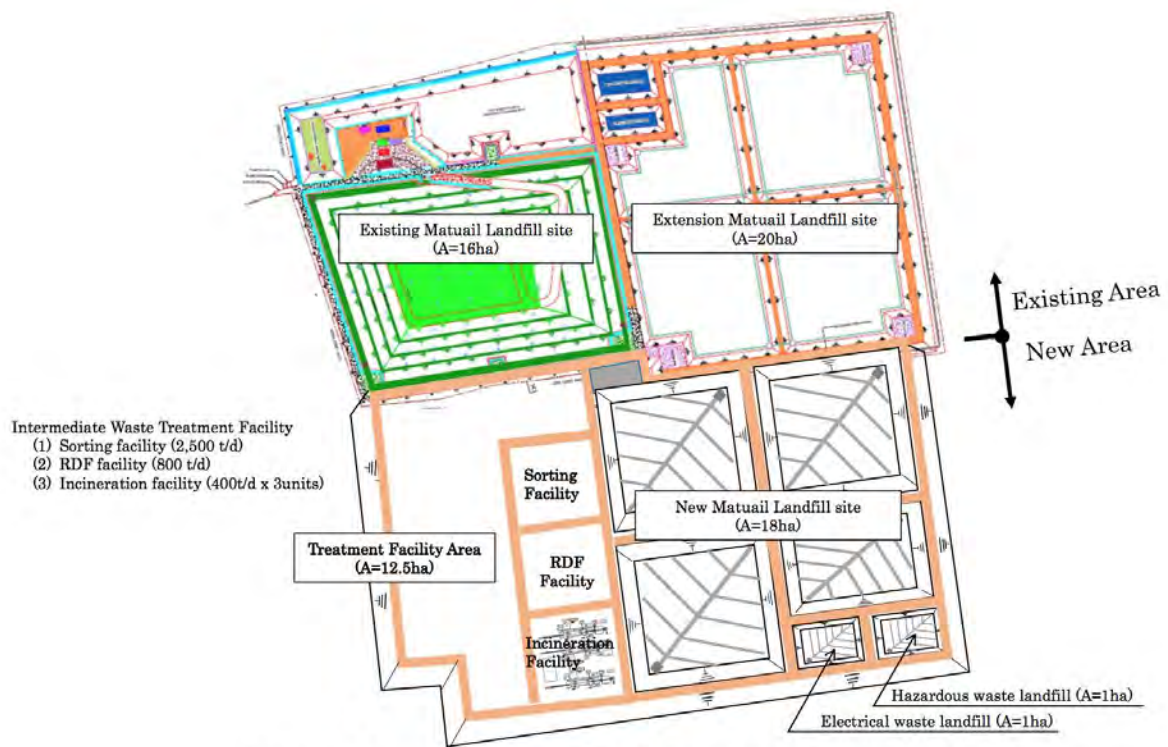


Image of Layout Plan on New Matuail Waste Treatment Complex

Figure 4.1-5: Image of Layout Plan on New Matuail Waste Treatment Complex

Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City”

Table 4.1-1: Budget for Expansion of Matuail Landfill Site

No.	item	Size and Quantity	Cost (Lac Tk)
1	Land Acquisition		
(1)	New final disposal site	20 ha	31,733.50
(2)	Incinerator and RDF Facility	12.5 ha	19,732.46
2	Construction		
(1)	New final disposal site	20 ha	9,637.19
(2)	Land grading for Incinerator and RDF Facility	12.5 ha	2,990.00
(3)	Safe closing of existing landfill site	41 ha	2,766.35
3	Procurement of landfilling equipment		
(1)	Dump truck	4 units	340
(2)	Bulldozer	2 units	1,140.00
(3)	Excavator	3 units	1,245.00
(4)	Wheel loader	3 units	1,050.00
(5)	Fuel and oil	1 unit	1,400.00
4	Consulting service	1 unit	413.43
Total			72,448.50

Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City”

However, the collection of “waste from outside Dhaka city” and “Industrial wastes” are not DSCC’s ordinary duty. Therefore, BEZA submitted a special request to DSCC for accepting AEZ’s waste in this expansion site. As a result, DSCC has agreed to accept the waste under the following conditions.

- ① Type of waste: non-hazardous
- ② Expected years of acceptance: from Year 2021 to Year 2024 (if necessary, extension shall be discussed)
- ③ Quantity of waste: up to 1,000 ton/year
- ④ Disposal site: Matuail Landfill site (the expansion site)

DSCC has also agreed to dispose the waste at a non-profit level of disposal charge, which shall be proposed by DSCC later. As an example of disposal cost in Dhaka, the Savar Tannery Estate’s case can be referred. According to RMG Bangladesh’s website (<https://rmgbd.net/>), the Savar Tannery Estate authority is supposed to dump solid waste of tanneries to Amin Bazar landfill site for the time-being. This is a result of discussions between the Savar Tannery Estate authority and Dhaka North City Corporation (DNCC) although Savar is outside the waste collection coverage area of Amin Bazar landfill site, which is under the control of DNCC. The Savar Tannery Estate authority agreed to pay BDT 1,000 per ton of waste to DNCC in addition to mandatory certificate from the Bangladesh University of Engineering and Technology that the waste is free from chromium and lead. The average transportation cost can be estimated at 3~6\$/ton based on the distance from AEZ.

3) Other Potential Options;

① Hazardous Waste Treatment Facility for Ship Recycling Industry in Chittagong

The International Maritime Organization (IMO), the Government of Bangladesh and the Secretariat of the Basel, Rotterdam and Stockholm Conventions (BRS) jointly implemented the 30-month “Safe and Environmentally Sound Ship Recycling in Bangladesh – Phase I” (SENSREC project) between 2014 and 2017. According to IMO, this included economic and environmental studies on the ship-recycling industry in Bangladesh; studies on managing hazardous materials; refining the Government One-Stop Service; developing training materials; and preparing a document for a follow-up Phase 2 to implement the recommendations of the first phase. The main counterpart for this project is the Ministry of Industry of Bangladesh.

The waste is separated into three categories based on waste disposal criteria at a TSDF as explained below.

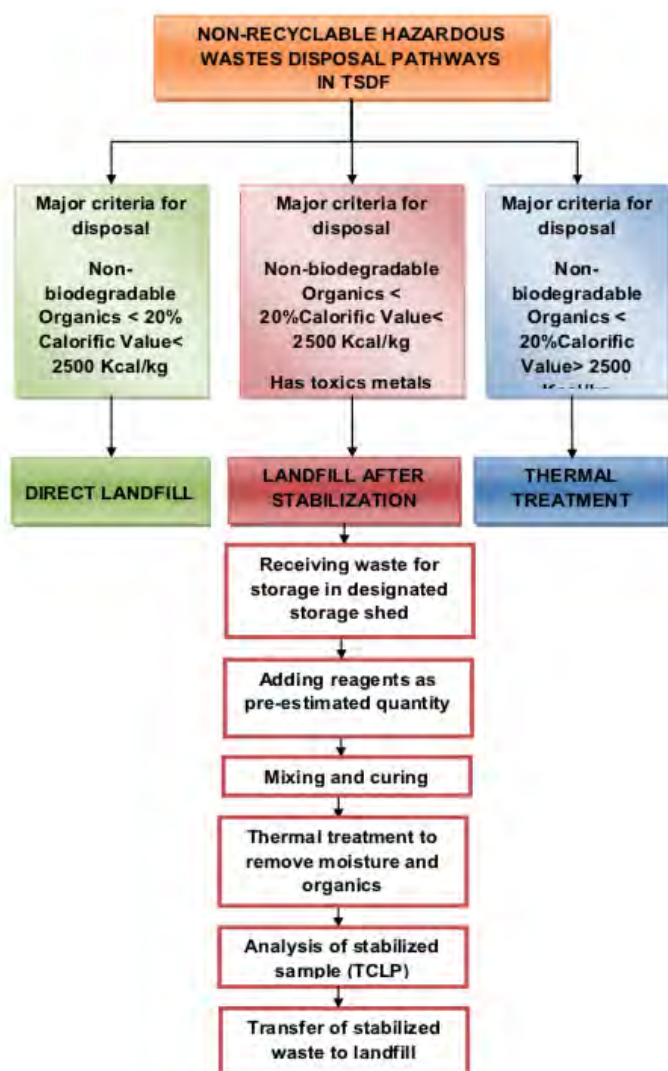


Figure 4.1-6: Hazardous waste management within TSDF based on waste disposal criteria

Source: Document for Implementation of Phase-II of SENSREC Project in Chittagong, Bangladesh (Common Hazardous Waste Treatment, Storage & Disposal Facility: Design Options for the Environmentally Sound Management of Hazardous Waste in Chittagong, Bangladesh) 2017 prepared by Centre for Environmental Science & Engineering, Indian Institute of Technology Bombay

The tentative "design basis" for the proposed TSDF in Chittagong is shown in Table 4.1-15.

Table 4.1-15: Tentative "Design Basis" for the proposed TSDF in Chittagong

Sr No.	Disposal Method	Estimated Inventory		Tentative Design Basis		
		From the ship recycling yards (MT/year)	From the industrial areas (MT/year)	From ship recycling yards 10-yr lifetime capacity @ 4% growth rate (MT)	From other industries 10-yr lifetime capacity @ 6% growth rate (MT)	Total Waste 10-yr lifetime capacity (MT)
1	Incinerable Wastes	5,900	14,000	71,000	184,500	255,500
2	Toxic & Inert Landfillable Wastes	8,900	400	107,000	5,300	112,300
3	Bilge water + Scrubber Effluents + Landfill Leachates + Sewage?	100 m ³ /day	75 m ³ /day	0.45 million m ³	0.35 million m ³	0.80 million m ³

Source: Document for Implementation of Phase-II of SENSREC Project in Chittagong, Bangladesh (Establishing the Common Hazardous Waste Treatment, Storage & Disposal Facility and Planning for Implementation of the Training Modules) 2017 prepared by Centre for Environmental Science & Engineering, Indian Institute of Technology Bombay

A layout and the ground plan for the TSDF site was designed in the first phase of SENSREC. The basic design is prepared by Indian Institute of Technology Bombay as shown in the figure below. It needs a 10-15 ha land.

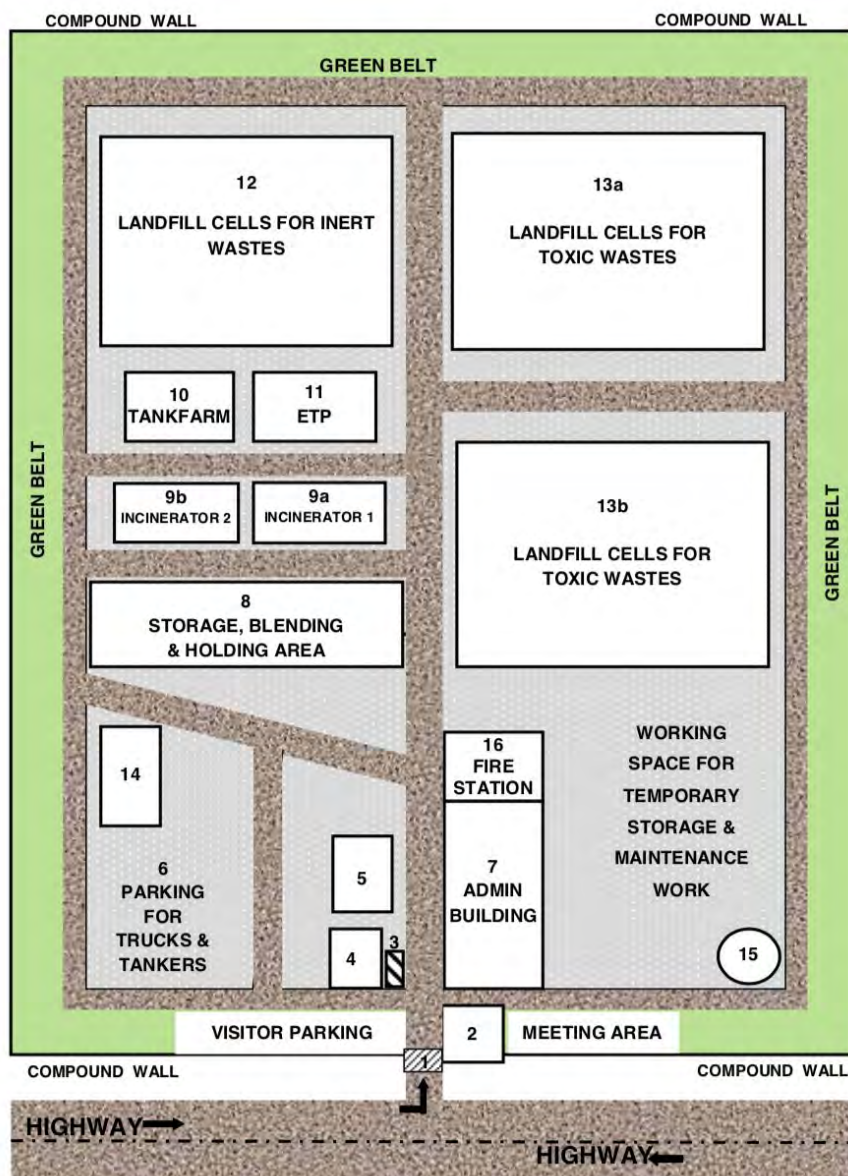


Figure 4.1-7: Layout and the ground plan for a TSDF site

Source: Document for Implementation of Phase-II of SENSREC Project in Chittagong, Bangladesh (Establishing the Common Hazardous Waste Treatment, Storage & Disposal Facility and Planning for Implementation of the Training Modules) 2017 prepared by Centre for Environmental Science & Engineering, Indian Institute of Technology Bombay

The funds needed for the construction of a TSDF was also calculated as shown below.

Waste transportation cost from AEZ

Because the distance from AEZ to TSDF in Chittagong is somewhat similar to the distance from AEZ to the location of Lafarge-Holcim factory thus estimated average transportation cost would be estimated at somewhat to 21-25\$/ton (250\$/10-12ton truck). Waste treatment costs cannot be measured during the study since the facility is still in planning phase.

Table 4.1-16: Funds needed for establishing the TSDF site

Sr No	Type of Waste or Area	Funds Needed now for Construction of CHW-TSDF having 10-year Life in million USD	Additional Funds Needed after 10-yrs for Extending Life of the TSDF by another 10 years in million USD
1a	Landfillable Wastes for the first 10-yr period	2.50	
1b	Landfillable Wastes for the next 10-yr period		6.57
2a	Incinerator for the first 10-yr period	6.84	
2b	New Incinerator for the next 10-yr period		20.99
3	Bilge water + Scrubber Effluents + Landfill Leachates	0.47	1.38
4	Civil Work, storage and blending sheds, site development, infrastructure, chemical laboratory (modest), firefighting facility, green belt, etc.	1.47	4.34
Sub-total of the costs for construction and erection of CHW-TSDF =		11.28	33.28
5a	Initially, for obtaining the permission and approvals from the relevant Authorities and Agencies, certain investigations and assessments will be conducted. Those include EIA, hydro-geological and geo-technical surveys among several things.	4.80	
5b	After 10 years, for obtaining the permissions for extending the life by 10 years, the relevant Authorities and Agencies may demand that certain investigations and assessments be conducted afresh.		4.50
TOTAL =		16.1	37.8
		million USD	million USD

Source: Document for Implementation of Phase-II of SENSREC Project in Chittagong, Bangladesh (Establishing the Common Hazardous Waste Treatment, Storage & Disposal Facility and Planning for Implementation of the Training Modules) 2017 prepared by Centre for Environmental Science & Engineering, Indian Institute of Technology Bombay

The second phase of the project is expected to focus on constructing a dedicated waste-management facility for treating, storing and disposing of the hazardous waste (TSDF). According to the Ministry of Industry, the feasibility study shall be started in 2018 and be completed by February 2019. However, the budget for the construction of the facility has not been secured yet. The exact location of the facility has not been fixed yet. However, it will be located in Sitakunda upazila, Chittagong district.

This facility is originally planned to take waste from ship recycling industry and the other industries in the Chittagong region. Considering the 14,400ton capacity for other industries, which is large enough for AEZ's hazardous waste of 1,238 ton, BEZA may negotiate with the Ministry of Industry for their permission to accommodate hazardous waste from AEZ.

② New Waste Treatment Site in Narayanganj City Corporation

Narayanganj City Corporation (NCC) has a plan to develop a new waste treatment site in Jalkuri. NCC already secured the budget for this. Currently it is in the land acquisition stage. Specs/capacity is to be

decided after acquisition. However, NCC's duty is only Waste from Narayanganj City (not all district). Acceptance depends on negotiation.

