

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

249.6kWp Solar Mini Grid Power Plant



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ABBREVIATIONS

ADB	Asian Development Bank
AEZs	Agro-ecological Zones
BBS	Bangladesh Bureau of Statistics
CITES	Convention on International Trade in Endangered Species
CoI	Corridor of Impact
DoD	Depth of Discharge
DoE	Department of Environment
DPHE	Department of Public Health Engineering
ECA	Ecologically critical area
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
FGD	Focus Group Discussion
GHGs	Greenhouse Gases
GIS	Geographical Information System
GPS	Global Positioning System
IEE	Initial Environmental Examination
IP	Indigenous People
IPCC	Inter-government Panel on Climate Change
IUCN	International Union for Conservation of Nature
IDCOL	Infrastructure Development Company Limited
JICA	Japan International Cooperation Agency
MFF	Multitranches financing facility
MSDS	Material Safety Data Sheet
NAPA	National Adaptation Programme on Action
NOC	No Objection Certificate
OSHA	Occupational Safety and Health Administration
PSMP	Power Sector Master Plan
PV	Photovoltaic
RAPSS	Remote Area Power Supply Systems
SLM	Sound Level Meter
SPM	Suspended particulate matter
SRDI	Soil Resource Development Institute
SREDA	Sustainable and Renewable Energy Development Agency
TDS	Total Dissolved Solids
TMP	Traffic Management Plan
ToR	Terms of References
UNDP	United Nations Development Program

EXECUTIVE SUMMARY

INTRODUCTION

Despite its large population, Bangladesh has achieved substantial economic growth over the last 15 years. Deficient infrastructure prevents the country from achieving its full growth potential. This situation is particularly evident in the economically disadvantaged remote and rural areas. Whereas access to energy is a priority in the development framework, much work needs to be done on basic infrastructure for rural electrification. Remote and dispersed areas are currently adopting off-grid electrification as a viable alternative to the national grid service.

Eastec Limited proposed a project of a 249.6 kWp stand-alone AC coupled solar photovoltaic based mini-grid power plant at Char Paka under Paka Union of Shibganj upazilla of Chapainawabganj district. The proposed system will include 249.6kWp on-grid solar PV panels, 336 batteries of 1540 Ah (at 2 V) each along with a 150 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation on 30 September 2017 and supply electricity to the adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

METHODOLOGY

The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including community representatives and a wide range of Char areas.

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

Legislative bases for Environmental Impact Assessment (EIA) in Bangladesh are the Environmental Conservation Act 1995 (ECA'95, as amended in 2010) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE.

DESCRIPTION OF THE PROPOSED PROJECT

The project site, Paka union, is located on the Padma River and lies about 17.8 km to the west of Chapainawabganj Sadar. The island lies on the border of India and to its West lies the districts of West Bengal like Suti, Dhuliyan, Jangipur and so on. To the north-east of the island lies Farakka Barrage about 32 kilometers away.

The nearest grid from the project area is about 16 kilometer away in Shibganj. Because of its geographical position, ensuring grid electricity services on the island in the near future seems

to be challenging and expensive. Currently, the electricity demand of the area is met by solar home systems, diesel and kerosene lamps.

The Global Positioning System (GPS) coordinator of the project site 24°34'31.95"N, 88°05'52.26"E, Eastec has identified 4.5 bighas of land located at the project site. The selected site has land filling requirement of about 4 feet.

DESCRIPTION OF THE BASELINE ENVIRONMENT

The project area is located in the Western region climatic zone. The region has a tropical climate with three main seasons; pre-monsoon hot season, the rainy season and the cool dry winter season. The highest average recorded temperature in this weather station was 35.9°C in April. The lowest average recorded temperature was found in the month of January which was 10.3°C. Statistical data of 1990 to 2013 shows that Rajshahi stations experience maximum rainfall 7206 mm during monsoon in July. In the month of December the rainfall becomes 161mm. The statistical data of humidity from 1990 to 2013 indicates that humidity in the above stated areas maximized in June to October in the year which is ranges from 83% to 87%. On the other hand, humidity falls 65% in March during the winter season in the Rajshahi station area. The statistical wind speed data from 1990 to 2013 shows that average wind speed remained maximum with 1.7 m/s knots in May. The minimum wind speed was 0.8m/s in the month of November in the area of Rajshahi weather station. The statistical sunshine data from 1990 to 2013 shows that average sunshine remained maximum with 8.3 hours in the month of March. The minimum sunshine was 4.5 hours in the month of July in the area of Rajshahi weather station. The statistical cloud coverage data from 1990 to 2013 (Figure 6.7) shows that average cloud coverage remained maximum from 4 Octas to 6.1 Octas during May to September. The minimum cloud coverage was 1 Octas in the month of December in the area of Rajshahi weather station.

The proposed site is presently using for agriculture. Air quality test has been conducted on 10th April 2017 at the proposed project site. According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended by Notification SRO 29-Law/2002 of 16 February 2002 and amended in SRO 355-Law/2010; any of the measures parameter of the local ambient air does not exceed Bangladesh standard. Noise level has been monitored at inside and outside of the project location during day time and the time weighted average value of the sound monitored at inside and outside of the project area did not exceed the standard fixed for the respective areas except for NM-01 and NM-06.

The project area falls in the Ganges River Floodplain physiographic unit. The topography of the specific project location is 6.97 – 10.84 m a.m.s.l. The project area is surrounded by the mighty river Padma. There are also significant numbers of natural water bodies around the project location. Most of the water bodies become waterless during dry period or contain minimum amount of water during the dry season and gets full of water in rainy season.

On 10th April 2017, surface water sample was collected by environmental team from a pond near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The concentration levels of all the parameters for surface water were within the

acceptable limit set by the DoE, GoB, according to the best practiced based classification except for the value of DO and BOD. The groundwater sample was also analyzed and all the parameters concentration levels are within the acceptable limit of drinking water quality standard set by DoE except for the value of Arsenic (As).

The soil near the project area is Calcareous Alluvium soils. As per the seismic zone map, project area falls in the zone III. According to the bioecological map zones the project area falls in Major Rivers ecological zone. No endangered/ critically endangered or threatened terrestrial or aquatic species were found in the project area. No archaeological but some culturally protected areas were found that would have anticipated impact.

The land use pattern of the study area is mainly for agriculture, fisheries, agro-forestry, homestead, homestead forestry and vegetation, animal husbandry, etc. The project area is connected with the main land by waterways. The mode of transport in the char are motorbike, van, and horse cart. The char people are typically involved in activities such as agriculture, livestock breeding, fishing and trade. Comparison of the data collected during household surveys found that the average household size of these villages was 4.7 members per household. The majority of households were headed by males (91%).

A socio-economic study was undertaken in Char Paka within 500m radius of the project site. The high impact zone has been considered as households within 250m radius from the center of the project site and the low impact zone as between 250m to 500m radius.

By far the most predominant land use in the Project area is agricultural constituting more than 71 percent of the land use. Other major non-agricultural land uses include rural settlements (11.5%), water bodies (7.5%) and mud flats (6%).

Approximately 19.8 percent of households surveyed were found to own arable land, and of these landowners 5.6 percent owned less than 1 acre and 5.3 percent owned between 1 and 2 acres. Of the 32.4 percent of households that own homesteads, more than 97 percent own less than 1 acre. Approximately 10.8 percent of households surveyed owned land used for ponds, and 24.2 percent owned land used for orchards. Of all households surveyed more than 90 percent had some form of ownership of land used for food production.

The average literacy rate of Shibganj Upazilla is 32.5%. Where the percentage of male is 33.7 and female is 31.2. The noted educational institutions are Adina Fazlul Haque Government College (1938), Kansat High School (1917), Dadanchack HM High School (1919), Harinagar High School (1959), Naya Naobhanga Government Primary School (1870), Satrujitpur Senior Madrasa (1944), Radhakantapur Senior Madrasa (1950).

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities are classified as: (i) impacts during pre-construction and construction phase and ii) impacts during operation phase (iii) impacts during decommissioning phase.

During pre-construction phase, the impacts associated with the land use and flood hazards. The project developer has bought the land from the owner with a good value. There is no conflict in land use. Therefore, there are no anticipated impacts of land use of the Project. Since the area is subject to potential risk of local flood hazards during the rainy season. It should be considered in the design stage.

During construction phases, the major impact associated with environmental quality like air, noise, water, soil quality might be degraded due to improper management of the generated waste. Dust generated from construction machineries and gaseous emissions from vehicular transport as well machineries may deteriorate the air quality of the local area. Noise quality can be deteriorated due to the operation of various machineries and equipment. Various grease and oily substances may be released from the construction machineries may deteriorate the natural water of the project site. Soil quality may be deteriorated due to the leaching of various oily substances to the soil. The transmission line laying may occur some negative impacts on vegetation, agricultural lands and existing utility lines. All the impacts will be very much localized in nature. The project contractor is to take responsibility of minimizing environmental impact on the surroundings during construction phases by following the project's environmental management plan (EMP). Other social impacts associated with the visual amenity, health safety of the labors, cultural resources, employment opportunity etc. such type of impacts will be localized in nature and not anticipate to the project. The contractor should follow the rules and guidelines related to the environmental and social mentioned in the EMP.

Photo Voltaic power plants do not release greenhouse gases or any toxic pollutants during their operation. The solar power do not exhibit any significant noise from operations, the inverters and transformers may produce noise, but this is not anticipated to the environment. In addition, there is some residential dwellings beside the project area. The residential dwellings are sensitive receptors within the project site. Every phase of the construction and operation must be followed the project's environmental management plan (EMP). Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. Another most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/runoff from plant area. The pollutants associated with the plant activities include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from plant chemicals such as batteries etc. Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster development of the surrounding of the project area. This will exert stress on the availability of groundwater in the project area. Other impact issue like ecology, waste generation will not be significant for the project. Some social impact are associated with health safety, employment, visual amenity etc.

To minimize/mitigate the impacts the developer should follow the Environmental Management Plan (EMP) properly.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

Environmental Management Plan has been developed for addressing all adverse impacts pertaining to the implementation of the project. The plan presented in tabular form includes impacts, their sources of occurrence, their mitigation measures, actors responsible for implementation of mitigation measures and their responsibilities.

Environmental Monitoring Plan has incorporated key environmental components and parameters to be monitored their indicators, frequency, timing and locations of monitoring and also the actors responsible for carrying out such monitoring.

Eastec Limited is the Executing Agency, responsible for overall project implementation and will establish a Project Management Unit (PMU) to manage the project on their behalf. This will be headed by a Project Director (PD), supported by technical staff including Design and Supervision Consultants (DSC), who will design the infrastructure, management of Contractors, and supervise construction.

Mitigation is the responsibility of Eastec. The EPC contractor engaged by the project authority will implement the EMP along with mitigation measures, as part of the contractual obligation, and the DSC will supervise the work. The cost for Environmental Mitigation Measures and Monitoring will be included in the DPP and allocated of fund will made accordingly.

CONCLUSION AND RECOMMENDATION

On the basis of the analysis, it may be concluded that the project stands environmentally sound and sustainable when the recommended mitigation measure and environmental management processes are adopted properly.

Severe weather conditions would have an impact on the construction activities. The construction activities may even have to be stopped during these periods. So it is recommended that commencing construction in early winter season may help to reap the benefit of full dry spell of the season.

In order to enhance the occupational health and worker safety during the construction period, construction equipment would have to be kept in good order. Adequate safety measures should be taken and safety related equipment including personal protective and safety equipments (PPE), firefighting equipment etc. must be provided in order to reduce the potential for accidents.

Solid waste will be generated during the construction period from excavation and refuse from construction camps.

The major issue is the need to minimize disturbance to the local population in the areas of construction.

A positive policy of employing local people during the construction phase should be adopted.

Since, the implementation of the proposed project will bring about huge benefit through help meet countries power demand for development, certain minor environmental impacts of the

associated project will have to be compromised for the better interest of the country. However, the anticipated impacts are mostly of short duration and relatively minor in nature.

In view of the above considerations and the fact that the executing agency (Eastec Limited) will maintain standard quality of implementation of the program with due consideration to other standing rules and regulations including but not limited to updated ECA 1995 (amended 2010) and ECR 1997 the project may be recommended for implementation.

1 INTRODUCTION

1.1 Background

“Electricity for all by 2021” with this vision in mind the government of Bangladesh has taken many initiatives to ensure electricity for all the people of Bangladesh by 2021, the Golden Jubilee of its Independence. Electrifying every individual household in this country is not technically and financially feasible by extending the national grid. Government has initiated the Solar Home System (SHS) based rural electrification program in 2003 through Infrastructure Development Company Limited (IDCOL) to provide electricity to the off grid areas of Bangladesh. So far the program has installed more than 3.6 million SHS all over the country. The program has become the most successful SHS based rural electrification program in the world. Around 11.5% of the total population of the country is getting benefits from the program.

It is worthwhile to note here that seven mini-grids have already been installed in the country. Eleven more are in the process of implementation while 32 others are at the planning stage. Besides, a considerable number of households are being benefited from the SHSs. Hopefully; these would help the 'structural' take-off of local economies because of their installation in the somewhat isolated areas within the country, having business and trade potential.



Figure 1.1: Solar Mini grid in Bangladesh

Despite its large population, Bangladesh has achieved substantial economic growth over the last 15 years. Deficient infrastructure prevents the country from achieving its full growth potential. This situation is particularly evident in the economically disadvantaged remote and rural areas. Whereas access to energy is a priority in the development framework, much work needs to be done on basic infrastructure for rural electrification. Remote and dispersed areas are currently adopting off-grid electrification as a viable alternative to the national grid service.

Solar Home Systems (SHS), established as a complementary solution to grid electrification, has proven it to be the most viable off-grid electrification today. Currently Bangladesh deploys over 70,000 SHS per month, with over 2.7 million in total, under the national solar home program executed by Infrastructure Development Company Limited (IDCOL). This is one of the most successful off-grid SHS programs, with the highest installation rate in the

world today. Similar to SHS, solar mini-grid can also offer reliable service for rural off-grid areas in Bangladesh.

Eastec Limited proposed a project of a 249.6 kWp stand-alone AC coupled solar photovoltaic based mini-grid power plant at Char Paka under Paka Union of Shibganj upazilla of Chapainawabganj district. The proposed system will include 249.6kWp on-grid solar PV panels, 336 batteries of 1540 Ah (at 2 V) each along with a 150 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation on 30 September 2017 and supply electricity to the adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

Compared to the price of the national grid electricity, that of the Solar Mini Grid Projects (SMGPs) power, however, is costlier. This complaint notwithstanding, the demand for mini-grid solar power has been on the rise. The grid managements are undone. They ask the aspiring consumers to wait until they can increase their production capacity. It is now a hard reality that the country's off-grid people are in a desperate need for this handy power that is produced by a seemingly unending source in Mother Nature. This has, to a large extent, been engendered by the country's prevailing electricity scenario. The national grid's capacity of power generation and supply is yet to come free of the impediments that continue to plague the sector. The situation has lately improved but the ambitious goal of ensuring energy for all is yet to be realized. Hence, Solar Mini Grid Projects (SMGPs) deserves to be encouraged and patronized.

1.2 Purpose of the Study

The main purpose of this ESIA are to evaluate the impact of project location from the environmental point of view along with possible measures to be included in an Environmental and Social Management Plan (ESMP) to minimize the potential impacts resulting from project activities during the implementation and operation phase of the project. This study investigates renewable energy-based rural electrification in Bangladesh, with a specific focus on the mini grid experiences. Specific references are made to solar PV technologies implemented under publicly supported program. The study is also providing an examination and assessment of the environmental impacts of the project.

Eastec Limited as an implementing agency of 249.6kWp stand-alone AC coupled solar photovoltaic based mini-grid power plant that illustrates environmental issues in connection with the planning, design and implementation of this project. This ESIA is a part of the process of compliance with the guidelines and legal requirement of Government of Bangladesh, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines in relation to 249.6kWp stand-alone AC coupled solar photovoltaic based mini-grid power plant.

The ESIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The ESIA also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work. In order to mitigate the potential impacts, appropriate measures have also been proposed in the Environmental and Social Management Plan (ESMP). Extensive public consultations undertaken as part of the ESIA work have been considered for identifying the mitigation measures.

1.3 Scope of the Work

This ESIA report has been prepared keeping in view the Term of Reference (ToR) approved by the Department of Environment (DoE), Bangladesh. The scope of the present ESIA report describes the following most important features:

- A review of the environmental legislative, regulatory and policy guidelines and considerations relating to the implementation of the project;
- A general description of the project and existing physical, biological and socio-economic conditions;
- Consultation with the locals/stakeholder involving concerned people in order to identify and act on any undocumented or perceived environmental issues;
- Identification and assessment of the potential impacts on the natural and human environment in the project area, from the construction of the AC mini-grid power plant;
- Identification of mitigation measures and monitoring actions in the form of an Environmental and Social Management Plan (ESMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

1.4 Extent of the Study

Assessment is carried out on the following environment components: terrestrial and aquatic ecology, soil, water, air, noise, and socio economic aspects. The impacts on ecologically sensitive areas (e.g. wildlife sanctuaries, biosphere reserve, and protected places) within 1 Km of the project areas have also been assessed. This ESIA is carried out based on proposed development. The influence of impact has been defined as 1 Km on each side from the project location. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project area for above purposes.

According to DoE an area of 5 Km on each side from the project location has to be surveyed. But solar projects being very low impact project we have set 1 Km area on each side as core area. Though 1 Km on each side of the location is surveyed, around 5 Km area on each side is observed as well. Sensitive locations being found within the 5 Km area and proper mitigation measures are applied to reduce the impact.

1.5 ESIA Content

The report fulfills the requirements of EIA under ECR, 1997 and has been prepared in accordance with the TOR. This ESIA report is also consistent with the Government of Bangladesh guidelines, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines. The report contains twelve chapters and the chapter details are discussed below:

- Chapter 1 describes the introduction containing background, purpose of the ESIA study, scope of the study, and approach methodology of ESIA study.
- Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the ESIA process.
- Chapter 3 contains detailed project description including the all the aspects of the proposed project.
- Chapter 4 describes the technological aspects
- Chapter 5 analyzes of the project alternatives
- Chapter 6 describes environmental baseline condition with details on physical environment, land resources of the area.
- Chapter 7 describes the agricultural resources, fisheries and ecosystem condition.
- Chapter 8 describes social baseline condition including socio-economic condition and social characteristics of the area.
- Chapter 9 describes public consultation discussion with local stakeholders with their ideas, views about the project through knowledge sharing
- Chapter 10 presents the impacts of project during pre-construction; construction and post-construction phase and describes mitigations measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.
- Chapter 11 describes the environmental and social management plan (ESMP) and monitoring plan along with the costing of the mitigation measures and monitoring plan.
- Chapter 12 includes the environmental and social benefits.
- Chapter 13 concluding the ESIA report along with the recommendations.

1.6 Approach and Methodology

1.6.1 Approach

The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including community representatives and a wide range of Char areas. The main purpose of this approach was to obtain a fair impression on the people's

perceptions of the project and its environmental impacts. The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GoB) EIA Guidelines, 1997, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines. The route map of this ESIA preparation is given in Figure 1.2.

1.6.2 Methodology

The following methodology was adopted for carrying out the ESIA of the proposed project:

(i) Orientation

Meetings and discussions were held among the members of the ESIA Team. This activity was aimed at achieving a common ground of understanding of various issues of the study.

(ii) Data Collection Planning

Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan was developed for the internal use of the ESIA Team. The plan included identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection; and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

(iii) Data Collection

In this step, primary and secondary data were collected through field observations, environmental monitoring in the field, concerned departments and published materials to establish baseline profile for physical, biological and socioeconomic environmental conditions. A map in Figure 1.3 is showing the data collection spots of several environmental features in the project area. Following activities were performed for data collection:

- Site Reconnaissance
- Analysis of Maps and Plans
- Literature Review
- Desk Research
- Field Observations and Studies
- Public Consultations
- Laboratory Analysis

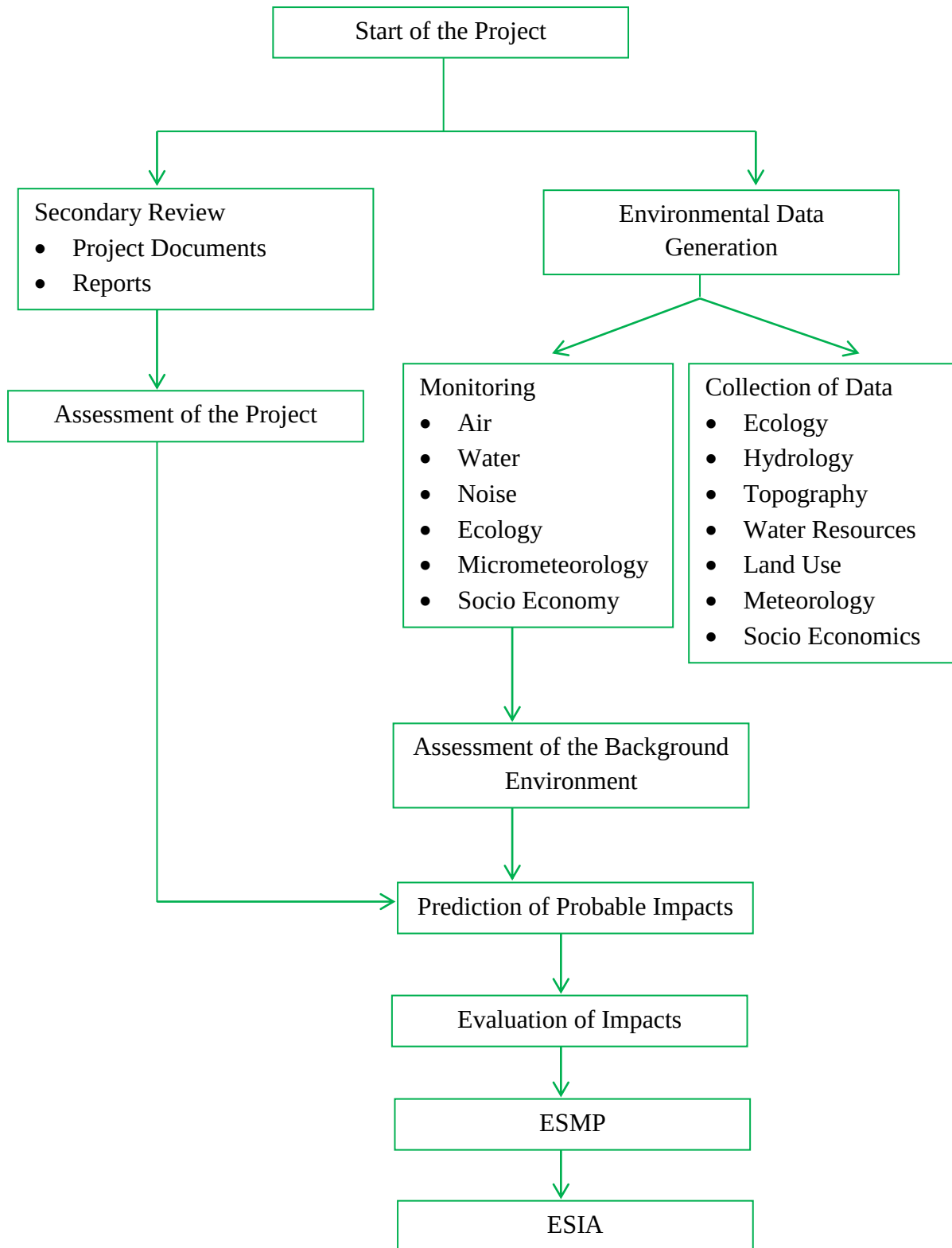


Figure 1.2: Route Map of Environmental and Social Impact Assessment

Physical Environment

Information was collected on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, water quality, air quality and noise. The primary sample collection map for the environmental issues has been given Figure 1.3.

Geology, Topography, Soils

Data related to geology, topography and soil was collected to establish the baseline of the project area and further to find out the impacts of the Project during the construction and operational phases.

Hydrology and Drainage

Data related to hydrology and drainage was collected to identify the elements of the hydrological cycle that are likely to have impacts on the project and the possible impacts that the project could have on the hydrological regime. Field assessments included a determination and verification of all the existing inflows into the drain, assessment of drainage issues, interviews with local community members.

Air Quality

Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed construction on air quality conditions. To monitor ambient air quality, carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen oxide (NO), nitrogen dioxide (NO₂), particulate matter (PM₁₀), particulate matter (PM_{2.5}), and suspended particulate matter (SPM) have been included for ambient air quality monitoring.

Noise

The noise monitoring was performed by a trained specialist, using a calibrated Sound Level Meter set to A-weighting, fast response and statistical analysis settings. The Sound Level Meter (SLM) was mounted on a tripod at a height of approximately 1.5m, facing in the direction of the apparent predominant noise source. The SLM was programmed to record statistical noise levels for 15 minutes at each location and was calibrated before and after the survey; no significant drift was detected.

Ground /Drinking Water Quality

Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Chloride (Cl⁻), Total Dissolved Solids (TDS), Iron (Fe), Arsenic (As), and Alkalinity.

Surface Water Quality

Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD₅).



Figure 1.3: Location of Sample Collections

Biological Environment

The status of the flora and fauna of the project area were determined by an ecological survey, review of literature relevant to the area, and an assessment of terrestrial environment.

Flora

The vegetative communities were identified and classified into community types. Identification was carried out of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover.

Fauna

Information on fauna was gathered from existing literature on reported species as well as observations in the field.

Socio-Cultural Environment

The ESIA study was conducted in-depth consultation meetings with stakeholders including socio-economic survey at several locations to have detailed project interventions. The following tools were used to complete the ESIA study:

- Socioeconomic data of the sample population will be collected by using a semi-structured questionnaire
- Public consultation meetings will be conducted to supplement the quantitatively collected information
- Gender, livelihood, social risks and vulnerability, and communication related information will be collected through socioeconomic survey (SES) and consultation meetings.

The Consultants utilized a combination of desk research, field investigations, census data, structured interviews, maps, reports to generate the data required for description of the existing social environment and assessment of the potential impacts due to the construction of the project. Data was collected on the following aspects given below:

- Land use
- Transportation and access Roads
- Demographics
- Livelihoods
- Education
- Health
- Community facilities
- Recreational activities
- Archaeological and cultural heritage

(iv) Public Consultation

For this report, at first the EA study has conducted in-depth consultation meetings with stakeholders including socioeconomic survey at several locations that have been proposed to have project interventions. Respondents were selected from each of the ghat, bazar and dredging locations with a range from 15 to 25 people. A team of experienced professional and support staff has conducted surveys and consultation meetings after being briefed about the project. The orientation session was facilitated by the survey team leader. Techniques of data collection, sampling methods, methods of filling up questionnaire, potential locations of the survey, etc. were discussed in the orientation session using map of the study area. The respondents were selected by random sampling method from each of the locations and also by purposive sampling method in some locations. The questionnaire had modules on demography, socio-economic profile, income and livelihoods, social infrastructure and river related issues. Respondents' contact information was collected for further verification, if and when required. The consultation meeting participants were from project stakeholders on site and the FGD participants were selected from various occupation groups.

2 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 General

The need to comply with the requirements of the EIA Regulations ensures that decision makers are provided the opportunity to consider the potential environmental impacts of a project early in the project development process, and assess if environmental impacts can be avoided, minimized or mitigated to acceptable levels. Comprehensive, independent environmental studies are required to be undertaken in accordance with the EIA Regulations to provide the competent authority with sufficient information in order for an informed decision to be made.

An ESIA is an effective planning and decision-making tool for the project proponent. It allows for the identification and management of environmental impacts/issues that may occur through the establishment and operation of such a facility. Furthermore, an ESIA allows for resolution of the issue(s) reported on in the Scoping and ESIA Reports as well as dialogue with affected parties.