Functional components (6 acres=261,360 square feet)

- Compost Plant (200*100 sq.ft)
- Incinerator+ Hospital Waste Management center (100*80 sq ft)
- ETP (300*200 sq feet)
- Segregation Shed (200*100 sq.ft)
- Sub-station (40*40 sq.ft)
- Recycling center+Bio-Gas Plant (100*50 sq ft)
- Canteen (30*20 sq.ft)
- Administrative Building (100*50 sq.ft)
- Garage/Parking Area (70*30 sq.ft)
- Leachate Pond (128*128 sq.ft)
- Water tank
- Septic tank
- Guard room (15*10 sq.ft)

Land filling site (17 acre = 740,520square feet)

(10 feet under the ground and 30 feet on the ground=total 40 feet land filling)

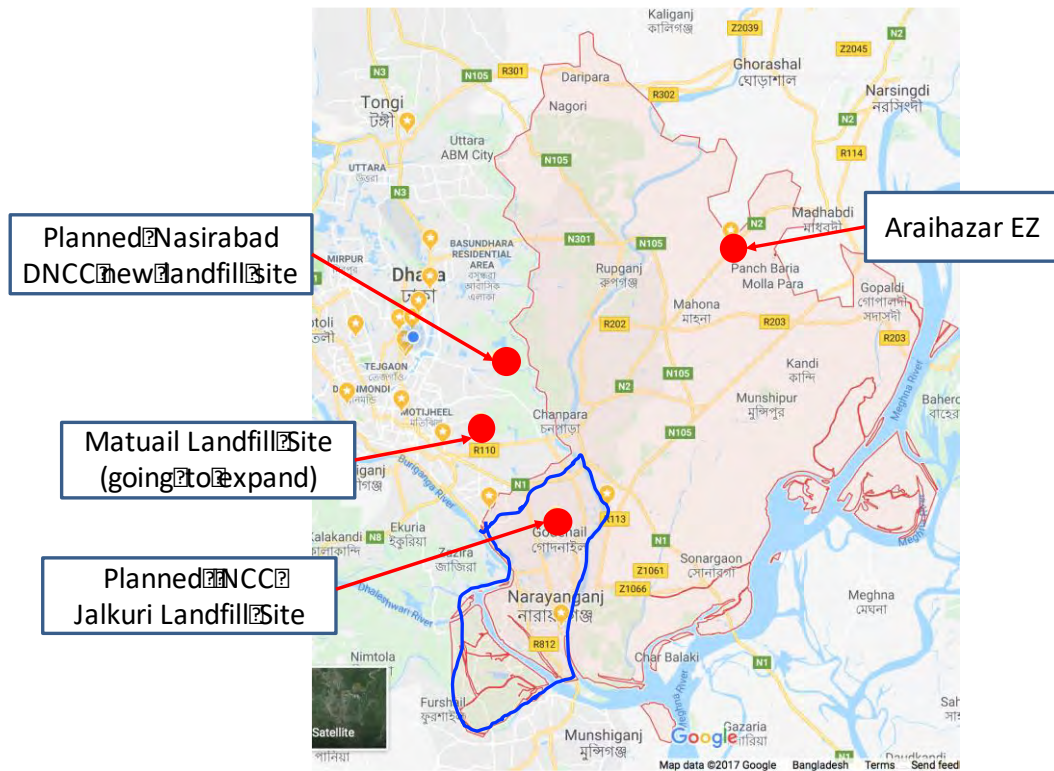
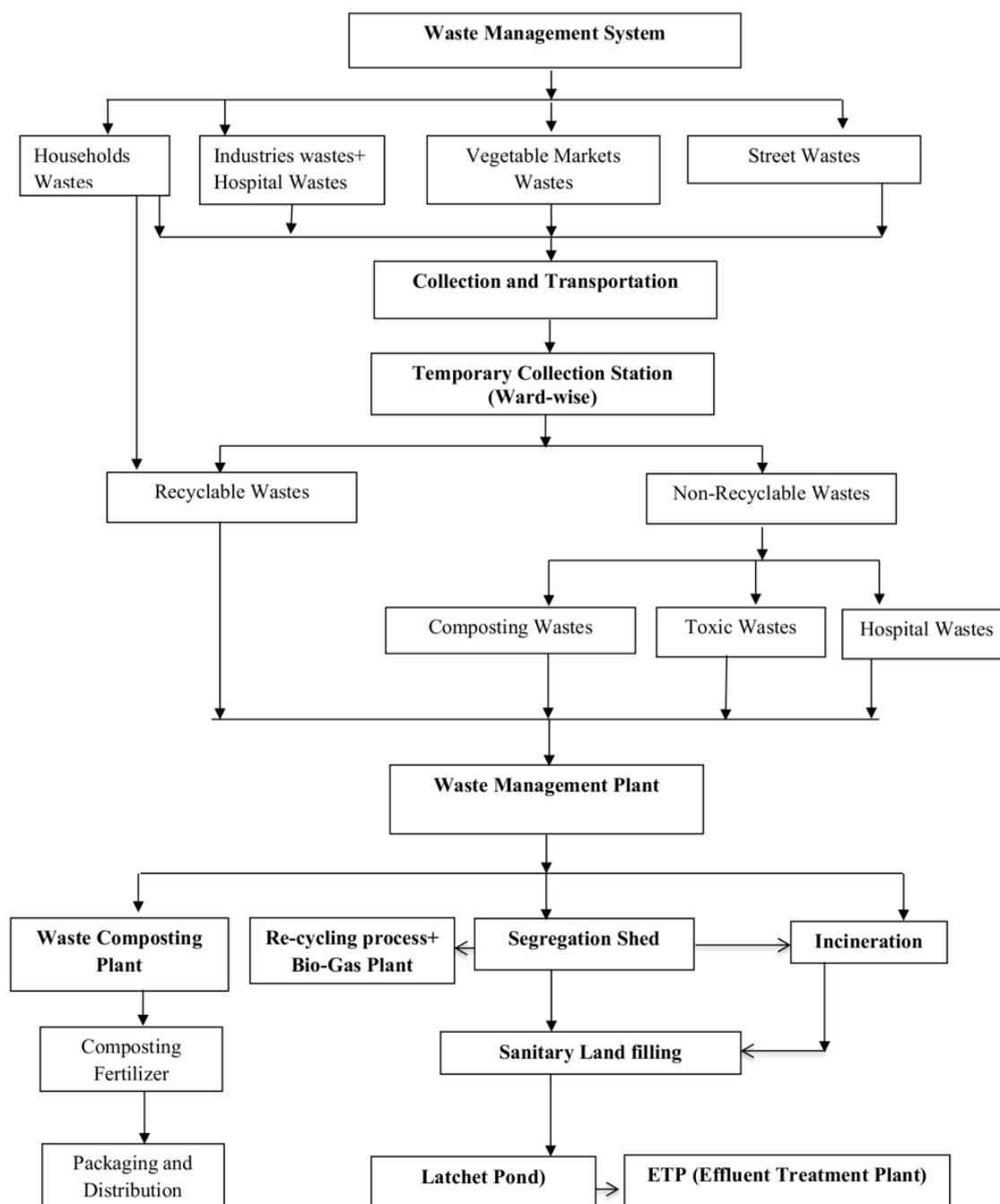


Figure 4.1-8: Locations of AEZ and Other Waste Treatment Sites



Source: NCC

Figure 4.1-9: Land Use Plan of NCC's New Waste Treatment Site



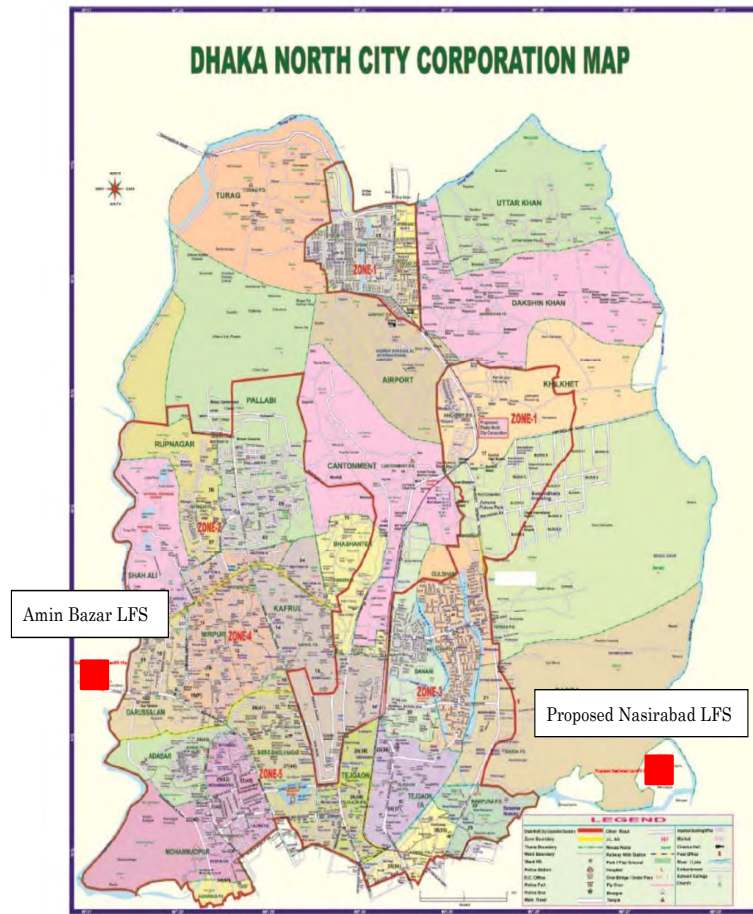
Source: NCC

Figure 4.1-10: Waste Flow of NCC's New Waste Treatment Site

③ New Landfill Site of North Dhaka City Corporation

Dhaka North City Corporation (DNCC) has the Amin Bazar Landfill Site in the west of Dhaka City. Since this existing site is going to reach full capacity soon, DNCC has an expansion plan for the Amin Bazar Landfill Site. Besides, a new Landfill Site shall be developed by DNCC in Nasirabad in the east of Dhaka city in near future. However, the budget and development plan are still currently under consideration by DNCC with support of JICA. However, "Waste from outside Dhaka city" and

“Industrial waste” are out of Dhaka North City Corporation (DNCC)’s duty. Therefore, if BEZA wishes to dispose AEZ’s waste in this new site, BEZA needs negotiate with DNCC for acceptance of waste.



Source: JICA project team of “Project for Strengthening of solid waste management in North and South Dhaka City and Chittagong City”

Figure 4.1-11: Image of Layout Plan on New Matuail Waste Treatment Complex

④ Development of PPP Industrial Waste Treatment Facility in Government Land

Waste treatment companies including Japanese companies may be interested in investing industrial waste treatment facilities as a PPP project. Their decision will depend on conditions such as land price, public support, etc. As an example, the Matuail expansion site may be developed as a PPP RDF (Refuse Derived Fuel) Project, proposed by companies such as a South Korean company.

As an example of waste management facilities developed for a SEZ supported by JICA, Thilawa SEZ in Myanmar can be referred. A Japanese-Myanmar joint venture company, with the capital of USD 36 million, has developed the facilities in a 42ha land inside the SEZ, which has functions of final disposal, intermediate treatment, sorting, transporting and recycling. Its development plan had the following schedule.

Activities		Year	2014	2015	2016	2017	2018	2023	2028	2038	2053	2063	2073
			1st	2nd	3rd	4th	5th	10th	15th	25th	40th	50th	60th
EIA Study and Designing			■										
Landfill (Phase 1) Non-Haz + Haz Waste	Construction		■										
	Operation and Restoration			■	■	■	■	■	■				
	Aftercare (at least 10 years)									■	■		
Landfill (Phase 2-) Non-Haz + Haz Waste	Construction								■				
	Operation and Restoration								■	■	■	■	■
	Aftercare (at least 10 years)												■
Incinerator	Planning		■	■									
	Installation				■	■							
	Test Operation and Monitoring					■	■						
	Operation						■	■	■	■	■	■	■
Transportation, Sorting, Stabilization, Wastewater Treatment, Fuel Blending for Cement Plant	Operation			■	■	■	■	■	■	■	■	■	■

Figure 4.1-12: Schedule of Waste Treatment plant of Thilawa SEZ in Myanmar

Source: “Environmental Impact Assessment (EIA) Report in respect of the “Construction of Solid Waste Management Facilities in Thilawa SEZ Zone A”, DOWA Eco-System Co., Ltd. 2015



Location of Waste Management Facilities inside Thilawa SEZ



Overview of Treatment Facilities

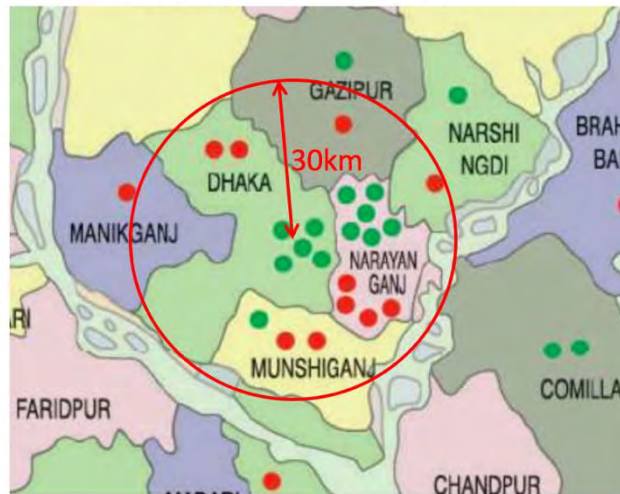


Treatment Facilities

⑤ Development of Industrial Waste Treatment Facility by Bangladesh Government

With an increasing number of EZs being planned by the public and private sectors, the capacity of existing facilities treating industrial waste may not be sufficient in near future. There are a number of new EZ projects within 30km distance in the area surrounding Dhaka city, especially in Narayanganj District, as shown in the figure below. It should be necessary to develop a common-use industrial waste treatment facility in Narayanganj District in the future, when a number of EZs are developed. After development by the Bangladesh Government, the operation of the facility could be done by the private sector.

Public (●) and Private EZs (●) Planned



Source: Prepared by JICA project team based on BEZA information

Figure 4.1-13: Planned EZs in Narayanganj district and nearby districts

Recommendations

The above two realistic options and other potential options are summarized in the following tables in terms of development stage and disposal methods.

Table 4.1-18: Availability and development stage of the seven options

		Option for Hazardous Waste	Option for Non-Hazardous Waste	Potential Future Option 1	Potential Future Option 2	Potential Future Option 3	Potential Future Option 4	Potential Future Option 5
		Cement factory	Matuail Expansion	Chittagong	NCC	NDCC	PPP	Govt.
1	Type of waste	Hazardous	Non-hazardous	Hazardous	Non-hazardous	Non-hazardous	Hazardous and non-hazardous	Hazardous and non-hazardous
2	Target area	Nation-wide	South Dhaka	Chittagong	Narayanganj	North Dhaka	-	-
3	Permission needed from	Obtained from Cement factory	Obtained from DSCC	MOI	NCC	NDCC	-	-
4	Available even now	☐						
5	Under construction		☐					
6	Land is purchased		☐					
7	Budget is approved		☐	☐				
8	Facility Design is approved		☐	☐	☐			
9	FS is completed				☐			
10	FS is on-going					☐		
11	FS is planned						☐	☐

Table 4.1-19: Types of disposal method for the seven options

		Option for Hazardous Waste	Option for Non-Hazardous Waste	Potential Future Option 1	Potential Future Option 2	Potential Future Option 3	Potential Future Option 4	Potential Future Option 5
		Cement factory	Matuail Expansion	Chittagong	NCC	NDCC	PPP	Govt.
1	Landfill (non-hazardous)		☐	☐	☐	☐		
2	Landfill (hazardous)		(☐)	☐				
3	Incineration			☐				
4	Co-processing (hazardous and non-hazardous)	☐						

The following table compares waste treatment costs among four selected countries. The current co-processing cost in Bangladesh is relatively high as the calorific value of the current waste is low and therefore cannot be used as alternative fuel. If waste of higher calorific value can be efficiently collected, it may be treated at lower cost in future in Bangladesh like other countries.

Table 4.1-20: Comparison of Waste Treatment Costs in Selected Countries (US\$/ton)

	Bangladesh (2017)	India (2017)	Thailand (2014)	Japan (2017)
Co-processing at cement factory (non-hazardous)	150 (173)		72	
Co-processing at cement factory (hazardous)	500-600 (523-623)			
Land filling (non-hazardous)	13 (23) - 33 (56)	29	67	227
Land filling (after treatment)	59 (82)	54		
Incineration	450 (473)	408	175	318
Incineration after treatment	500 (523)		667	1,000

*The figures in parentheses include both treatment costs and transportation costs (from Araihaazar to the destinations).

**“Co-processing at cement factory (non-hazardous and hazardous)” in Bangladesh is an indicative price at the Chattak Cement factory.

**“Land filling (non-hazardous)” in Bangladesh is an price estimated based on DNCC’s past example (US\$13/ton) and a price for the proposed treatment facility (TSDF) for ship recycling industry in Chittagong (US\$33/ton).

**“Land filling (after treatment), incineration and incineration after treatment” in Bangladesh is an indicative price for the proposed treatment facility (TSDF) for ship recycling industry in Chittagong.

Source: LafargeHolcim Bangladesh Limited, Kyoto Environmental Preservation Public Corporation, Mumbai Waste Management Ltd., Ministry of Environment of Japan (“Report on Hazardous Industrial Waste Management Project in Thailand (2014)”), Document for Implementation of Phase-II of SENSREC Project in Chittagong, Bangladesh (Establishing the Common Hazardous Waste Treatment, Storage & Disposal Facility and Planning for Implementation of the Training Modules) 2017 prepared by Centre for Environmental Science & Engineering, Indian Institute of Technology Bombay

Base on the consideration on types of waste, costs and treatment methods, the following industrial waste management is recommended for AEZ. Both short and mid/long-term recommendations are proposed below.

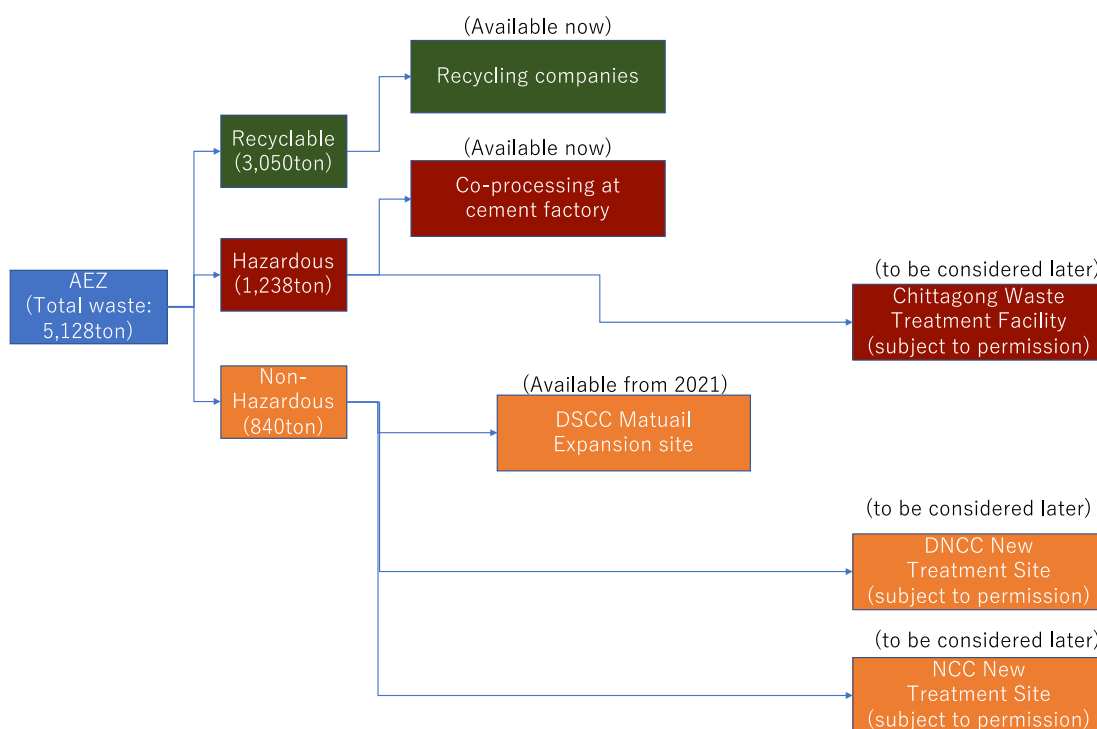


Figure 4.1-14: Recommendation on AEZ Waste Management

Source: prepared by JICA Study Team

• Short-term recommendation

Out of the 5,128 ton of AEZ waste, 3,050 ton of recyclable waste is assumed to be collected by local recycling companies. The remaining 2078 ton of waste is divided into 1,238ton of hazardous waste and 840 ton of non-hazardous waste. The non-hazardous waste is expected to be accommodated by nearby landfill sites of city corporations such as DSCC. These city corporations may be preferable in terms of transportation and treatment cost rather than a remote treatment facility. The DSCC Matuail expansion site may be the most prospective option out of the three city corporations. BEZA may negotiate with other city corporations later once their new landfill sites become operational. A definitive option for hazardous waste is currently limited to co-processing at the cement factory. The Chittagong treatment facility is also expected to accommodate the waste of the AEZ once it becomes operational in future.

Basically, it is the responsibility of the tenant companies to manage the industrial waste under applicable laws and regulations. Individual industrial waste management plans shall be prepared by individual tenant companies in their EIAs. The AEZ operator will monitor their proper management by the authorized records such as in/out material inventories, invoices and certification by the authorized waste management agencies.

• Long term recommendation

There is an obvious limitation in the availability of industrial waste management facilities around the AEZ as well as in the whole county at present. In a long term viewpoint, it is necessary to consider

Potential Option 4 or 5. NCC's planned facility is basically limited to the waste generated in Narayanganj city (not in whole Narayanganj district), and DSCC and DNCC are also originally limited to the waste generated inside Dhaka city. Although DSCC agrees to accept waste from AEZ for the initial stage, it should be considered as a temporary destination of waste.

Therefore, it is recommendable for BEZA and Bangladesh Government to conduct a feasibility study to set up a comprehensive industrial waste treatment complex not only for AEZ but also for other private and public economic zones and businesses in Narayanganj district and surrounding areas with collaboration among relevant local authorities and other regulatory agencies. The comprehensive industrial waste treatment complex would enable the lowering of the cost of industrial waste management for the AEZ tenants and sustain the economically viable operation for the operators/owners of the complex.

4.2. Waste water standard and enforcement for AEZ

(1) International Standard

Inadequate treatment of waste water could have short-term and long-term adverse impact on surrounding environment thus enforcement of appropriate waste water treatment and setting practical standards are mandatory measures in development of economic zones where multiple industries and companies concentrate in single zone.

For AEZ, domestic wastewater of each tenant factory (kitchen and toilet wastewater etc.) will be treated by the central processing facility in the EZ. In regards to industrial wastewater from AEZ as well as each tenant factory, "Two-step" waste water treatment could be most suitable for AEZ. First-step would be primary treatment or pre-treatment which should be carried out by tenant companies in accordance with industry-specific standards set forth by SPC. These standards must be met at the point of discharge from each tenant factory before discharge of wastewater into a sewage treatment plant (STP) or a central effluent treatment plant (CETP) as "inlet water". STP/CETP shall functions as secondary-treatment of waste water which should conform to international/ASEAN standards for outlet water quality before discharging water to outside AEZ.

JICA requested BEZA to refer to international standards such as IFC-EHS Guideline and/or ASEAN's industrial wastewater standards, and BEZA agreed to the request during JICA's mission in June 2018.

Over the past few decades, a large number of economic zones have been developed in ASEAN nations and each nation or each economic zone may have its own standards and there is no single universal waste water standard in ASEAN.

Due to the excessive number of wastewater standards exist in ASEAN, this report has narrowed the selection down to few ASEAN countries which are generally considered to be preferred destinations among Japanese investors for many years, thus some countries are omitted due to their immaturity of economic zone development. In these selected countries, their wastewater standards are currently being practiced and it can be said that they have been proven feasible and manageable.

As JICA has requested BEZA, AEZ could refer to these ASEAN standards even though some parameters may not be applicable in the context of Bangladeshi economic zones.

Along with ASEAN standards, IFC-EHS standards can be examined as reference but there are discrepancies for some parameters between IFC-EHS standards and that of ASEAN's thus appropriate standards may need to fill these gaps during planning.

BEZA/SPC must determine feasible and acceptable but also effective and reliable waste water quality standards and monitoring plan before a detailed design of a wastewater treatment plant starts.

JICA study team has gathered several standards for reference as shown in the following tables;

Pre-treatment standards by tenant factories;

Table 4.2-1: Industry-specific standards of IFC-EHS and proposed AEZ water discharge standard.

Table 4.2-2: Industry-specific standards of Indonesia

Table 4.2-3: Industry-specific standards of Myanmar

Inlet water quality (after pre-treatment)

Table 4.2-4: Inlet water (inlet for common STP/CETP) quality of Vietnam, Thailand and Indonesia, and quality standard of discharge water (to outside EZ) of India.

Table 4.2-5: Outlet (after secondary-treatment by STP/CETP) water quality of of Vietnam, Thailand and Indonesia, and proposed AEZ water discharge standard

Table 4.2-6: Thilawa SEZ, Myanmar Inlet water quality standard (not national standard).

Table4.2-1-1 : Wastewater standard proposed (grey column) based on IFC-EHS standards and Bangladesh national standard (ECR 97)

Pollutant		Proposed Effluent Discharge Standards for AEZ based on IFC-EHS	SCHEDULE – 9 Standards for Sewage Discharge [Rule 1212, ECR’97]	SCHEDULE – 10 Standards for Waste from Industrial Units or Projects [Rule 13, ECR’97] Inland Surface Water	Table 1.3.1 Indicative Values for Sanitary Sewage Discharges IFC EHS Guidelines <Primary Guideline Values>	Table 1. Effluent levels for food processing IFC EHS Guidelines	Table 6: Effluent Levels for Metal, Plastic, and Rubber Products Manufacturing IFC EHS Guidelines	Table 2. Effluents for Levels Pharmaceuticals and Biotechnology Manufacturing IFC EHS Guidelines	Table 1. Effluent levels for Semiconductors and Electronics Manufacturing IFC EHS Guidelines	Table 2. Effluent levels for the textile industry ^a IFC EHS Guidelines
	Unit									
pH	S.U.	6 – 9		6-9	6-9	6-9	6-9	6-9	6 – 9	
BOD5	mg/L	30	40	50	30	50	30	160	30	
COD	mg/L	125		200	125	250	150	50	160	
Dissolved Oxygen (DO)	mg/L	4.5 - 8		4.5 - 8						
Electric-conductivity (EC)	micro mho/cm	1200		1200						
Total Suspended Solids (TSS)	mg/L	50	100	150	50	50	50 / 25*	10	50	50
Total Dissolved Solids	mg/L	2100		2100						
Oil and grease	mg/L	10		10	10	10	10	10	10	10
AOX (absorbable organic bound halogens)	mg/L	1						1	0.5	1
Aluminum	mg/L	3					3			
Arsenic	mg/L	0.1		0.2			0.1	0.1	0.1	
Cadmium	mg/L	0.1		0.5			0.1	0.1	0.1	0.02
Chromium (total)	mg/L	0.5		0.5			0.5		0.5	0.5
Chromium (hexavalent)	mg/L	0.1		0.1			0.1	0.1	0.1	0.1
Cobalt	mg/L	0.5								0.5
Copper	mg/L	0.5		0.5			0.5		0.5	0.5
Iron	mg/L	2		2			3			
Lead	mg/L	0.1		0.1			0.2		0.1	
Mercury	mg/L	0.01		0.01			0.01	0.01	0.01	
Manganese (Mn)	mg/L	5		5						
Nickel	mg/L	0.5		1			0.5		0.5	0.5
Selenium	mg/L	0.05		0.05					1	
Silver	mg/L	0.2					0.2		0.1	
Tin	mg/L	2					2		2	
Zinc	mg/L	2		5			2		2	2
Cyanides (total)	mg/L	1					1		1	
Cyanides (free)	mg/L	0.1		0.1			0.2		0.1	
Active ingredient (each)	mg/L							0.05		
Ammonia	mg/L	5		5			10 / 20*	30	10	10
Ammoniacal Nitrogen (NH ₃ -N)	mg/L	50		50						
Boron	mg/L	2		2						
Fluorides	mg/L	2		2			20		5	
Phenols	mg/L	0.5		1			0.5	0.5		0.5
Nitrate	mg/L	10		10						
Total nitrogen	mg/L	15	250	100	10	10	15	10		10
Dissolved Phosphorus	mg/L	8		8						

Table4.2-2 : Industry-specific wastewater standards in Indonesia

		Outlet Effluent standard in Indonesia (for general factories with less than 1500 BOD and less than 3000 COD)	Outlet Effluent standard in Indonesia for mental plating	Outlet Effluent standard in Indonesia for textile industry	Outlet Effluent standard in Indonesia for food (soft drink) industry	Outlet Effluent standard in Indonesia for pharmaceutical industry (manufacturing of raw material)	Outlet Effluent standard in Indonesia for industrial zone
			2014 Ministry of Environment Decree No.5 Annex Table I	2014 Ministry of Environment Decree No.5 Annex Table XLII	2014 Ministry of Environment Decree No.5 Annex Table VIX	2014 Ministry of Environment Decree No.5 Annex Table XXXIX	2010 Ministry of Environment Decree No.3
Maximum discharge per ton product	m3/ton		20L/m2	100			
pH	S.U.	6-9	6-9	6-9	6-9	6-9	6-9
BOD5	mg/L	50	50	60	50	100	50
COD	mg/L	100	100	150	100	300	100
Total Suspended Solids (TSS)	mg/L	200	20	50	30	100	150
Total Dissolved Solids	mg/L	2000	2000	2000	2000	2000	2000
Oil and grease	mg/L	10	10	3.0	6.0	10	15
Arsenic	mg/L	0.1	0.1	0.1	0.1	0.1	0.1
Cadmium	mg/L	0.05	0.05	0.05	0.05	0.05	0.05
Chromium (total)	mg/L	0.5	0.5	1.0	0.5	0.5	0.5
Chromium (hexavalent)	mg/L	0.1	0.1	0.1	0.1	0.1	0.1
Cobalt	mg/L	0.4	0.4	0.4	0.4	0.4	0.4
Copper	mg/L	2	0.6	2	2	2	2
Iron	mg/L	5	5	5	5	5	5
Lead	mg/L	0.1	0.1	0.1	0.1	0.1	0.1
Mercury	mg/L	0.002	0.002	0.002	0.002	0.002	0.002
Manganese (Mn)	mg/L	2	2	2	2	2	2
Nickel	mg/L	0.2	1	0.2	0.2	0.2	0.2
Selenium	mg/L	0.05	0.05	0.05	0.05	0.05	0.05
Tin	mg/L	2	0.1	2	2	2	2
Zinc	mg/L	5	1	5	5	5	5
Cyanides (total)	mg/L	0.05	0.2	0.05	0.05	0.05	0.05
Ammoniacal Nitrogen (NH ₃ -N)	mg/L	5	5	8	5	5	5
Fluorides	mg/L	2	2	2	2	2	2
Phenols	mg/L	0.5	0.5	0.5	0.5	1.0	1.0
Nitrate	mg/L	20	20	20	20	20	20
Total nitrogen	mg/L	30	30	30	30	30	30
Sulfide	mg/L	0.5	0.5	0.3	0.5	0.5	0.5
Coliform bacteria	MPN /100ml	10000	10000	10000	10000	10000	10000
Ammonium (asN)	mg/L			8			20
Excess chlorine	mg/L	1	1	1	1	1	1
Barium	mg/L	2	2	2	2	2	2
Temperature	°C	38	38	38	38	38	38
Sulphur (S)	mg/L	-	-	0.3		-	1
MBAS	mg/L	-	-	-	-	-	10
Color		-	-	3.0	-	-	-

Table 4.2-3: Myanmar: Industry-specific “National Environmental Quality Guideline (NEQG)” in conformity with IFC-EHS.

Metal, Plastic and Rubber Products Manufacturing				Metal, Machinery and Electronics				Pharmaceuticals and Biotechnology Manufacturing			
Parameter	Unit	Guideline Value		Parameter	Unit	Guideline Value		Parameter	Unit	Guideline Value	
5-day Biochemical oxygen demand	mg/l	30		Aluminum	mg/l	0.2		1,2-Dichloroethane	mg/l	0.1	
Adsorbable organic halogens	mg/l	1		Arsenic	mg/l	0.05		5-day Biochemical oxygen demand	mg/l	30	
Ammonia	mg/l	10		Cadmium	mg/l	0.05		Acetates (each) ^a	mg/l	0.5	
Cadmium	mg/l	0.02		Chemical oxygen demand	mg/l	50		Acetonitrile	mg/l	10.2	
Chemical oxygen demand	mg/l	160		Copper	mg/l	0.1		Active ingredient (each)	mg/l	0.05	
Chromium (hexavalent)	mg/l	0.1		Fluoride	mg/l	5		Adsorbable organic halogen	mg/l	1	
Chromium (total)	mg/l	0.5		Hydrocarbons	mg/l	5		Amines (each) ^b	mg/l	102	
Cobalt	mg/l	0.5		Lead	mg/l	0.1		Ammonia	mg/l	30	
Color	m ⁻¹	7 (436 nm ^a , yellow) 5 (525 nm, red) 3 (620 nm, blue)		Mercury	mg/l	0.01		Arsenic	mg/l	0.1	
				Nickel	mg/l	0.1		Benzene	mg/l	0.02	
				pH	S.U. ^a	6-9		Cadmium	mg/l	0.1	
Copper	mg/l	0.5		Temperature increase		<3 ^b		Chemical oxygen demand	mg/l	150	
Nickel	mg/l	0.5		Total suspended solids		20		Chlorobenzene	mg/l	0.06	
Oil and grease	mg/l	10		Zinc	mg/l	0.2		Chloroform	mg/l	0.013	
Pesticides	mg/l	0.05-0.10 ^b		^a Standard unit				Chromium (hexavalent)	mg/l	0.1	
pH	S.U. ^c	6-9		er not	Parameter	Unit	Guideline Value	Dimethyl sulfoxide	mg/l	37.5	
Phenol	mg/l	0.5			5-day Biochemical oxygen demand	mg/l	50	Isobutyraldehyde	mg/l	0.5	
Sulfide	mg/l	1			Ammonia	mg/l	10	Isopropanol	mg/l	1.6	
Temperature increase	°C	<3 ^d			Chemical oxygen demand	mg/l	250	Isopropyl ether	mg/l	2.6	
Total coliform bacteria	100 ml	400			Chloride	mg/l	1,000	Ketones (each) ^c	mg/l	0.2	
Total nitrogen	mg/l	10			Chromium (hexavalent)	mg/l	0.1	Mercury	mg/l	0.01	
Total phosphorus	mg/l	2			Chromium (total)	mg/l	0.5	Methanol / Ethanol (each)	mg/l	4.1	
Total suspended solids	mg/l	50			Oil and grease	mg/l	10	Methyl cellosolve	mg/l	40.6	
Zinc	mg/l	2			pH	S.U. ^a	6-9	Methylene chloride	mg/l	0.3	
^a Nanometers					Phenols	mg/l	0.5	n-Heptane	mg/l	0.02	
					Sulfate	mg/l	300	n-Hexane	mg/l	0.02	
					Sulfide	mg/l	1.0	o-Dichlorobenzene	mg/l	0.06	
					Temperature increase	°C	<3 ^b	Oil and grease	mg/l	10	
					Total coliform bacteria	100 ml	400	pH	S.U. ^d	6-9	
					Total nitrogen	mg/l	10	Phenol	mg/l	0.5	
					Total phosphorus	mg/l	2	Tetrahydrofuran	mg/l	2.6	
					Total suspended solids	mg/l	50	Toluene	mg/l	0.02	
					^a Standard unit			Total nitrogen	mg/l	10	
					er not	Parameter	Unit	Guideline Value	Total phosphorus	mg/l	2
						Oil and grease	mg/l	10	Total suspended solids	mg/l	10
						pH	S.U. ^d	6-9	Xylenes	mg/l	0.01
						Phenol	mg/l	0.5	^a n-Amyl acetate, n-Butyl acetate, Ethyl acetate, Isopropyl acetate, Methyl formate		
						Tetrahydrofuran	mg/l	2.6	^b Including Diethylamine and Triethylamine		
						Toluene	mg/l	0.02	^c Including Acetone, Methyl isobutyl ketone		
						Total nitrogen	mg/l	10	^d Standard unit		
						Total phosphorus	mg/l	2			
						Total suspended solids	mg/l	10			
						Xylenes	mg/l	0.01			