According to the national environmental legislation of Bangladesh all development projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development project, it is hence required to obtain environmental clearance from DOE. Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the environmental laws and regulations like ECA'95 (amended in 2010) and ECR'97.

2.2 Bangladesh Environmental Conservation Act (ECA) 1995, as amended in 2010

The Environmental Conservation Act (ECA) of 1995 is the main legislative framework document relating to environmental protection in Bangladesh. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. This Act established the DOE, and empowers its Director General to take measures as he considers necessary which includes conducting inquiries, preventing probable accidents, advising the Government, coordinating with other authorities or agencies, and collecting & publishing information about environmental pollution. According to this act (Section 12), no industrial unit or project shall be established or undertaken without obtaining, in a manner prescribed by the accompanying Rules, an Environmental Clearance Certificate (ECC) from the Director General of the DOE.

The Act was amended in 2010 on collection and recycling of used/non-functional batteries for conservation of environment, improving environmental standard and control and prevention of environmental pollution. According to this amendment, no recycling of battery will be permitted without environmental clearance of DOE. This also restricted the improper

disposal of used batteries or any parts of used battery in open place, water bodies, waste bins, etc. All used batteries must be sent to the DOE approved battery recycling industry at earliest convenience. No financial transaction was allowed for used/non-functional batteries.

2.3 Bangladesh Environmental Conservation Rules, 1997

The Environment Conservation Rules, 1997 were issued by the Government of Bangladesh in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas;
- Classification of industries and projects into four categories;
- Procedures for issuing the Environmental Clearance Certificate;

The Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA'95. It empowers the Government to declare an area 'ECA', if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall be carried out or shall not be initiated in the ecologically critical area. Under this mandate, MOEF has declared Sundarbans, Cox's Bazar-Tekhnaf Sea Shore, Saint Martin Island, Sonadia Island, Hakaluki Haor, Tanguar Haor, Marzat Baor and Gulshan-Baridhara Lake as ecologically critical areas and prohibited certain activities in those areas.

ECR'97 (Rule 7) classifies industrial units and projects into four categories depending on environmental impact and location for the purpose of issuance of ECC. These categories are:

- Green
- Orange A
- Orange B, and
- Red

All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange- A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be issued. A detailed description of those four categories of industries has been given in Schedule-1 of ECR'97.

Apart from general requirement, for every Orange-B and Red category proposed industrial / plant unit or project; the application must be accompanied with feasibility report on Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved ToR by DOE, Environmental Management Plan (EMP) along with lay-out plan (showing location of ETP), time schedule of ETP, etc. Although there is no categorization for renewable energy project, DoE has categorized the mini-grid project considering the potential adverse environmental impacts.

The law was later amended by notification SRO 29 Law/2002 of 16 February 2002 and again in SRO 355 Law/2010.

2.4 Renewable Energy Policy of Bangladesh, 2008

The renewable energy policy of Bangladesh has been approved on December 18, 2008 with the target of developing renewable energy resources. This Policy laid out the target of meeting 5% of total power demand from renewable energy sources by 2015 and 10% by 2020. The policy provides an overall guidance of

- institutional arrangements
- resource, technology and program development
- investment and fiscal incentives
- regulatory policy

The policy promotes appropriate, efficient and environment friendly use of renewable energy. It also suggest that for large biomass electricity projects (i.e., greater than 1 MW) the project developer must demonstrate that the biomass is being sustainably harvested and that no adverse social impact will result from that development. It also restricted the larger scale production and use of bio-fuels which may jeopardize the existing crops.

Solar power being one of the sources of renewable energy, the solar power plant project is relevant to the policy. According to the policy, the 10% of the total power demand should meet from the renewable energy sources. The solar mini grid power plant project targets to supply electricity to adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

2.5 Guidelines for the Implementation of Solar Power Development Program, 2013

It is clearly mentioned in the section 3.8 of guidelines for the implementation of Solar Power Development Program (2013) that according to the Renewable Energy Policy, to establish a solar mini grid projects with a capacity up to 5 MW, entrepreneur will be exempted to get a waiver certificate. Mini grid projects with a capacity up to 250 MW will not be required any waiver certificate/license, but entrepreneur will have to inform the Commission by sending a letter. For implementation and operation of solar mini grid projects, license for a period of minimum 20 years may be issued with a condition to renew every year.

As the project is of 249.6 kWp which is below 5MW, the entrepreneur will be exempted to get a waiver certificate.

2.6 Remote Area Power Supply Systems (RAPSS) Guideline of 2007

The Remote Area Power Supply Systems (RAPSS) guideline of 2007 allows for private sector participation in development, operation, and maintenance of electricity generation system and distribution networks in remote rural areas including isolated islands to supplement GoB efforts at achieving universal access by 2020. However, there has not been

much progress in implementing the RAPSS schemes. GoB is in the process to establish the Sustainable and Renewable Energy Development Agency (SREDA) as an autonomous body to lead its efforts in promoting renewable energy and energy efficiency in the country.

In accordance with the Remote Area Power Supply Systems (RAPSS) guideline of 2007, Eastec being a Private organization is allowed to participate in development, operation and maintenance of the solar mini grind power plant in remote area Char Paka.

2.7 Bangladesh Labor Law, 2006

This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. In the chapter VI of this law safety precaution regarding explosive or inflammable dust/ gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. And in the Chapter VIII provision safety measure like as appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance, etc. are illustrated.

Being the implementation unit, Eastec will take proper safety precautions and provide safety measures including first aid, safety record book etc.

2.8 The Japan International Cooperation Agency Requirements

“JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010)” provide four categories of projects as per its environmental classification system. The Projects classified under this system are screened for the anticipated environmental impacts and are set under relevant categories. JICA has classified Projects in the following four categories:

1. *Category A*: A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. Borrowers and related parties must submit Environmental Impact Assessment (EIA) reports. For projects that will result in large-scale involuntary resettlement, basic resettlement plans must be submitted. EIA and other reports need to be submitted through the borrower before the JICA environmental reviews.
2. *Category B*: A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects.
3. *Category C*: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact.
4. *Category FI*: A proposed project is classified as Category FI if it satisfies all of the following:
 - JICA’s funding of the project is provided to a financial intermediary etc.;
 - the selection and assessment of the actual sub-projects is substantially undertaken by such an institution only after JICA’s approval of the funding

and therefore the subprojects cannot be specified prior to JICA's approval of funding (or assessment of the project); and

- those sub-projects are expected to have potential impact on the environment.

The solar mini grid project, as per the above categorization, falls under Category B for the purpose of environmental investigations. Final ESIA report approved by DoE needs to be submitted to JICA and JICA discloses the results of environmental reviews on its website after concluding agreement documents for category B projects.

2.9 World Bank's Guidelines on Environmental and Social Safeguards Policies

There are two types of safeguards requirement of the World Bank-environmental and social. Under these two safeguards there are a number of operational policies. Among them, the following operational policies could have relevance with the proposed Project:

OP 4.01 Environmental Assessment

The Bank requires environmental assessment (EA) of projects proposed to ensure that they are environmentally sustainable, and thus to improve decision making. EA is a process whose extent and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, sitting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA takes into account the natural environment (air, water and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples and physical cultural resources); and trans-boundary and global environmental aspects. The borrower is responsible for carrying out the EA and the Bank advises the borrower on the Bank's EA requirements.

The Bank classifies the proposed project into three major categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Category A: The proposed project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.

Category B: The proposed project's potential adverse environmental impacts on human population or environmentally important areas-including wetlands, forests, grasslands, or other natural habitats are less adverse than those of Category A projects. These impacts are site specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than Category A projects.

Category C: The proposed project is likely to have minimal or no adverse environmental impacts.

OP 4.04 on Natural Habitats

The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into national and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats.

According to the categorization of World Bank the solar mini grid project falls into Category B, because the project impacts will be site specific

2.10 ADB Guidelines on Environmental and Social Safeguards

Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects. New lending modalities and financing instruments, such as the multitranche financing facility (MFF), have increased the complexity of applying safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB's safeguards, which has been reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009 (SPS 2009).

The objectives of ADB's safeguards are to:

- avoid adverse impacts of projects on the environment and affected people, where possible;
- minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

Since the ADB Safeguard Policy Statement had been approved it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para 73, and paras 77–85 and 92 of the Public Communications Policy (2005).

According to the objectives of ADB's safeguards policies, the project proponent will avoid adverse impacts on environment and people where possible, will minimize, mitigate and compensate for adverse impacts and help borrowers/clients to strengthen their safeguard systems.

2.11 Environmental Clearance

Formal EIA guidelines in Bangladesh are set out in “Rules and Regulations under the 1995 Environmental Protection Acts” as published in the official Gazette on August 27, 1997. Any proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance letter:” from the Department of Environment.

As the ESIA (Environmental and Social Impact Assessment) report and the EIA (Environmental Impact Assessment) report are mutually inclusive, the procedure for obtaining Environmental Clearance Certificate for EIA is followed here for ESIA.

Steps to be followed for obtaining the Environmental Clearance Certificate for this rail link are shown in Figure 2.1 as the solar power plant is yet not categorized by the DoE so they have circulated an amendment to prepare a full EIA prior to implementation of such project for approval.

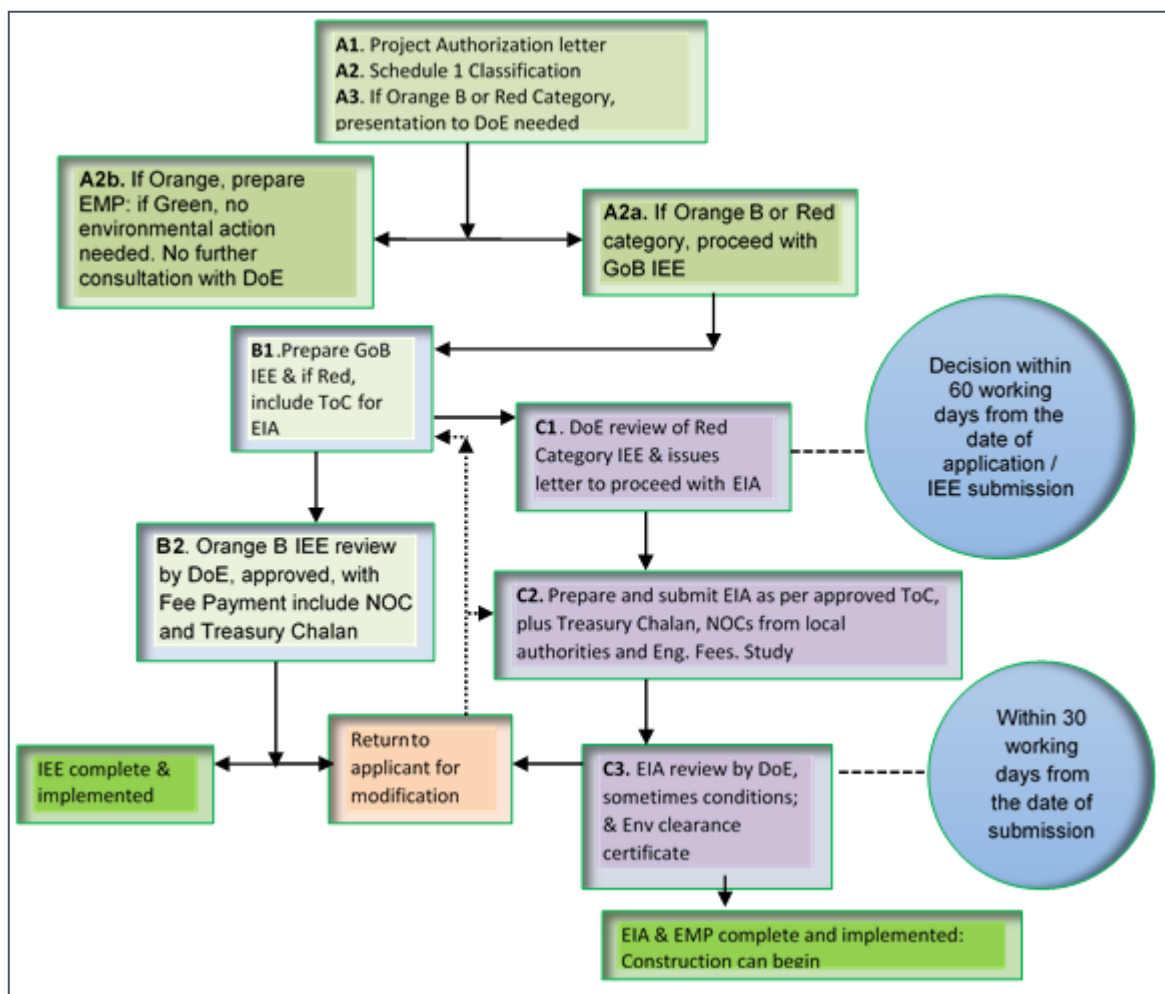


Figure 2.1: Government of Bangladesh Environmental Assessment Process

The first to obtain environmental clearance is for the project proponent to complete & submit an application form which may be obtained from the appropriate DoE regional offices as per the category. The application is accompanied by other supporting documents (i.e. project profile, lay-out plan, NOC from local authority, Government fees etc.) reviewed by the divisional and district offices of DoE who has the authority to request supporting documents as applicable. The divisional office has the power to take decision on Green and Amber-A & B category projects and the Red category projects are forwarded to head office for approval. The proposed project will receive an environmental site clearance at the beginning and the environmental clearance subject to the implementation of the project activities and all mitigation measures suggested in the ESIA report or in the application.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

The project site, Paka union, is located on the Padma River and lies about 17.8 km to the west of Chapainawabganj Sadar. The island lies on the border of India and to its West lies the districts of West Bengal like Suti, Dhuliyan, Jangipur and so on. To the north-east of the island lies Farakka Barrage about 32 kilometers away. The geographic view of the project location is shown below:



Figure 3.1: Geographic View of the Project Location

The satellite view of the project location is shown below:



Figure 3.2: Satellite view of the Project Location

The nearest grid from the project area is about 16 kilometer away in Shibganj. Because of its geographical position, ensuring grid electricity services on the island in the near future seems

to be challenging and expensive. Currently, the electricity demand of the area is met by solar home systems, diesel and kerosene lamps.

The Global Positioning System (GPS) coordinator of the project site 24°34'31.95"N, 88°05'52.26"E, Eastec has identified 4.5 bighas of land located at the project site. The selected site has land filling requirement of about 4 feet.

The only accessible route to the project site of Char Paka is using motor boats, locally known as 'trawlers' that are taken from 'Alimnagar Ghat' located in Chapainawabganj Sadar Upazilla. Chapainawabganj Sadar Upazilla is directly accessible by road transportations from Dhaka city. The journey from Alimnagar Ghat to Char Paka takes about 2 hours in the trawler boat. Upon reaching the island, one has to get off at 'Char Paka Ghat' from where the project site is about 3 km and can be reached via motor bike or another motor vehicle locally known as Nosimon. After reaching at Char Paka Ghat, motor bike or Nosimon is used to reach project location which is another thirty minutes journey. The selected project site is thus about 11-12 hours away from Dhaka city, considering travel route by road and trawler.



Figure 3.3: Accessible Route to Project Site

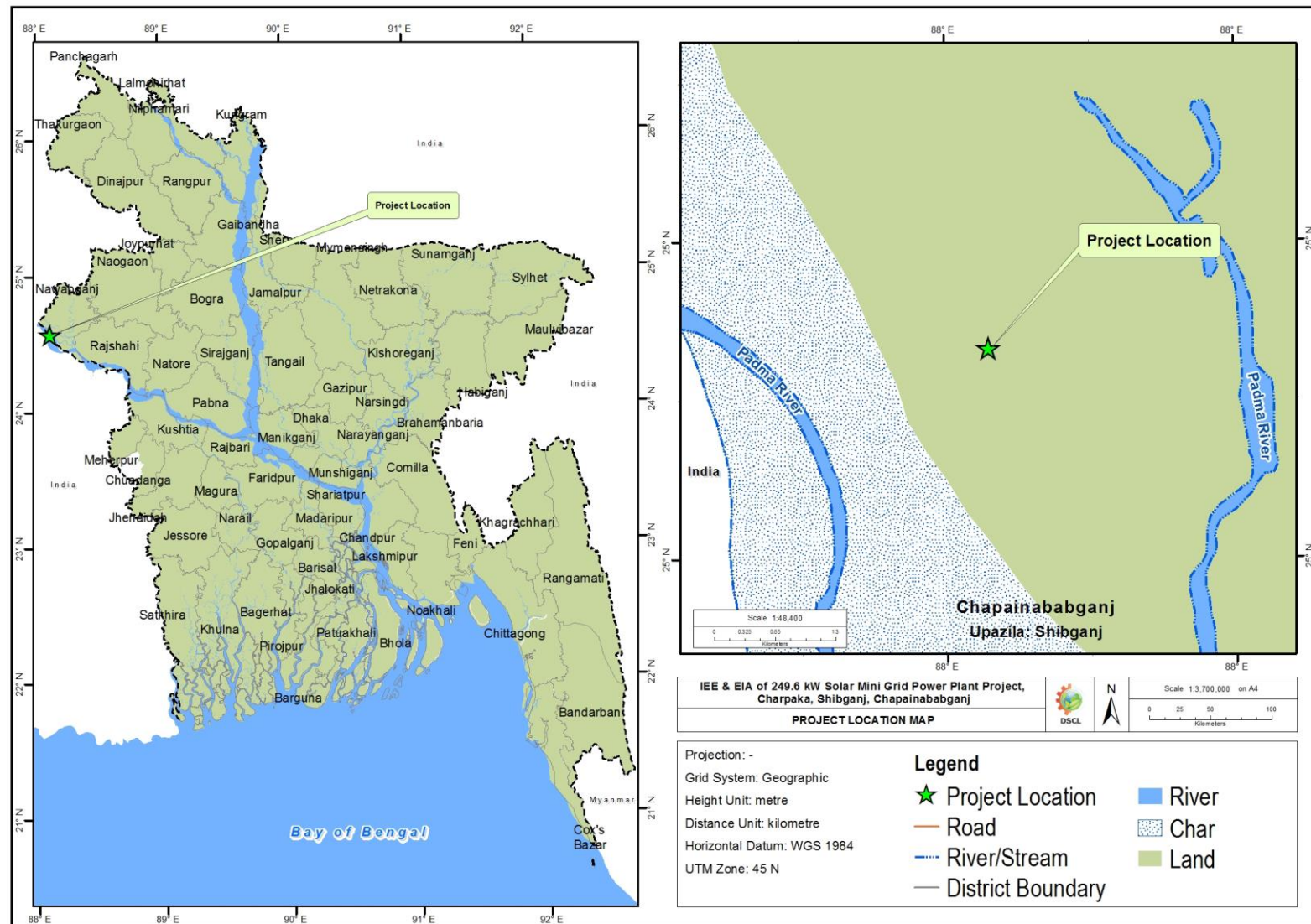


Figure 3.4: Project Location

3.2 Project Description

Expansion of rural electrification is the key to the development of rural areas of the country. The Government of Bangladesh has a vision of ensuring access to affordable and reliable electricity for all by 2021. However, supply of electricity at subsidized prices with depleting fossil fuel is becoming an ongoing challenge for the government. Only 62% of the population (including renewable energy) has access to electricity most of which are living in urban areas. Given the dispersed nature of rural settlements, grid expansion into those areas is difficult and expensive. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

The proposed Project involves setting up of a 249.6-kWp AC coupled solar photovoltaic based mini-grid by Eastec Ltd. (Eastec) at Char Paka, Paka Union, Shibganj Upazilla in Chapainawabganj District. The proposed system will include 249.6kWp on-grid solar PV panels, 336 batteries of 1540 Ah (at 2 V) each along with a 150 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation on 30 September 2017 and supply electricity to the adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

The proposed area, Char Paka, is an elongated island located in the river Padma. The nearest grid from the project area is about 16 kilometer away in Shibganj. Because of its geographical position, ensuring grid electricity services on the island in the near future seems to be challenging and expensive. Currently, the electricity demand of the area is met by solar home systems, diesel and kerosene lamps.

The following table presents key Project information:

Table 3.1: Project Key Information

Particulars	Description
Project Company	Eastec Limited
Date of incorporation	05 May, 2016
Registration no.	C-130732/2016
Registered address	Zaman Chamber (3 rd floor), 47, Dilkusha, Motijheel, Dhaka
Business address	House No. 31/A, Road 8, Dhanmondi 1205, Dhaka
Authorized capital	BDT 100 million
Paid-up capital	BDT 2 million
Trade license no. and issuer	02066881 (Dhaka South City Corporation)
Tax identification no.	510348260195
Type of business	Renewable energy activities

Plant type and capacity	249.6kWp solar PV based AC mini-grid
Location	Char Paka, Paka, Shibganj, Chapainawabganj
Project land area	4.5 Bigha
Technical Consultant	Mr. Shahriar Ahmed Chowdhury
Major equipment and accessories	Solar modules, batteries, grid-tie and bi-directional inverters, backup diesel generator, pole and pole fittings
Equipment Manufacturers	Solar module: JA Solar Holdings Co. Ltd., China Battery: Confidence Electric Ltd., Bangladesh Inverter: SMA Solar Technology AG, Germany Generator: Engine- Perkins, UK, Alternator-MeccAlte, Italy Poles and pole fittings: Exelon Bangladesh Ltd., Bangladesh Cable: Elco Wires and Cables Ltd., Bangladesh Energy meter: ZheJiang Joy Electronic Co. Ltd., China
Equipment Suppliers	Solar module: Exelon Bangladesh Ltd. Battery: Confidence Electric Ltd. Inverter: Electro Solar Power Ltd. Generator: Exelon Bangladesh Ltd., Bangladesh Poles and pole fittings: Exelon Bangladesh Ltd., Bangladesh Cable: ElcoWires and Cables Ltd., Bangladesh Energy meter: Solarland Bangladesh Co. Ltd.
Installation and supervision	Respective suppliers
O&M	Eastec
Estimated no. of customers	970 households, 160 shops 17 other commercial and social entities, 4 rice mills, 5 husking mills and 20 irrigation pumps.
Distribution network length	Three phase distribution line: 10-km Single phase distribution line: 6-km
Villages to be electrified	Batasmor Bazar, Bishroshiya, Debipur, Dokhin Paka, Dokhin Paka Bazar, Dosroshiya, Dosroshiya Bazar, Jamaipara, Jamaipara Bazar, Jawaina, Kalopur, Kalopur, Narayanpur, Satroshiya, Shampur
Expected commercial operation date	30 September 2017

3.3 Rationale of the Project

In Bangladesh, 32% of total population is connected to grid electricity. But still, most households meet their daily needs with biomass fuel. The country's electricity distribution board is failing to cope with the exponential growth in demand for power in the capital and all over the country. The possibilities of using solar power are already being tested and will mostly increase. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

Expansion of rural electrification is the key to the development of rural areas of the country. The Government of Bangladesh has a vision of ensuring access to affordable and reliable electricity for all by 2021. However, supply of electricity at subsidized prices with depleting fossil fuel is becoming an ongoing challenge for the government. Only 62%¹ of the population (including renewable energy) has access to electricity most of which are living in urban areas. Given the dispersed nature of rural settlements, grid expansion into those areas is difficult and expensive. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

Generating electricity through PV power is rather pollution-free during operation and compared with the current conventional way of producing electricity, the clean energy produced from renewable energy resources is expected to reduce consumption of alternative gas/coal/liquid fuels for electricity generation in Bangladesh, and will thus help in reducing greenhouse gas emissions, as well as air pollutant emissions. The Project will produce clean energy which will contribute to lowering electricity generation costs compared to the current costs associated with other fuels and thus leads to a substantial decrease in the Government of Bangladesh's fiscal deficit. Realizing the potential of this sector, IDCOL explored the opportunity of combining their relevant expertise to promote and develop the alternative/renewable energy production through Solar Power Plant Project.

The proposed area does not have access to grid electrification. Moreover, the project area is an isolated island in Padma River along the border of India and surrounded by water. Therefore, expansion of grid in this location will be challenging as well as expensive, making it unlikely for the grid electricity to be expanded in the project site in the near future.

The project location has a dynamic population comprising of various income generating people who have capabilities and willingness to pay higher premium for electricity connection. The monthly income level of the population in the project area is BDT 15,091 on average which is relatively higher by Bangladesh standard. Field surveys conducted by the sponsors as well as IDCOL confirm the availability of electricity demand and customer's willingness to pay in that area.

In view of the above, the proposed Project Envisages to supplying reliable and grid quality electricity to the households and local shops in fourteen (14) villages: Batasmor Bazar, Bishroshiya, Debipur, Dokhin Paka, Dokhin Paka Bazar, Dosroshiya, Dosroshiya Bazar, Jamaipara, Jamaipara Bazar, Jawaina, Kalopur, Kalopur, Narayanpur, Satroshiya, Shampur. Electricity would be supplied at an affordable, reasonable and competitive price to encourage income generating activities more than before and enhance standard of living of the local people. Electricity will be mainly used for lighting, operating TV, DC ceiling and table fans, refrigerator, use of mobile phone chargers, etc. and for running motors of some commercial entities such as rice mills and husking mills as well as irrigation pumps.

¹Source: <http://www.powerdivision.gov.bd/user/brec/85/85>

3.4 Land Filling Activities

Environmental team visited the project site in April 2017 to physically verify the suitability of project location for implementation. According to local people, flood occurs irregularly there because of higher elevation and they only experienced flood during most devastating flood in Bangladesh such as, flood in the year of 1998, 2004. During consultation meeting with the local people, it was found that the island (Char Paka) was formed more than 50 years ago. The char is susceptible to momentous river-erosion.

Total land coverage of the project site is 64,800 square feet (4.5bigha) and land coverage of the office building is 4,500 square feet. The selected land for implementing the Project is elevated compared to the surroundings of project area. Hence, 4 feet of soil filling will be required for the land. Soil filling will ensure protection of the project area from flood and clogging during rainy season. Additional land filling of 1.5 feet has been considered for the office building. It is also to be noted that compaction factor has been taken into consideration for calculating total land filling requirements.

The soil filling material will be collected from the nearby private land which is given for digging a pond. There was a mutual understanding with the private land owner and developer using this land for extraction of soil. No objection was found during field visit time. No anticipated impact was found. The developer will use dredging machine for extracted soil for land filling of the project site. The extracted soil materials will be deposited in the project site through a long pipe.

For land filling of the project site, there will be some anticipated impacts on vegetation and agricultural practices. According to the local people and field visit, Rice production was observed beside the land. The land was mainly used for agricultural practices. But no significant anticipated impact will occur for this activity.

3.5 Details of Transmission and Distribution Line

The details transmission line and distribution line are given in Table 3.2, Figure 4.5 and Table 3.3.

Table 3.2: Details of Transmission Line Diagram

3- ϕ Line Pole Interval	33.33m
Number of Pole in F1	99 No.s
Number of Pole in F2	51 No.s
Number of Pole in F3	108 No.s
Number of Pole in F4	42 No.s
1- ϕ Line Pole Interval	33.33m
All 1- ϕ Line in F1 Contains Poles	06 No.s

Table 3.3: Details of Transmission Line

Total no. of Electric Pole	480 Nos.(3phase-180 Nos & Single Phase-300 Nos.)
Total Line Length	16 Km (3 Phae-6 Km, Single Phase-10 Km) and No.of pole/ Km 30 Nos.
Electrical Earthing distance (Transmission Line Per Earthing) between	5 Pole to 6 Pole
Distribution cable	AAC WASP insulated-18 Km
Distribution cable	AAC ANT insulated- 18 Km
Distribution Conductor	D-12 (Messenger) Bare-12 Km
Service connection	[BYFY- 2X2 rm] [20m/household, Total Consumer: 400]-8 Km
Service connection	[BYFY- 2X1.5 rm] [20m/household, Total Consumer: 300]-6Km
Cable Sag	PDB Stranded per km 12% (1.12km)
Electrification of plant area (lighting)	[6 poles in (9 meters) corners and edge of the plant], plant lightning arresters will be installed in these poles.

4 TECHNOLOGICAL ASPECTS

4.1 Solar Mini Grid

4.1.1 What's a Solar Mini Grid

A mini-grid is a small scale electricity network fed by solar energy. The generated electricity is supplied directly or indirectly via batteries to clients who are connected to this mini-grid electricity network. A group of people, who live close to each other, in for instance a village, can be easily connected to the grid.

The advantage of a solar mini-grid is that it can meet higher energy demands by for instance local businesses. A solar mini-grid boosts business activities in rural areas, but can only be realized economically if the distance between clients is relatively small.

4.1.2 How Does a Mini Grid Work

Solar panels capture sunlight, which is converted to electricity. The electricity then goes to an inverter that converts direct current into alternating current, which is then fed directly or indirectly (via the batteries) into the electricity network. The electricity reaches all customers connected to the network.

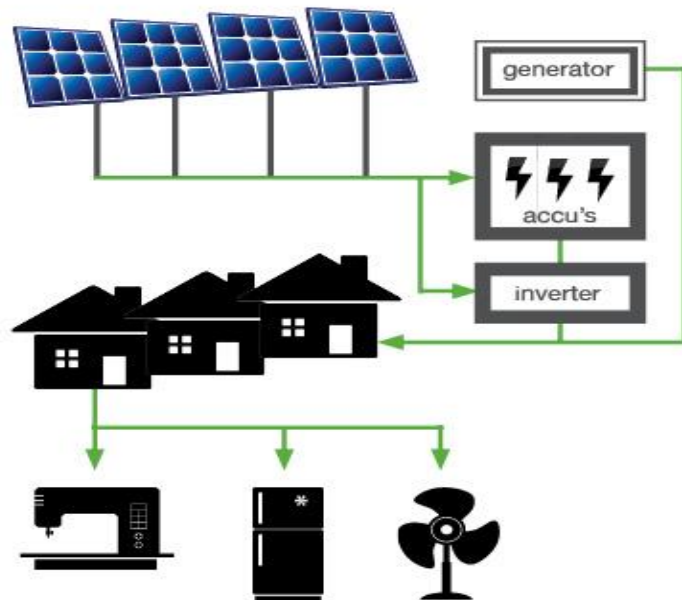


Figure 4.1: Working of a Solar Mini Grid

A diesel generator is used as a backup for the solar power plant. The generator will feed the network or batteries at times when the solar energy production is insufficient. To allow the batteries of the electricity network to be recharged, customers will not have access to the network for a period of time.

4.1.3 Advantages of a Mini Grid

- Provides a higher power level
- Little maintenance
- No emission of pollutants
- No dependence on the import of diesel and fluctuating energy prices

4.2 Proposed Process and Technology

The basic process flow diagram of the proposed solar mini-grid project is shown below:

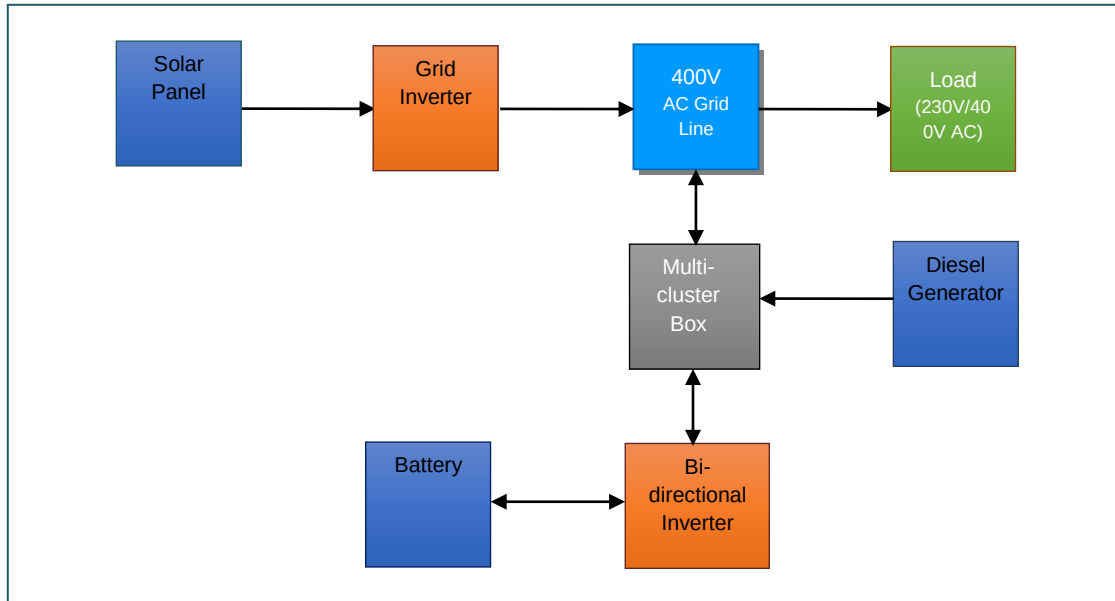


Figure 4.2: Process Flow Diagram

The plant layout of the project is given below:

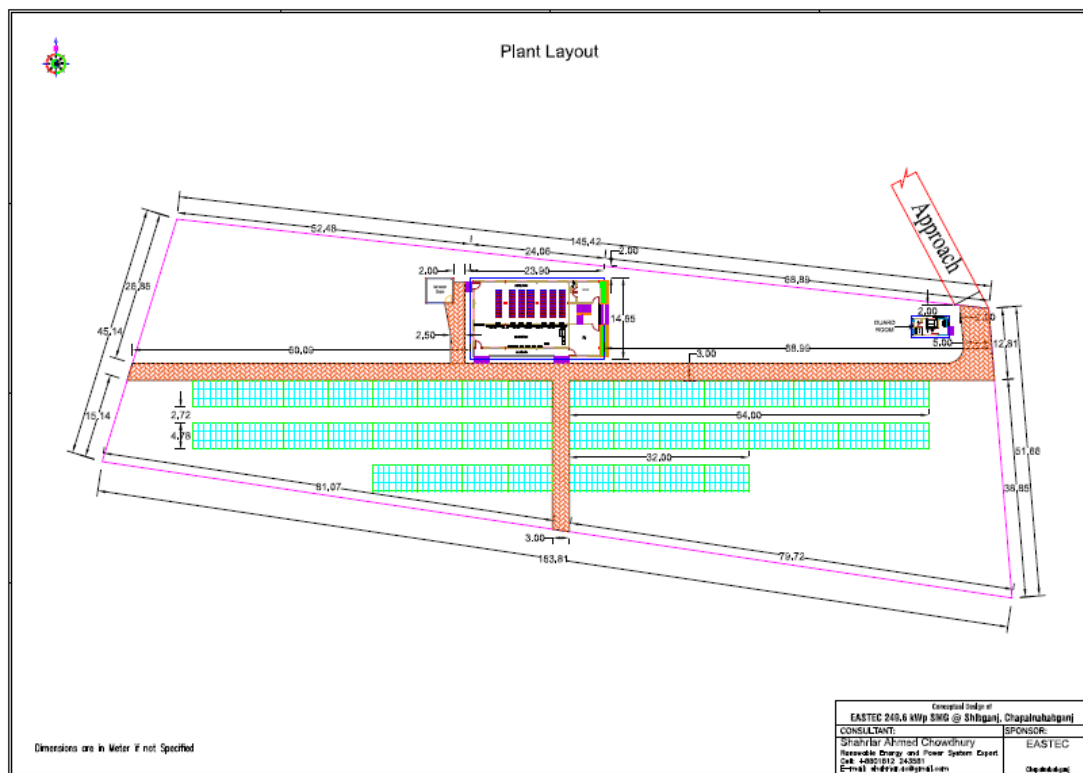


Figure 4.3: Plant Layout of the Proposed Project

The proposed Project will have the following components:

- **Solar PV modules and grid connected inverters:**

Solar PV modules with a total capacity of 249.6 kWp will be installed to supply electricity to the grid while ten (10) grid connected inverters will be installed to convert DC output from solar panels to grid quality AC electricity. Solar PV modules are the main sources of power

generation during daytime. Electricity generated from solar PV modules is converted to AC electricity through the inverters and then supplied at 400 V through 3-phase distribution line. However, electricity will be supplied to the customers at 230V using single phase & 3-phase distribution line.

- **Battery bank and bi-directional inverters:**

Excess power from solar PV modules will be stored in the battery bank using bi-directional inverters. Battery banks will be comprised of 336 units of 2V low maintenance lead acid type batteries, each of 1540 Ah capacity. Excess energy stored in the battery banks will be converted to AC electricity using bi-directional inverters (Sunny Island inverters) to be supplied to the grid. Sunny Island inverters will be automatically synchronized with the generator through a multi-cluster box.

- **Multi-cluster box**

Multi-cluster box is an interface for all the connectors and control. It is completely wired and fitted to make all the connections easier. Multi-cluster box is equipped with connection facility for external generator, load distribution and PV system.

- **Diesel generator**

A backup diesel generator will be connected to the mini-grid to supply electricity in case of electricity shortage from solar PV modules and the batteries. This scenario is likely to take place during the peak time or during rainy and foggy days. Using the multi-cluster box, the generator can also be used to charge the batteries in case of consecutive foggy and rainy days to avoid any damage to the batteries due to insufficient charge for a longer period of time. The consumption of the diesel generator is optimized automatically by programmable Sunny Remote Control (SRC) supplying electricity to the loads and charging the batteries with the surplus. The diesel generator will also run in parallel with the battery bank to supply electricity to high load demand, if necessary.

4.3 Adequacy of Solar Irradiation

The proposed location of the Project is at Char Paka, Shibganj Upazila of Chapainawabganj District. The coordinate of the proposed location is 24°34'31.95"N, 88°05'52.26"E. The solar irradiance profile² of the project location is shown in the following figure:

²Sponsor's consultant

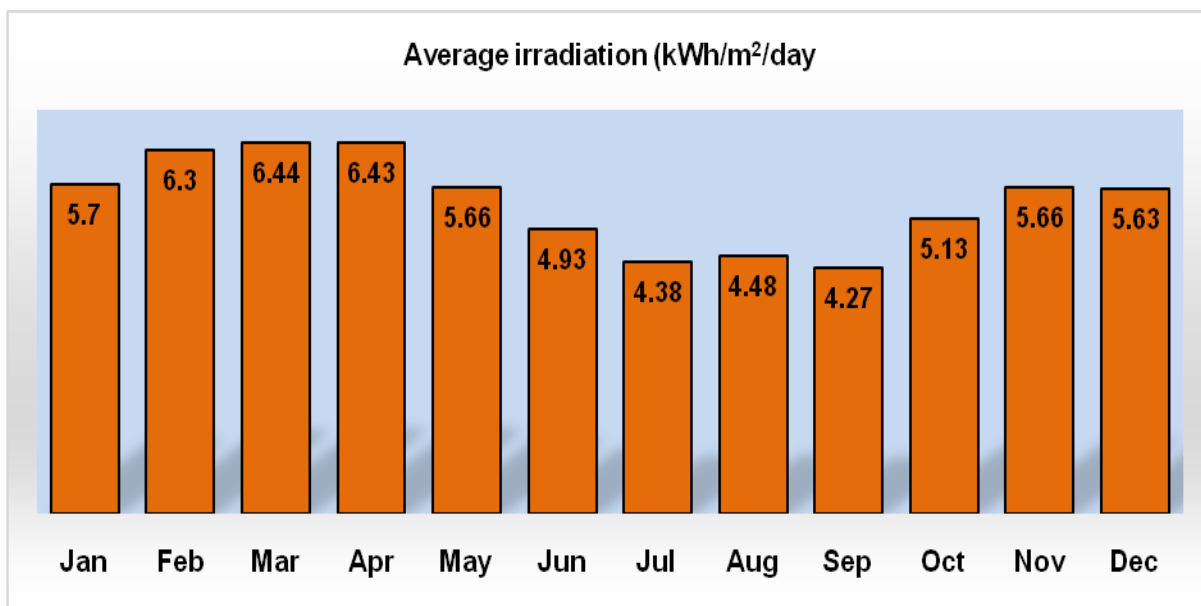


Figure 4.4: Monthly Average Solar Insolation Incident at Tilted Angle

The optimum tilt angle for solar panels in Bangladesh is considered to be 23.7 ± 1 degrees at any place in Bangladesh³. Average solar insolation in Bangladesh is considered to be 4.5 kWh/m²/day. In the project site, the average insolation is 5.41 kWh/m²/day, which is greater than the average of the country by 20.2 %. Insolation data of the project site suggests that the project location is suitable for solar mini grid project as the solar irradiance profile is steady throughout the year and the plant is expected to yield required energy output.

4.4 Plant Capacity Selection

Plant capacity selection is determined based on the load survey and optimization parameters. The survey mechanism is discussed in detail in Chapter 5. Optimization parameters for selecting plant capacity are chosen carefully to ensure satisfactory plant performance. The optimization parameters used by the sponsor are (a) consumption of diesel fuel over the year as percentage of the total consumption, (b) unused solar energy as percentage of total solar generation and (c) ratio between capacities of grid-tied inverters and bi-directional inverters. The trade-off analysis of these three parameters is discussed below:

a) Energy supplied by diesel generator

Diesel generator (DG) will be used as backup to meet the supply and demand gap throughout the year. The diesel generator will run in such cases as lack in stored energy in battery backup, rainy and foggy days. Under-sizing the plant capacity will result in excessive usage of the diesel generator. Purposes of installing a solar mini-grid project will be hampered if diesel generator is used most of the time. Hence, minimization of usage of diesel generator is an important optimization parameter. The parameter will be defined as follows:

$$\text{Percentage of energy supplied by DG} = \frac{\text{Annual consumption of energy from diesel generator} \times 100\%}{\text{Total annual consumption of energy from the plant}}$$

³ Source: Optimum Tilt Angle for the south facing solar devices installing in Bangladesh, M M Rahman, Indian Journal of Radio and Space Physics, Volume: 30, December 2001, pp 292-293.

b) Unused solar energy

Increasing the plant capacity will certainly decrease the percentage of diesel consumption annually. However, it can lead to the wastage of excessive solar energy during peak solar irradiation. Minimizing the excessive unusable energy will restrain the sponsor from overdesigning the system. There is a trade-off between minimization of unused solar energy and diesel consumption. The parameter of unused solar energy is defined as follows:

$$\text{Percentage of unused solar energy} = \frac{\text{Annual unused solar energy from the plant} \times 100\%}{\text{Total generation from solar PV modules}}$$

c) Ratio between capacities of grid-tied inverters and bi-directional inverters

The proposed design of the mini-grid is AC-DC coupled system. To ensure safety of the plant, extreme situations need to be analyzed and kept into design consideration. Bi-directional inverters to be used in the plant are of 6kW capacity and take maximum of 11.5 kWp AC input power. If the loads are disconnected in any case, the bi-directional inverters should be capable of handling the AC input power from the grid-tied inverters before necessary measures are taken. Hence, the ratio of grid-tied inverters and bi-directional inverters is an important parameter. Since the bi-directional inverters can take up to twice its power, the ratio of grid-tied inverter and bi-directional inverter capacity should not cross the value of 2. The parameter can be defined as:

$$\text{Ratio} = \frac{\text{Capacity of a grid tied inverters} \times \text{No of grid tied inverters}}{\text{Rated Capacity of bi-directional inverter} \times \text{No of bidirectional inverters}}$$

d) Simulation results

Performance of the plant and optimization parameters was analyzed based on selection of different capacities. The simulation results are shown in the Table 4.1 and graphical representation is shown in the following:

Table 4.1: Simulation result for capacity selection

Plant Capacity(K Wh)	Ratio between grid-tied and bi-directional inverter capacities	Excess Energy	Energy supplied by DG(% of total consumption)
124.8	0.79	0.0%	47.28%
156.0	0.99	0.0%	35.7%
187.2	1.19	0.0%	24.2%
218.4	1.39	0.0%	15.0%
249.6	1.59	10.6%	8.19%
280.8	1.79	20.4%	8.1%

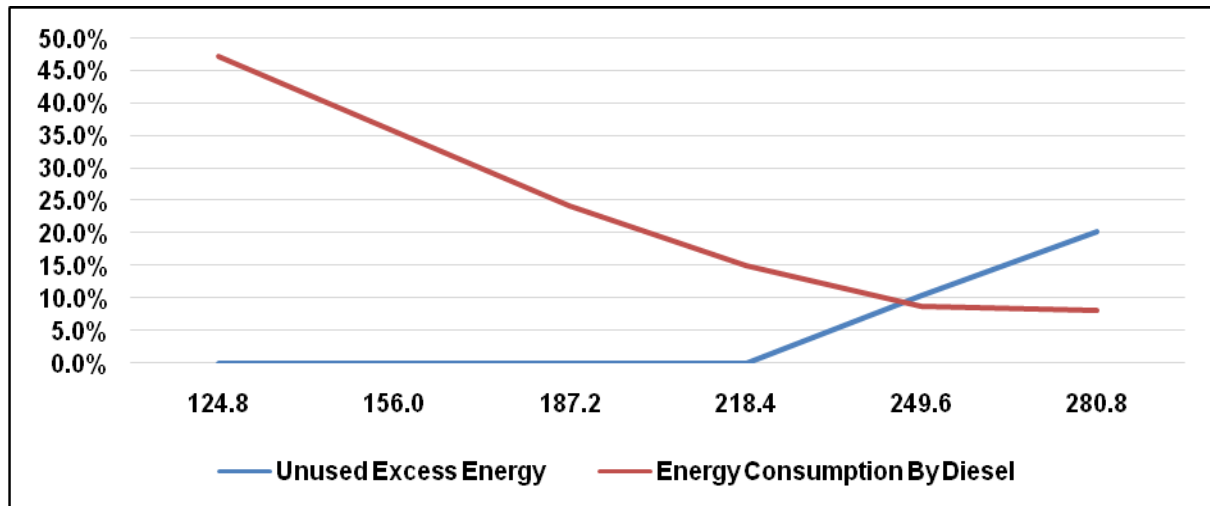


Figure 4.5: Plant Capacity Selection

Based on the simulation results, a plant capacity of 249.6 kWp was found most optimized. Therefore, the plant capacity of 249.6 was selected for the solar mini grid project.

4.5 Adequacy of Generator Size

Diesel generator will play a major role in operating solar mini-grid when the generation of electricity from solar PV is insufficient to meet the demand. In that case, the diesel generator should be able to supply necessary electricity as per the electricity demand. While undersized generators will be overloaded if the demand is higher than the rated capacity of the generator, using oversized generators will be inefficient as it will result in higher diesel consumption.

In view of the above, the sponsor selected a generator of 150 kVA prime capacity. The justification for selecting 150 kVA generators is discussed below.

The estimated daily load profile of the Project is shown below:

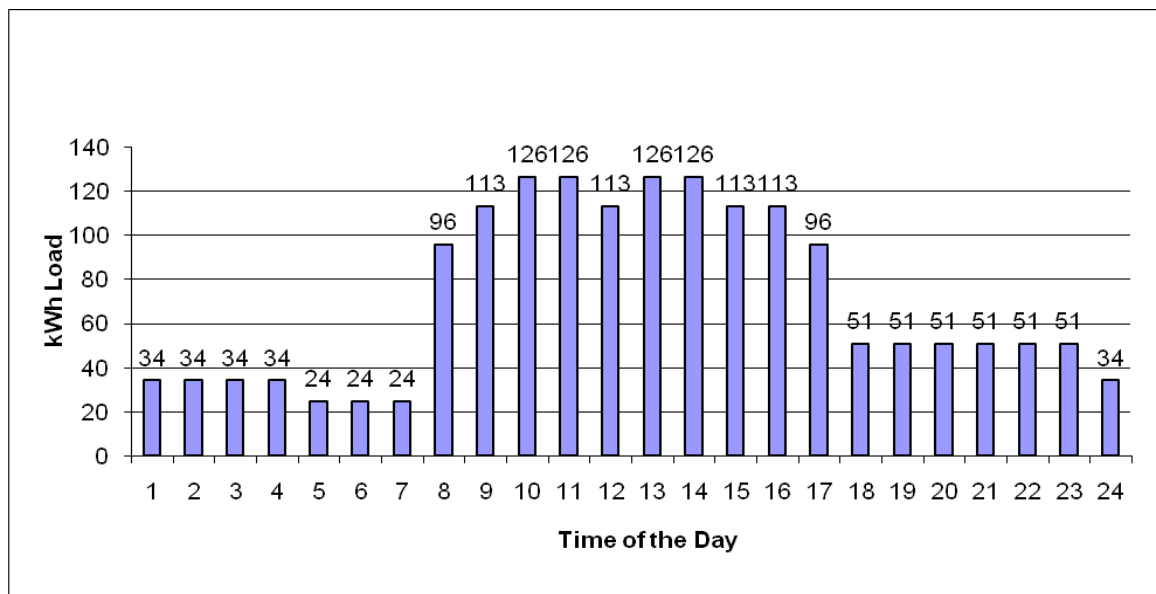


Figure 4.6: Estimated Daily Load Profile

According to the load profile, peak load in 24 hours will be 126 kW during 10-11 and 1-2 pm. Notably, it is equally important to charge the batteries along with serving the loads with the generator. However, the generator size will be unusually high if it had to charge the full capacity of battery along with serving the peak load. Inverter manufacturers suggest keeping the back-up generator within the following range:

$$0.8 P_{SI} < P_{gen} < 1.2 P_{SI}$$

where P_{SI} is total installed capacity of bi-directional inverters

and P_{gen} is the prime capacity of the generator set.

If the selection criterion is considered, generator capacity should be within 100.8 kW to 151.2 kW whereas a generator of 120 kW has been selected for this mini grid.

Generator will start automatically when the energy stored in the battery goes below the allowable threshold. Higher capacity generator will help to charge the batteries quickly along with providing electricity to the customers.

In addition, generator can also work in parallel with the battery if needed for bigger inductive loads e.g. irrigation pumps. The selected generator of such capacity will be able to supply electricity to run the peak load even in case of low solar generation, to charge battery banks in rainy and foggy days, to avoid system shutdown or to back up high current driven commercial loads.

4.6 Adequacy of Energy Storage Requirement

Low maintenance lead acid batteries will be used as energy storage device to provide electricity during night time and periods of low solar irradiation. Determining battery capacity depends on the required consumption of energy during night time.

Under the Project, twenty four (24) batteries will be connected in series to be compatible with 48V input of bi-directional inverters. Notable, the allowable Depth of Discharge (DOD) of the batteries is 50% and no autonomy has been considered for the system to optimize initial investment. In case of consecutive rainy or foggy days the demand will be met through using generator. Notably, electricity supplied from the battery banks through bi-directional inverters will be used to run the loads connected from 6 pm to 8 am (night loads).

According to the load profile, energy requirement from batteries is 548 kWh per day. Calculation to derive required battery capacity is given below considering above mentioned parameters and requisites:

Table 4.2: Design Considerations

Design considerations	Description
Supply from battery (6 pm to 8 am)	548 kWh
Battery Depth of Discharge DOD	50%
Minimum required capacity of the battery (2V, 50% DOD)	$548,079/2/0.5=548,079$ Ah
Required no. of batteries (2V, 1540 Ah)	$548,079/1540 \approx 356$

Design considerations	Description
No. of battery banks (48V system) ⁴	15.0
Suitable no. of battery banks/racks	14
Number of batteries	14 x 24=336
Battery capacity	336 x 1540 x 2 x 50%=517 kWh

As shown above, the designed battery capacity will be able to meet the peak demand at night. Therefore, the selected battery capacity is suitable for the project.

⁴ Two (2) parallel strings of battery will be connected in each bank, each with 24 batteries.

5 ANALYSIS OF PROJECT ALTERNATIVES

5.1 General

The range of feasible alternatives is selected and discussed in a manner to foster meaningful public participation and informed decision making. Among the factors that may be taken into account when addressing the feasibility of alternatives are environmental impacts, site suitability, economic viability, social and political acceptability, technological capacity, availability of infrastructure, general plan consistency, regulatory limitations, jurisdictional boundaries, and whether the proponent could reasonably acquire, control, or otherwise have access to an alternative site. An ESIA need not consider an alternative whose effects could not be reasonably identified, whose implementation is remote or speculative, and that would not achieve the basic project objectives.

An ESIA should describe a range of reasonable alternatives to the proposed project or to the location of the proposed project site that could feasibly avoid or lessen any significant environmental impacts of the proposed project while attaining most of the project's basic objectives. An ESIA also must compare and evaluate the environmental effects and comparative merits of the alternatives. This chapter describes alternatives considered but eliminated from further consideration (including the reasons for elimination), and compares the environmental impacts of several alternatives retained with those of the proposed project.

The proposed project has the potential to have significant adverse effects on visual amenity; air quality; noise; biological resources; cultural resources; geology/soils; GHG emission; hazards and hazardous materials; hydrology and water quality; land use and planning; noise; public services; transportation and traffic; and utilities and service systems within the County. Even with the mitigation measures described in Chapter 10 of this ESIA, impacts in some of these issue areas would be significant and unavoidable. Therefore, this section discusses alternatives that are capable of avoiding or substantially lessening effects on these resources. Section 5.2 below, restates the project objectives. Section 5.3 summarizes the project. Section 5.4 presents alternatives to the proposed project that were considered but eliminated for further analysis. Section 5.5 presents alternatives fully analyzed in this EIA and provide a comparison of alternatives. Section 5.6 makes a determination about the environmentally superior alternative.

5.2 Project Objectives

The following objectives have been established for the proposed project and will aid decision makers in the review of the project and associated environmental impacts:

The objectives for the proposed project are to:

- Electrification of remote rural area.
- Increasing the livelihood of the local people.
- Increase the socio-economic status of the area.

5.3 Proposed Project Summary

The project site, Paka union, is located on the Padma River and lies about 17.8 km to the west of Chapainawabganj Sadar. The island lies on the border of India and to its West lies the districts of West Bengal like Suti, Dhuliyani, Jangipur and so on. To the north-east of the island lies Farakka Barrage about 32 kilometers away. The Global Positioning System (GPS) coordinator of the project site 24°34'31.95"N, 88°05'52.26"E, Eastec has identified 4.5 bighas of land located at the project site. The selected site has land filling requirement of about 4 feet.

The proposed Project involves setting up of a 249.6-kWp AC coupled solar photovoltaic based mini-grid by Eastec Ltd. (Eastec) at Char Paka, Paka Union, Shibganj Upazilla in Chapainawabganj District. The proposed system will include 249.6kWp on-grid solar PV panels, 336 batteries of 1540 Ah (at 2 V) each along with a 150 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation on 30 September 2017 and supply electricity to the adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

5.4 Alternatives Eliminated from Further Consideration

Alternatives may be eliminated from detailed consideration in an EIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Alternatives that are remote or speculative, or the effects of which cannot be reasonably predicted, also do not need to be considered. Eastec Limited considered several alternatives to reduce project impacts on aesthetics and agriculture resources, and cumulative impacts on aesthetics, agriculture resources, air quality, and biological resources. The following alternatives were initially considered but were eliminated from further consideration in this ESIA because the alternatives do not meet project objectives or were infeasible.

5.4.1 Other Energy (Wind) Alternative

This alternative would involve the use of wind energy as an alternative to development of a solar site. Similar to solar power, power from the wind is an alternative to energy production from nonrenewable resources like coal and oil, or nuclear sources. Wind energy provides several benefits, including, but not limited to the following:

- Wind is a renewable and infinite resource.
- The generation of wind energy does not produce any air emissions, including carbon dioxide (GHG).
- Although wind energy requires a significant upfront capital investment, it is a free resource after the capital cost of installation (excluding maintenance).
- In addition, energy production from wind power would not require the significant water usage associated with coal, nuclear, and combined-cycle sources.