Table 4.2-4: Inlet Effluent Standards of Vietnam, Thailand and Indonesia (After primary treatment) (Table on left), and Secondary-treated water standard (discharge from STP/CETP) (Table on right)

Parameter for inlet effluent quality of CETP	Standard (Concentration in mg/l)					Treated Effluent Quality of Common Effluent treatment Plant (CPCB, India)		
	India (Total discharge upto 25kl/day)	V&IP (Vietnam)	Leamchabang (Thailand)	Amata Nakorn / Amata City (Thailand)	Greenland International Industrial Center (Indonesia)	Into land surface waters	On land irrigation	Into Marine Coastal areas
pH	5.5 - 9.0	6.0 - 9.0	5.5 - 9.0	5.5 - 9.0	6.0 - 8.0	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0
Temperature °C	45	40	45	45	45	*1	-	45
Odour	-	-	-	-	-	-	-	-
Colour, Co-Pt at pH=7 / Chromaticity		50	-	-	300	-	-	-
BODs (20 °C) (mg/l)		400	500	500	300	30	100	100
COD (mg/l)		600	750	750	500	250	-	250
Suspended solids (SS) (mg/l)		400	200	200	200	100	200	*2
TDS			3000	3000	2000	2100	2100	-
TKN (Total Kjeldahl Nitrogen)			100	100		100	-	100
Oil & Grease	20		10	10		10	10	20
Mineral oil and fat		5			10			
Animal vegetable fat and oil (mg/l)		16			5			
Ammonical Nitrogen (as N)	50	8				50	-	50
Free ammonia (mg/l)					1			
Arsenic (as As) (mg/l)	0.2	0.05	0.25	0.25	0.1	0.2	0.2	0.2
Barium (as Ba) (mg/l)			1	1	2			
Blue methyl active compound (mg/l)					5			
Boron (as B)	2					2	2	-
Cadmium (as Cd) (mg/l)	1	0.05	0.03	0.03	0.05	1	-	2
Total Cadmium (as Cr)						2	-	2
Cyanide (as N)	2	0.07				0.2	0.2	0.2
Cyanide (as HCN) (mg/l)			0.2	0.2	0.5			
Chloride (as Cl2)		500	2000	2000		1000	600	-
Residual Chlorine		1				1	-	1
Free chlorine			1	1	1			
Chlorine gas (mg/l)					1			
Chromium (VI) (as Cr6+) (mg/l)	2	0.05	0.25	0.25	0.1			
Chromium (III) (as Cr3+)		0.2	0.75	0.75				
Chromium (total) (as Cr) (mg/l)	2				0.5			
Cobalt (mg/l)					0.4			
Coliform		5						
Copper (as Cu) (mg/l)	3	2	2	2	1	3	-	3
Fluoride / Fluorine (as F) (mg/l)	15	5	5	5	5	2	-	15
Formaldehyde			1	1	1			
Iron (mg/l)		1		10	5			
Lead (as Pb) (mg/l)	1	0.1	0.2	0.2	0.1	0.1	-	1
Manganese (as Mn) (mg/l)		0.5	5	5	2			
Mercury (as Hg) (mg/l)	0.01	0.005	0.005	0.005	0.002	0.01	-	0.01
Nickel (as Ni)	3	0.2	1	1	0.2	3	-	5
Nitric acid (mg/l)					20			
Nitrous acid (mg/l)					1			
PCBs (Poly chlorinated biphenyl)		0.003						
Pesticides						X	X	X
Pesticides: Organic Phosphorous		0.3	-	-	X			
Pesticides: Organic Chloride		0.05	-	-	X			
Phenol (as C6H5OH) (mg/l)	5	0.1	1	1	0.5	1	-	5
Percent Sodium						-	60	-
Silver (as Ag) (mg/l)			1	1	1			
Scandium (as Sc)		0.02						
Selenium (as Se) (mg/l)	0.05			0.02	0.05	0.05	-	0.05
Sulphate (as SO4)						1000	1000	-
Sulfide (mg/l)		0.2	1	1	0.05	2.8	-	5
Surfactants			30	30				
Tin (mg/l)					2			
Total iron			10					
Total nitrogen		20						
Total phosphorous		5						
Zinc (as Zn) (mg/l)	15	3	5	5	5	5	-	15
Gross α activity		0.1						
Gross B activity		1						
Radioactive Materials:		-	-	-	X			
Alpha emitters, Hc /mL	10.7							
Beta emitters, He /mL	10.8							

Table 4.2-5 Outlet Effluent Standards of Vietnam, Thailand and Indonesia (After secondary treatment)

Pollutant	Unit	Outlet Effluent standard in Thailand (MNRE Decree on Industrial Effluent Standard B.E. 2016)	Outlet Effluent standard in Indonesia (for general factories with less than 1500 BOD and less than 3000 COD)	Outlet Effluent standard in Vietnam (discharged into the water sources serving tap water supply) (QCVN 40:2011/BTNMT -	Outlet Effluent standard in Vietnam (discharged into the water sources not serving tap water supply)(QCVN 40:2011/BTNMT -	Proposed Effluent Discharge Standards for AEZ	SCHEDULE - 9 Standards for Sewage Discharge [Rule 1212, ECR'97]	SCHEDULE - 10 (Bangladesh) Standards for Waste From Industrial [Rule 13, ECR'97]
pH	S.U.	5.5-9	6-9	6-9	6-9	6-9		6-9
BOD ₅	mg/L	20	50	30	50	30	40	50
COD	mg/L	120	100	75	150	125		200
Dissolved Oxygen (DO)	mg/L	-	-	-	-	4.5 - 8		4.5 - 8
Electric-conductivity (EC)	micro mho/cm	-	-	-	-	1200		1200
Total Suspended Solids (TSS)	mg/L	50	200	50	100	50	100	150
Total Dissolved Solids	mg/L	3000	2000	-	-	2100		2100
Oil and grease	mg/L	5	10	5	10	10		10
AOX (adsorbable organic bound halogens)	mg/L	-	-	-	-	1		
Aluminium	mg/L	-	-	-	-	3		
Arsenic	mg/L	0.25	0.1	0.05	0.1	0.1		0.2
Cadmium	mg/L	0.03	0.05	0.05	0.1	0.1		0.5
Chromium (total)	mg/L	-	0.5	-	-	0.5		0.5
Chromium (hexavalent)	mg/L	0.25	0.1	0.05	0.1	0.1		0.1
Cobalt	mg/L	-	0.4	-	-	0.5		
Copper	mg/L	2	2	2	2	0.5		0.5
Iron	mg/L	-	5	1	5	2		2
Lead	mg/L	0.2	0.1	0.1	0.5	0.1		0.1
Mercury	mg/L	0.005	0.002	0.005	0.01	0.01		0.01
Manganese (Mn)	mg/L	5	2	0.5	0.1	5		5
Nickel	mg/L	1	0.2	0.2	0.5	0.5		1
Selenium	mg/L	0.02	0.05	-	-	0.05		0.05
Silver	mg/L	-	-	-	-	0.2		
Tin	mg/L	-	2	-	-	2		
Zinc	mg/L	5	5	3	3	2		5
Cyanides (total)	mg/L	0.2	0.05	-	-	1		
Cyanides (free)	mg/L	-	-	-	-	0.1		0.1
Ammonia	mg/L	-	-	-	-	5		5
Anmoniacal Nitrogen (NH ₃ -N)	mg/L	-	5	-	-	50		50
Boron	mg/L	-	-	-	-	2		2
Fluorides	mg/L	-	2	5	10	2		2
Phenols	mg/L	1	0.5	0.1	0.5	0.5		1
Nitrate	mg/L	-	20	-	-	10		10
Total nitrogen	mg/L	100	30	20	40	15	250	100
Dissolved Phosphorus	mg/L	-	-	-	-	8		8
Total phosphorus	mg/L	-	-	4	6	5	35	
Sulfide	mg/L	1	0.5	0.2	0.5	1		1
Volatile Organic Halogens (V/OXH)	mg/L	-	-	-	-	0.1		
Ketones (each) ⁽¹⁾	mg/L	-	-	-	-	0.2		
Acetonitrile	mg/L	-	-	-	-	10.2		
Acetates (each) ⁽²⁾	mg/L	-	-	-	-	0.5		
Benzene	mg/L	-	-	-	-	0.02		
Chloride	mg/L	-	-	500	1000	600		600
Chlorobenzene	mg/L	-	-	-	-	0.06		
Chloroform	mg/L	-	-	-	-	0.013		
o-Dichlorobenzene	mg/L	-	-	-	-	0.06		
1,2-Dichloroethane	mg/L	-	-	-	-	0.1		
Anines (each) ⁽³⁾	mg/L	-	-	-	-	102		
Dimethyl sulfoxide	mg/L	-	-	-	-	37.5		
Methanol / ethanol (each)	mg/L	-	-	-	-	4.1		
n-Heptane	mg/L	-	-	-	-	0.02		
n-Hexane	mg/L	-	-	-	-	0.02		
Isobutyraldehyde	mg/L	-	-	-	-	0.5		
Isopropanol	mg/L	-	-	-	-	1.6		
Isopropyl ether	mg/L	-	-	-	-	2.6		
Coliform bacteria	MPN /100ml	-	10000	3000	5000	400	1000	
Chromium (Trivalent)	mg/L	0.75	-	0.2	0.1			
Ammonium (asN)	mg/L	-	-	5	10			
Excess chlorine	mg/L	1	1	1	2			
Gross α activity	Bq/L	-	-	0.1	0.1			
Gross β activity	Bq/L	-	-	1	1			
Total PCB	mg/L	-	-	0.003	0.01			
Total Organochlorine pesticide	mg/L	0	-	0.05	0.1			
Total Organophosphorus pesticide	mg/L	0	-	0.3	0.1			
Formaldehyde	mg/L	1	-	-	-			
Barium	mg/L	1	2	-	-			
Temperature	°C	40	38	40	40			
Color		300ADM	-	50 Pt/Co	150 Pt/Co			

Source: “ (Thailand)”, “ (Indonesia)”, “ QCVN 40:2011/BTNMT - National Technical Regulation On Industrial Wastewater (Vietnam)”

Table 4.2-6: Thilawa SEZ (MJTD Standard of Wastewater quality after Pre-wastewater treatment)

[MJTD Standard of Wastewater quality after Pre-wastewater treatment by the Locator]			
No.	Parameter	TSEZ-A's WQ standard	Unit
1	BOD ₅ (5days at 20-°C)	max 200	ppm
2	Suspended Solids (SS)	max 200	ppm
3	Total Dissolved solids	max 2,000	ppm
4	pH Value	6.5-8.5	-
5	COD _{Mn} Permanganate value *Under Review	max 150	ppm
6	COD _{Cr} Dicromate value	max 300	ppm
7	Sulphide (as HS)	max 1	ppm
8	Cyanide (as HCN)	max 0.2	ppm
9	Oil and grease	max 5	ppm
10	Total coliform bacteria	max 400	MPN/100ml
11	Tar	none	-
12	Formaldehyde	max 1	ppm
13	Phenols and cresols	max 1	ppm
14	Free chlorine	max 1	ppm
15	Zinc	max 5	ppm
16	Chromium	max 0.5	ppm
17	Arsenic	max 0.25	ppm
18	Copper	max 1.0	ppm
19	Mercury	max 0.005	ppm
20	Cadmium	max 0.03	ppm
21	Barium	max 1.0	ppm
22	Selenium	max 0.02	ppm
23	Lead	max 0.2	ppm
24	Nickel	max 0.2	ppm
25	Insecticides	None	-
26	Radioactive Material	None	-
27	Temperature	max 35	°C
28	Colour and Odor	150	[Co-Pt]
29	T-N	80	ppm

Source: “Application form of Environmental Conservation and Prevention Plan” of Thilawa SEZ

(2) Monitoring and enforcement

BEZA/SPC should carry responsibility to enforce its tenant factories to comply with the standards respectively and to take necessary measures for monitoring. Thus, it can be suggested that the standards and responsibilities of each tenant should be fully understood and agreed at the time of lease agreement.

In some economic zones, each tenant, EZ operators or SPCs requires all tenants to install wastewater quality monitoring device whose data will be automatically provided to the operators or SPCs so that any violation of the regulation that occur at pre-treatment phase is detected immediately by the operators.

(3) Penalties on violation

BEZA/SPC should set and enforce penal regulation on violation or breach of given standard against its tenant companies. This also should be clarified at the time of lease agreement.

Penalties could include; temporal stoppage of utility (power, water, gas) provision, imposing fines (financial penalty), temporal suspension of operation etc. Severity or terms of penalties may use other foreign economic zones as a reference but too severe penalties that lack practicality may affect the overall operation of the EZ.

4.3. Waste water treatment facility– activated sludge

As waste water standards were discussed in the previous paragraphs, AEZ will need to establish waste water treatment plant also known as STP, a centralized sewage treatment, that will function as the secondary treatment of waste water and can conform to the standards of AEZ. According to the conditions given by DoE, AEZ also needs to have a CETP in order to treat industrial waste water which requires special treatment.

Planning and designing of STP and/or CETP for AEZ is not within the scope of JST's study and due to limited information, this report can only provide suggestions based on assumptions. Especially, the capacity, specification, type of waste/effluent water treatment method for CETP is difficult to determine at this point because those depend on the characteristics of the influent (inlet water from tenants) and regulatory bindings (standards).

For AEZ, "Activated sludge" is proposed for wastewater treatment plant. It is universally adopted in many economic zones including Thilawa EZ and EPZs in Bangladesh as centralized wastewater facilities. However, it would be beneficial to consider other options beside conventional activated sludge treatment.

"Stabilization pond" is another wastewater treatment. It too uses both aerobic and anaerobic micro-organism and algae. Pond is usually divided into multiple ponds and each one carries out different stage of the process. It is suitable for countries with tropical or subtropical climate due to its dependency on sun light. Due to the nature of the process, large area of land needs to be available. Thus, stabilization pond treatment is not suitable for places like economic zones which have limited land, Its advantages and disadvantages are as follows;

Advantage

- Require minimum maintenance
- High reduction of solid, BOD and pathogens
- High nutrient removal if combined with aquaculture
- Low operating cost – No energy required
- No electrical energy required
- No real problems with flies or odours if designed and maintained correctly
- Aerator

Disadvantage

- Requires large land area
- High capital cost depending on the price of land
- Requires expert design and construction
- Sludge requires proper removal and treatment

"Activated Carbon" uses different type of treatment method. In general, carbon is used in a form of "Powdered activated carbon" or "Granular activated carbon" which optimize the surface area (contact area) to wastewater. Micro-organism used in activated sludge treatment can not react to some chemicals. To supplement this shortcoming of activated sludge, activated carbon treatment can be used or combined.

Other options may be effective depending on the characteristics of wastewater in AEZ thus determining an most effective method for wastewater treatment must take into account the types of industries and tenants that will be in AEZ and how and to what extent the primary treatment by the tenants will be required to carry out in accordance with the wastewater standards which are yet to be finalized.

4.4. Safety measures plan

4.4.1 Current security conditions of Bangladesh

Since the terror incident of July 1, 2016, where 21 foreigners including 7 Japanese were killed by ISIS influenced terrorists, Bangladesh is considered as "Security Level 2" by Japanese Government until now.

Therefore, the security measures in Bangladesh have been strengthened since then.

(1) JICA

Following the Japanese Government designation of Bangladesh as Security Level 2, JICA have been strengthening security measures in the following way:

- 1) All JICA experts & consultants receive security briefing in Tokyo and Dhaka.
- 2) Maximum stay in Bangladesh have been limited within two weeks.
- 3) All JICA experts and consultants were required to stay at specified high security hotels and to avoid outside diner & shopping.
- 4) All JICA experts and consultants were required to avoid night flights and Friday for traveling in and out of Bangladesh.