Commercial wind farms typically use three-bladed turbines that range in size from 300 feet up to 500 feet in height, with blades of 150 feet in length that are pointed into the wind by computer-controlled motors. The wind farm would consist of a group of wind turbines placed where sufficient and consistent wind resources exist and electrical power transmission infrastructure is located. The individual turbines would be interconnected with a medium-voltage power collection system and a communications network. Similar to solar energy production facilities, wind energy production facilities also require substations, which would increase the medium-voltage electrical current through a transformer before connection to the high-voltage transmission system. Compared with traditional energy sources, the environmental effects of wind power are relatively minor.

Unlike the proposed project, wind turbines would have the potential to impact avian species in the local area. The development of wind farms would also typically result in greater adverse aesthetics impacts due to the height of the turbines. Agriculture resources would also still be impacted by the presence of wind turbines and associated facilities. Additionally, wind energy production facilities do not reduce short-term construction-related air quality emissions.

While the project area has been identified as suitable for solar projects based on the solar insolation levels (the amount of solar radiation energy) in the area, wind energy production is not well-suited to the project site due to relatively low wind speeds and directionality sufficient to drive wind turbines. No significant facilities have been developed in the project vicinity due to the lack of adequate wind resources.

As noted above, alternatives may be eliminated from detailed consideration in an ESIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Therefore, this alternative was eliminated from further consideration because:

- It would result in additional/greater impacts than the proposed project (aesthetics and biological resources);
- It would not substantially reduce the significant environmental impacts associated with aesthetics, agriculture resources, air quality and biological resources;
- It would fail to meet the objectives for the proposed project; and
- The project site is not suited for wind energy production; therefore, a wind energy production facility would not generate as much electricity as solar equipment.
- Wind energy is uncommon in Bangladesh and the production material is not available.

5.4.2 Alternative Site

Relocation option to a different site is an option available for the project implementation. At the moment, there are no alternative sites for the proposed development (i.e. the project proponent doesn't have an alternative site). This means that the proponent has to look for the land if relocation is proposed and land is not available and if available it will be too expensive for the proponent to realize his dream.

Looking for the land to accommodate the scale and size of the project and completing official transaction on it may take a long period. In addition, it is not a guarantee that such land would be available. It's also worth noting that the said project is already underway in terms of seeking development approvals in various government departments.

The project proponent would spend another long period of time on design and approvals of the plans by the relevant government departments. The project design and planning before the stage of implantation would call for cost; already encountered in the proposed development i.e. whatever has been done and paid to date would be counted as a loss to the proponent. Assuming the project will be given a positive response (after relocation) by the relevant authorities including DoE, it (project) would have been delayed for a long period before implementation. This would also lead to a situation like No Action Alternative. In consideration of the above concerns and assessment of the current proposed site, relocation is not a viable option.

5.5 Alternatives Selected for Analysis

The following four alternatives have been determined to represent a reasonable range of alternatives that have the potential to feasibly attain most of the basic objectives of the proposed project but which may avoid or substantially lessen any of the significant impacts of the proposed project. The “Environmentally Superior” Alternative, as required is described in Section 5.5, Environmentally Superior Alternative. The following alternatives are analyzed in detail below:

- Alternative A: No Project
- Alternative B: Reduced Project (Avoid Williamson Act Contract and Prime Agricultural Lands)
- Alternative C: Build-Out of Existing Land Use
- Alternative D: No Utility-Solar Development—Distributed Commercial and Industrial Rooftop Solar Only

Table 5.1 provides a summary of the relative impacts and feasibility of each alternative. A complete discussion of each alternative is provided below.

Table 5.1: Summary of Development Alternatives

Alternative	Description	Basis for Selection and Summary for Analysis
Proposed Project	249.6 kWp standalone AC coupled solar photovoltaic mini grid power plant on 4.5 bighas	-
Alternative A: No Project Alternative	• Existing land use designations and zoning designations would remain. • No Development would occur on site.	Avoids significant impacts.

Alternative	Description	Basis for Selection and Summary for Analysis
	Site would remain as agricultural land.	
Alternative B: Reduced Project Alternative	45 kWp on 1 bigha	Avoids significant impacts to agricultural lands.
Alternative C: Build-Out of Existing Land Use Alternative	Existing land use designation will be build out.	Several environmental impacts reduced whereas others increase.
Alternative D: No Utility Solar Development – Distributed Commercial and Industrial Rooftop Solar Only	249.6 kWp of photovoltaic solar distributed on rooftops throughout the region.	Avoids significant impacts to visual amenity, air quality and ecological resources.

5.5.1 Alternative A: No Project Alternative

The No Project Alternative in respect to the proposed project implies that the status quo is maintained. This option is most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. However, the project activities have already been started. This option will however, involve several losses both to the project proponent and the donor organization. The property will remain under-utilized. The No Project Option is the least preferred from the socio-economic and partly environmental since if the project is not done.

- The economic benefits especially during construction i.e. provision of jobs for skilled and non-skilled workers will not be realized.
- There will be no generation of income by the developer to the Government.
- The local skills would remain under-utilized.
- No employment opportunities will be created who will work in the project area.
- Discouragement for donors to allot this level of standard and affordable developments.

5.5.1.1 Impacts Compared to Project Impacts

5.5.1.1.1 Visual Amenity

In contrast to the proposed project, the project site under the No Project Alternative would remain under agricultural production, largely vacant and undeveloped. Under the No Project Alternative, solar arrays and other project components would not be developed at the project site and no views of the project area would be altered. The area surrounding the project site is mostly under agricultural production and undeveloped land. Under the No Project Alternative, no impact to the undeveloped nature of the project area would occur. Therefore, because the project site would remain unchanged under the No Project Alternative, this alternative would result in fewer impacts than the proposed project.

5.5.1.1.2 Air Quality

During construction, air quality emissions associated with the project would be equal to, if not greater than the existing farming operations. Following the construction period (during

project operations), the proposed project would likely produce less air pollution than existing land uses by removing gas- and diesel-powered farming equipment and vehicles (e.g., tractors, crop dusting, haul trucks) and ground-disturbing activities (e.g., planting, harvesting, plowing), and replacing them with the minor vehicle and equipment emissions and minimal soil disturbance associated with the solar facility. In addition, the proposed project would decrease regional air pollutant emissions by reducing the demand for new fossil-fuel-burning power generation facilities. Therefore, there would be greater long-term air pollution impacts resulting from the No Project Alternative than the proposed project.

5.5.1.1.3 Terrestrial Ecology

According to ecological surveys performed at the project site, some sensitive plant and animal species have the potential to be located within 1 kilometer of the project site or on the site itself. Under the No Project Alternative, no new construction and/or operational activities would result, and impacts would generally not be increased. There would be fewer impacts to biological resources from the No Project Alternative as compared to the proposed project. The project-level impacts resulting from the proposed project would be less than significant with mitigation. Implementation of the No Project Alternative would successfully avoid project-level impacts to biological resources by minimizing the potential loss of sensitive species habitat onsite.

5.5.1.1.4 Archaeology and Cultural Resources

Field surveys indicate the presence of very few cultural resources on the project site. Mitigation measures are provided to reduce impacts to these resources to below a level of significance. Under the No Project Alternative, the project site would remain as is, and no ground disturbing activities would occur. Therefore, unlike the proposed project, the No Project Alternative would not have the ability to accidentally uncover potentially significant cultural, archaeological, or paleontological resources which may be located beneath the surface project site. There would be no impact to cultural resources, and no mitigation measures would be necessary. Accordingly, there would be fewer impacts from the No Project Alternative than the proposed project.

5.5.1.1.5 Soil

Implementation of the No Project Alternative would result in a continuation of existing land uses. The site is expected to continue to be used in its current capacity and condition. No change in geology or soils conditions would occur with this alternative.

5.5.1.1.6 Dust & Exhaust Emissions

Unlike the proposed project, the No Project Alternative would not involve construction activities or operation of a solar generating facility; therefore, heavy equipment operation, truck deliveries, and construction worker commute trips would not be utilized and increased dust and exhaust emissions would not occur as a result. The No Project Alternative would have fewer impacts than the proposed project during the project's construction period, but would result in greater impacts during the proposed project's operational period. Because the construction period is temporary and is anticipated to last for only three years, whereas the operational period is anticipated to last for many decades, the long-term impact of the No

Project Alternative on air quality is greater than the impact of the proposed project.

5.5.1.1.7 Waste Generation

If the No Project Alternative is implemented, the proposed project would not be implemented. It is expected that there would be no change at the project sites relative to their current agricultural practices, and expected current use of pesticides, fertilizers, and fuels for farming equipment. No change regarding existing on-site hazards or potential use of hazardous materials is expected.

5.5.1.1.8 Water Quality

The No Project Alternative would not result in degradation of surface water quality in the adjacent rivers, channels and ponds due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, and noxious chemicals. Accordingly, there would be fewer impacts from the No Project Alternative than the proposed project.

5.5.1.1.9 Land Use

Under the No Project Alternative, the project site would remain undeveloped and vacant. Similar to the proposed project, the No Project Alternative would not physically divide an established community. The project site is not within the boundaries of any natural community conservation plan, therefore no impact would occur. No land filling will be required under no project alternative. Nonetheless, because no degradation of the surrounding agricultural land will occur, there would be fewer impacts from the No Project Alternative than the proposed project.

5.5.1.1.10 Noise

If the No Project Alternative is implemented, short-term construction activities of the PV solar project and long-term operation of the PV solar project would not occur and the associated noise levels would not be generated. The No Project Alternative would result in the continuation of agricultural use-related noise levels at the site. The No Project Alternative would eliminate the project-specific less than significant short-term construction noise impacts.

5.5.1.1.11 Traffic

In contrast to the proposed project, there would be no development associated with the No Project Alternative. Therefore, the No Project Alternative would not have the potential to affect traffic volumes on nearby roadways as a result of either construction activities. Because transportation and traffic impacts associated with construction of the project would be greater than existing agricultural operations, the No Project Alternative would result in fewer impacts as compared to the proposed project.

5.5.1.2 Conclusion

5.5.1.2.1 Avoid or Substantially Lessen Project Impacts

The No Project Alternative would reduce the significant and unavoidable impacts of the proposed project related to air quality (project-level and cumulative). This alternative would

also result in fewer impacts to archaeological and cultural resources, water quality, land use, and traffic, but would result in greater long-term impacts associated with air quality and exhaust emissions.

5.5.1.2.2 Attainment of Project Objectives

Alternative A, the No Project Alternative, would not meet any of the project objectives.

5.5.1.2.3 Comparative Merits

The No Project Alternative would avoid some impacts associated with the proposed project's short-term, long-term, and cumulative impacts, but would result in a greater long-term and cumulative impacts in certain environmental issue areas. Unlike the proposed project, this alternative would not have significant and unavoidable impacts associated with air quality (project-level and cumulative). Long-term air quality and emissions impacts would be substantially greater with the No Project Alternative. In addition, this alternative would not meet any of the project's objectives.

5.5.2 Alternative B: Reduced Project Alternative

Under the Reduced Project Alternative, development would involve an 82 percent reduction in project size. The project under this alternative would consist of an approximate 45 kWp solar PV generating facility on 1 bigha. Under this alternative, the following specific project components could be reduced in number or size in comparison to the proposed project:

- A solar field of PV panels and associated improvements (e.g., access roads, fencing, secondary access drives, combiners, etc.),
- An electrical collection system (transformer and inverter) that aggregates the output from the PV panels and converts the electricity from DC to AC,
- The transmission to the transmission line, and Project substations.

5.5.2.1 Impacts Compared to Project Impacts

The following discussion evaluates the potential environmental impacts associated with the Reduced Project Alternative, when compared to the impacts of the proposed project.

5.5.2.1.1 Visual Amenity

A reduction in project size under the Reduced Project Alternative would result in less modification of the existing environment, and would therefore result in fewer impacts to visual amenity than the proposed project. However, a smaller solar energy facility covering one bigha would continue to have a significant and unavoidable impact on aesthetics as the landscape and character of the project area would change from vacant and undeveloped or agricultural operations to a solar energy facility.

5.5.2.1.2 Air Quality

During the construction period, overall air quality emissions associated with the Reduced Project Alternative would be less than the proposed project, because there would be less land area disturbed. No significant and unavoidable air quality impacts are expected with the

proposed project; therefore, the Reduced Project Alternative construction period air quality impacts would also be less than significant. However, because there would likely be some overlap of construction periods for the various projects in the cumulative analysis, cumulative construction-period emissions are likely to exceed thresholds of significance and result in cumulatively significant impacts. Therefore, cumulative air quality impacts associated with construction of the Reduced Project Alternative would, like the proposed project, be significant and unavoidable. Following the construction period (during project operations), the proposed project would produce less air pollution than the Reduced Project Alternative as no farming would occur, meaning there would be no gas- and diesel-powered farming equipment and vehicles (e.g., tractors, crop dusting, haul trucks) and ground-disturbing activities (e.g., planting, harvesting, plowing) associated with agricultural operations. These activities and operations would be replaced with the minor vehicle and equipment emissions and minimal soil disturbance associated with the solar facility. In addition, the proposed project would decrease regional air pollutant emissions by reducing the demand for new fossil-fuel-burning power generation facilities more than the Reduced Project Alternative. Therefore, there would be fewer long-term air pollution benefits resulting from the Reduced Project Alternative than the proposed project.

5.5.2.1.3 Terrestrial Ecology

Both the proposed project and Reduced Project Alternative would result in the development of a project site that consists of undeveloped agricultural lands. Although the Reduced Project Alternative would result in less development of the project site, as compared to the proposed project, the Reduced Project Alternative would still require the implementation of mitigation measures in order to reduce the severity of potential impacts to biological resources. Similar to the proposed project, the Reduced Project Alternative has some potential to result in impacts to burrowing owls, nesting raptors, migratory birds and other sensitive non-migratory bird species. However, with the implementation of the avoidance, minimization and mitigation measures outlined, these impacts would be reduced to a level of less than significant. The Reduced Project Alternative would use the same gen-tie route, so the impacts associated with loss of habitat along that route would not be reduced; however, because the Reduced Project would cover less land, less burrowing owl foraging habitat would be lost. Nonetheless, because the Reduced Project Alternative would develop less of the project site as compared to the proposed project, impacts from this alternative would be slightly less than the proposed project.

5.5.2.1.4 Archaeology and Cultural Resources

Under the Reduced Project Alternative, less of the project site would be disturbed, reducing the likelihood of accidental discovery of potentially significant cultural, archaeological, or paleontological resources which may be located beneath the surface project site. There would be less of an impact to cultural resources, although mitigation measures would still be necessary. Accordingly, there would be fewer impacts from the Reduced Project Alternative than the proposed project.

5.5.2.1.5 Soil

The Reduced Project Alternative would generally have impacts to geology and soil that are

similar to, or the same as, the proposed project. During construction, the amount of soil disturbances would be similar to, or the same as, the project. The increased setbacks would decrease the size of the PV array; however, some level of site clearing and shallow grading would still be required for the perimeter landscape. This alternative would include the same facilities described for the proposed project. The character of on-site soils and the depth of the groundwater table make the potential for liquefiable materials to be present beneath the site.

5.5.2.1.6 Dust & Exhaust Emissions

Similar to the proposed project, the Reduced Project Alternative would result in short-term exhaust emissions during construction activities, albeit to a lesser degree than the proposed project. However, impacts from both construction-related and cumulative exhaust emissions for each project would still be less than significant without implementation of mitigation measures. Once operational, it would begin to offset emissions by reducing the amount of fossil fuels burned to generate other forms of electricity. However, the proposed project would offset significantly more emissions from fossil-fuel-based energy sources, as compared to the Reduced Project Alternative. The proposed project would also result in reduced emissions on the project site by eliminating the use of diesel-powered farm equipment. Given that both the proposed project and the Reduced Project Alternative would ultimately result in a net decrease in emissions, operational impacts for both projects would be less than significant. However, because the proposed project would offset far more emissions than the Reduced Project Alternative, there would be fewer long-term emissions benefits resulting from the Reduced Project Alternative than the proposed project.

5.5.2.1.7 Waste Generation

The Reduced Project Alternative would have similar impacts to the proposed project related to construction and decommissioning because this alternative would be a reduced-sized version of the proposed project at the same site and using the same PV technology, and the same mitigation measure would be implemented to reduce the potential for spills to occur and to manage spills that do occur. Its difference is that this alternative would have a larger setback distance from the surrounding roads. The Reduced Project Alternative would create a less than significant hazard to the public and the environment through the routine transport, use, or disposal of hazardous materials. The Reduced Project Alternative would also create a less than significant impact with mitigation related to an inadvertent release during construction of hazardous materials into the environment. Overall, impacts regarding hazards and hazardous materials would be essentially the same for this alternative as for the proposed project.

5.5.2.1.8 Water Quality

The Reduced Project Alternative would result in small degradation of surface water quality in the adjacent rivers, channels and ponds due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, bentonite and noxious chemicals. Therefore, because both projects would result in less than significant impacts with adherence to all applicable regulations, impacts to hydrology and water quality

from the Reduced Project Alternative would be similar as compared to the proposed project.

5.5.2.1.9 Land Use

With approval of all discretionary requests, both the proposed project and the Reduced Project Alternative would be consistent with the land use and zoning designations at the project sites, and neither project would conflict with any applicable land use plans, policies or regulations. Similar to the proposed project, the Reduced Project Alternative would not be located between housing developments or communities; therefore, this alternative would not physically divide an established community. Accordingly, because both the proposed project and the Reduced Project Alternative would require approval of discretionary requests in order to maintain consistency with all applicable land use plans, impacts from the Reduced Project Alternative would be similar to those resulting from the proposed project.

5.5.2.1.10 Noise

If the Reduced Project Alternative is implemented, short-term construction/decommissioning and long-term operation would result in slightly lower maximum noise levels to surrounding areas due to the increased setbacks for project facilities from the road networks surrounding each of the sites when compared to the proposed project. In addition, construction and decommissioning activities would likely occur for a slightly shorter duration compared to the project. Similar to the project, the Reduced Project Alternative would result in less than significant short-term construction/decommissioning and long-term operational impacts from noise and vibration.

5.5.2.1.11 Traffic

Although the Reduced Alternative would involve fewer construction vehicle trips, potential impacts to traffic volumes on nearby roadways would not differ substantially in comparison to the proposed project. Similar to the proposed project, impacts from construction and operational vehicle trips for the Reduced Project Alternative would be less than significant without implementation of mitigation. Nonetheless, because the Reduced Project Alternative would result in slightly fewer construction trips, this alternative results in fewer impacts than the proposed project.

5.5.2.2 Conclusion

5.5.2.2.1 Avoid of Substantially Lessen Project Impacts

Compared to the proposed project, the Reduced Project Alternative would result in fewer impacts to aesthetics, terrestrial ecology, air quality (construction period/short-term), archaeological and cultural resources, and traffic, but would result in greater long-term impacts associated with air quality and exhaust emissions.

5.5.2.2.2 Attainment of Project Objectives

Alternative B, the Reduced Project Alternative, meets all project objectives. However, it meets certain objectives to a lesser degree than the proposed project. Among these are:

- Assist in achieving exhaust emissions reduction objectives to the maximum extent possible based on anticipated transmission facility capacity and reserved queue

position.

- Ensure that the project can be constructed, and power provided at a competitive price.

5.5.2.2.3 Comparative Merits

The Reduced Project Alternative would reduce impacts associated with visual amenity, air quality (project-level), ecological resources, archaeological and cultural resources, and traffic, when compared to the proposed project. Despite a reduction in their severity, significant and unavoidable impacts to air quality (cumulative) would remain.

The Reduced Project Alternative would have similar impacts associated with water quality, land use, when compared to the proposed project. Once operational, this alternative would result in greater impacts to air quality and exhaust emissions than the proposed project.

Therefore, the Reduced Project Alternative would reduce impacts in most environmental issue areas as compared to the proposed project.

5.5.3 Alternative C: Build-Out of Existing Land Use Alternative

Under Alternative C: Build-Out of Existing Land Use Alternative, the project site could be developed to the maximum intensity allowed under the land use designations of the plan of Eastec Limited. This alternative would yield a number of residential units with agricultural and grazing uses, including breeding and/or grazing of animals. Under this alternative, no utility scale solar PV panels would be developed, as those entitlements do not currently exist on-site.

5.5.3.1 Impacts Compared to the Project Impacts

The following compares environmental impacts associated with the Build-Out of Existing Land Use Alternative to those identified for the proposed project.

5.5.3.1.1 Visual Amenity

Under the Build-Out of Existing Land Use Alternative, the project site would be developed with a number of residential units with agricultural and grazing uses, including breeding and/or grazing of animals. Development of the project site with structures other than solar panels would not necessarily reduce the environmental impacts associated with the proposed project. Similar to the proposed project, the project site under the Build-Out of Existing Land Use Alternative would be fully developed with residential and agricultural operations; therefore, views of the project area would be altered from their undeveloped condition. Therefore, although different structures would be built, the Build-Out of Existing Land Use Alternative would still impact the aesthetic character of the project site. Accordingly, impacts to aesthetic resources resulting from implementation of the Build-Out of Existing Land Use Alternative would be similar to those of the proposed project.

5.5.3.1.2 Air Quality

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in short-term construction emissions. However, it is likely that the Build-Out of Existing Land Use Alternative would require more equipment and potentially a longer construction

period to construct the necessary infrastructure (e.g., utility lines, water quality facilities, etc.), site improvements, and buildings, which would result in significantly higher short-term air quality impacts. The specific levels of emissions to determine which air emissions standards would be violated are not known until a final site plan, infrastructure needs analysis, and an accompanying phasing plan is developed. However, because construction emissions under the Build-Out of Existing Land Use Alternative would likely be much greater than the proposed project, this alternative would result in significant cumulative level construction-related air quality emissions.

Once operational, emissions associated with the proposed project would be minor and limited to maintenance and monitoring activities only. The facility would reduce future regional air pollution by taking the place of fossil-fuel-burning power generation, or reducing the need for construction of additional polluting facilities. Conversely, operational emissions associated with the development of a number of residential units with agricultural and grazing uses, including breeding and/or grazing of be greater due to increased traffic and other emissions sources. Therefore, although the exact amount of operational emissions cannot be ascertained for the Build-Out of Existing Land Use Alternative at this time, it can be assumed that emissions would be higher than the proposed project. As such, impacts to air quality during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

5.5.3.1.3 Terrestrial Ecology

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in the development of a previously undeveloped project site. Therefore, similar to the proposed project, it is anticipated that the Build-Out of Existing Land Use Alternative would also require the implementation of mitigation measures in order to reduce the severity of potential impacts to ecological resources. The transmission line corridors would not be built out. This would reduce some of the biological impacts associated with the project. However, this alternative would result in fewer project-level impacts to various species because a reduced amount of total acreage would be developed. However, the exact level of significance is not known until a site plan is created and biological impacts associated with the plan can be assessed. Therefore, impacts to biological resources from the Build-Out of Existing Land Use Alternative would be less than those of the proposed project.

5.5.3.1.4 Archaeology and Cultural Resources

Field surveys indicate the presence of a number of cultural resources on the project site. Mitigation measures are provided to reduce impacts to these resources to below a level of significance. The Build-Out of Existing Land Use Alternative would require similar mitigation measures be instituted to reduce impacts to below a level of significance. Impacts to cultural resources from the Build-Out of Existing Land Use Alternative would be similar to those resulting from the proposed project.

5.5.3.1.5 Soil

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in impacts to geology and soil that are similar to, or the same as, the proposed project. During

construction, the amount of soil disturbances could be greater, or the same as, the project. The character of on-site soils and the depth of the groundwater table make the potential for liquefiable materials to be present beneath the site. Actions required by law would reduce the risks of seismic ground-shaking hazards, and would ensure that all impacts related to seismic ground shaking would be less than significant.

5.5.3.1.6 Dust & Exhaust Emissions

Similar to the proposed project, the Build-Out of Existing Land Use Alternative would result in short-term exhaust emissions during construction activities for potential residences on the three sites. However, unlike the Build-Out of Existing Land Use Alternative, as a solar PV generating facility, its ongoing operations would offset exhaust emissions generated by fossil-fuel-based sources of energy. Conversely, the Build-Out of Existing Land Use Alternative would continue to generate operational exhaust emissions throughout the life of the proposed development from increased traffic, operation of residential and agricultural operations, with no offsets, and therefore a net gain of exhaust emissions would result. Therefore, because the Build-Out of Existing Land Use Alternative would result in a net gain of exhaust emissions impacts from this alternative would be greater as compared to the proposed project.

5.5.3.1.7 Waste Generation

The Build-Out of Existing Land Use Alternative at the project sites would continue their current agricultural practices, and expected current use of pesticides, fertilizers, and fuels for farming equipment. In comparison to the proposed project, the on-site hazards or potential use of hazardous materials would be greater.

5.5.3.1.8 Water Quality

The proposed project would only require grubbing and light grading during construction. The Build-Out of Existing Land Use Alternative would likely require changes to the landscape and drainage patterns of the portion of the project sites where development would occur (residential area). Construction of these areas could also result in the discharge of wastewater and urban runoff at the project sites.

The proposed project would reduce site pervious by less than one percent; the Build-Out of Existing Land Use Alternative would likely reduce preciousness by a much higher percentage.

Once operational, water demand associated with the proposed project would be minimal and limited to maintenance activities (i.e., panel washing) only; the required water would be less than baseline demand (current agricultural usage). Conversely, operational water demand associated with the development of residences and continued agricultural operations, as proposed under this alternative, would be significantly greater. As such, impacts to water supplies during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

In summary, the Build-Out of Existing Land Use Alternative results in similar impacts related to flooding, erosion, and siltation, but greater impacts than the proposed project to

groundwater recharge and water usage. Accordingly, impacts to hydrology and water quality from the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

5.5.3.1.9 Land Use

Unlike the proposed project, the Build-Out of Existing Land Use Alternative would not conflict with the existing general plan land use designations at the project site; therefore, this alternative would not require approval of certain discretionary requests such as a Specific Plan Amendment. However, with approval of all discretionary requests, the proposed project would also be consistent with the land use and zoning designations at the project site and would not conflict with any applicable land use plans, policies, or regulations. Similar to the proposed project, the Build-Out of Existing Land Use Alternative would not be located between housing developments or communities; therefore, this alternative would not physically divide an established community.

Because the Build-Out of Existing Land Use Alternative would not require approval of certain discretionary requests in order to maintain consistency with all applicable land use plans, there would be fewer impacts to land use and planning from the Build-Out of Existing Land Use Alternative than the proposed project.

5.5.3.1.10 Noise

If the Build-Out of Existing Land Use Alternative is implemented, short-term construction would result in slightly lower maximum noise levels to surrounding areas due to the reduced amount of structures being built at the same time and continued operation of agricultural operations when compared to the proposed project. Similar to the project, the Build-Out of Existing Land Use Alternative would result in less than significant short-term construction impacts from noise and vibration.

5.5.3.1.11 Traffic

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in short-term increases in traffic volumes on local streets as a result of construction vehicles and equipment traveling to and from the project site. However, it is likely that the Build-Out of Existing Land Use Alternative would require more equipment and a significantly longer construction period to construct the necessary infrastructure (e.g., utility lines, water quality facilities, etc.), site improvements and buildings. While the precise length of the construction period cannot be known until a site plan, infrastructure needs analysis, and an accompanying phasing plan is developed, the construction of a number of residences and continued agricultural operations would require more time than the proposed construction period of the solar project on all three sites, and also necessitate more construction workers required for the proposed project. Therefore, it is likely that the Build-Out of Existing Land Use Alternative would result in significantly greater construction-period traffic and transportation impacts.