(2) Yen loan projects implementation by Bangladesh Government

Several large Yen loan projects have been under implementation such as (1) 1200 MW coal power plant, (2) construction three bridges and improvement of surrounding roads along the Dhaka-Chittagong highway and (3) Metro Railway project and (4) Water Supply project etc. These Yen loan projects have been added a special security measures by additional budgets by Bangladesh government. Especially, (1) Walls surrounding construction area, (2) Special security personnel and (3) A hotline system to police and security organizations have been added.

(3) Private Companies

Since the 2016 Dhaka terror incident, the security issue has become an important issue for foreign investors locating in Bangladesh. After Japanese government classified Bangladesh as a high risk country (security level 2), Japanese citizen are recommended to avoid unnecessary trips to Bangladesh. And if any Japanese citizen requires visiting Bangladesh, a special safety measures are recommended.

The number of Japanese companies established and operating in Bangladesh has been increasing in the past 10 years from 85 companies in 2006 to 250 companies in 2016 with about 1,000 Japanese people. About 34 manufacturing companies are located in EPZs and about 10 factories are located individually outside EPZs mostly in Dhaka area. However, due to the terror incident in July 2016, number of Japanese nationals in Bangladesh declined from about 1,000 to 800 after the incident up to now. Most of Japanese companies located in EPZ have been following the EPZ security instruction. Other Japanese companies are mostly increasing security personnel by employing outside security officers or employing own security staffs.

The security warning by Japanese government is still being issued. Therefore, foreign investors especially Japanese people are concerned about the security in Bangladesh seriously.

4.4.2 Security Measures Situation of EPZs

Most of Japanese manufacturing companies have located their factories in Export Processing Zones (EPZs). Bangladesh currently has 8 EPZs where about 518 companies with 487,000 workers are located. So far, no serious incidents at the 8 EPZs have been occurred since the 2016 terror. For considering the security measures for Araihaazar Economic Zone, the security measures taken by the existing EPZs is an important reference and give us a hint for the security measure to be taken for the proposed Araihaazar EZ.

The security measures taken previously by existing 8 EPZs are as below.

- Boundary wall surrounding the EPZ site.
- Gate check for vehicle and visitors by security officers.
- 24 hours security staffs at the gate checking all vehicles and visitors.
- Periodical Security patrol check (Mainly night time:1-2 times)

Since the 2016 terror incident, BEPZA has improved security measures as below.

- Introduction of CCTV cameras for 24 hours surveillance.
- Introduction of metal detector and mirror for checking the bottom of cars.
- A hot line with special security office and local police for security issues.
- Employing woman security officers for security body check for women.
- Increased security staffs at the gate, frequent patrol of local police officer, and security patrol of foreign worker's residence area.

4.4.3 Security Measures Situation of EZs

Since the new Economic Zone (EZ) has been introduced since 2010 and already 3 EZs are opened and operating, now improved security measures are proposed by BEZA and the following measure are being implemented.

- (1) Boundary walls plus 24 hours video surveillance camera system. Using the new technology seems to be effective tool to increase security.
- (2) Issuing and checking of ID cards for workers and EZ staffs).
- (3) 24 hour security checks at the gate and periodical patrol (every 4 hours) of the EZ site. More frequent patrol is also improving the security.
- (4) Regular visit by local police officers to EZs and set up a hotline with local police station for emergency situation. In order to increase security of EZs, additional support from the police is considered securing safety of potential investors.
- (5) If an escort by police officers is requested by a foreign company, BEPZA & BEZA can dispatch police escorts.

Proposed Security Measures for Araihaazar Economic Zone

We recommend security measures for Araihaazar Economic Zone as below.

- (1) Option 1: In case that Security Level 2 remains when the Araihaazar EZ will be open in 2021 or 2022

As long as the country security level remains at level 2, similar security measures discussed above are recommended to Araihaazar Economic Zone. Strengthened security measures by the SPC of the Araihaazar EZ plus additional security measures of Special Security Agent may be assigned at Entrance of the EZ and a hot line with Police and Military security force may be recommended.

- (2) Option2: In case that Security Level 2 is lowered to Level 1 when the Araihaazar EZ is open in 2021 or 22

If the security situation improves to a normal level, the security measures can be normalized without special security measures taken by the EZ.

4.5. Consolidation settlement analysis

4.5.1. Locations of boring

14 of borings, ST-1 to ST-14, at the project site were carried out as shown by Figure 4.3-1 and laboratory test on undisturbed/disturbed soil specimens for ST-5 to ST-14 were carried out.



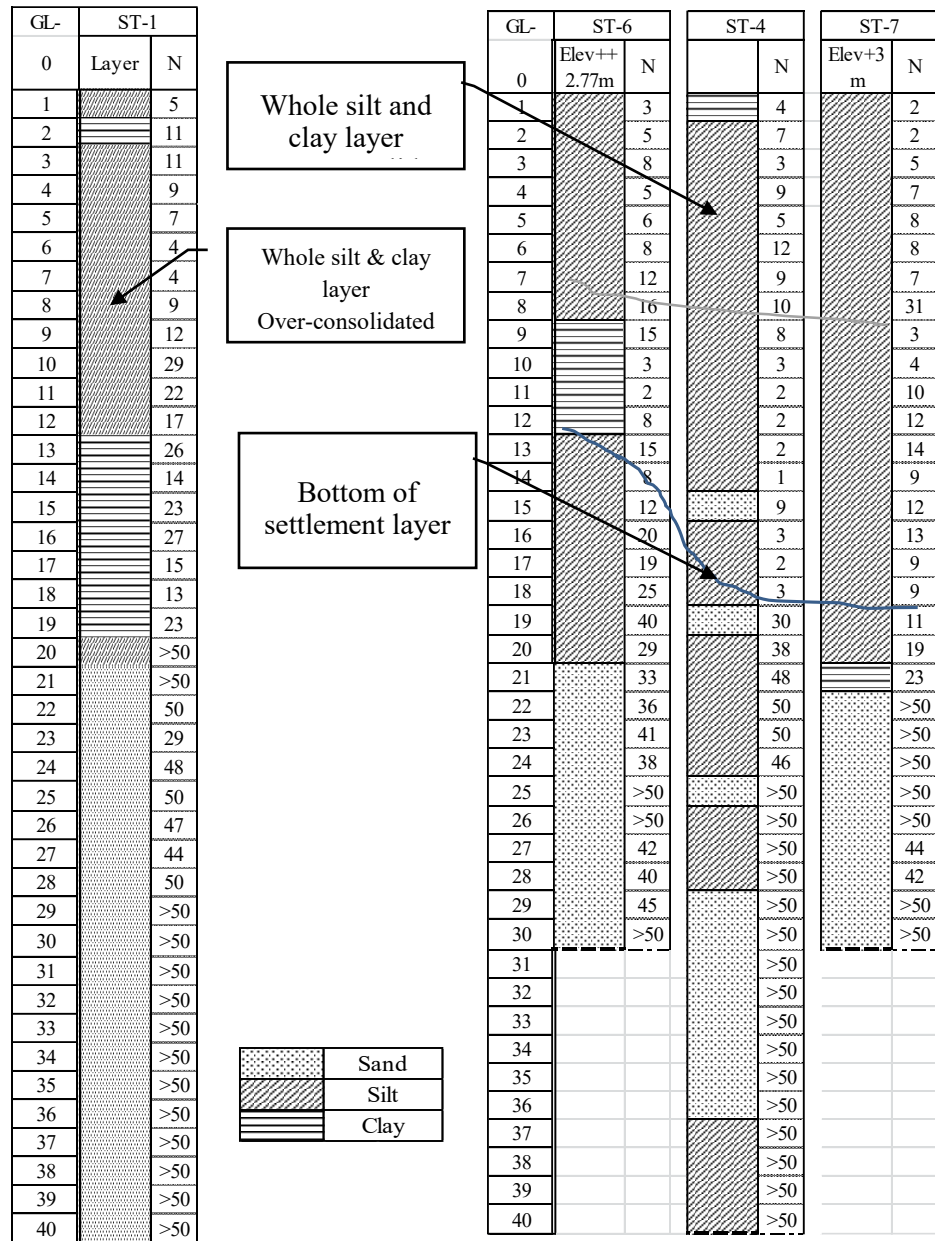
Figure 4.5-1: Location of borings

4.5.2. Feature of stratifications at the Project site

According to the geological investigation report⁴, elevation of the surface ground varies +2.5m to 3m and the stratification in the project site seems to be mainly composed of sandy/ silty/ clayey soil but their composition are rather complicated. In spite of such a difficulty to describe a simple feature on the stratifications, grouped bore logs based on the similar compositions of stratifications are shown in Fig. 4.5-2 (a) ~ (d) .

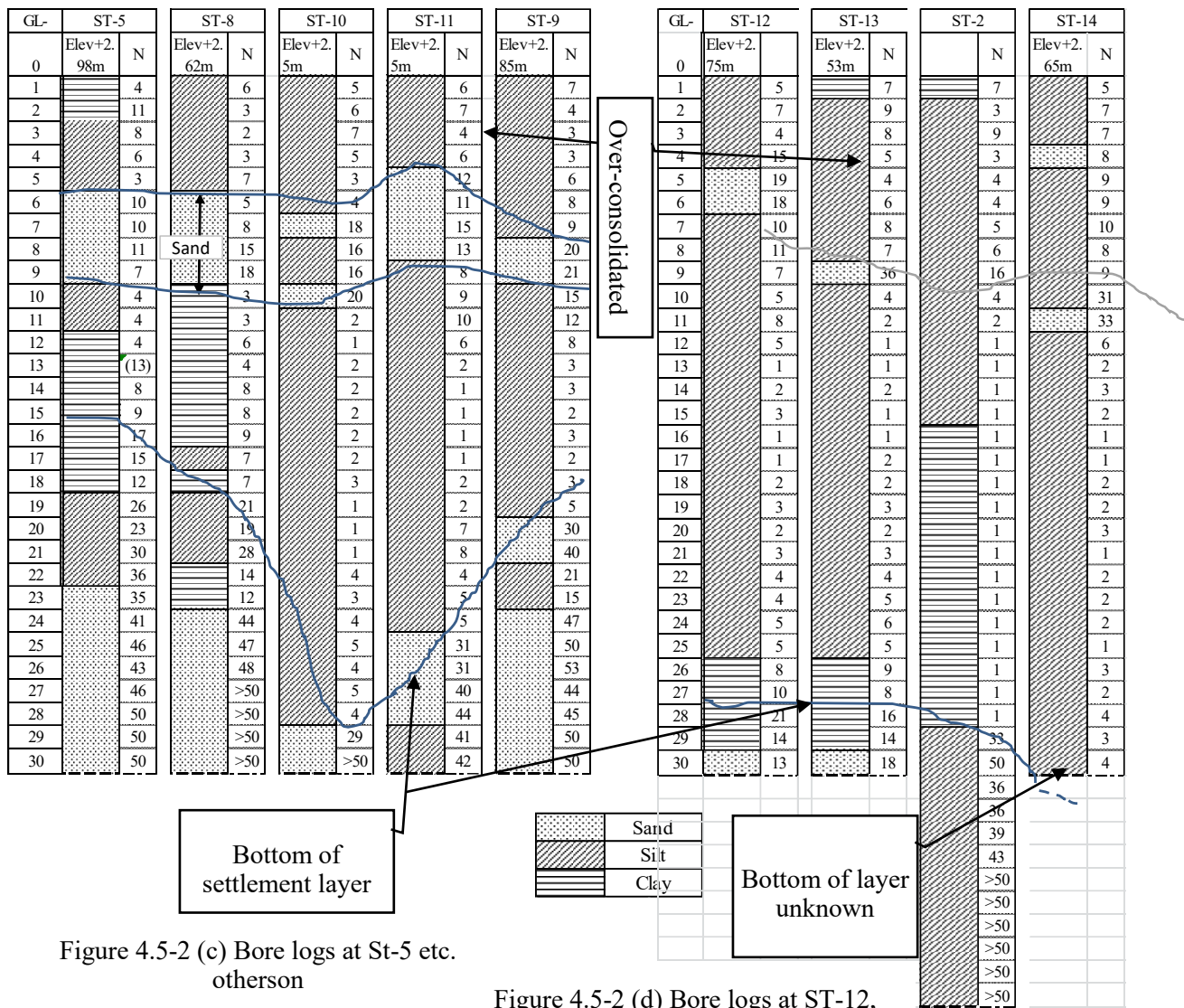
Fig. 4.5-2(a) shows the bore log with distribution of N values at ST-1, where whole layer is composed of sit/clay layer with rather large N value despite of shallow depth. It is presumed that consolidation settlement seems to be very small or no settlement. 4.5-2 (b) shows the bore logs at ST-6, ST-4 and ST-7. It is shown that surface layer up to GL-8-10 seems to be over-consolidated due to rather large N value and underneath it, silty layer with N of 2 to 14 is deposited. 4.5-2 (c) shows at ST-5, ST-8, ST-9, ST-10 and ST-11. It is realized that the sandy layer with thickness of 2 ~ 4 m underneath surface stiff clay layer. Underneath sandy layer, soft silty layer with thickness of 6 ~ 18m are deposited. Fig. 4.5-2(d) shows at ST-2, ST-12, ST-13 and ST-14, where weak and thick silty soil layer is deposited. The composition of stratification at this zone seems similar to the other zones but bottom of silty layer at ST-14 has not been confirmed. Fig. 4.5-3 show the zone divisions based on the above described stratifications.

⁴ Geological investigation report for the pre-feasibility study on the economic zone in Araihaazar of Narayanganj district in Bangladesh.



4.5-2 (a): Bore log at ST-1

4.5-2 (b): Bore log at ST-6, ST-4 and ST-7



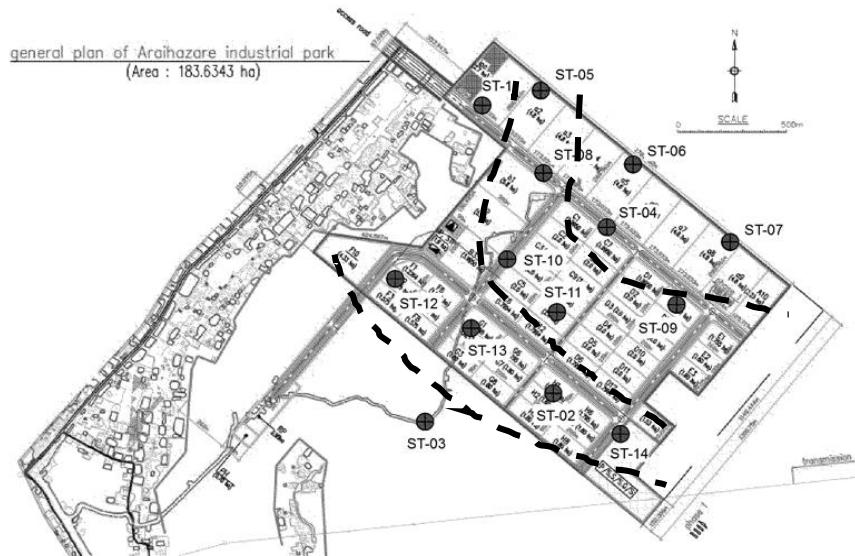


Figure 4.5-3: Zoning by stratification bedding

4.5.3. Soil properties

Table 4.5-1 shows the soil properties obtained by the physical and mechanical laboratory test. According to the grain size distribution, although clay fraction of the soil is approximately 90% but the natural water content is 26 to 27%. It is presumed that clay/silty soil would be over-consolidated or desiccated in the past.

Table 4.5-1: Soil properties

			Depth		W _n (%)	γ _t (kN/m ³)	Grain size distribution (%)			Consistency			Consolidation				Shear strength	
BH	UD No	GH	Depth	Elev			Sand (%)	Silt (%)	Clay (%)	W _L (%)	W _p (%)	IP	e ₀	P _c (kPa)	C _c	C _v (m ² /day)	C (q _u /2) (kPa)	C _{uu} (kPa)
5	1	2.98	1.3	1.68	21	18.4	2	94	4	42	26	16						
	2		3.3	-0.32	17		(46)	(48)	(6)									
	3		5.3	-2.32	28	18.6											35	
8	1	2.62	0.55	2.07			1	96	3									
	2		~~2.55~~	0.07														
	3		4.55	-1.93														
	4		6.55	-3.93			(35)	(62)	(3)									
9	1	2.65	0.55	2.1												197.5	26.6	
	2		1.55	1.1		18.6										23	10.6	
	3		4.55	-1.9	31	17.9	8	84	8				1.02	110	0.18			
10	1	2.5	0.55	1.95	32		1	96	3	44	29	15				46	27.4	
	2		1.55	0.95												135	53.7	
	3		2.55	-0.05	31	18.9										47	28.5	
11	1	2.5	0.55	1.95	29		1	96	3							102	33.8	
	2		1.55	0.95		18.4				51	25	26				22.5	28.2	
	3		2.55	-0.05	29	20	1	94	5	38	28	10				88		
Ave					27	19	2	93	4	44	27	17	1.02	110	0.18		77	30
6	1	2.77	1.55	1.22	28	19.8							0.73	95	0.11		75.8	
	2		3.55	-0.78														
	3		~~6.55~~	-3.78														
7	1	3	0.55	2.45	29												30.3	
	2		2.55	0.45		19.3										41.5	35.5	
	3		4.55	-1.55	21													
Ave					26	20						0.73	95	0.11		42	47	
12	1	2.75	0.55	2.2	32		3	94	3	39	22	17				85		
	2		1.55	1.2												77	30	
	3		2.55	0.2	29	18.8	2	92	6	35	27	8	0.87	42	0.12			
13	1	2.53	0.55	1.98	27	18.1				50	28	22	0.87	72	0.16	194	68.4	
	2		1.55	0.98	32	17.9						0.94	102	0.12		35.1		
	3		2.55	-0.02	31	19.1	8	74	17	43	28	15				174	50.9	
14	1	2.65	0.55	2.1	31					42	28	14				49	38.3	
	2		1.55	1.1												101	40.9	
	3		2.55	0.1	24		18	80	2									
	4		~~12.55~~	-9.9														
Ave					29	18	18	85	7	42	27	13	0.89	72	0.13		113	44

Remarks: W_n; Natural water content, W_L; Liquid Limit, W_p; Plasticity limit, e₀; Initial void ratio, P_c; Consolidation yield stress, C_c; Consolidation Index, C_v; Consolidation coefficient, C; Cohesion, C_{uu}; Triaxial Unddrained Test, FV; Field Vave Test,

4.5.4 Calculation of consolidation settlement

(1) Equation of settlement calculation

Consolidation settlement of clay layer is illustrated schematically with relationship between “ $e \sim \log p$ ” shown by Fig. 4.5-4 Vertical axis shows change of void ratio, which is equivalent to settlement of clay, induced by consolidation load. Horizontal axis shows the magnitude of consolidation stress that would induce settlement. In case existing clay layer is defined as normally-consolidated clay, overburden pressure (P_z), calculated by Equa.4.1, equal to the yield stress of clay (P_c), which is to be obtained by the consolidation test. On the contrary, in case of over-consolidated clay, P_c would turn to be larger than P_z due to long-time loading in the past.

Incremental consolidation load (ΔP) such as reclamation fill on the existing ground can be estimated as 87 kPa (= fill load of 4m in thickness and building load of 15 kPa).

$$P_z = \sum \gamma_i \times H_i \quad \dots\dots\dots \text{(Equa. 4.1)}$$

Here, P_z ; Overburden pressure, γ_i ; unit density of soil, H_i ; Thickness soil

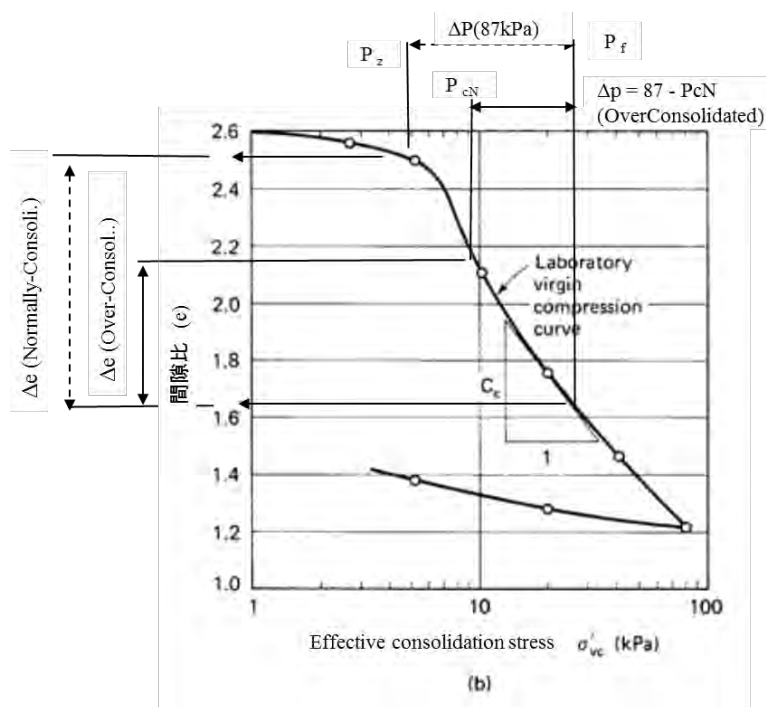


Figure 4.5-4: $e \sim \log P$ relationship

Consolidation settlement for normally consolidated clay can be calculated by Equa. 4.2. Relationship of time with settlement is calculated by Equa. 4.3. In case of over-consolidated clay, the equation of settlement calculation is turned to be Equa. 4.4. In the equation, P_{cN} is identified as P_c in the equation.

$$S_f = \frac{C_c \times H}{(1+e_0)} \times \left(\frac{P_f}{P_z} \right) \quad \dots\dots\dots \text{(Equa. 4.2)}$$

Here, S_f ; Total settlement of clay (m), C_c ; Consolidation coefficient, H ; Thickness of clay, e_0 ; Initial void ratio of clay, P_z ; Overburden pressure, $P_f = P_z + \Delta P$, ΔP ; Incremental load.

$$t = H^2 \times T_v / C_v \quad \dots\dots\dots \text{(Equa. 4.3)}$$

Here, t ; Consolidation time (day), H ; thickness of clay layer (m), C_v ; Consolidation coefficient (m^2/day), T_v ; Consolidation factor

$$S_f = \frac{C_c \times H}{(1+e_0)} \log \frac{P_f}{P_c} \quad \dots\dots\dots \text{Equa. 4.4}$$

(2) Comparison with Overburden Pressure (P_z) and consolidation yield stress (P_c)

It is essential to determine the consolidation yield stress of the clay layer to calculate the settlement. Fig. 4.5-5 shows distribution of P_z , P_{cc} and P_{cN} of clay layers at ST-5, ST-6, ST-8, ST-9, ST-12 and ST-13, where P_{cc} is obtained by consolidation test and P_{cN} by N value of clay using Equa. 4.5.

As shown in Fig. 4.5-5, both P_{cc} s and P_{cN} s from ground surface ($\doteq +3m$) up to $-5m$ tend to be larger in general than P_z and clay/silt layers from $-5m$ to $-15m$, seems to be normally consolidated other than ST-5, ST-6 and ST-8. Figure 4.5-7 (a)~Fig. 4.5-7 (f) show the distributions of P_z , P_{cc} ,

PcN and Pf (=Pz+ΔP) line so as to investigate the possibility of settlement of clay layer. It is figured out that since Pcc and PcN at most points are distributed between Pz-line and Pf-line, thus clay layer from -5m to -15m at most points would settle by incremental consolidation load.

$$P_{cN} = \frac{1}{0.34} \times \frac{N}{16} \times 98 \quad (\text{in kPa}) \quad \dots\dots\dots (\text{Equa. 4.5})$$

Here, assumed by $C_u / P_c = 1 / 0.34^5$ (Figure 4.3), and $C_u = N / 16^6$

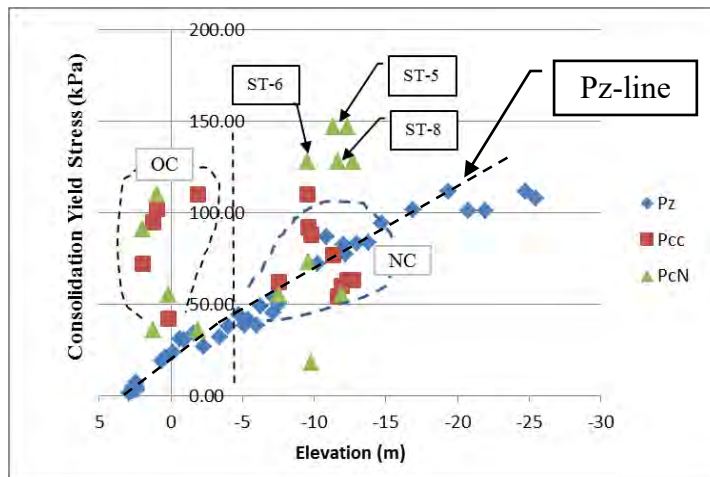


Figure 4.5-5: Comparison of Pz, Pcc and PcN

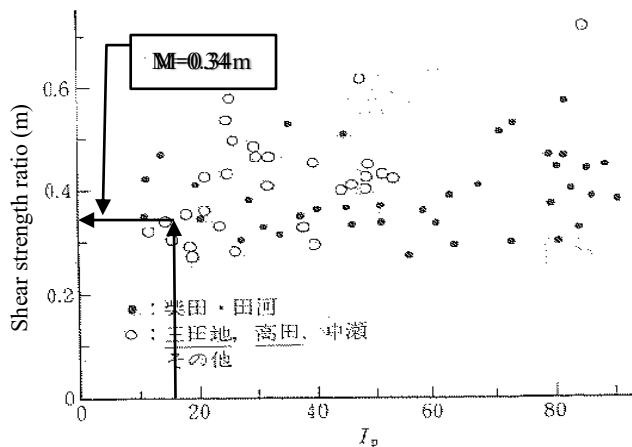


Figure 4.5-6: $m(=c_u/P_c) \sim I_p$ by means of triaxial shear test

⁵ Shibata, T. (1967); Shear strength ratio of saturated clay, Proceeding of geotechnical symposium, JGS, pp.7-11, in Japanese.

⁶ Murayama et. al. (1956), Standard penetration test and bearing capacity of ground, "Tsuchi to Kiso", Vol.2 No.5, PP.12-18, in Japanese.

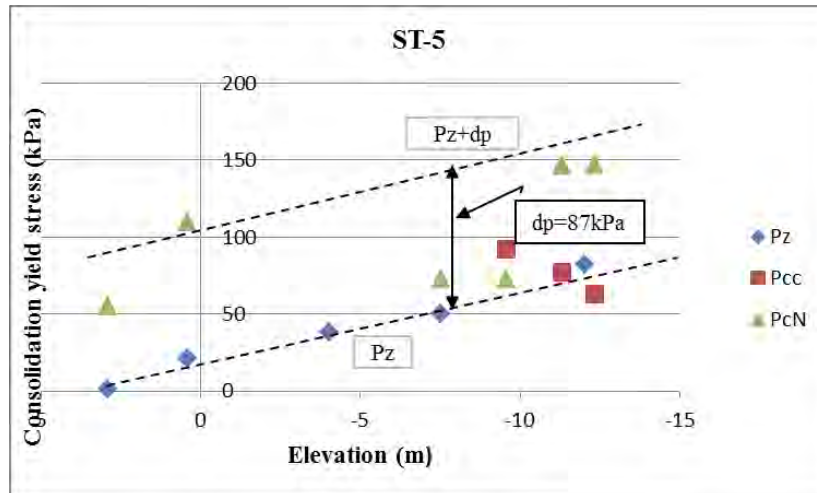


Figure 4.5-7(a): Comparison of P_z , P_{cc} and P_{cN}

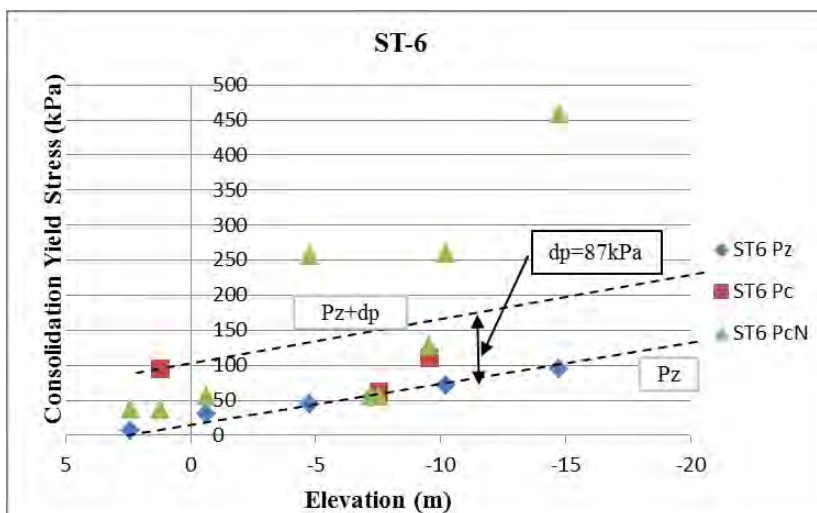


Figure 4.5-7 (b) Comparison of P_z , P_{cc} and P_{cN}

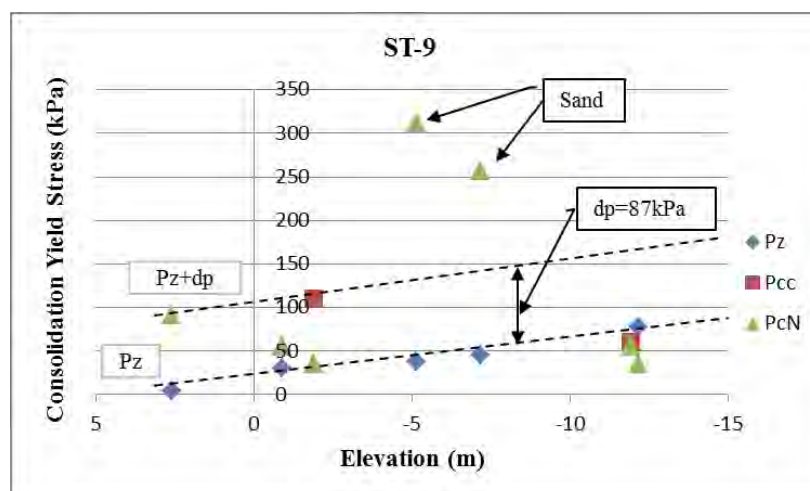


Figure 4.5-7 (d): Comparison of P_z , P_{cc} and P_{cN}

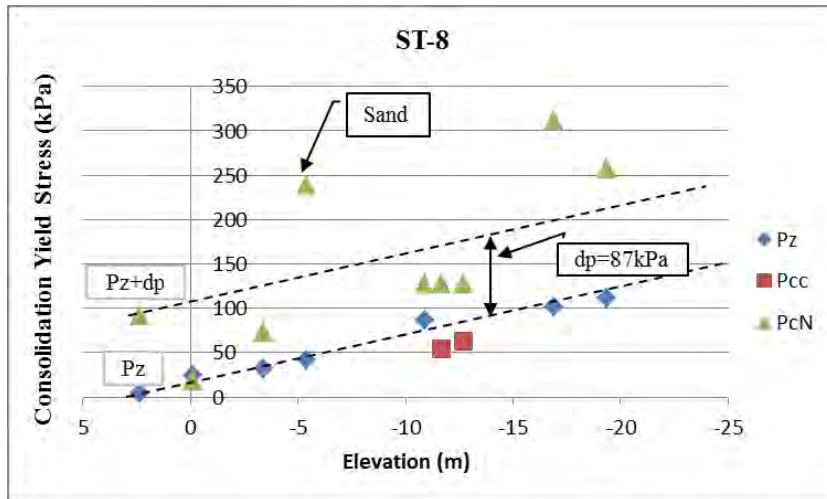


Figure 4.5-7 (c); Comparison of P_z , P_{cc} and P_{cN}

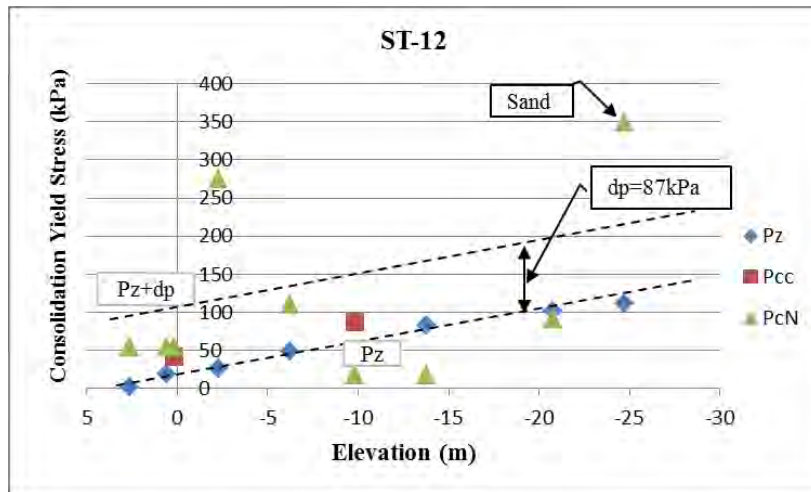


Figure 4.5-7 (e): Comparison of P_z , P_{cc} and P_{cN}

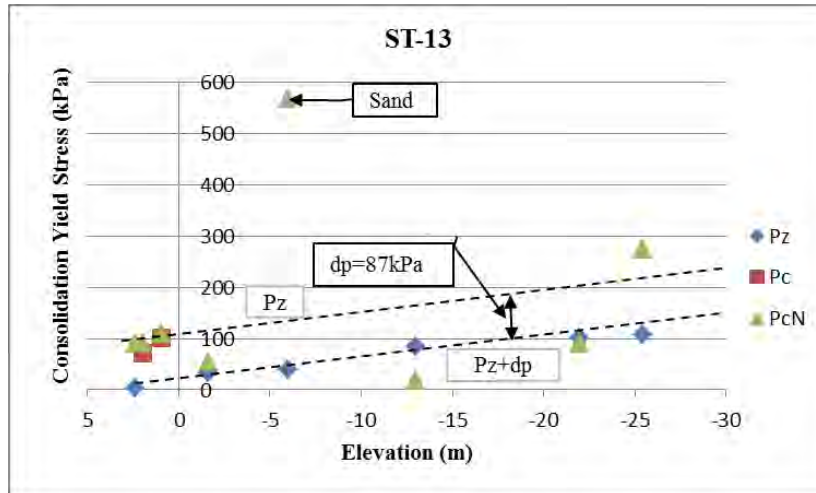


Figure 4.5-7 (f) Comparison of Pz, Pc and PcN

(3) Consolidation settlement

Consolidation settlement by total load of reclamation fill and building

- 1) Calculated consolidation final settlements (S_f) at ST-5, ST-6, ST-8, ST-9, ST-12 and ST-13 induced by the incremental load of 87 kPa, are shown in Tab.4.1. Total settlement at each point are obtained by summing up the final settlements of each layer divided with range of N value, layer of silt/clay/sand and so on. Total settlement of layers at each point are summed up followingly.