Once operational, additional vehicle trips associated with the proposed project would be minor and limited to maintenance and monitoring activities and commute trips. Conversely, operational vehicle trips associated with the development of a number of residences and

continued agricultural operations would be greater due to the nature and intensity of the land uses. Therefore, although the exact amount of operational vehicle trips cannot be ascertained for the Build-Out of Existing Land Use Alternative at this time, it can be assumed that vehicle trips would be higher than the proposed project. As such, impacts to traffic and transportation during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

5.5.3.2 Conclusion

5.5.3.2.1 Avoid or Substantially Lessen Project Impacts

While this alternative would reduce impacts to agricultural lands, biological resources, and land use and planning the Build-Out of Existing Land Use Alternative would not avoid the significant and unavoidable impacts of the proposed project related to air quality. The Build-Out of Existing Land Use Alternative would also result in fewer impacts to land use and planning as compared to the proposed project. However, this alternative increases project impacts related to air quality, exhaust emissions, waste generation, water quality, and traffic.

5.5.3.2.2 Attainment of Project Objectives

Alternative C, the Build-Out of Existing Land Use Alternative, would not meet any of the project objectives.

5.5.3.2.3 Comparative Merits

The Build-Out of Existing Land Use Alternative would reduce impacts associated with agricultural lands, biological resources, and land use and planning when compared to the proposed project. The Build-Out of Existing Land Use Alternative would have similar impacts associated with visual amenity, cultural resources, soils, noise, when compared to the proposed project. This alternative would result in greater impacts to air quality, emissions, waste generation, water quality, and traffic than the proposed project.

5.5.4 Alternative D: No Utility Scale Solar Development Distributed Commercial and Industrial Rooftop Solar Only Alternative

This alternative would involve the development of a number of geographically distributed small to medium solar PV systems within existing developed areas, typically on the rooftops of commercial and industrial facilities situated throughout the project area.

Under this alternative, no new land would be developed or altered. However, depending on the type of solar modules installed and the type of tracking equipment used (if any), a similar or greater amount of acreage (i.e., greater than 4.5 bighas of total rooftop area) may be required to attain proposed project's capacity of 249.6 kWp of solar PV generating capacity. Because of space or capital cost constraints, many rooftop solar PV systems would be fixed-axis systems or would not include the same type of sun-tracking equipment that would be installed in a freestanding utility-scale solar PV project and, therefore, would not attain the same level of efficiency with respect to solar PV generation. This objective would enable the generation of 249.6 KWp of electricity, but it would be for on-site use only. This alternative assumes that rooftop development would occur primarily on commercial and industrial structures due to the greater availability of large, relatively flat roof areas necessary for

efficient solar installations.

This alternative would involve a number of installation locations across the area, many of which would require discretionary action, such as design review, or zone variances, depending on local jurisdictional requirements. Similar to the proposed project, this alternative would be designed to operate year-round using PV panels to convert solar energy directly to electrical power. Power generated by such distributed solar PV systems would typically be consumed on site by the commercial or industrial facility without requiring the construction of new electrical substation or transmission facilities.

Like utility-scale PV systems, the area of rooftops or other infrastructure required per kWp of electricity produced is wide ranging, which is largely due to site-specific conditions (e.g., solar insolation levels, intervening landscape or topography, PV panel technology, etc.).

5.5.4.1 Impacts Compared to Project Impacts

5.5.4.1.1 Visual Amenity

This alternative would reduce aesthetics impacts compared to the proposed project. Under this alternative, vacant land would not be developed to accommodate solar panels, but rather existing developed areas would be modified. In many cases, the installation of solar panels on large commercial and industrial rooftops would be visually unobtrusive or unnoticeable from receptors at ground level. In other circumstances, the installation of rooftop solar panels may be visible, but would not likely affect the visual character or scenic quality of an area, because the character or quality of an area has already been altered as a result of the building's construction. The exceptions may be if rooftop solar were proposed on historic buildings, which could affect the historic character and integrity of the buildings. Implementation of this alternative would require historic surveys and investigations to evaluate the eligibility of potentially historic structures that are over 50 years old, and either avoidance of such buildings, or incorporation of design measures to minimize impacts on historic integrity of historically-significant structures. This alternative would also have less than significant aesthetic impacts as the proposed project.

5.5.4.1.2 Air Quality

This alternative would reduce impacts on air quality compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified. No construction activities or ground disturbance would occur. Vehicular mobile-source emissions from commuting workers associated with installation of the equipment under this alternative would be similar to the construction worker trip emissions generated by the proposed project. However, these emissions would be spread out over a larger area, and potential impacts would be lower. During operations, this alternative would have the same beneficial impacts on air quality as the proposed project.

5.5.4.1.3 Terrestrial Ecology

This alternative would reduce impacts on biological resources compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified. As a result, there would be no potential for

disturbance of sensitive or endangered species because no construction or operational activities would occur. Potential loss of foraging habitat for burrowing owls would be avoided. Thus, this alternative would have fewer biological impacts than the proposed project.

5.5.4.1.4 Archaeology and Cultural Resources

This alternative would reduce impacts on cultural resources compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified, and there would be no potential for disturbance or damage to identified or concealed cultural resources at or near the project site. If rooftop solar were proposed on historic buildings, this alternative could affect the historic character and integrity of the buildings. Implementation of this alternative would require historic surveys and investigations to evaluate the eligibility of potentially historic structures that are over 50 years old, and either avoidance of such buildings, or incorporation of design measures to minimize impacts on historic integrity of historically-significant structures. Therefore, the potential impact on cultural resources would be less than the impact under the proposed project.

5.5.4.1.5 Soil

This alternative would reduce impacts associated with geologic conditions. Under this alternative, the project sites would remain agricultural land, and only developed areas would be modified, and there would be no potential for disturbance to undeveloped land. Under this alternative, the number of sun-tracking structures built would be reduced and rooftop solar would be developed, and no potential impacts would occur. Impacts to geology and soils under this alternative would be slightly less as compared to the proposed project.

5.5.4.1.6 Dust & Exhaust Emissions

This alternative would reduce construction-period exhaust emissions compared to the proposed project. This alternative would involve construction activities, but would be at a much smaller scale than the proposed project. Much fewer heavy equipment operation and large truck deliveries would be required to implement this alternative, and construction emissions that contribute to emissions would be reduced. Trips by commuting workers to install rooftop equipment would be spread out over a larger area when compared with construction worker trip emissions of the proposed project, and potential impacts would be lower. During project operations, the potential offsets or displacement of emissions, compared with traditional gas- or coal-fired power plants, would be realized to the same degree as they would under the proposed project because of reduced renewable power generating potential. Thus, exhaust emissions from this alternative would be less than those of the proposed project during construction, and emissions reductions would be similar to those of the proposed project during operations.

5.5.4.1.7 Waste Generation

Although Alternative D would result in the development of fewer PV panels as compared to the proposed project, this alternative would still result in hazardous waste generated during the construction period and would consist of liquid waste, including cleaning fluids, dust

palliative, herbicides, and solvents. Alternative D would have reduced ground disturbing construction activities, therefore, this alternative would reduce impacts related to these hazardous materials.

5.5.4.1.8 Water Quality

This alternative would reduce impacts on water quality compared to the proposed project. Under this alternative, no construction would occur and drainage patterns on the project site would not be altered. However, water use with a continuation of the current agricultural land uses on the project site would be significantly higher than those that would exist with implementation of the proposed project. Overall, there are unique environmental benefits related to water quality present with implementation of either the proposed project or this alternative, and the impacts of the two proposals are therefore judged to be similar.

5.5.4.1.9 Land Use

Installation of rooftop solar would be consistent with current zoning as well as existing land use plans, policies, and regulations. This alternative would also achieve the goals and policies relative to accommodating renewable energy facilities. As there would be no large-scale solar field, no decommissioning plan would need to be prepared as a mitigation measure. However, the placement of solar panels on other structures throughout the region would result in unknown entitlement requirements, depending on the project location, zoning, land use, and potential environmental impacts on the site and surrounding areas. Impacts to land use and planning related to this alternative are therefore assumed to be similar to those of the proposed project.

5.5.4.1.10 Noise

Because more solar panels may be required, there may be an increase in the transportation related noise near sensitive receptors. Therefore, impacts from noise generating activities would be greater than the proposed project.

5.5.4.1.11 Traffic

This alternative would require a similar number of vehicular trips to transport and install the solar panels. However, the trips would be more dispersed and would not congregate in one location, thereby reducing impacts on surrounding roadways. This alternative would have nominal effects on transportation and traffic, and impacts would be reduced compared to the proposed project.

5.5.4.2 Conclusion

5.5.4.2.1 Avoid or Substantially Lessen Project Impacts

This alternative would result in fewer impacts to ecological resources, archaeological and cultural resources, soils, and traffic. Similar impacts compared to the proposed project would result from this alternative in the areas of air quality, exhaust emissions, water quality, and land use. Therefore, for most environmental issue areas, this alternative would result in fewer environmental impacts, both short-term and long-term, when compared to the proposed project.

5.5.4.2.2 Attainment of Project Objectives

Alternative D, the No Utility-Scale Solar Development Alternative, would not meet the following project objectives:

- Locate solar power plant facilities as near as possible to electrical transmission facilities with anticipated capacity and reserved queue position.
- Ensure that the project can be constructed, and power provided at a competitive price.

5.5.4.2.3 Comparative Merits

The No Utility-Scale Solar Development Alternative would reduce impacts associated with ecological resources, archaeological and cultural resources, soils, and traffic when compared to the proposed project. Impacts related to air quality, exhaust emissions, water quality, and land use would be similar to those of the proposed project.

Additionally, this alternative would achieve most of the project objectives, such as assisting in achieving the State's RPS and GHG reduction objectives, siting panels on disturbed areas and using a proven and available solar PV technology. This alternative however includes a number of drawbacks, including, but not limited to the following:

- There would be difficulties with respect to build out of the system within a timeframe that would be similar to that of the proposed project.
- Given the distributed nature of such a network of facilities, management and maintenance would not be as efficient, and total capital costs would likely be higher.
- The requirement to negotiate with a large number of individual property owners to permit placement of solar panels on rooftops.
- The difficulty of ensuring proper maintenance of a large number of smaller solar installations.
- The lack of an effective electricity distribution system for large numbers of small electricity producers.

Given the size of the proposed project, the project objectives, the need to arrange a suitable assemblage of participating commercial and industrial properties and the challenges stated above, it is impractical and infeasible to propose a distributed generation project of this type and still proceed within a reasonably similar timeframe.

5.5.5 Comparison of Alternatives

Table 5.2: Comparison of Alternatives

Environmental Resource	Alternative A: No Project	Alternative B: Reduced Project	Alternative C: Build Out of Existing Land Use	Alternative D: No Utility Scale Solar Development
Visual Amenity	Fewer	Fewer	Similar	Similar
Air Quality	Fewer	Fewer	Fewer	Fewer
Ecological	Greater	Fewer	Greater	Similar

Environmental Resource	Alternative A: No Project	Alternative B: Reduced Project	Alternative C: Build Out of Existing Land Use	Alternative D: No Utility Scale Solar Development
Resources				
Archaeological and Cultural Resources	Fewer	Fewer	Fewer	Fewer
Soils	Fewer	Fewer	Similar	Fewer
Dust & Exhaust Emissions	Similar	Similar	Similar	Fewer
Waste Generation	Similar	Similar	Greater	Fewer
Water Quality	Fewer	Similar	Greater	Similar
Land Use	Fewer	Similar	Fewer	Similar
Noise	Fewer	Fewer	Similar	Greater
Traffic	Fewer	Fewer	Greater	Fewer
Meet Project Objectives?	NO	YES	NO	NO
Reduce Significant and Unavoidable Impacts?	YES	YES	NO	YES

5.5.6 Environmentally Superior Alternative

As presented in the comparative analysis above, and as shown in Table 5.2, the Environmentally Superior Alternative for the proposed project would be Alternative A, or the No Project alternative. This alternative would avoid all significant and unavoidable impacts that would occur under the proposed project. No substantially adverse and long-term impacts would occur to the environment as a result of this alternative. This alternative would also result in fewer impacts to visual amenity, agricultural and forest resources, biological resources, cultural resources, hydrology and water quality, land use, noise, and traffic as compared to the proposed project, but the failure to construct a renewable energy production facility results in increased impacts in the long-term to air quality and exhaust emissions.

Alternative D, or the No Utility-Scale Solar Development—Distributed Commercial and Industrial Rooftop Solar Only, similarly avoids significant impacts to agriculture resources, biological resources, cultural resources, public services and traffic and transportation.

Alternative B like the No Project Alternative, reducing the scale of the project increases long-term impacts to air quality and emissions. Alternative C would include the build-out of existing land use designations in the project area, resulting the preservation of agricultural areas and no impacts in the land use and planning categories. However, increased development in the area, without the inclusion of a renewable energy generation facility, would significantly increase impacts in several other environmental issue areas, including air quality, emissions, waste generation, water quality, and traffic.

6 DESCRIPTION OF THE BASELINE PHYSICAL ENVIRONMENT

6.1 General

The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, land and socio-economic, etc. The primary objective of identifying and describing existing environmental conditions is to provide an understanding of the baseline conditions prior to undertaking any development activities.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. Firsthand information have been collected to record the micro-environmental features within and adjacent to the project area. Collection of primary information includes extrapolating environmental features on proposed project design, tree inventories, location and measurement of socio-cultural features adjoining proposed project area. Ambient air, noise, and water quality samples were collected in terms of environment quality to prepare a baseline database. Consultation was another source of information to explain local environmental conditions, impacts, and suggestions, etc.

The following section describes the baseline environment into three broad categories:

- **Physical Environment-** factors such geology, climate and hydrology;
- **Biological Environment-** factors related to life such as flora, fauna and ecosystem; and
- **Socio-economic Environment-** anthropological factors like demography, income, land use and infrastructure.

6.2 Physical Environment

Physical environment denotes the physical features that occur naturally (air, water, soil, atmosphere, etc.). In order to depict the existing physical environment in the project area, a few of the major parameters are considered like geology & soil, ambient air, noise, surface & ground water, etc.

6.2.1 Climate

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification, the project area is located in the North-western region climatic zone (Figure 6.1).

Western zone: This is the driest area in Bangladesh with lower rainfall and summer humidity less than 50%. In summer, it is the hottest and driest of all climatic zones. Mean summer maximum temperature is over 35°C (Banglapedia, 2014). The area has a tropical wet and dry climate. The climate of this region is generally marked with monsoons, high temperature, considerable humidity and moderate rainfall. The hot season commences

early in March and continues till the middle of July. The maximum mean temperature observed is about during the months of April, May, June and July and the minimum temperature recorded in January is about 7 to 16 °C (45 to 61 °F). The highest rainfall is observed during the months of monsoon. The annual rainfall in the district is about 1,448 millimetres (57.0 in).

Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon and it has these three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

The pre-monsoon hot season is characterized by high temperatures and thunderstorms. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, at this time can account for 10 to 25 percent of the annual total.

The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September.

The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meager rainfall. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.

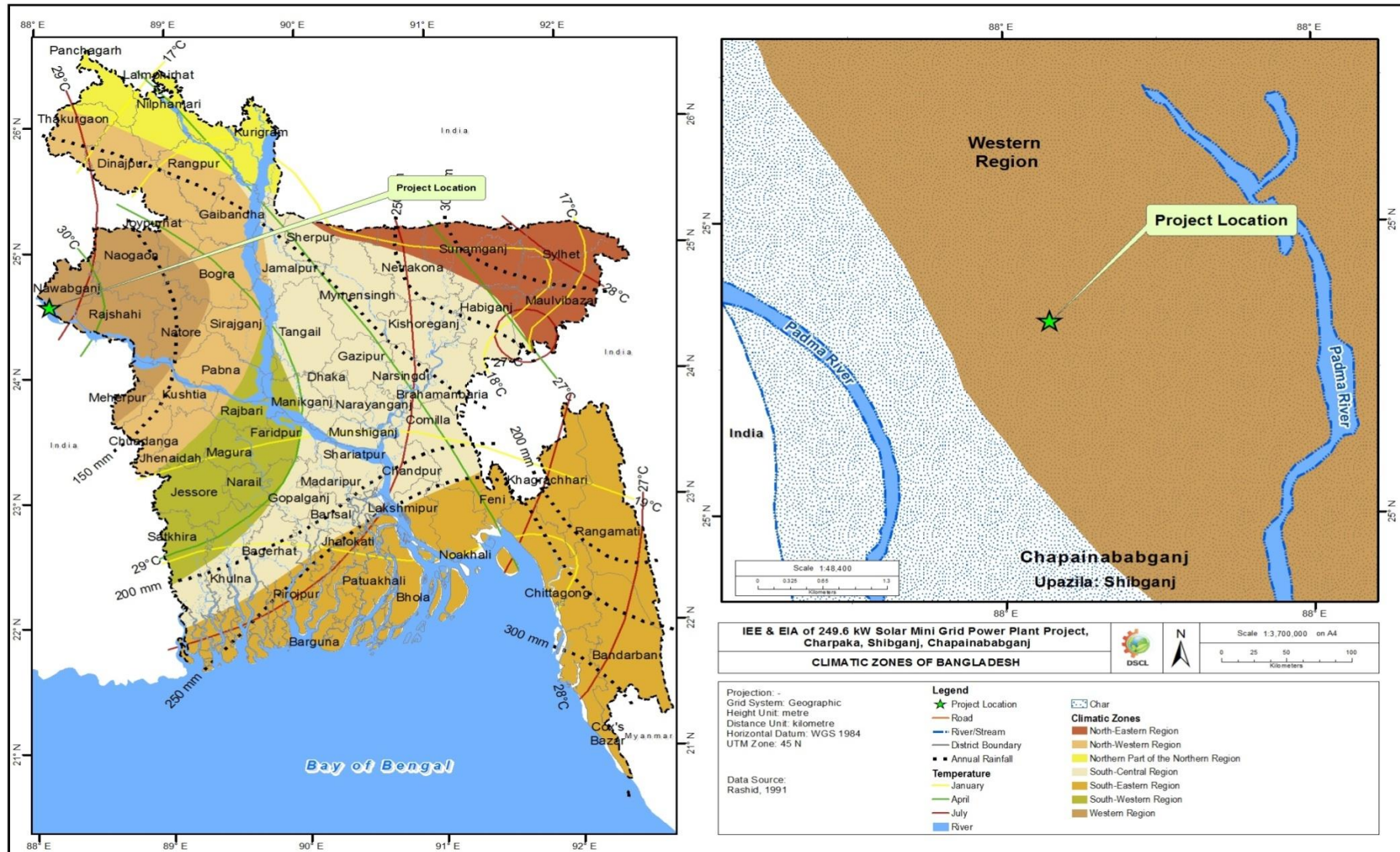


Figure 6.1: Climatic Zones of Bangladesh

Temperature

Long-term average monthly temperature data (1990-2013) collected at Rajshahi weather station of Bangladesh Meteorological Department. The highest average recorded temperature in this weather station was 35.9°C in April. The lowest average recorded temperature was found in the month of January which was 10.3°C. The average monthly temperature graph shows that this area faces high temperature from March to September and lowest temperature during winter remains from December to February in the year.

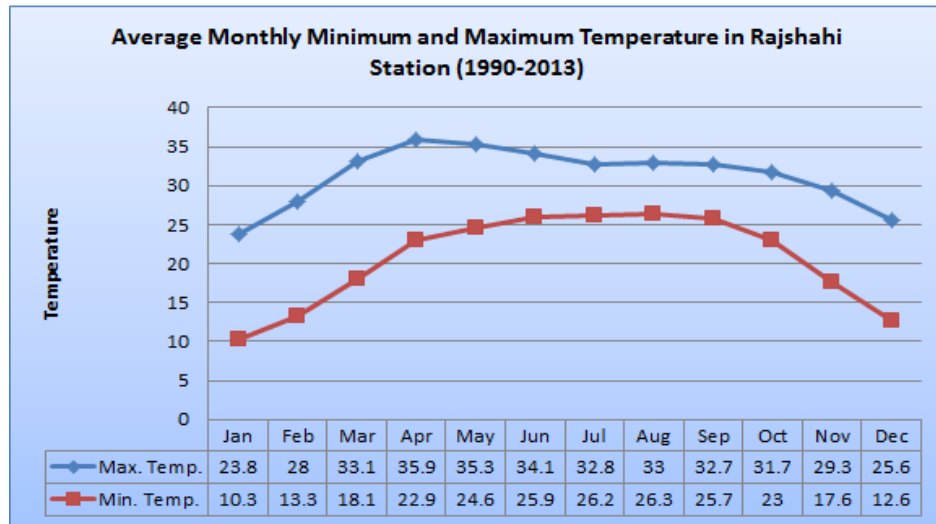


Figure 6.2: Average Monthly Maximum and Minimum Temperature

Rainfall

The rainfall data collected from the above stated station represents that maximum rainfall occurs during April to October and the lowest rainfall occurs in November to February during winter season. Statistical data of 1990 to 2013 shows that Rajshahi stations experience maximum rainfall 7206 mm during monsoon in July. In the month of December the rainfall becomes 161mm.

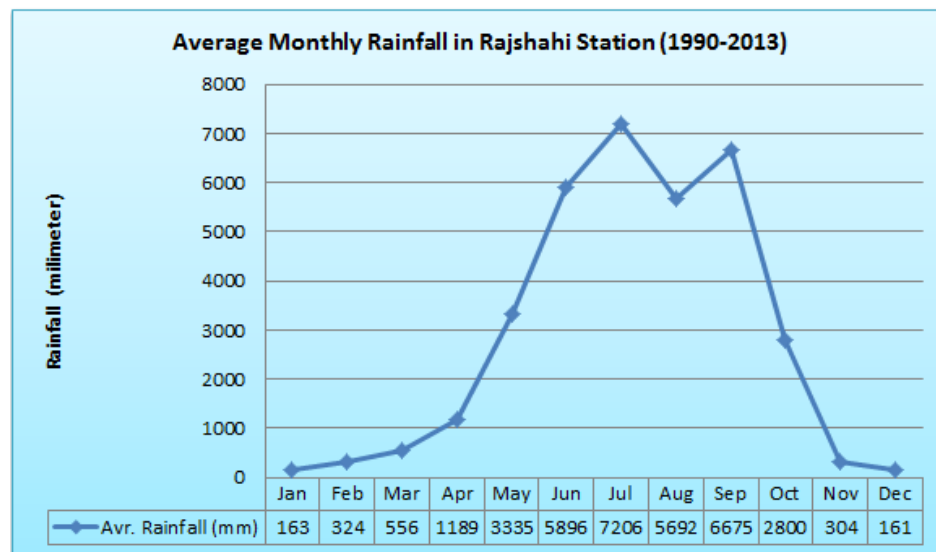


Figure 6.3: Average Monthly Total Rainfall

Humidity

Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1990 to 2013 indicates that humidity in the above stated areas maximized in June to October in the year which is ranges from 83% to 87%. On the other hand, humidity falls 65% in March during the winter season in the Rajshahi station area (Figure 6.4).

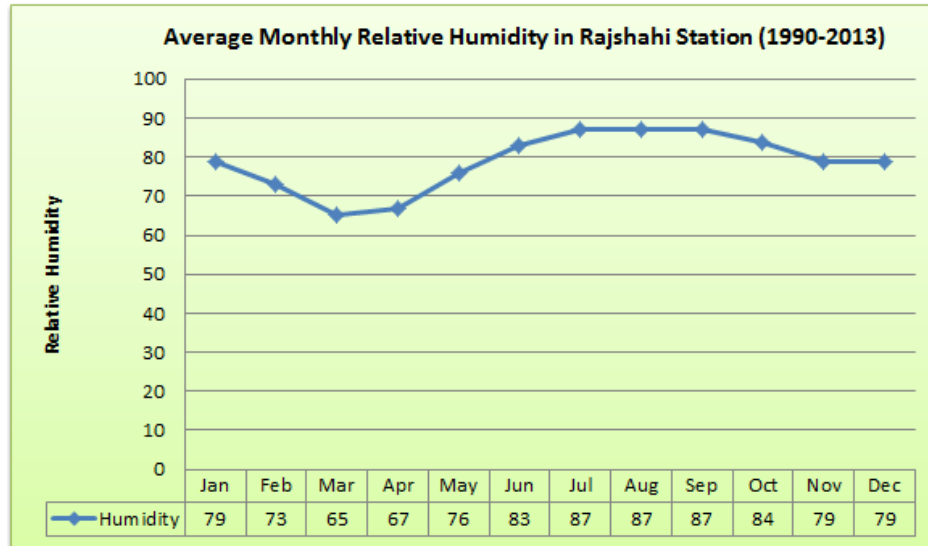


Figure 6.4: Average Monthly Relative Humidity

Wind Speed

The statistical wind speed data from 1990 to 2013 (Figure 6.5) shows that average wind speed remained maximum with 1.7 m/s knots in May. The minimum wind speed was 0.8m/s in the month of November in the area of Rajshahi weather station.

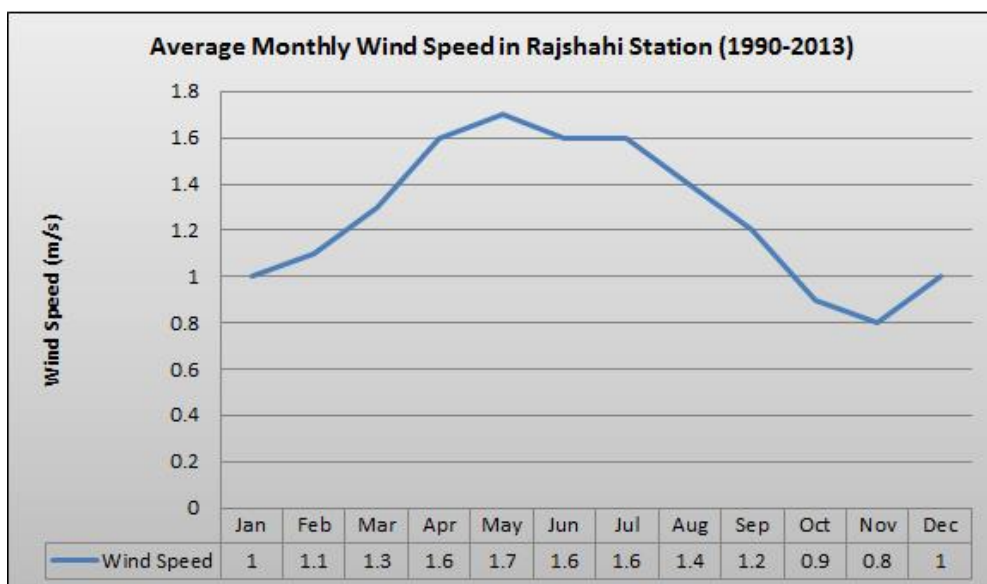


Figure 6.5: Average Monthly Maximum Wind Speed

Sunshine

The statistical sunshine data from 1990 to 2013 (Figure 6.6) shows that average sunshine remained maximum with 8.3 hours in the month of March. The minimum sunshine was 4.5 hours in the month of July in the area of Rajshahi weather station.

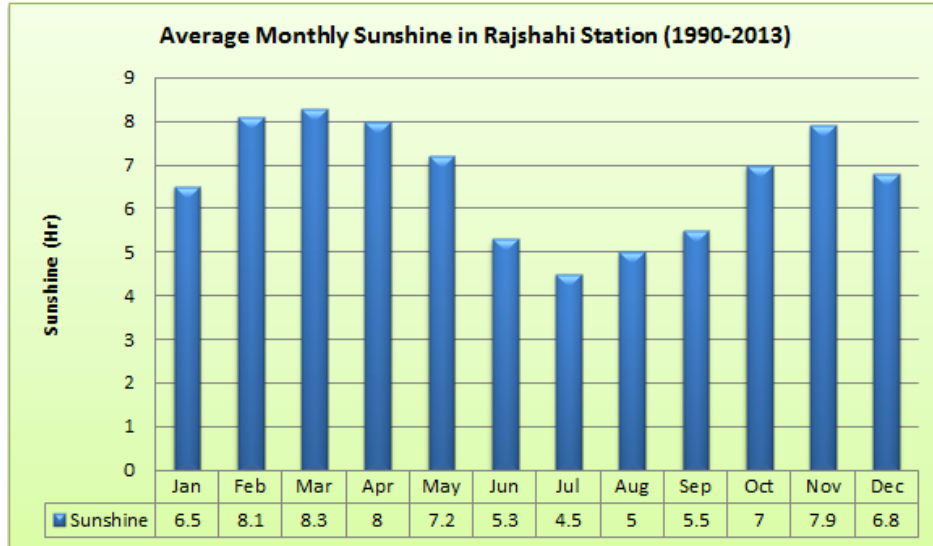


Figure 6.6: Average Monthly Maximum Sunshine

Cloud Coverage

The statistical cloud coverage data from 1990 to 2013 (Figure 6.7) shows that average cloud coverage remained maximum from 4 Octas to 6.1 Octas during May to September. The minimum cloud coverage was 1 Octas in the month of December in the area of Rajshahi weather station.

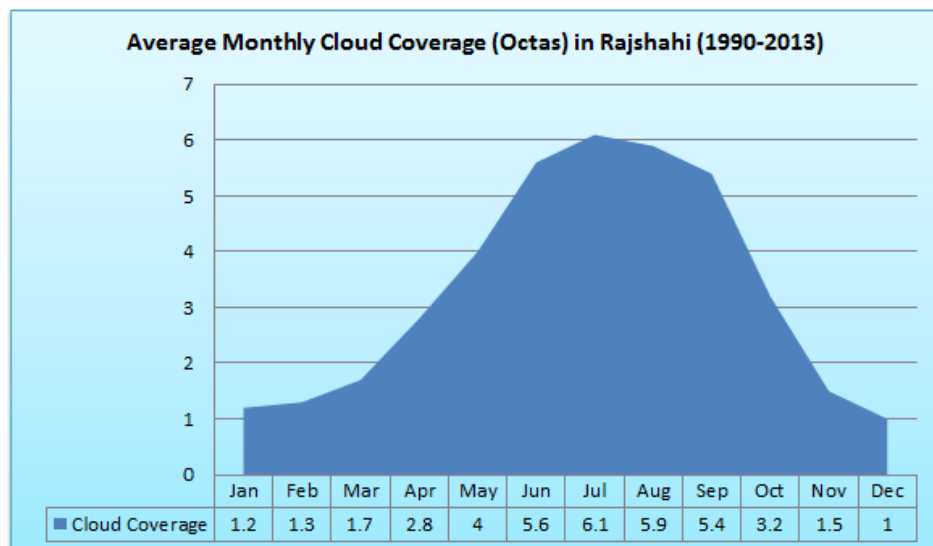


Figure 6.7: Average Monthly Cloud Coverage

6.2.2 Climate Change and Natural Disaster

Building large solar power plants requires significant long-term investment so understanding impacts from climate change will aid financial planning, technology selection, and energy output projections. Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are considered to be particularly susceptible to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events. Given this limited capacity to adapt, they are considered to be particularly vulnerable to damages associated with climate, just as they are particularly vulnerable to other stresses.

Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. Climate Change is basically the change in climate over a time period that ranges from decades to centuries. It is a normal part of the Earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. However, the term "climate change" is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (IPCC, 2007). The risks associated with these changes are real but highly uncertain. Societal vulnerability to the risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for those parts of societies in developing countries dependent on resources that are sensitive to changes in climate.

Bangladesh is recognized worldwide as one of the most vulnerable countries to the impacts of climate change. This is due to dominance of floodplains, low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources and services. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains. The people and social system have knowledge and experience of coping with the effects of such events—to some degree and extent. Historically, Bangladesh is trying to adapt with the changing environment. The Intergovernmental Panel on Climate Change (IPCC) has identified the country as one of the most vulnerable countries to climate change, which may severely affect lives and livelihoods of millions of Bangladeshi people in coming decades. In this regard, Bangladesh has already prepared the National Adaptation Programme on Action (NAPA) and Climate Change Strategy and Action Plan (MoEF, 2005 and MoEF, 2009).

According to the fourth assessment, report of IPCC, continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century, which would very likely be more severe than those observed during the 20th century would.

Photovoltaic (PV) electricity generation depends on solar irradiance, named surface-down welling shortwave (that is, wavelength interval 0.2–4.0 μm) radiation (RSDS) by climate models, and other atmospheric variables affecting panel efficiency, namely surface air temperature (TAS) and surface wind velocity (VWS). Climate change may therefore affect PV power generation and its temporal stability for a given panel fleet.

6.2.3 Ambient Air Quality

Ambient air quality refers to the background air quality levels in a region, characterized by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their concentrations depends on the type of polluting sources, and other factors that influence their flow and dispersion. In most cases vehicular emissions are the predominant source of air pollution.



Figure 6.8: Air Quality Monitoring at Project Site

Ambient air quality measurements are essential to provide a description of the existing conditions or the baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed Solar Mini-grid Power Plant air quality. Air quality test has been conducted on 10th April 2017 at the proposed project site and the test was analyzed by DSCL Environmental Laboratory. The test results (see Appendix A) is given in the below Table 6.1. According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005; any of the measures parameter of the local ambient air does not exceed Bangladesh standard.

Table 6.1: Test Results of Ambient Air Quality Analysis

Parameter	Unit	Project Site	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
PM _{2.5}	$\mu\text{g}/\text{m}^3$	30.29	65	25	24	Sunny	Gravimetric
PM ₁₀	$\mu\text{g}/\text{m}^3$	85.77	150	50	24		Gravimetric
SPM	$\mu\text{g}/\text{m}^3$	109.23	200	NF	24		Gravimetric

Parameter	Unit	Project Site	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
SO ₂	µg/m ³	7.85	365	20	24		West- Geake
NO _x	µg/m ³	10.63	100	40	24		Jacob and Hochheiser
CO*	mg/m ³	<1	10	10	8		CO Meter

* Onsite Test Using Field Test Kit Source: Lab Analysis by DSCL Environmental Laboratory

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-Lam/2005.

***WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.

Project Site GPS Coordination: Latitude - 24.63840°N, Longitude - 89.74391°E

Abbreviation: PM_{2.5} - Fine Particulate Matter, PM₁₀ - Respirable Dust Content, SPM - Suspended Particulate Matter, SO₂ - Sulphur Di-oxide, NO_x - Oxides of Nitrogen, CO - Carbon Monoxide, µg/m³ - microgram/cubic meter, ppm - parts per million.

6.2.4 Noise Level

Excessive noise is a potential issue for both human and biological receivers and can potentially cause a range of negative issues, from mild annoyance and moderately elevated levels of aggression to significant disturbance of behavioral patterns and in severe cases temporary or permanent hearing loss. According to World Health Organization's Guidelines for Community Noise (1999), daily sound pressure levels of 50 decibels (dB) or above can create discomfort amongst humans, while ongoing exposure to sound pressure levels over 85 dB is usually considered the critical level for temporary hearing damage.

The noise level of the surroundings of the project area is insignificant. The proposed site is presently using for agriculture and the anthropogenic disturbance is less. However, there is negligible sound pollution from the traffic movement on the nearby road. Noise level has been monitored at inside and outside of the project location (Appendix B) during day time (Figure 6.9). Results of the noise level monitored along with details of the sampling locations have been showed in Table 6.2. The results show that time weighted average value of the sound monitored at inside and outside of the project area did not exceed the standard fixed for the respective areas except NM-01 & NM-06.



Figure 6.9: Noise Level Monitoring in the Project Area

Table 6.2: Noise Level at Different Locations of Project Area

ID	Location	Zone	GPS Location	Noise Level dB(A) at Day Time	Bangladesh Standard at Day Time dB (A)**	Remarks
NM-01	Project Site	Residential	24.57311°N, 88.09890°E	55.01	55	High
NM-02	Char Bishroshia Kalupur Primary School	Residential	24.57611°N, 88.09739°E	44.32	55	Low
NM-03	Jauniapara, Narayanpur	Residential	24.57238°N, 88.09984°E	51.58	55	Low
NM-04	Narayanpur Adarsha College	Residential	24.57352°N, 88.10818°E	52.62	55	Low
NM-05	Kalupur, Narayanpur	Residential	24.57406°N, 88.09286°E	46.01	55	Low
NM-06	Bishroshia Char pakajame Mosque	Residential	24.58686°N, 88.09047°E	59.74	55	High

Notes:

- Land use category is based on the classification provided in the Noise Pollution Control Rules (2006)
- Shaded cells indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area
- The sound level standards for residential area are 45 dBA , for silent area 50 dBA and for commercial area 70 dBA at day time
- The sound level standards for silent area are 35 dBA, for residential area 40 dBA and for commercial area 60 dBA at night time

Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

6.2.5 Physiography

In the context of physiography, Bangladesh can be divided into three broad categories based on topography, physical features, and geological history (Brammer, 1996):

1. Floodplains
2. Terraces
3. Hills

Within these 3 broad categories, a number of authors have further divided the land surface into a series of Physiographic Units based on a combination of topographical/landscape features, underlying geology and surface soils (Brammer, 1996, Rashid, 1991, Morgan and McIntyre, 1959). The most recent study was undertaken by the Soil Resource Development Institute (SRDI) who further refined the previous classifications into 26 Physiographic Units (20 primary units and 6 sub-units) based on an assessment of more recent and detailed data (SRDI, 1997).

The project lies depends on the Padma River for freshwater supply. The project area falls in the Ganges River Floodplain physiographic unit (Figure 6.10).

Ganges River floodplain: It comprises the active floodplain of the Ganges and the adjoining meander floodplain. The latter mainly comprises a smooth landscape of ridges, basins and old channels. The relief is locally irregular alongside the present and former river courses, especially in the west, comprising a rapidly alternating series of linear low ridges and depressions. The Ganges channel is constantly shifting within its active floodplain, eroding and depositing large areas of new char land each flood season, but it is less braided than that of the Brahmaputra-Jamuna. Ganges alluvium is calcareous when deposited, but most basin clays and some older ridge soils have been decalcified and acidified in their upper layers; lime is found only in the subsoil or substratum of such soils. Clay soils predominate in basins and on the middle parts of most ridges, with loamy soils (and occasionally sands) occurring mainly on ridge crests.

Seasonal flooding is mainly shallow in the west and north, with the highest ridge crests remaining above normal flood levels, but flood depths increase towards the east and the south. Flooding is mainly by accumulated rainwater and the raised groundwater table, except on the active Ganges floodplain and close to distributary channels which cross the meander floodplain. In time of small-scale mapping, Mahananda floodplain in the northwest and some detached areas of the Old Meghna estuarine floodplain in the southeast used to be included within this unit. The Mahananda floodplain comprises all irregular landscapes of mixed Tista and Ganges sediments. The cut-off parts of the Meghna floodplain have a smooth relief and predominantly silty soils, which are deeply flooded (by rainwater) in the monsoon season. The unit covers most of the districts of Rajshahi, Natore, Pabna, entire Kushtia, Rajbari, Faridpur, Meherpur, Chuadanga, Jhenaidaha, Magura, parts of Manikganj, Narayanganj, Munshiganj, Shariatpur, Madaripur, Barisal, Gopalganj, Narail, Khulna, Bagerhat, Satkhira, and most of Jessore. This physiographic unit is almost triangular in shape and bounded by the Ganges tidal floodplain on the south. On its southern end it traps the Gopalganj-Khulna Beels (Banglapedia, 2015).

6.2.6 Topography

Topography is the configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers.

The project area is plain land with many small ponds and water reservoirs, bounded by the Rivers. But, recently, the geography has changed due to the erosion by the river Padma. Overload of river sediment caused by farrakka barrage eroded the river banks and created a large area of land full of sand which almost looks like a small desert in this area (Banglapedia, 2015). The topography of the specific project location is 6.97-10.84 m a.m.s.l (Figure: 6.11).

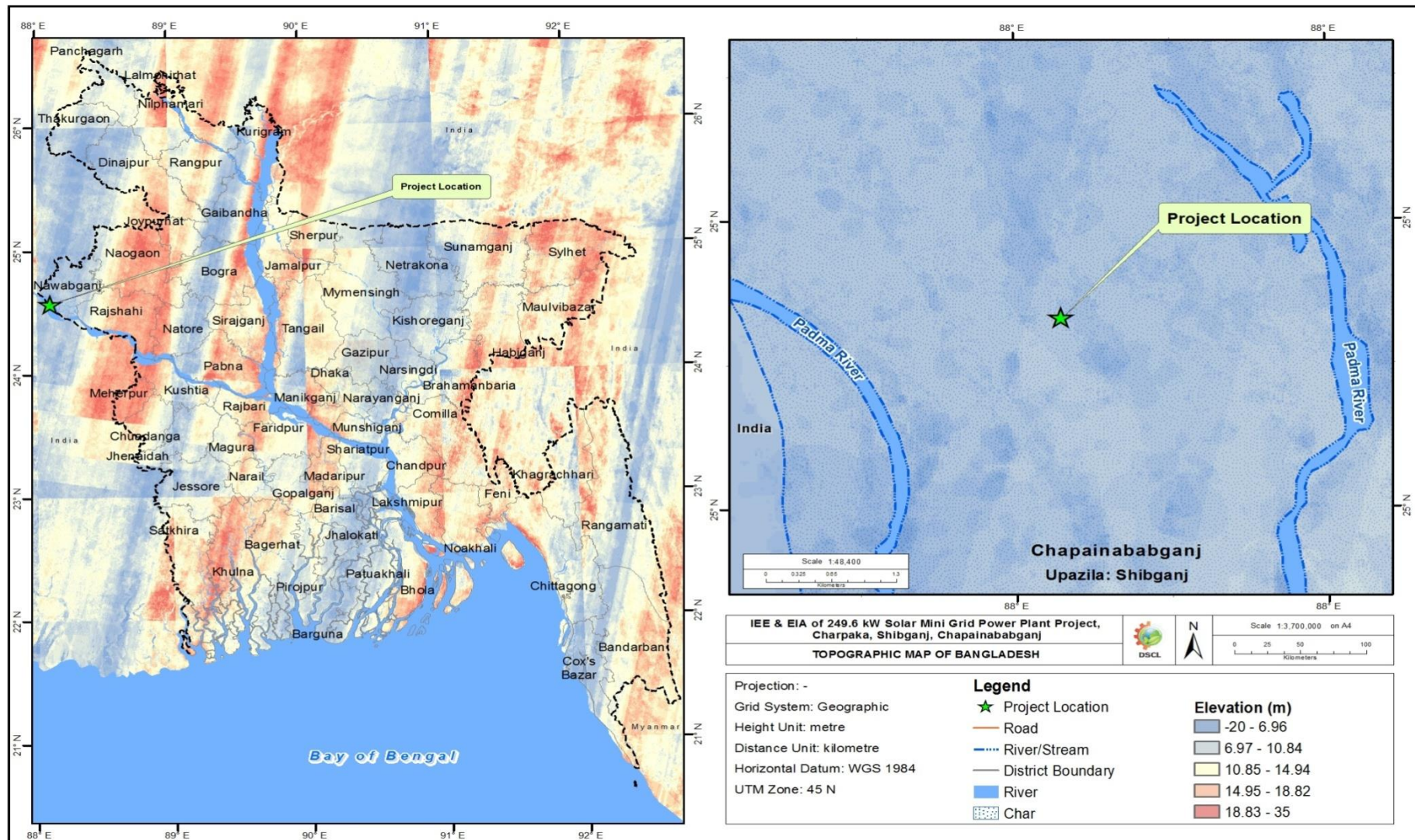


Figure 6.11: Topographic Elevation of the Project Area

6.2.7 Geology

Bangladesh is situated to the east of the Indian sub-continental plate. Nearly 85% of Bangladesh is underlain by deltaic and alluvial deposits of the Ganges, Brahmaputra, and Meghna river systems. Bangladesh is divided into two major tectonic units: (i) Stable Precambrian Platform in the northwest, and (ii) Geosynclinal basin in the southeast. A third unit, a narrow northeast-southwest trending zone called the Hinge Zone separates the above two units almost through the middle of the country. The geosynclinal basin in the southeast is characterised by the huge thickness (maximum of about 20 km near the basin centre) of clastic sedimentary rocks, mostly sandstone and shale of Tertiary age. It occupies areas of greater dhaka, faridpur, noakhali, sylhet, comilla and chittagong and the Bay of Bengal. The huge thickness of sediments in the basin is a result of tectonic mobility or instability of the areas causing rapid subsidence and sedimentation in a relatively short span of geologic time. The geosynclinal basin is subdivided into two parts, ie fold belt in the east and a foredeep to the west.

Bengal Foredeep occupies the vast area between Hinge Line and ArakanYoma Folded System and plays the most important role in the tectonic history of Bengal Basin. Tectonically, Bengal Foredeep can be divided into two major regions- (a) Western Platform Flank and (b) Eastern Folded Flank. The Western Platform flank is further subdivided into (a) Faridpur Trough (b) Barisal-Chandpur High (c) Hatiya Trough (d) Madhupur High and (e) Sylhet Trough. The project area is situated in the Bogra Shelf.

Rangpur Saddle Rangpur Saddle represents Indian Platform and connects the Indian Shield with the shillong massif and the Mikir Hills. Shillong Massif is a large thrust block of the Indian Shield. In Rangpur Saddle the basement is the most uplifted and is covered with thin sedimentary deposits. In Madhyapara area of dinajpur the basement is only 130m deep from the ground surface and is overlain by Dupi Tila Sandstone and Madhupur Clay of Plio-Pleistocene age. Rangpur Saddle can be divided into 3 parts- Rangpur Saddle, Northern Slope of Rangpur Saddle and Southern Slope of Rangpur Saddle. It is evident from seismic data acquired out by OGDC (Oil and Gas Development Corporation) during 63-64 in Rangpur-Dinajpur districts that both the northern and the southern slopes of Rangpur Saddle are quite gentle. The basement plunges gently from Madhyapara towards the southeast upto the Hinge Zone, which is known as the Southern Slope of Rangpur Saddle. The tentative boundary of the Rangpur Saddle with the northern and the southern slopes has been marked at approximately 700m contour line on the basement. It separates the Bengal Foredeep and the Himalayan Foredeep. The Northern Slope of Rangpur Saddle also known as Dinajpur Slope, occupies the north western part of Rangpur-Dinajpur districts and gently slopes towards the Sub-Himalayan Foredeep with dips 3-4' which sharply increases in Tetulia area. The only well drilled in 1988 located on the north-western most tip of Bangladesh at salbanhat by Shell for oil and gas exploration to probe a carbonate reef ended in basement with depth 2518m penetrating the Mio-Pliocene sequence without encountering Eocene Limestone. The nature of junction between the Dinajpur Slope and the Sub-Himalayan Foredeep is not clear. (Banglapedia, 2015). The generalized geological feature of the project area is shown in the geological map of Bangladesh (Figures 6.12).

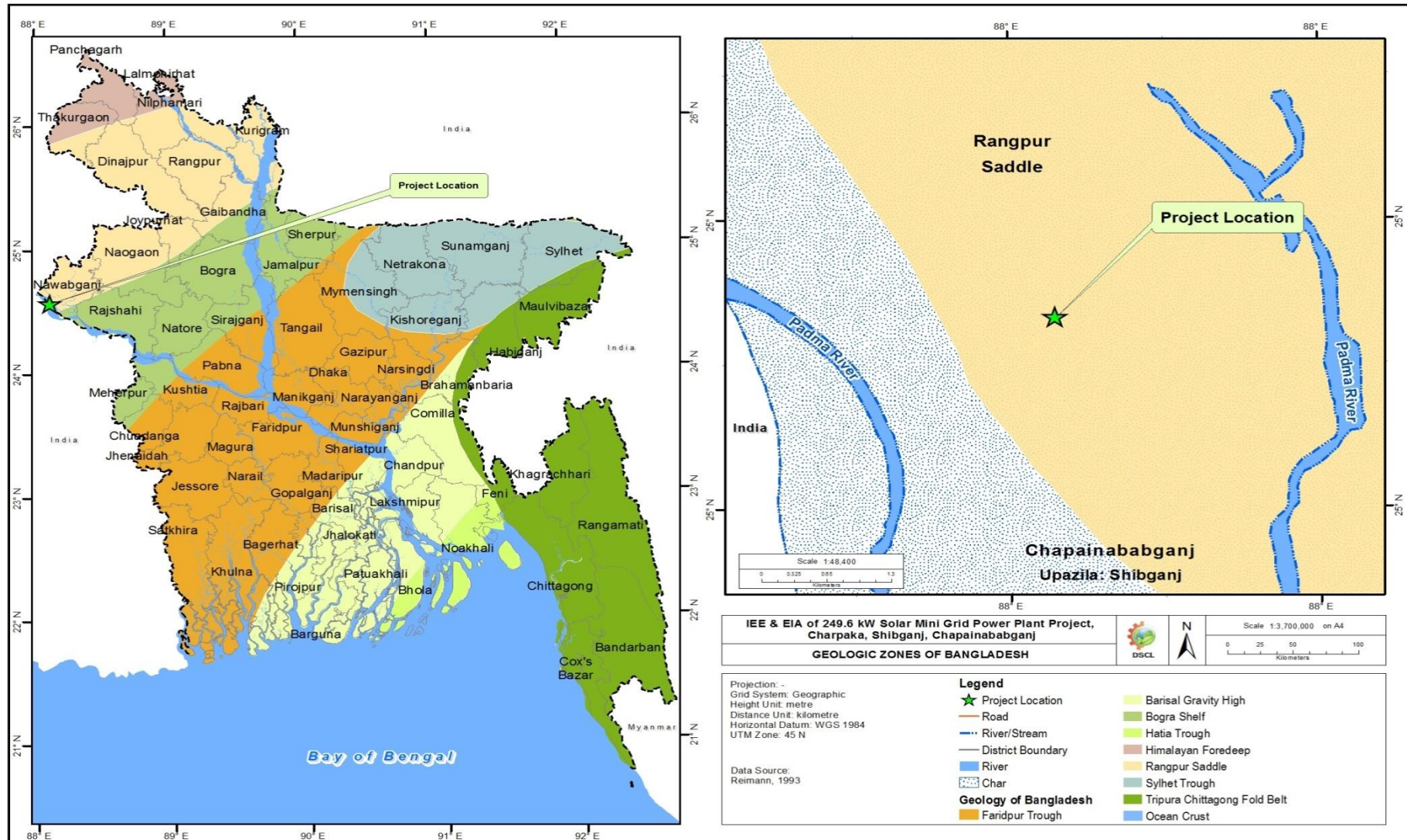


Figure 6.12: Geology of Bangladesh

6.2.8 Water Resources

The sources of water in Bangladesh are surface water, groundwater and rainwater. The Ganges-Brahmaputra-Meghna river system discharges huge amount of surface water through Bangladesh, a part enters into ground to form groundwater. About 93% of the stream flow passing through the country originates from outside the Bangladesh (Khan, 1993). Rainfall within country contributes to the total water available in Bangladesh, a part of which infiltrates into ground to recharge existing groundwater and the remaining rainwater flows as surface run-off. These sources of water available for the development of water supplies have their relative advantages and disadvantages in Bangladesh context.



Figure 6.13: Water Bodies in the Project Area

6.2.8.1 Surface Water

Surface water is abundant in the wet season in Bangladesh. An estimated 795,000 million cubic meter (Mm^3) of surface water is discharged through the Ganges-Brahmaputra system, in the downstream of the confluence of the Ganges and the Brahmaputra. This is equivalent to 5.52 m deep water over a land area of $144,000 \text{ km}^2$. There are other rivers discharging surface water into the Bay of Bengal. An average annual rainfall of 2.40 m within the country partly replenishes surface water sources. Each year about one-third of Bangladesh is submerged in a normal flood, and the area submerged may increase to about two-thirds during severe floods. In the dry season water scarcity persists in many areas. In this period surface water is only available in part of the 22,155 km of major rivers, $1,922 \text{ km}^2$ major standing water bodies and about $1,475 \text{ km}^2$ of ponds in the country. Surface water irrigation systems in the country compete for this available water in the dry season. The perennial water bodies are decreasing with the use of more and more surface water.

Traditionally, before and during the early stages of tubewells installation, rural water supply was largely based on protected ponds. There are about 1,288,222 ponds in Bangladesh having an area of 0.114 ha per pond and 21.5 pond per mauza (BBS, 1997). About 17% of these ponds are derelict and probably dry up in the dry season. The biological quality of water in these ponds is extremely poor due to unhygienic sanitary practices and absence of any sanitary protection. Many of these ponds are chemically and bio-chemically contaminated for

fish culture. If one pond per mauza could be protected from contamination, it would provide a source of drinking water with minimal treatment and water for other domestic uses without treatment. The Government of Bangladesh has greatly emphasized the development of protected pond-based water supply systems. The protected ponds should not receive any surface discharge and should only be replenished by rain and groundwater infiltration.

The project area is surrounded by the mighty river Padma. There are also significant numbers of natural water bodies around the project location. Most of the water bodies become dry during dry period or contain minimum amount of water and full of water in rainy season. People use the water from the river and ponds for washing, bathing and irrigation purposes. In the wet season, substantial amount of the land in the area is inundated due to flood.

The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically water quality improves during the monsoon due to the influx of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases.

On 10th April 2017, surface water sample was collected by environmental team from a beel near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (Appendix C & Appendix D) of the surface water sample and the GoB standards for fishing water (ECR, 1997) are shown in Table 6.3. The concentration levels of all the parameters for surface water were within the acceptable limit set by the DoE, GoB, according to the best practiced based classification except for Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD).



Figure 6.14: Surface Water Sampling from the Project Location

Table 6.3: Results for Surface Water Field Sample

Water Quality Parameters	Unit	Concentration Present	Bangladesh Standard	Method of Analysis
pH*	---	8.5	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	18	-	TDS Meter
Dissolved Oxygen (DO)	mg/l	6.41	6.0	Multimeter
Chemical Oxygen Demand (COD)	mg/l	8	4.0	CRM
Biochemical Oxygen Demand (BOD)	mg/l	3	0.2	5 Days Incubation

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

6.2.8.2 Ground Water

Groundwater is the most important source of water supply in Bangladesh. Except for few hilly regions Bangladesh is entirely underlain by water-bearing aquifers at depths varying from zero to 20 m below ground surface. The soil is mostly stratified and formed by alluvial deposits of sand and silt, having occasional lenses of clay. The main constituent of the aquifer materials is the medium-grained sand deposited at the lower reach by the mighty rivers - the Ganges, the Brahmaputra and the Meghna with their tributaries. Groundwater can be easily abstracted by installation of wells for the development of water supply systems. The water abstracted for various purposes is replenished in the monsoon.

Physically groundwater is generally clear, colorless with little or no suspended solids and has a relatively constant temperature. Groundwater is also free from disease-producing micro-organisms which are normally present in large numbers in surface waters. The slow filtering action of fine-grained soil through which the surface water percolates to join the groundwater removes almost all suspended impurities. Moreover, the lack of oxygen and nutrients in groundwater makes it an unfavorable environment for disease-producing micro-organisms to survive, grow or multiply. On the other hand, being a universal solvent, water dissolves many of the minerals present in earth's crust during its slow travel through the ground. Anaerobic conditions in soils in some flood plains, and the presence of organic acids and carbon dioxide increase the solubility of groundwater. As a result, groundwater may contain minerals in varying concentrations depending on soil conditions. Arsenic contamination of groundwater is believed to be the result of such reactions in the adverse geoenvironment.

In the context of high prevalence of diarrheal diseases in Bangladesh, groundwater received priority as a source of water supply because it is generally free from pathogenic micro-organisms. Almost all rural water supplies and most of urban water supplies are groundwater based. Groundwater collected by tube wells is fit for consumption. Groundwater abstracted from shallow aquifers by hand tube wells has received acceptance in rural areas for drinking purposes, but due to its high iron content, hardness, etc. people do not want to use hand tube well water for other domestic purposes like cooking, bathing and washing. The high iron in groundwater makes the cooked food blackish in color and produces stains on utensils.