Final settlement at investigated points						
	ST-5	ST-6	ST-8	ST-9	ST-12	ST-13
S_f (m)	0.14	0.19	0.46	0.53	0.73	0.83

It is realized that the calculated settlements at ST-5 and ST-6, are approximately 0.2m due to over-consolidated clay and at the area around ST-12 and ST-13 with large settlements of nearly 1m. On top of it, due to unknown bottom of clay layer at ST-14, where thickness of clay layer could be larger than ST-13, expected settlement would be getting larger toward ST-14. Taking such a distribution of settlement within the project site into consideration, whole project area could be divided into 3 zones such as a) A zone; settlement with 0.2m, b) B zone; settlement with 0.5m and c) C zone; settlement with 1m or more as shown in Fig. 4.5-8.

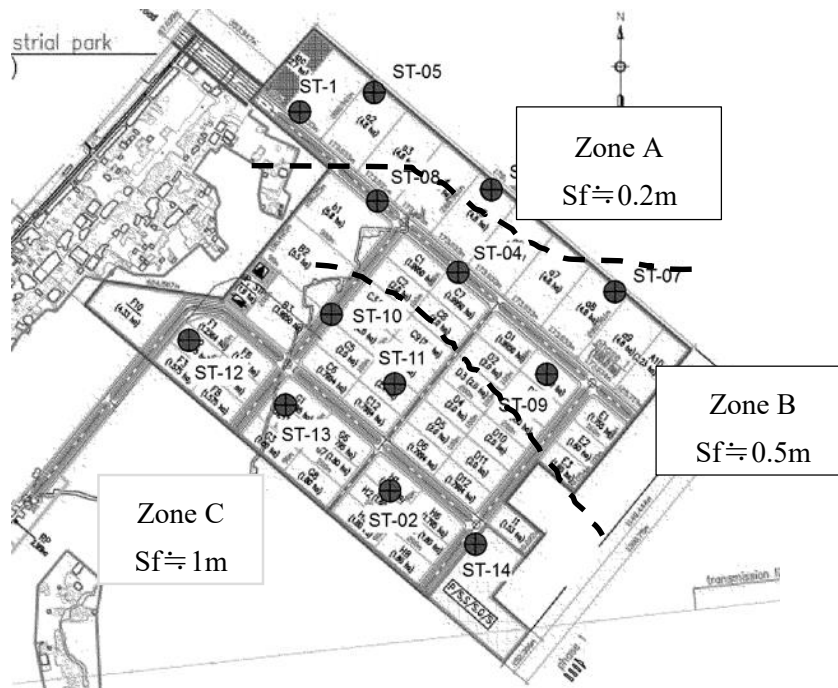
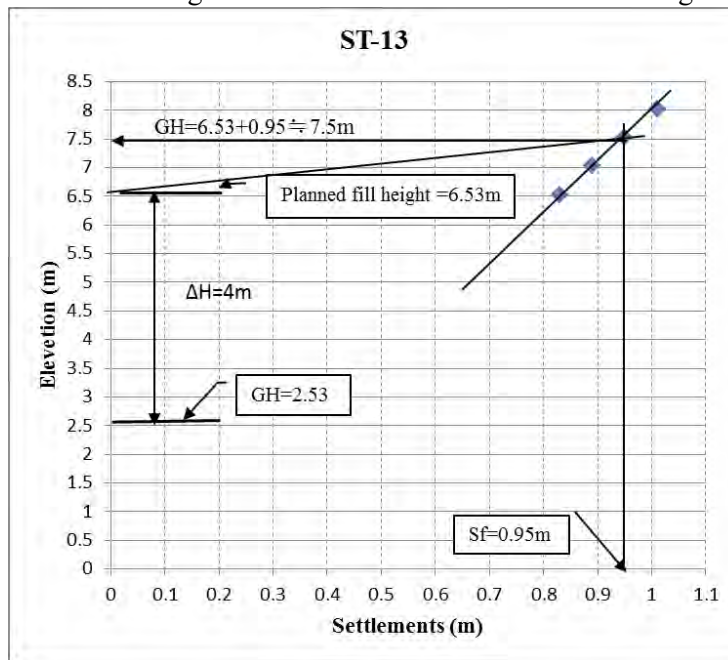


Figure 4.5-8 Zoning by distribution of consolidation settlements

Figure 4.5-8: Determination of extra-fill height at ST-13



2) Extra fill to attain planned ground level

It is easily understood that when reclamation fill up to the planned ground height is executed on existing ground, final ground height can be lower than the planned ground height due to the settlement. Therefore, extra-fill should be added on the planned reclamation height. Fig.4.5-8 shows how to determine extra-fill height, as sample at ST-13, where targeted fill height could be +7.5m and 0.95m of settlement. Therefore final ground height would settle to be 6.5m ($+7.5-0.95 \approx 6.5$). Table 4.5-2 shows the extra fill at Zone B and Zone C, while Zone A seems not to be necessary to consider the extra fill due to small settlement. It is figured out that extra fill would be 10% at Zone B and 15% at Zone C.

Table 4.5-1: Calculated consolidation settlement

ST-5	Clay/ Sand	H (m)	Pz (kPa)	Pz+dP (kPa)	PcN (kPa)	NC/ OC	e0	Cc	Sf (m)
1	Clay	0.15	14	101	> 55	OC	0.73	0.11	0.00
2		4.85	20	107	≅ 110				0.00
3	Sand	4				NS	-	-	
4	Clay	3	50	137	> 73	OC	0.82	0.18	0.08
5		6	82	169	> 147		0.52	0.23	0.05
Sum =									0.14
ST-6									
1	Clay	0.72	7	94	> 36	OC	0.73	0.11	0.02
2		5.34	31	118	> 55				0.11
3		2.94	44	131	< 259	NS	-	-	0.00
4		2	53	140	> 55	OC	0.71	0.12	0.06
5		4	71	158	< 259	NS	-	-	0.00
6		5	94	181	< 459				0.00
Sum=									0.19
ST-8									
1	Clay	0.5	4	91	≅ 91	NC	0.73	0.11	0.04
2		4.5	23	110	> 18				0.19
3	Sand	2					-	-	
4	Clay	2	41	128	< 238	NS	-	-	0.00
5		9	86	173	> 128	NC	0.46	0.12	0.22
6		3	101	188	< 312	NS	-	-	0.00
7		2	111	198	< 257				0.00
Sum =									0.46
ST-9									
1	Clay	0.5	4	91	≅ 91	OC	1.02	0.18	0.00
2		6.5	30	117	> 55				0.19
3	Sand	2							
4	Clay	2	45	132	< 257	NS	-	-	0.00
5		8	77	164	> 36	NC	1.19	0.28	0.34
Sum =									0.53
ST-12									
1	Clay	0.25	2	89	> 55	OC	0.87	0.12	0.00
2		3.75	18	105	> 55				0.07
3	Sand	2					-	-	
4	Clay	6	49	136	> 110	OC	1.13	0.30	0.08
5		9	83	170	> 18	NC			0.39
6		5	101	188	> 91				0.19
7		3	111	198	< 349	NS			-
Sum=									0.73
ST-13									
1	Clay	0.3	2	89	≅ 91	OC	0.87	0.16	0.00
2		3.24	34	121	> 55		0.94	0.12	0.07
3	Sand	1					-	-	
4	Clay	13	83	170	> 18	NC	1.13	0.30	0.57
5		5	100	187	> 91				0.19
6		2	107	194	< 275	NS			
Sum=									0.83

Note: H; Thickness of clay layer, P_z; Current over-burden pressure, dP; Incremental load inducing settlement, P_{cN}; Consolidation yield stress by N value, NC; Normally consolidated clay, OC; Over-consolidated clay, NS; No-settlement due to extremely over-consolidated clay, e₀; Initial void ratio, C_c; Compression Index.

Table 4.5-2 Percent of Extra fill to final settlement

	Zone B		Zone C	
	ST-8	ST-9	ST-12	ST-13
Sf (m)	0.46	0.53	0.73	0.83
Sf with extra fill (m)	0.5	0.53	0.73	0.83
Increment	8%	10%	16%	14%
Average	10 %		15 %	

2) Possibility of underestimation of total settlement

It should be notified that calculated final settlements are subjected to include an error induced by the theoretically simplified assumption to calculate consolidation settlement of clay layer, inaccurate constants utilizing in the calculation such as C_c , C_v , e_0 etc. obtained through laboratory test and disturbance effect to the soil specimen. In particular, low quality of undisturbed sample would take place during sequence of pulling out clay specimen using thin-wall sampler and transportation from the site to the laboratory. Since it seems very difficult to get rid of them, underestimation of consolidation settlement would take place through ordinary soil investigation sequence.

Fig.4.5-9⁷ shows the comparison of $e \sim \log P$ relationship by Japanese sampler and locally popular sampler of Shelby sampler carried out at the same site. It can be understood that $e \sim \log P$ curve by Japan sampler show distinct consolidation yield stress (P_c), where e would sharply decrease once consolidation stress exceed P_c and thus P_c would be easily determined. On the contrary, in case of Shelby sampler, change of e with increase of consolidation stress seems not clear thus definitely difficult to determine P_c . It is easily understood that C_c by Japanese sampler would give larger C_c than that of Shelby one.

Fig. 4.5-10 shows one of the typical $e \sim \log P$ relationship from UD4 at ST12 at the project site concerned. As can be seen, the shape of $e \sim \log P$ seems very similar to the one by Shelby sampler in Fig.4.5-9. Although it seems difficult to figure out the reason of its shape, it could be safer thought to judge that C_c shown in Tab.4.1 might be underestimated.

Therefore, it seems rationale to compare C_c obtained by another way. Fig.4.5-11³⁾ shows the relationship of W_L with C_c proposed by Terzaghi and Peck (1969) and Ogawa and Matsumoto (1978) shown by Equa. 4.6 and Equa. 4.7, respectively. As W_L at the project site is averaged by $W_L \approx 40$, C_c would be calculated by both equations as 0.27 and 0.31, respectively. Therefore, compared with averaged C_c (≈ 0.14 in Tab. 3.1) and 0.3 ($= (0.27+0.3)/2$) by Equa. 4.6 and Equa. 4.7, calculated settlement in Tab. 4.1 might be underestimated.

$$\begin{array}{lll} C_c = 0.009 (w_L - 10) & \dots\dots\dots & \text{Equa. 4.6} \\ C_c = 0.015 (w_L - 19) & \dots\dots\dots & \text{Equa. 4.7} \end{array}$$

⁷ H.Tanaka (2000), Print of keynote address of Special lecture at int'l symposium on coastal geotechnical engineering in practice (IS-Yokohama 2000),

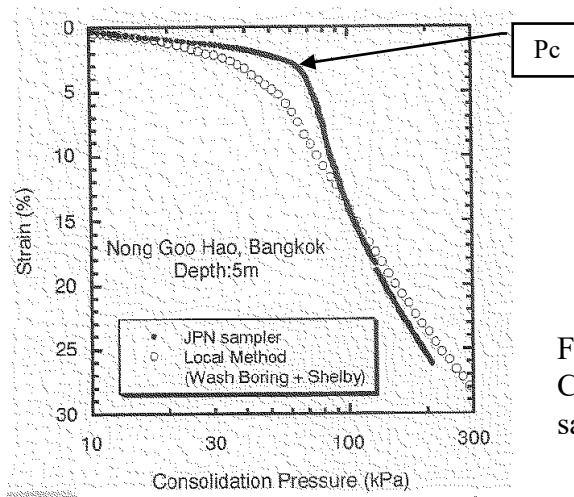


Figure 4.5-9
Comparison of $e \sim \log P$ curves for
samples with different quality

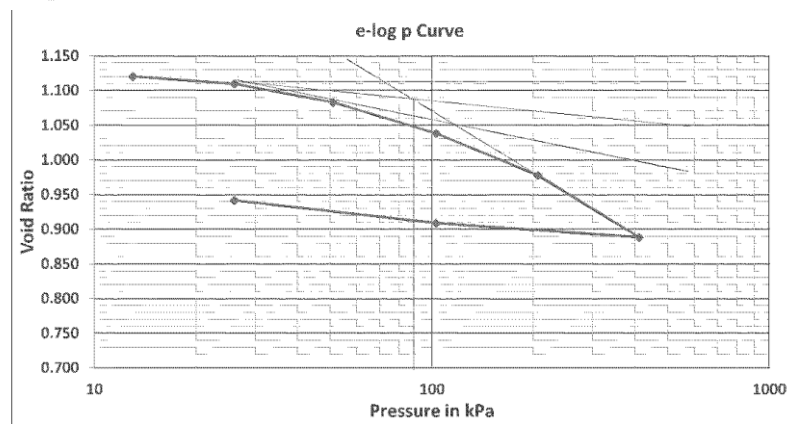


Figure 4.5-10: Typical $e \sim \log P$ relationship of UD4 at ST-12

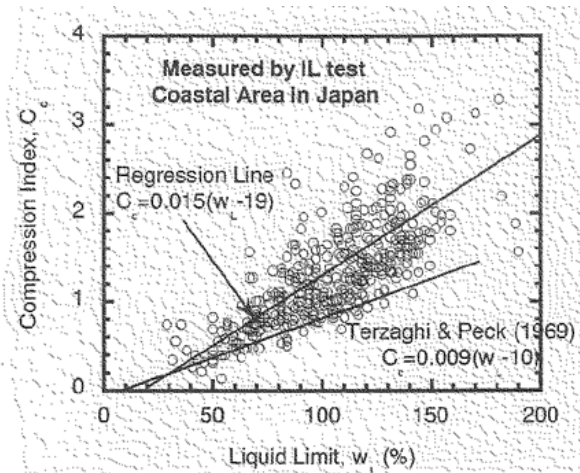


Figure 4.5-11: Relation of C_c and w_L for clays in coastal areas in Japan (after Ogawa & Matsumoto 1978)

(4) Settlement with time

Due to lack of consolidation coefficient (C_v), C_v would be converted from Plasticity index (I_p) as shown by Fig. 4.5-12⁸. According to Tab. 3.1, I_p is averaged as 16 and then C_v is converted to $1.1 \text{ cm}^2/\text{min}$ ($=5.78 \text{ m}^2/\text{yr}$). Taking the stratifications shown in Fig. 4.5-2 (a)~(d) and three zones shown in Fig.4.5-8 into consideration, presumed thickness clay layer to calculate the relationship with settlement and elapsed time are determined as the followings. As described in 4.3.1, although bottom of clay layer at ST-14 is unknown, clay layer at ST-14 seems to be deepest within the project site. Therefore it is important to investigate the time ~ settlement relationship at ST-14 with presumed thickness of 30m so as to avoid the risk of unexpected larger consolidation settlement. Drainage condition to calculated settlement with time is presumed as single drainage due to complicated distribution of clay and silt layers with low permeability.

	<u>Block A</u>	<u>Block B</u>	<u>Block C</u>	<u>ST-14</u>
Thickness (m)	13m	19m	25m	30m

Fig.4.5-13(a) ~(d) show the settlement with time at Zone A, Zone B, Zone C and ST-14. Frequency of maintenance work such as re-pavement or restoration of damaged structure by post construction settlement are to be carried out after settlement occurrence of each 30cm. Followings are summaries on the results at each zone.

- Zone A; Total settlement (S_f) is expected to be approximately 0.2m. So, there will not necessary of maintenance work such as over-lay of pavement work.
- Zone B; $S_f \doteq 0.5\text{m}$. After settlement occurrence of 0.3m at elapsed time of 20 years, maintenance work would be necessary.
- Zone C; $S_f \doteq 1\text{m}$. Maintenance work would be expected after elapsed time of 10 years, 20 years and 90 years at the settlement of 30 cm, 60 cm and 90 cm, respectively
- Proximity area to ST-14; $S_f \doteq 1.5\text{m}$. Maintenance works are expected to be necessary after elapsed time of 10 years, 20 years, 45 years and 90 years.