Arsenic is a problem in large part of Bangladesh ground water. The project area doesn't have acceptable limit of Arsenic levels in ground water. The acceptable quantity of arsenic in potable water is 0.05 mg per liter under the Department of Environment standard and 0.01 mg per liter under the WHO standards (Figure 6.17).

Based on field observations and interviews with local residents it was found that groundwater in the area is used as a drinking water source in many instances, as well as for irrigation purposes. Water is generally extracted via hand pump (tube wells) from the shallow regions of the composite aquifer, and via machine-driven pumps (deep tube wells) which draw from the deeper main aquifers. The ground water reservoir usually recharges from rainfall, floods and river. In summer season, the water table slightly goes down and goes up in rainy season.

On 10th April 2017, groundwater sample was collected by environmental team from a tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed

the sample. The result (see Appendix E and Appendix F) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 6.4. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE except for Arsenic (As).



Figure 6.16: Water Sampling from the Project Location

Table 6.4: Results for Groundwater Field Sample

Parameters	Unit	Concentration Present	Drinking Water Quality Standard, DOE	Method of Analysis
pH*	---	7.7	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	41	1000	TDS Meter
Alkalinity	mg/l	385	-	Trimetric
Chloride (Cl ⁻)	mg/l	12	150-600	Trimetric
Iron (Fe)	mg/l	0.73	0.3-1.0	AAS
Arsenic (As)	mg/l	0.094	0.05	AAS

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

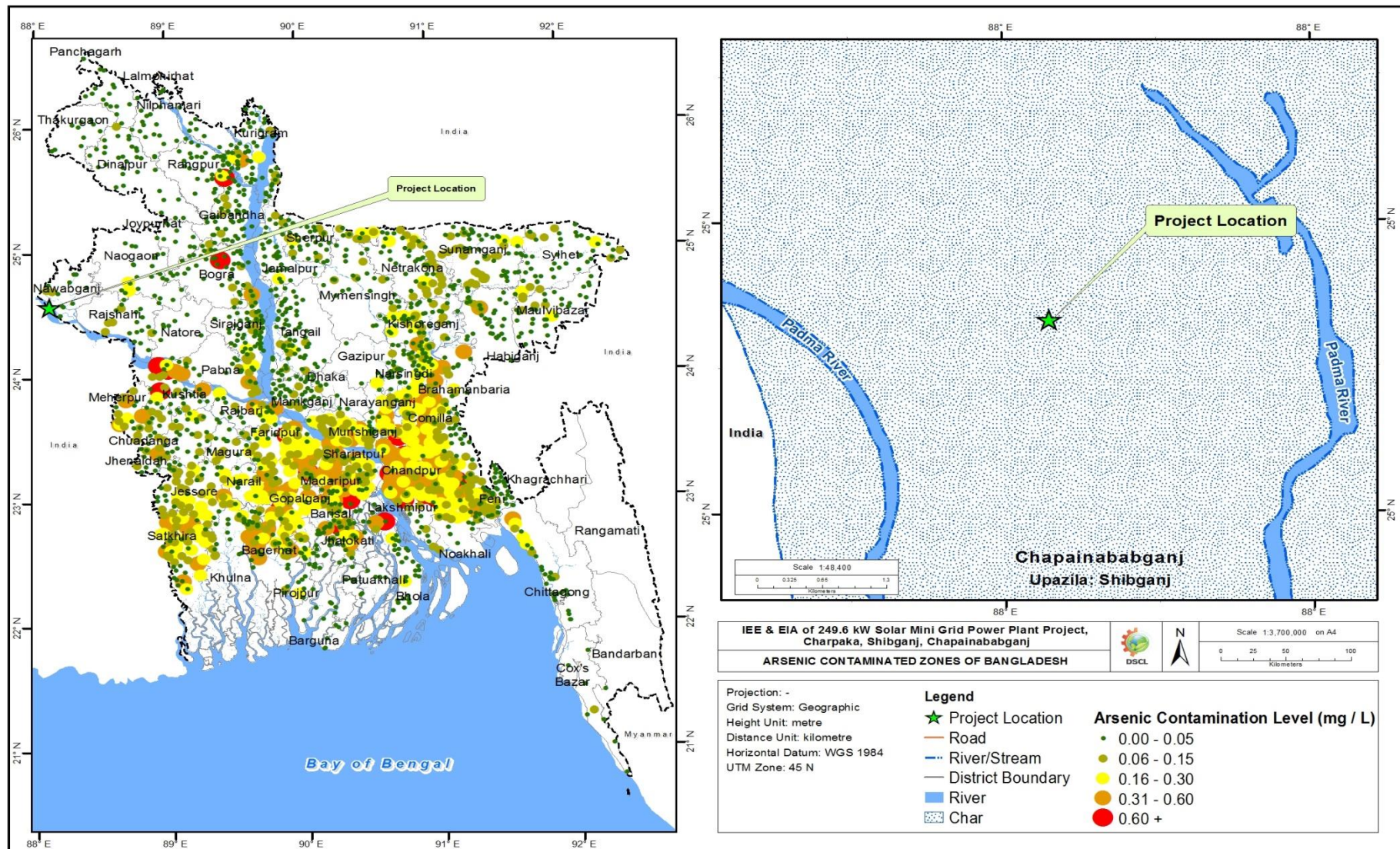


Figure 6.17: Arsenic Concentrations in Groundwater

6.2.9 Soil

The soil of the project area falls in Calcareous Alluvium category of Bangladesh soil types (Figure 6.18):

Calcareous Alluvium soils (14): Calcareous Alluvium soils are stratified or raw alluvium throughout or below the cultivated layer. They are calcareous throughout or part of it and lack in having diagnostic subsoil horizon. This alluvium on the active Ganges floodplain mainly comprises brownish grey to pale brown sandy and silty deposits, which are moderately calcareous. Soils on the Lower Meghna estuarine floodplain are slightly calcareous grey to olive, finely stratified silts. They are mainly Calcaric Fluvisols (Banglapedia, 2015).

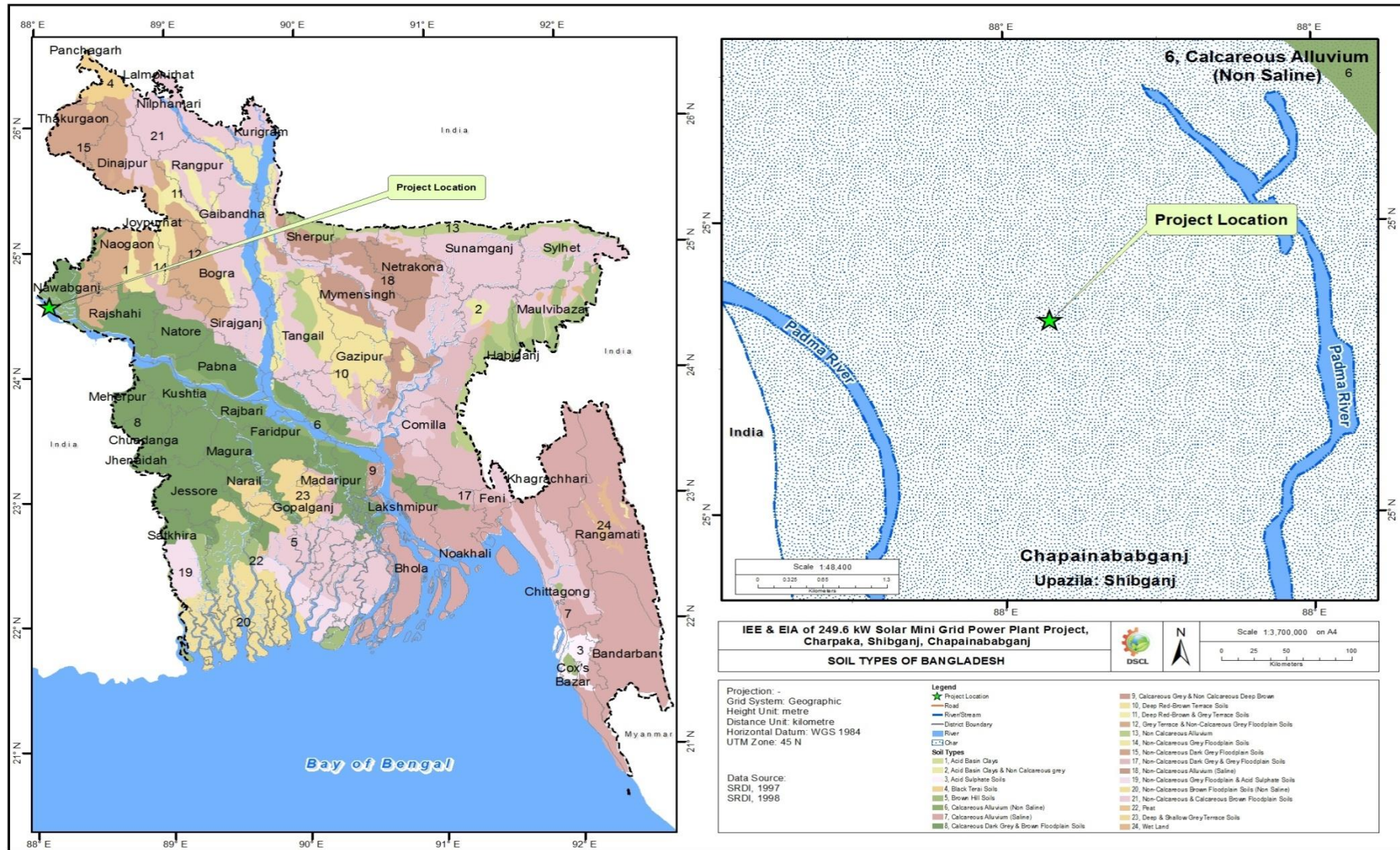


Figure 6.18: General Soil Categories of Bangladesh

6.2.10 Agro-ecological Zones within the Project Area

A 1988 study carried out by the United Nations Development Program (UNDP) classified Bangladesh into a series of Agro-ecological Zones (AEZs) based on an assessment of commonalities in characteristics such as physiography, soil types, climate and drainage. In total, 34 regions were identified and characterized, however this information has been updated and further refined on numerous occasions since the original study was undertaken.

The purpose of assessing the AEZs within the project area is to establish a broad overview of expected soil conditions which can be compared against more detailed, Upazila-level data sources.

The most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. The project area contains the below AEZ (refer Figure 6.20), namely:

Active Ganges Floodplain Active Ganges Floodplain (3,334 sq km) this region occupies unstable alluvial land within and adjoining Ganges river. It has irregular relief of broad and narrow ridges and depressions interrupted by cut-off channels and active channels. The area has complex mixtures of calcareous sandy, silty and clayey alluvium. The general soil types, predominantly include, calcareous, alluvium and calcareous brown floodplain soils. Soils are low in organic matter and mildly alkaline in reaction. General fertility level is medium but deficient in Nitrogen. (Banglapedia, 2014).

The nature and soil characteristics of this zone influence the crops and cropping patterns within the region.



Figure 6.19: Agricultural Practices in the Project Area

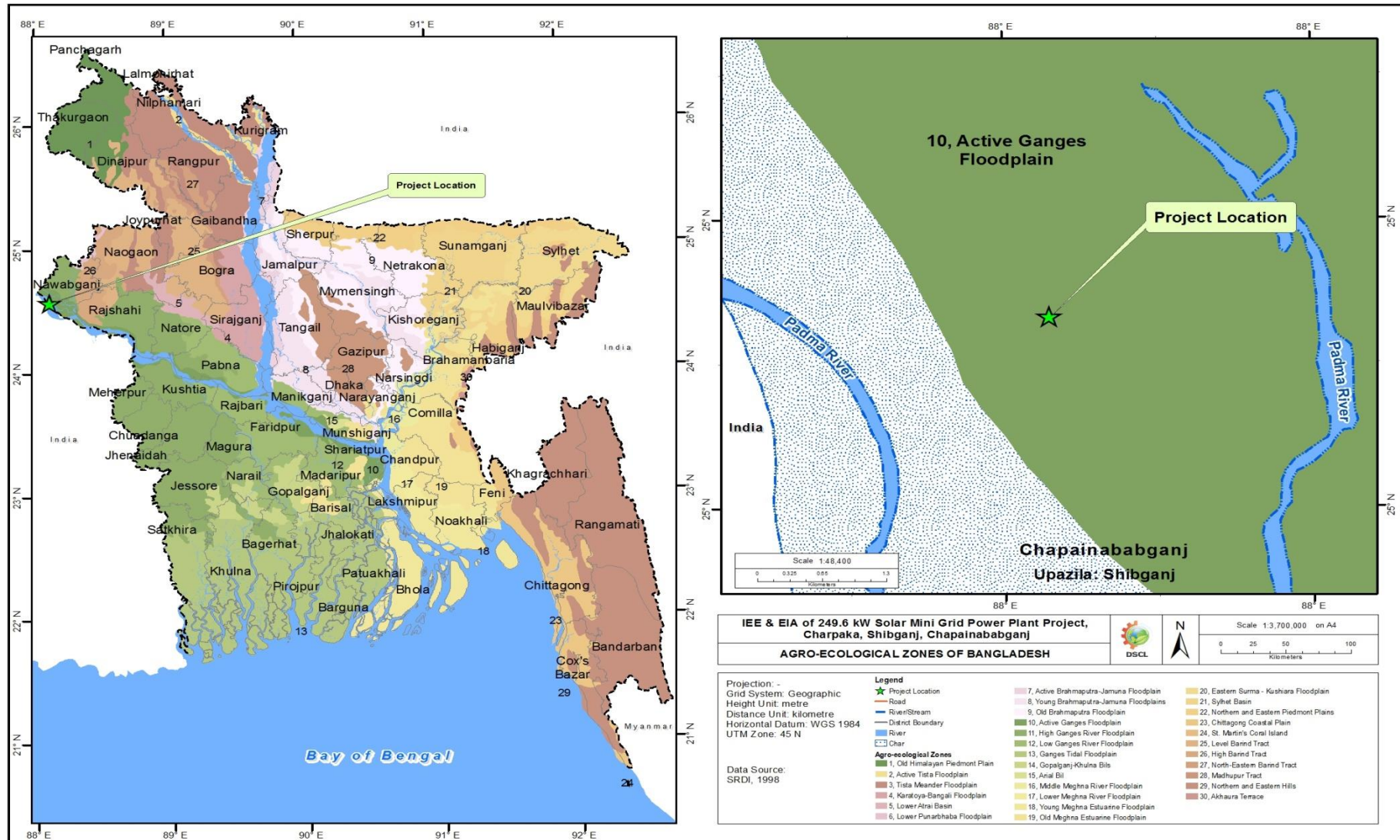


Figure 6.20: Agro-ecological Zones of Bangladesh

6.2.11 Seismicity

Bangladesh is situated in one of the most tectonically active regions in the world. Here is where three major plates meet (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate). The project area is located over the Indian Plate, which is moving north. However due to the location of relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (Table 6.5), based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes are likely to occur*). As per the seismic zone map (Figure 6.21), project area falls in the zone-III comprising the south-western part of Bangladesh. This zone is seismically quiet zone and represented with Bask coefficient 0.04. Ground condition (firm or soft) has not been taken into consideration during the seismic zonation of Bangladesh.

Table 6.5: Seismic Zonation of Bangladesh

Zoning	Area Mercalli Scale	Bask Seismic Coefficient
I	North and eastern regions of Bangladesh (Seismically most active)	0.08
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt.	0.05
III	Khulna division S-E Bangladesh (Seismically relatively quiet)	0.04

During the design of the project structure the historical information of earthquake should be taken care of. A recent historical earthquake statistics are shown in Table 6.6 (Source: Bangladesh Meteorological Department).

Table 6.6: Historical Earthquake around Bangladesh

Sl No.	Date (D/M/Y)	Lat (°N)	Long (°E)	Magnitude (Richter Scale)	Location of Epicenter
1	10-01-1869	24.79	93.17	7.5	Kachar, Assam, India
2	14-07-1885	24.70	89.55	7.0	Eastern Province, Nepal
3	12-06-1897	25.84	90.38	8.8	Shilang, Meghalaya, India
4	08-07-1918	24.16	91.75	7.6	Dauki, Meghalaya, India
5	02-07-1930	25.95	90.04	7.1	Dhubri, Assam, India
6	15-01-1934	26.60	86.8	8.3	Bihar-Nepal Border
7	23-10-1943	26.80	94.00	7.2	Assam, India
8	15-08-1950	28.79	95.62	8.6	Tibet, China
9	21-03-1954	25.86	94.00	7.2	Assam, India
10	08-07-1975	25.58	92.60	6.5	Assam, Sillon
11	06-08-1988	25.13	95.15	6.6	Manipur-Myanmar Border
12	21-11-1997	22.07	92.75	8.5	Arakan, Myanmar
13	11-08-2009	15.01	92.30	7.8	Andaman Islands

(Source: National Encyclopedia of Bangladesh, Banglapedia, CD Edition February 2006)

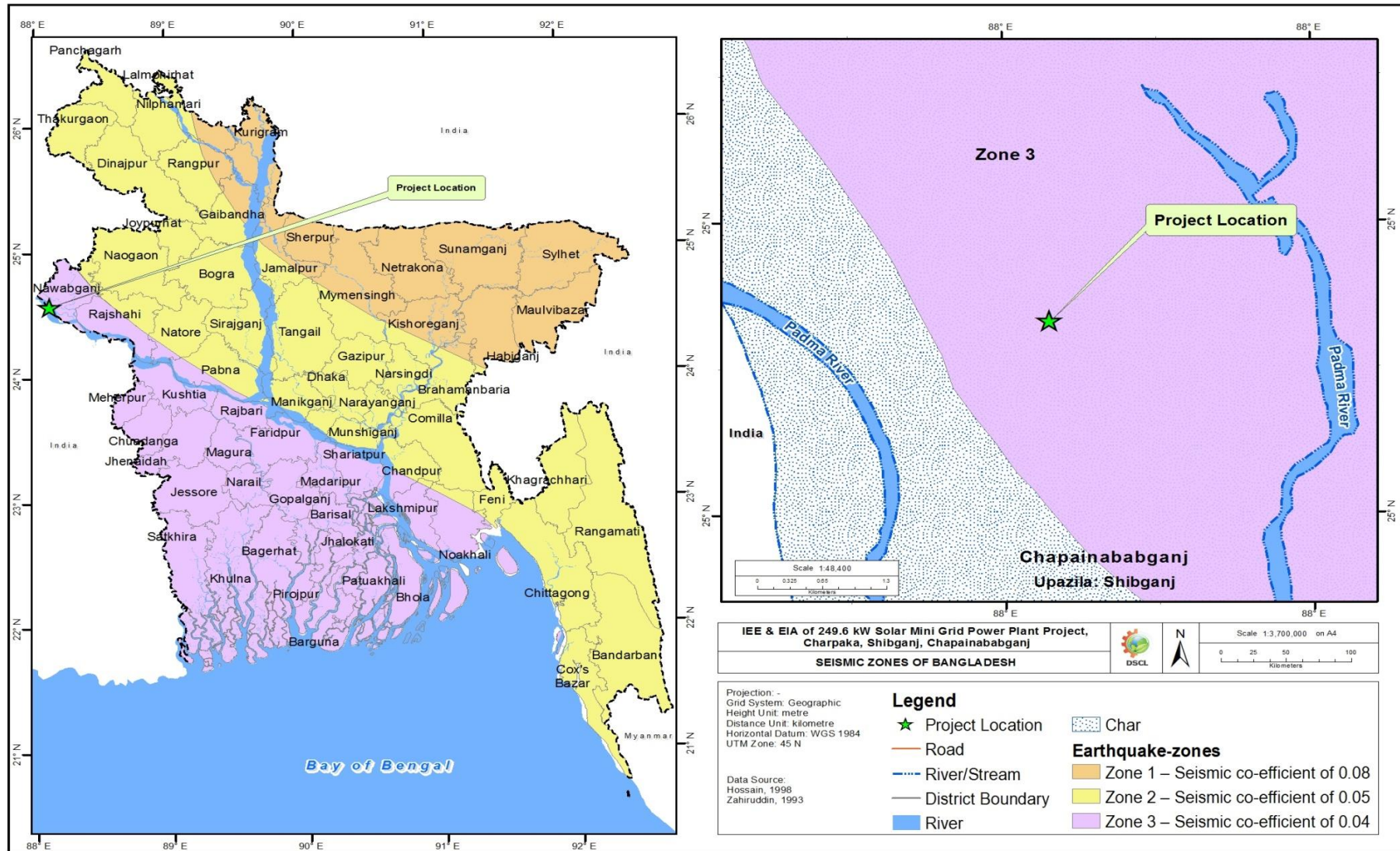


Figure 6.21: Seismic Zones within Bangladesh
 (Source: Hossain, 1988 & Zahiruddin, 1993)

7 DESCRIPTION OF BIOLOGICAL ENVIRONMENT

7.1 General

The countries of South and Southeast Asia are recognized by International Union for Conservation of Nature (IUCN) to be regions of high species diversity. A large number of native plants, including 3,000-4,000 species of woody flora, have been recorded from Bangladesh. The country lies at the meeting point (ecotonal region) of several floristic provinces, including the Manipur-Khasia, Bengal and North Burman provinces within the Indo-Malayan realm (IUCN, 2002).

Bangladesh was once well forested, but most of the native forests have disappeared in recent decades due to mounting pressure from human populations. Only scattered patches of native trees, wetlands and associated fauna habitat remain in isolated locations within the terrestrial environment (IUCN, 2002). In many parts of the country, the abundance of plantations and groves of trees around villages creates an aspect of discontinuous forest (Wahab, 2008).

The floodplains of Bangladesh have long been subject to cultivation, the most dominant land use within the project area, with only scattered patches of native trees, wetlands and associated fauna habitat remaining in isolated locations within the terrestrial environment (IUCN, 2002).

7.2 Bio-ecological Zones

Within a relatively small geographic boundary, Bangladesh enjoys a diverse array of ecosystems. Being a low-lying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios of Bangladesh. Temperature, rainfall, physiographic variations in soil and different hydrological conditions play vital roles in the country's diverse ecosystems. The ecosystems of Bangladesh could be categorized into two major groups, i.e. (i) land based and (ii) aquatic. The land-based ecosystems include forest and hill ecosystems, agro-ecosystems and homestead ecosystems; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine ecosystems fall into the aquatic category.

Each of the ecosystems has many sub-units with distinct characteristics as well. IUCN Bangladesh in 2002 classified the country into twenty five bio-ecological zones (Figure 5.20). The project area falls below the bio-ecological zone.

- **Major Rivers (Bioecological zone 11):** Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges and Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass for example). Dense growth of catkin grass can accelerate silt deposition on chars. Many of the species' natural distribution, migration and storage are primarily functioned via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowls are directly or ecologically dependent on these rivers and its associated ecosystems.

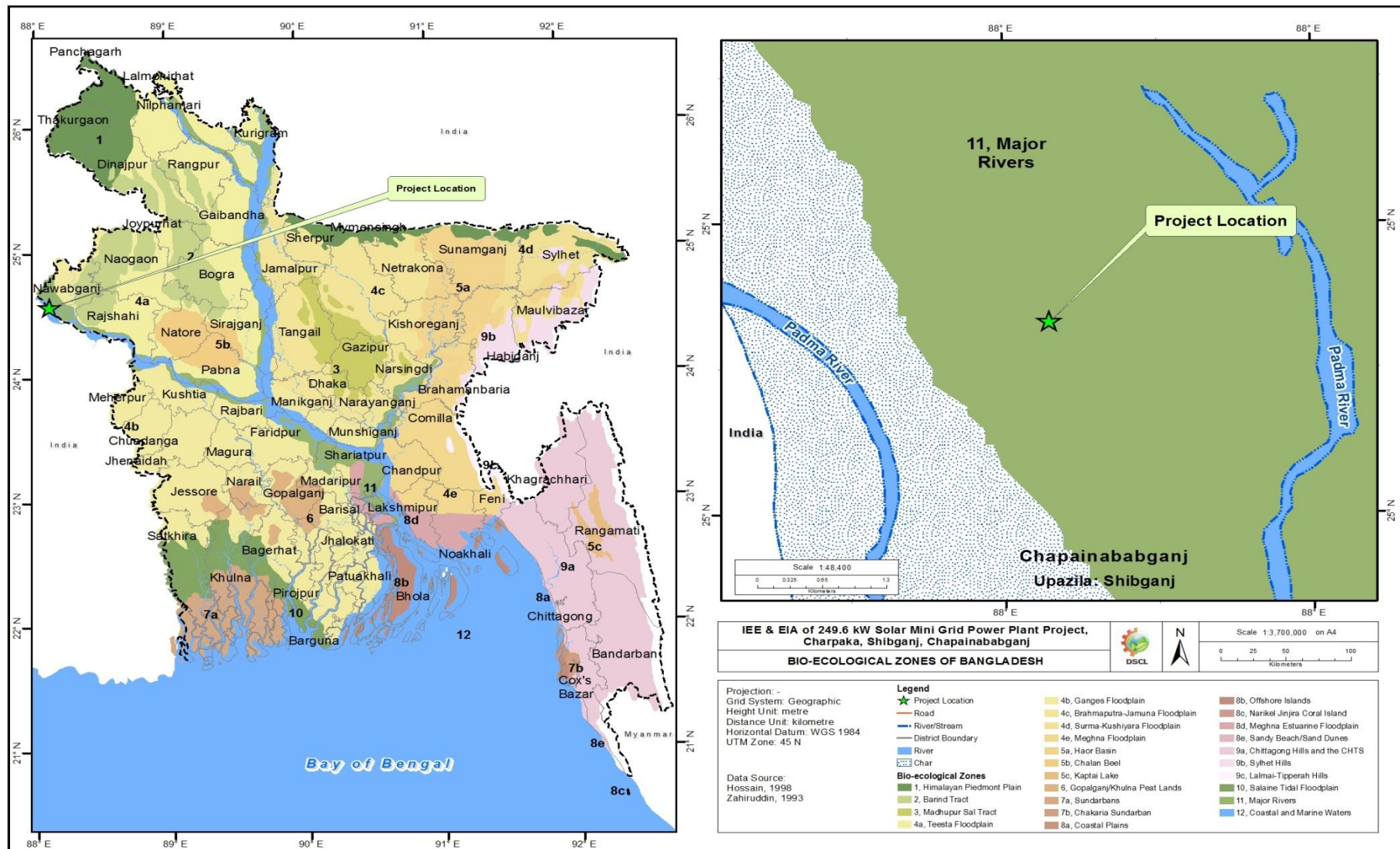


Figure 7.1: Bio-ecological Zones of Bangladesh

However, it is quit alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction (IUCN, 2002f).

7.3 Terrestrial Ecosystem

The status of terrestrial floras and faunas at the project site were assessed from visual observations, review of literature, and information documented by other agencies. The project area consists of several ecological subsystems e.g. open agricultural land, homesteads, and roadside vegetation. The open agriculture land ecosystem dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The vegetation covers of agricultural lands are different crop species, weeds and other herbaceous plants species. The faunal species in the agriculture land and roadside bush ecosystems include birds, amphibians, fishes, snakes rodents and few mammals. The homestead ecosystem provides the main tree covered areas within rural Bangladesh including the project site. The homesteads are covered by fruit, timber, fuel wood, medicinal plants and various multipurpose tree species. The wildlife species in homestead ecosystem include the birds, amphibians, reptiles, rodents and mammals like mongoose, jackal, cats, monkey, etc. Many of the species including mammals are vulnerable or/and endangered in Bangladesh due to habitat loss, over exploitation, natural calamities and lacking of management. The project command area is not the specific habitat for any particular species of flora and fauna hence none such species will be specifically affected due to project implementation.



Figure 7.2: Flora in the Project Area

7.3.1 Flora

The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice and homestead vegetables including brinjal and spinach. The fruit trees include mango, java plum, pomelo, banana, jackfruit, date, litchi, coconut etc. and timber trees include babla, and koroi. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. Babla has been found a lot in number during field visit. The composition of plant community includes low growing grasses, trees, herbs and shrubs. The data collected from the field survey and suggests that the

predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in Table 7.1.