⁸ Intermediate Soil, Geo-tech note 2, JGS, p.15

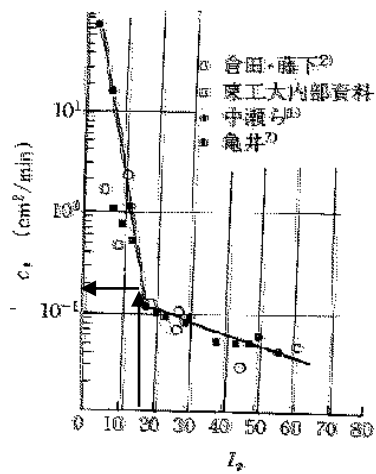


Figure 4.5-12
Relationship with C_v and I_0

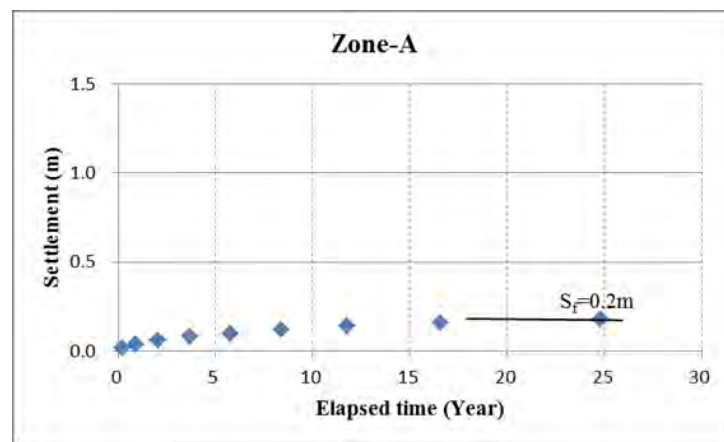


Figure 4.5-13(a): Settlement with time at Zone-A

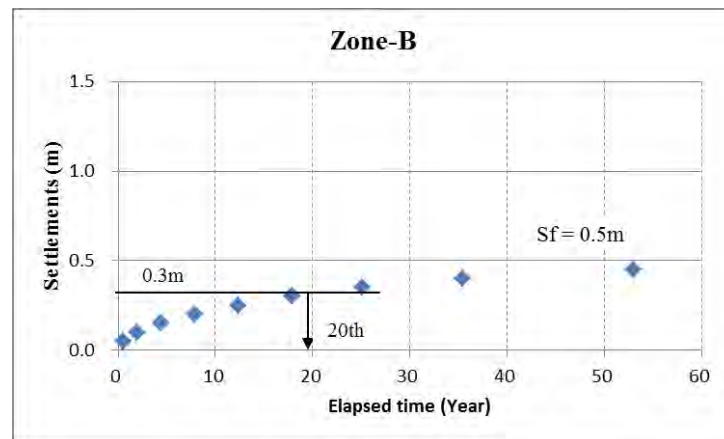


Figure 4.5-13(b): Settlement with time at Zone B

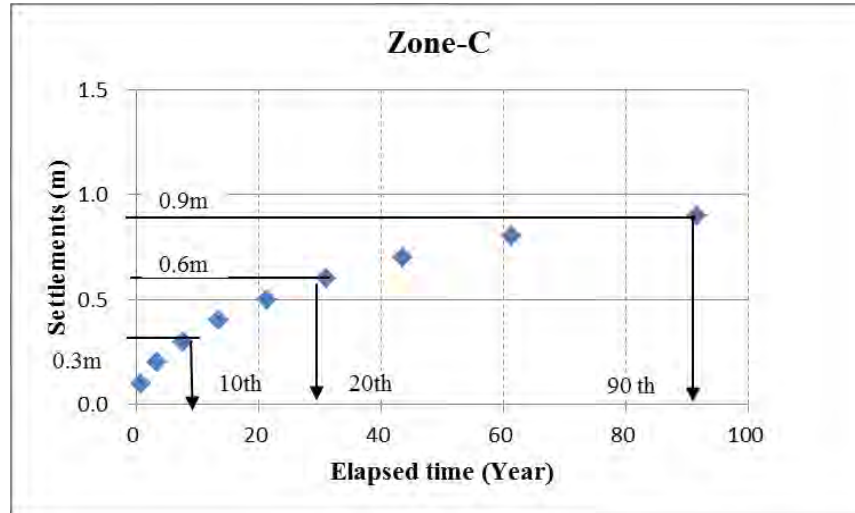


Figure 4.5-13 (c): Settlement with time at Zone C

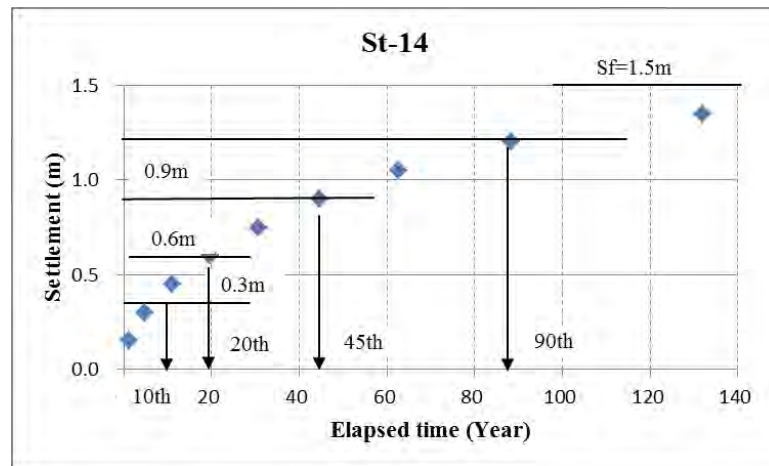


Figure 4.5-13 (d): Settlement with time at ST-14

(5) Acceleration technique of consolidation settlement

Plastic board drain method (PBD) would be one of the most popular techniques to accelerate consolidation settlement. As discussed in 4.4, consolidation settlement in Zone B and Zone C would last for 50 years to 100 years, even 150 years at ST-14, it might be one of countermeasures to minimize the maintenance cost by utilizing PBD.

Equa. 4.8 gives relationship with consolidation degree and its time in case of consolidation by vertical drain.

$$t = d_e^2 \times T_h / C_h \quad \dots\dots\dots \text{Equa.4.8}$$

$$U = 1 - \exp\left(\frac{-8T_h}{F(n)}\right) \quad \dots\dots\dots \text{Equq.4.9}$$

$$F(n) = \frac{n^2}{n^2-1} \ln(n) - \frac{3n^2-1}{4n^2} \quad \dots\dots\dots \text{Equa.4.10}$$

Here; $n = \frac{d_e}{d_w}$, d_e ; equivalent effective diameter of drain, d_w ; diameter of drain well,

U ; Consolidation degree, T_h ; Time factor, C_h ; Horizontal coefficient of consolidation.

Taking ordinary conditions of PBD such as:

- Spacing of PBD (d) ; 1.5m in square grid,
- d_w ; 0.05m

$$- C_h = C_v = 1.58 \times 10^{-2} \text{ (m}^2/\text{day)}$$

into calculation of time, consolidation time would be:

Degree of consolidation (U)	<u>80 %</u>	<u>90%</u>
Acceleration time	3 months	5 months

Fig. 4.5-14 shows the improvement area and its division with depths of the PBD installations.



Figure 4.5-14: Area to be improved by PBD technique

It must be emphasized to consider some difficulties when PBD is to be utilized. They are:

- When PBD is installed into the ground, mandrel would penetrate into the ground by hydraulic pressure system. Therefore, in case stiff layer larger than 10 of N value is deposited at surface layer, which is similar as this project site, additional preparatory boring work might be necessary for smooth penetration of the mandrel.
- Due to deep installation such as 30m or more, PBD machine with capability of its depth might be difficult to procure.
- In case of shortage of capable machines for deep installation, long execution time for PBD installation must be considered.

4.5.5. Shear strength of silty/Clayey layer

Figure 4.5-15 shows distribution of shear strength obtained by the Field Vane Test carried out at ST-05 to ST-14. It is realized that clay/silt layer from the ground surface to -6m have large strength due to over-consolidated state of silty/clayey soil.

Fig. 4.5-16(a) to Fig. 4.5-16(d) show distributions of N value with depth at ST-1, Zone A, Zone B and Zone C. It is figured out that N values increase with depth from the surface to 10m in common at Zone A to Zone C. Bearing stratum depth seem to vary from 20m at Zone A, 25m at Zone B and deeper than 30m at Zone C except for the vicinity of ST-14.

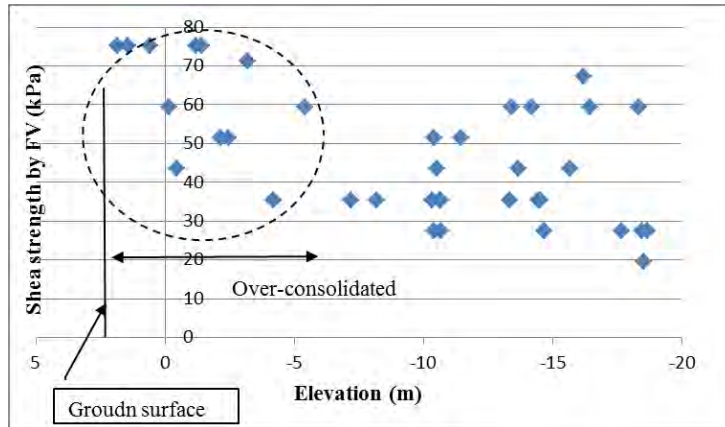


Figure 4.5-15: Shear strength by Field Vane Test

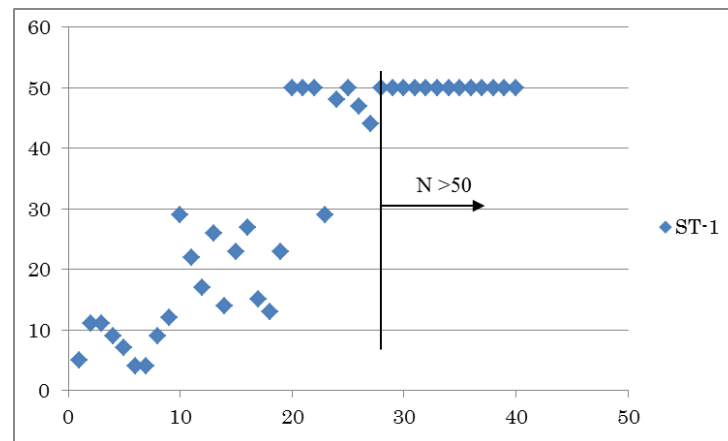


Figure 4.5-16(a): N vs Depth at ST-1

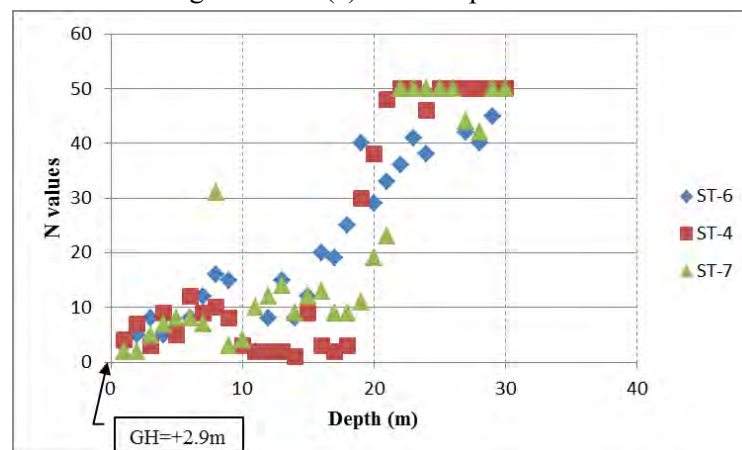


Figure 4.5-16(b): N vs Depth at Zone A

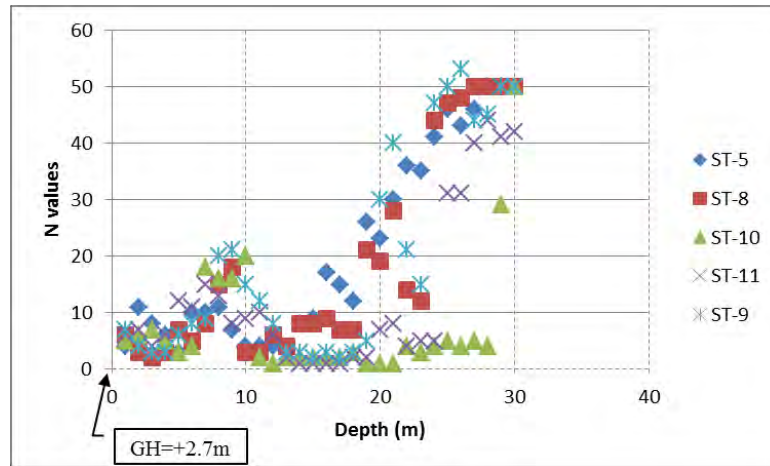


Figure 4.5-16(c): N vs Depth at Zone B

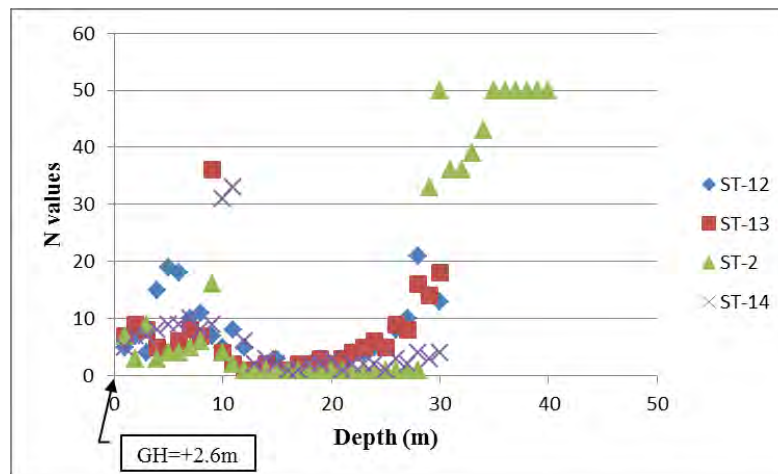


Figure 4.5-16(d): N vs Depth at Zone C

4.5.6. Summary

Project site would be divided into 3 zones together with ST-14 based on their expected consolidation settlements. Summaries of each Zone are:

	Zone A	Zone B	Zone C	ST-14(?)
Approximate settlement	0.2 m	0.5m	1m	1.5m
80 % /Consolidation	10yrs	40yrs	60yrs	90yrs
Maintenance (times)	≤ 1	≤ 2	≤ 3	≤ 4

There will be two ways of countermeasures against post construction settlement.

i) PBD technique to accelerate consolidation settlement; Large initial cost and less maintenance free

It could be ordinary way to utilize the PBD technique, which is one of the most popular in the South-East Asia to minimize post construction settlement. Without a word, the followings must be considered:

- The installation cost, which would be calculated by

$$C = \frac{c_0}{d^2} (A_{} \times l_B + A_{<C>} \times l_C + A_{ST-14} \times l_{st-14})$$

Here, C ; Total installation cost, C_0 ; unit cost of PBD installation per meter, d ; spacing of PBD (1.5m for this case), l ; installation depth +thickness of sand mat (1m),

- The execution time of PBD installation that depends on the efficiency of installation per a machine and number of installation machines
- Consolidation acceleration time, approximately 3 to 5 months, approximately 6 months.
- Additional possible cost and time would be necessary to make pre-boring for smooth installation of PBD

ii) Maintenance of structures; No initial cost but maintenance cost with damages by settlement

As described in 4.4, frequency of maintenance work would depend on the post construction settlement. Since damages to the structure would be easy to forecast, such as the utility, pavement of the road, drainage system and so on would be designed for easy maintenance.

Taking a consideration of the frequencies of maintenance such as 1st maintenance in 10 years and 20 to 30 years for 2nd maintenance, life cycle of building and so on, it seems advisable to take measure against post construction settlement by means of maintaining the structures as depending on their damages.

At the end of the report, it must be emphasized that as calculated settlement would be usually underestimated as described in 4.3, the importance is to carry out the further soil investigation before Detail Design and the importance during the execution time could be to monitor the settlement as one of supervision work and to reflect them to the management of the project.

4.6. Road development plan around the project site

Infrastructure development plan of Dhaka area

a) Araihaazar road network

The road access from the airport or the central Dhaka will go through Purbachar new-town development area, Kanchan bridge, Dhaka bypass road (Middle ring road), Bhulta intersection, Hwy 2 (Dhaka Sylhet Express way). The photo below is Kanchan bridge over Shitalakshya river.



RHD is expected to carry out road expansion plan of National Hwy2, and Dhaka bypass road. Bhulta intersection, which is constantly suffering from heavy traffic, will have a flyover road to ease the traffic. Photo below shows the plan of Bhulta intersection. The plan is currently under tendering process. Cross section plan is illustrated in the figure below. AEZ project site will be 4 km toward north east of the Bhulta intersection along the national hwy2.



Source: Google map – partially modified by JICA Study Team

Figure 4.6-2: Plan of Bhulta intersection flyover

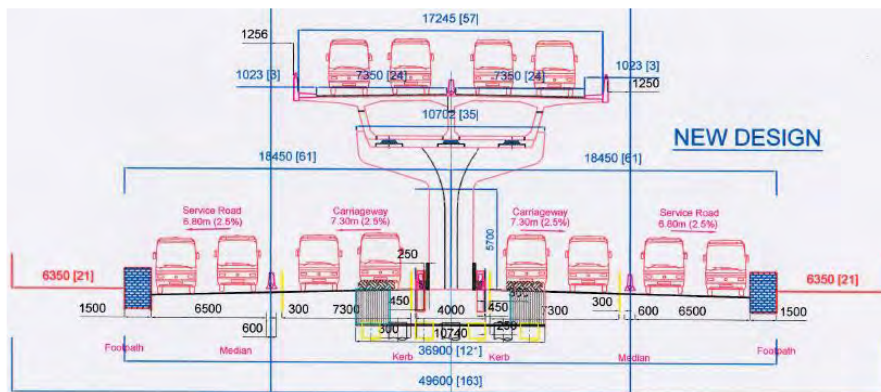


Figure 4.6-3: Bhulta Flyover Cross section plan

Additionally, Outer Ring Road is being planned allowing easier access to AEZ project site. Once these new road connections are in place, the access to AEZ from Dhaka will be significantly improved.