Table 7.1: List of Plants in the Project Area

Common Name	Scientific Name	English Name	Family
Aam	<i>Mangifera indica</i>	Mango	Anacardiaceae
Begun	<i>Solanum melongena</i>	Brinjal	Solanaceae
Dhan	<i>Oryzasativa</i>	Rice	Poaceae
Durbaghash	<i>Cynodondactylon</i>	Bermuda grass	Gramineae
Dholkalmi	<i>Ipomoea carnea</i>	Pink morning glory	Convolvulaceae
Babla	<i>Acacia nilotica</i>	Babla	<i>Fabaceae</i>
Jaam	<i>Syzygiumcumini</i>	Java Plum	Myrtaceae
Jambura	<i>Citrus maxima</i>	Pomelo	Rutaceae
Kola	<i>Musa sapientum</i>	Banana	Musaceae
Koroi	<i>Albiziaprocera</i>	Persian silk tree	Fabaceae
Kathal	<i>Artocarpusheterophyllus</i>	Jackfruit	Moraceae
Kalmilata	<i>Ipomoea aquatic</i>	Water spinach	Convolvulaceae
Khejur	<i>Phoenix dactylifera</i>	Date palm	Arecaceae
Kul	<i>Ziziphusmauritiana</i>	Chinese date	Rhamnaceae
Lau	<i>Lagenariasiceraria</i>	Bottle Gourd	Cucurbitaceae
Lebu	<i>Citrus sp.</i>	Lemon	Rutaceae
Lichu	<i>Litchi chinensis</i>	Litchi	Sapindaceae
Morich	<i>Capsicum annum</i>	Chilli	Solanaceae
Narikel	<i>Cocos nucifera</i>	Coconut	Arecaceae
Palong Shak	<i>Spinaciaoleracea</i>	Spinach	Chenopodiaceae
Peyara	<i>Psidiumguajava</i>	Guava	Myrtaceae
Pepe	<i>Carica papaya</i>	Papaya	Caricaceae
Supari	<i>Areca catechu</i>	Betel tree	Piperaceae
Taal	<i>Borassusflabellifer</i>	Palm	Areaceae
Tulsi	<i>Ocimum sanctum</i>	Holy basil	Lamiaceae

7.3.2 Fauna

The diversified habitat and ecosystem in the project area support various types of animals as given in Table 7.2. Primary and secondary mode was adopted for identification of fauna. Most of the birds are identified through direct observation rather than from people. Most of the Amphibians, Reptiles and Mammals were identified by using books and description of the local people during the field survey. A total of 21 species are identified during field survey among them 3 Amphibian, 3 Reptilian, 9Avian faunas and 6 Mammalian faunas.

Table 7.2: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name	IUCN Status
Class: Amphibia			
<i>Bufo melanostictus</i>	Common toad	Kuno bang	LC
<i>Rana tytleri</i>	Brown frog	Pana bang	LC

Scientific Name	English Name	Local Name	IUCN Status
<i>Uperodon globulosus</i>	Balloon frog	Belun bang	LC
Class: Reptilia			
<i>Chitra indica</i>	Indian narrow-headed soft shell turtle	Kocchop	EN
<i>Kachuga tectum</i>	Indian roofed turtle	Kari katta	LC
<i>Gecko gecko</i>	Wall lizard	Tokkhok	LC
Class: Aves			
<i>Milvus migrans</i>	Black kite	Bhubonchil	LC
<i>Bubo bubo</i>	Eagle owl	Pecha	LC
<i>Ploceus philippinus</i>	Baya weaver	Babui	LC
<i>Anas platyrhynchos</i>	Duck	Hash	LC
<i>Corvus splendens</i>	House crow	PatiKak	LC
<i>Alcedo atthis</i>	Common Kingfisher	Choto Maachranga	LC
<i>Picidae</i>	Woodpecker	Kath Thokra	LC
<i>Streptopelia chinensis</i>	Spotted Dove	Tila Ghughu	LC
<i>Columba livia</i>	Domestic Pigeon	Kobutor	LC
<i>Grus antigone</i>	Crane	Sharosh	VU
Class: Mammalia			
<i>Bos taurus</i>	Cow	Goru	LC
<i>Bubalus arnee</i>	Wild Water Buffalo	Mohish	EN
<i>Capra aegagrus</i>	Goat	Chagol	VU
<i>Felis catus</i>	Cat	Biral	LC
<i>Canis familiaris</i>	Dog	Kukur	LC
<i>Rattus rattus</i>	Rat	Indur	LC

LC = Least Concern, EN = Endangered, VU = Vulnerable

7.4 Protected Areas and Red Book Species

Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatened and are included in the appendices of Convention on International Trade in Endangered Species (CITES). Among the most endangered species are: elephant, tiger, wild Cat, Leopard or wild goat, serao, dolphin; birds: white-winged duck, comb duck, stork, carne, pheasant, partridge, and crocodile, python, monitor, lizard, tiger terrapin, roofed turtle, soft turtle, and marine turtles.

In and around the project no environmentally protected areas were found. Construction impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns are not anticipated. Figure 7.3 shows that no environmental sensitive area is present around the project region.

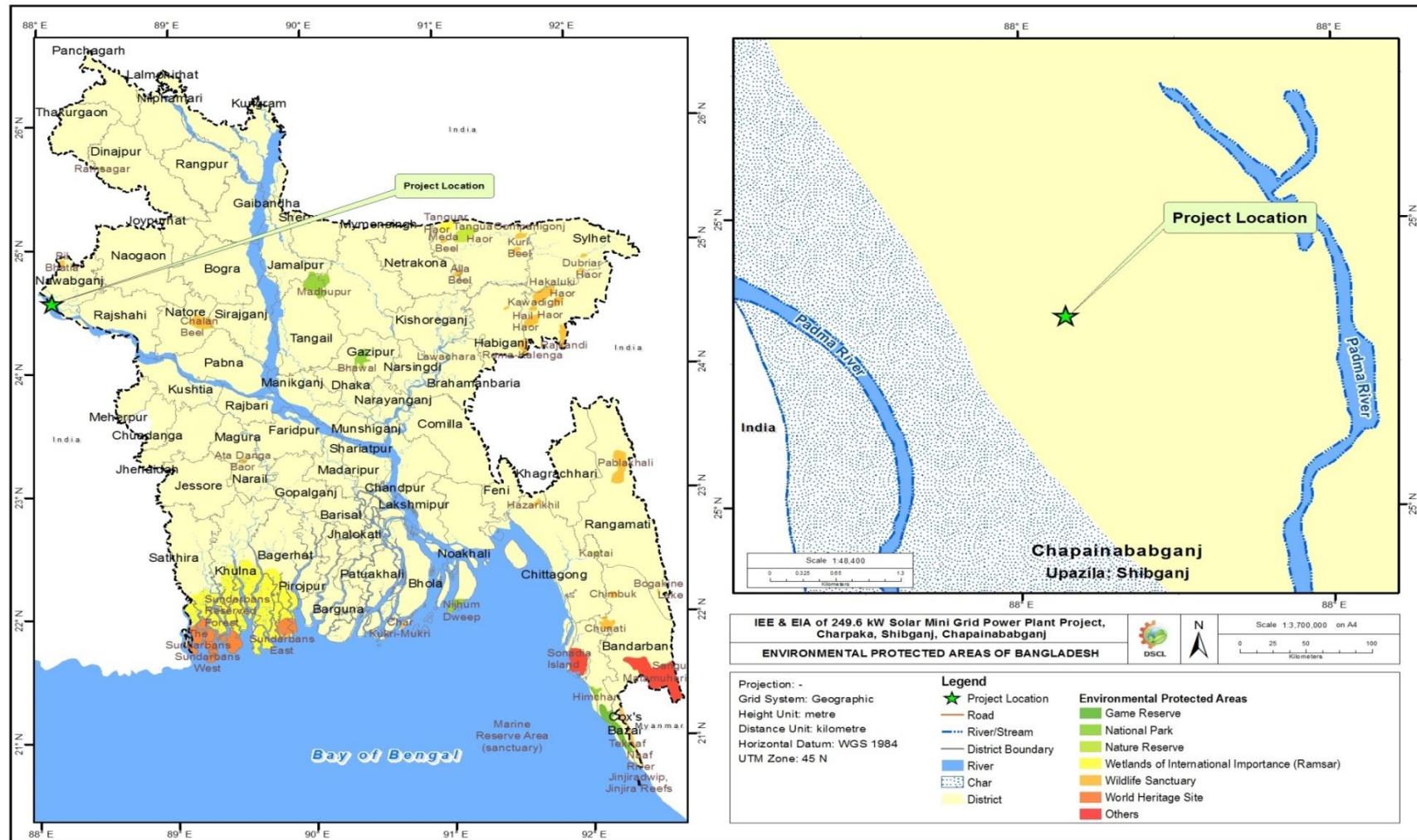


Figure 7.3: Environmental Protected Areas of Bangladesh

8 DESCRIPTION OF THE SOCIAL CONDITIONS

8.1 Socioeconomic Conditions

This section provides a profile and analysis of the socio-economic characteristics and practices that currently exist within the Project Area. Socio-economic baseline data has been collected in order to achieve a number of outcomes, namely to:

- Assess potential impacts that may arise as a result of the Project;
- Provide a basis for the effective monitoring of the Project during construction and operation; and to
- Allow for the evaluation of any social, economic and demographic changes in the Project Area that could be attributable to the Project.

It is essential for every development project, whether small or large, to understand the social, human and economic aspects of the primary stakeholders, i.e., people living in and around the project site. The following tools and techniques were used to collect the relevant data/information on the social and economic aspects of affected people:

- Literature review;
- Focus Group Discussion (FGD); and
- Questionnaire Survey.

In addition, data obtained from secondary sources were compared with the primary data/information gathered during the study. Data on population, age/sex composition, household patterns, and sources of drinking water, sanitation facility, and ownership of agricultural land were enumerated from the latest community series census published by the Bangladesh Bureau of Statistics (BBS).

It is to be noted from survey that, 78.50% currently have electricity by SHS. It has been also observed in the results of the surveys that 98.7% shops and 97.85% households are interested in having electricity from the proposed solar mini-grid project. Besides, 43.6% of the respondents earn less than BDT 10,000 per month and another 45.75% of the respondents earn between BDT 10,001-20,000 per month. The remaining earns more than BDT 20,000 per month. From the survey it can also be noted that most of the households are within 1.5-2 km radius of the project site. Notably, during the site visit, the local farmers expressed their willingness to avail electricity from the Project for irrigation purposes.

8.2 National Context

Bangladesh has experienced steady economic growth and improvement in macroeconomic stability during recent years, particularly in the past decade. This has been despite numerous natural disasters and external forces such as the global economic crisis. Rates of poverty have fallen from 57 percent in 1990 to 40 percent in 2005. The average growth of gross domestic product (GDP) between 2001 and 2007 was over 6 percent (World Bank, 2007). In addition, Bangladesh has made great strides towards achieving many of the Millennium Development

Goals (MDGs), including meeting the MDGs for gender parity in education and universal primary enrolment ahead of time.

Despite the improving track record, around 56 million people remain living below the poverty line. As such Bangladesh faces considerable challenges, including from ongoing natural disasters such as cyclones and floods, and from the potential impacts from climate change.

Development of socio-economic indicators for Bangladesh is provided in Table 8.1.

Table 8.1: Key Socio-economic indicators for Bangladesh

Key Indicator	Value
GDP (US\$ billions), 2008	79.0
GDP per capita (US\$), 2002	351
Exports of goods and services (% of GDP), 2002	14.3%
Imports of goods and services (% of GDP), 2002	19%
Agriculture (% of GDP), 2007	18.9%
Industry (% of GDP), 2003	28.5%
Services (% of GDP), 2003	52.6%
Population living below national poverty line, UNDP (2005)	40.0%
Life expectancy (2006)	
- Male	65.6
- Female	70.0
Total fertility rate (births per woman ages 15-49), 2007	2.39
Adult literacy rate (% age 7 and above), 2007	
- Male	59.4%
- Female	52.7%
Population with sustainable access to improved sanitation (%),2000	48%
Population with sustainable access to water source (%),2000	97%

(Sources: United Nations Development Program, 2004; Bangladesh Bureau of Statistics, 2008; Bangladesh Bureau of Statistics, 2009)

8.3 Administrative Information

It is important to highlight the administrative setup as framed by District and union boundaries of the Project area, as those will be referred to many times throughout the IEE document.

The project site, Paka union, is located on the Padma River and lies about 17.8 km to the west of Chapainawabganj Sadar. Paka union is located in Shibganj Upazilla in Chapainawabganj District. The island lies on the border of India and to its West lies the districts of West Bengal like Suti, Dhuliyon, Jangipur and so on. To the north-east of the island lies Farakka Barrage about 32 kilometers away. The total area of Shibganj Upazilla is 525.43 sq. km and the total area of Paka Union is 50.25 sq km. (BBS 2011)

8.4 Demographic Information

With an estimated 164.4 million inhabitants and an annual population growth rate of 1.4%, Bangladesh is considered to be one of the most densely populated countries in the world (UNFPA, 2010). The detail of demographic profile of the project area is presented below (Table 8.2). The demographic information is collected from Population Census, 2011 by Bangladesh Bureau of Statistics (BBS).

Table 8.2: Demographic Profile of the Project Area

Administrative Unit (Residence Community)	Total Households	Population			Population Density
		Total	In Households	Floating	
Paka Union	4725	22092	22092	0	440
Char Paka	614	3119	3119	0	-

Source: BBS, 2011

8.4.1 Household Size

Comparison of the data collected during household surveys found that the average household size of these villages was 4.7 members per household. The majority of households were headed by males (91%).

A socio-economic study was undertaken in Char Paka within 500m radius of the project site. The high impact zone has been considered as households within 250m radius from the center of the project site and the low impact zone as between 250m to 500m radius.



Figure 8.1: Interview with household owner

According to the household survey, the Table 8.3 shows that the average household size is 4.7 in all impact area (i.e. the average number of persons per household). Overall, the average household size in the Project area is higher than the national average radius household size which is 4.5 persons (BBS, 2011).

Table 8.3: Percentage Distribution of General Households by Size, Average Size, Residence and Community in the study area

Administrative Unit (Residence Community)	General Households	Percentage of Households Comprising								Average Size of Household
		1 Person	2 Persons	3 Persons	4 Persons	5 Persons	6 Persons	7 Persons	8+ Persons	
Paka Union	4722	1.9	8.7	16.4	23.1	21.3	13.7	7.1	7.7	4.7
Char Paka	614	0.7	5.2	13.2	19.7	25.1	16.6	8.6	10.9	5.1

8.4.2 Gender Distribution

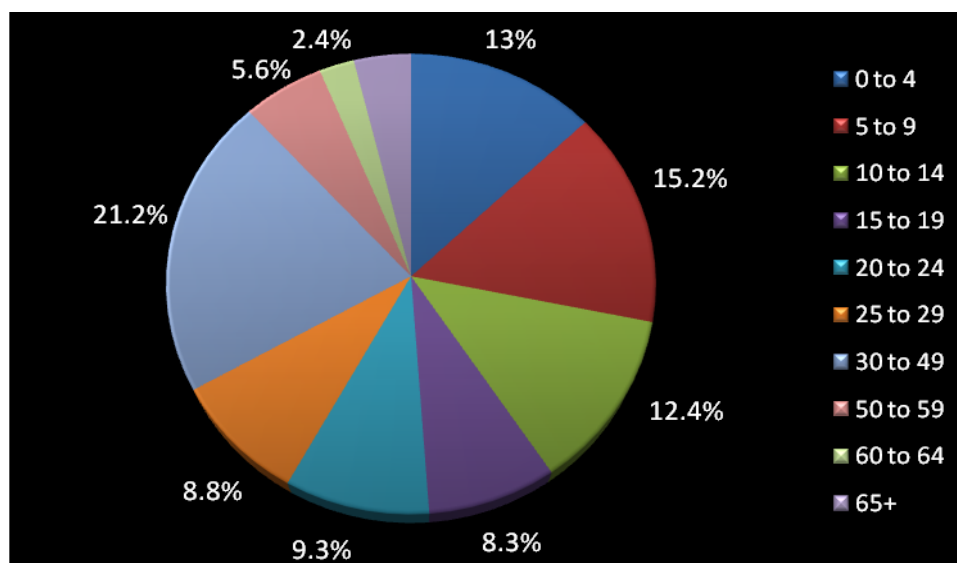
The sex ratio of the population is defined as the number of males per 100 females. In the country as a whole the sex ratio has remained fairly constant at around 106 since 1981, with the reported ratio for 2001 being 106.6. However, there is a significant urban-rural difference in sex ratios; 117.2 for the urban areas as opposed to 103.6 for rural areas. This difference can mainly be attributed to male labor migration to urban areas, specifically in the 20-29 age brackets and to a lesser degree in the 30-34 age brackets. The sex ratio of Paka Union is 99 and the sex ratio of Char Paka is 100 (BBS 20011).

Table 8.4: Distribution of Population by Sex and Sex Ratio

Administrative Unit (Residence Community)	Population			Sex Ratio
	Both	Male	Female	
Paka Union	22092	11018	11074	99
Char Paka	3119	1563	1556	100

8.4.3 Age Distribution of the Population

Age distribution of the population in all impact zone obtained from survey data shows that 13% of the population is children (0-4 years), 15.2% are adolescents in the 5-9 years old group, 12.4% are 10-14 years of age, 8.3% are of age 15-19, 9.3% are of age 20-24, 8.8 % are of age 25-29, 21.2% are of age 30-49, 5.6% are of age 50-59, 2.4% are of age 60-64 and the remaining 3.9% is above 60 years (Fig. 8.2).

**Figure 8.2: Age distribution of the household**

8.4.4 Nutrition

The malnutrition level among the children in Bangladesh is among the highest in the world. Almost one-half of children under the age of five are moderately underweight or stunted, and 16 percent are severely stunted (World Bank, 2007). These nutritional outcomes have lifelong consequences in terms of productivity, cognitive ability, educational attainment, vulnerability to disease and quality of life. In Bangladesh, female children are more vulnerable to malnutrition compared to male children.

8.4.5 Religion

According to Banglapedia, 2015 the majority of people of Shibganj are Muslim with a population of 492963. The number of Hindu people is 14765 and the number of Buddhist people is 119. Others living in the area are 245. The percentage of population distribution by religion is showed in the below table.

Table 8.5: Population Distribution by Religion of Shibganj Upazilla

Total Population	Muslim (%)	Hindu (%)	Buddhist (%)	Others (%)
508092	97.02	2.91	0.023	0.048

Source: Banglapedia, 2015

8.4.6 Ethnicity

Bangladesh is noted for the linguistic homogeneity of its population, with over 98 percent of the population classified as Bengali or Bangla-speaking. According to the 1991 Population Census (BBS, 2006), Bangladesh has 29 indigenous groups, who together constitute some 1.1% of the total population. These groups have traditionally inhabited the Chittagong Hill Tracts area, and the border and forest areas of north-western, north-central and north-eastern Bangladesh. All persons surveyed during the household survey were Bengali, with no indigenous groups recorded.

8.5 Land Use and Ownership

Lands at the project area are used for agriculture, fisheries, agro-forestry, homestead, homestead forestry and vegetation, animal husbandry, etc. The area at where the project is proposed characterized by an agricultural ecosystem.

By far the most predominant land use in the Project area is agricultural constituting more than 71 percent of the land use. Other major non-agricultural land uses include rural settlements (11.5%), water bodies (7.5%) and mud flats (6%).

Approximately 19.8 percent of households surveyed were found to own arable land, and of these landowners 5.6 percent owned less than 1 acre and 5.3 percent owned between 1 and 2 acres. Of the 32.4 percent of households that own homesteads, more than 97 percent own less than 1 acre. Approximately 10.8 percent of households surveyed owned land used for ponds, and 24.2 percent owned land used for orchards. Of all households surveyed more than 90 percent had some form of ownership of land used for food production.

8.5.1 Cropping Patterns

The Project area is located in the Padma River Island and floodplain and therefore rice paddy is a substantial crop. The main paddy grown in the Project Area is AUS (cultivated from February to June), Aman (cultivated from mid-July to mid-December) and Boro (irrigated and cultivated in the winter). Wheat, jute, wheat, mustard, sugarcane, potato, maize, vegetables, betel leaf, betel nut, are also grown within the Project area. Fruits like jackfruit, litchi, banana, lemon, black berry and guava are often grown in smaller amounts and in close proximity to dwellings.

Of the household surveyed approximately 62 percent grew some form of paddy, with Amon being the most commonly grown (46%). Crop rotation was seen to be prominent with 54% either having a rotation twice or three times a year. Further, based on the primary crop intensity and pattern 3.8% do not have a crop rotation pattern with a singular crop dominated by Amon. Of those who crop rotated twice (11.1%), 4.2% was of Amon and Aus and 47.4% of people surveyed rotated their crop three time, which 46.4% was made up of Amon, Aus and Rabi.

8.5.2 Project Land

The proposed plant is bounded by agricultural land in two sides; in addition the north of the project area is having some residential dwellings and the east side of the project is having a primary school which is around 150m far from the project site. The total land of the proposed project is about 4.5 bighas (148.5 decimal).

8.6 Literacy

The average literacy rate of Shibganj Upazilla is 32.5%. Where the percentage of male is 33.7 and female is 31.2. The noted educational institutions are Adina Fazlul Haque Government College (1938), Kansat High School (1917), Dadanchack HM High School (1919), Harinagar High School (1959), Naya Naobhanga Government Primary School (1870), Satrujitpur Senior Madrasa (1944), Radhakantapur Senior Madrasa (1950). The number of different educational institutions are listed in the below table.

Table 8.6: Number of Educational Institutions in Shibganj Upazilla

Educational Institutions	Number
College	17
Technical College	2
Secondary School	71
Primary School	231
Kindergarten	29
Madrasa	64

Source: Banglapedia, 2015

8.6.1 Educational Status

According to the survey, in all impact zones of the study area, 2.6% of the population is illiterate and 13.3% of the population can sign their name, although they can neither read nor write. The population in both the impact zones having primary level education (upto 5 years

of schooling) and secondary level education (up to 10 years of schooling) are 26.8% and 29.2% respectively.

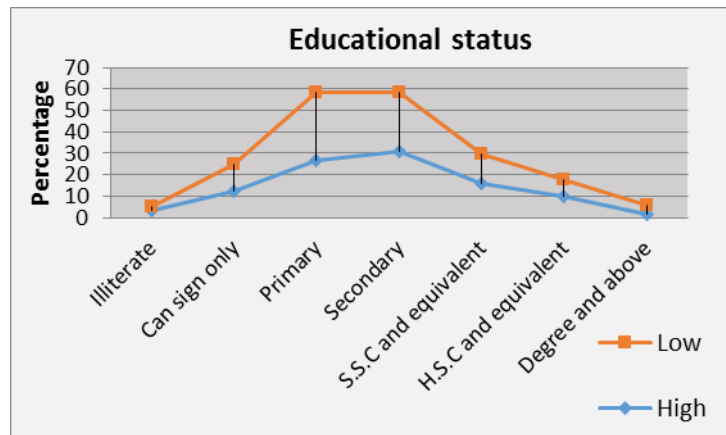


Figure 8.3: Educational status of the area

Based on the data collected from the socio-economic survey, 15.0% of the population in both the impact zones has a Secondary School Certificate (S.S.C) and equivalent. It has been found that 7.2% of population has Higher Secondary Certificate (H.S.C) and equivalent and 4.0% of the population in all impact zones has Bachelors/equivalent degree and above (Fig 8.3.). The national literacy rate is estimated at 55.91%, according to BBS 2011.

The population having primary level education in the high impact zone is 28.2% whereas it is 32.6% in the low impact zone of the study area. 12.5% of the population in the high impact zone has Secondary School Certificate (S.S.C) and equivalent whereas it is 15.0% in the low impact zone of the study area.

8.7 Occupational Patterns

Livelihoods encompass systems of accommodation and settlement, income-generation and resource use, as well as systems of social interaction, cooperation and mutual support. Recent reports on socio-economic development in Bangladesh refer to the changing nature of rural livelihoods with most households being shown to be pursuing a diversified range of activities for their livelihoods. Therefore information provided below on occupational status collected through household surveys provides more of a broad insight into livelihood strategies in the Project area.

8.7.1 Occupation and Employment

Most people in the Project area are either underemployed or unemployed, though most people disguise their unemployment by minor involvement in economic activities. Being underemployed is defined as *“the condition whereby a person’s employment is considered inadequate in terms of time worked, income earned, productivity or use of his/her skills and the person is looking for additional work in conformity with his/her education or skill to augment income.”*

Livelihoods allow people to secure the basic necessities of life, such as food, water, shelter and clothing. Engaging in livelihoods activities involves acquiring the knowledge, skills, social network, raw materials, and other resources to meet individual or collective needs on a

sustainable basis. The island people are typically involved in activities such as agriculture, livestock breeding, fishing and trade. Income provides the basis for food security and self-reliance, contributing towards general stability, prosperity and peace. The percentage of income sources is described in the below table.

Table 8.7: Percentage of Income Source of Shibganj Upazilla

Income Source	Percentage (%)
Agriculture	59.25
Non-Agricultural Laborer	5.63
Industry	1.59
Commerce	18.89
Transport & Communication	1.19
Service	3.50
Construction	1.73
Religious Service	0.12
Rent & Remittance	0.17
Others	7.93

Source: Banglapedia, 2015

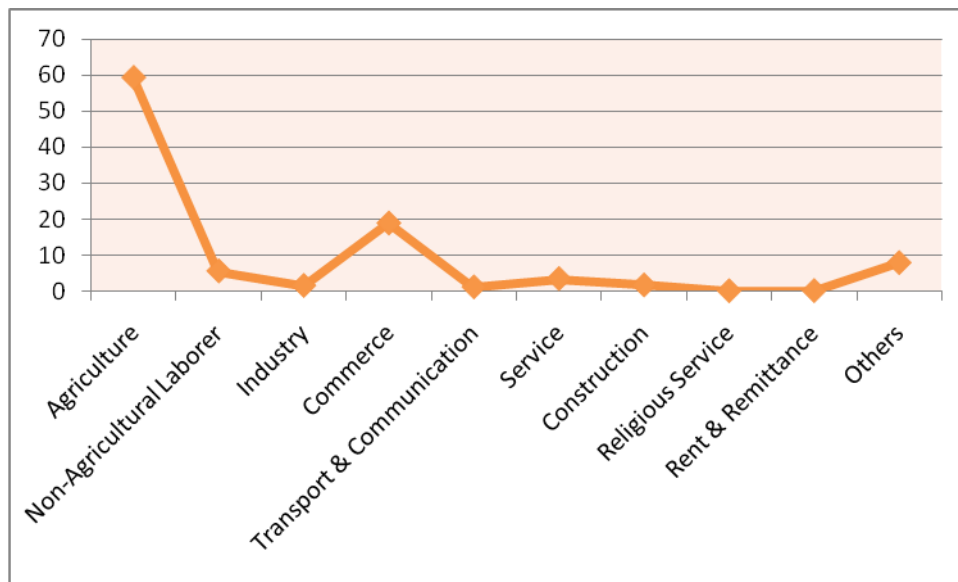


Figure 8.4: Distribution of Income Source of Shibganj Upazilla

8.7.2 Household Income, Expenditure and Distribution

According to the survey, average annual income per household in all impact zone is Taka 342,650 in the study area. However, the average annual expenditure per household in all impact zone is Taka 142,465 in the study area. Average annual income per household in the high impact zone is Taka 356,167 whereas it is Taka 322,525 in the low impact zone. Average annual expenditure per household in the high impact zone is Taka 143,117 compare to Taka 117,011 in the low impact zone of the study area (Table-8.8).

Table 8.8: Average Annual Income and Expenditure per Household by Study Area

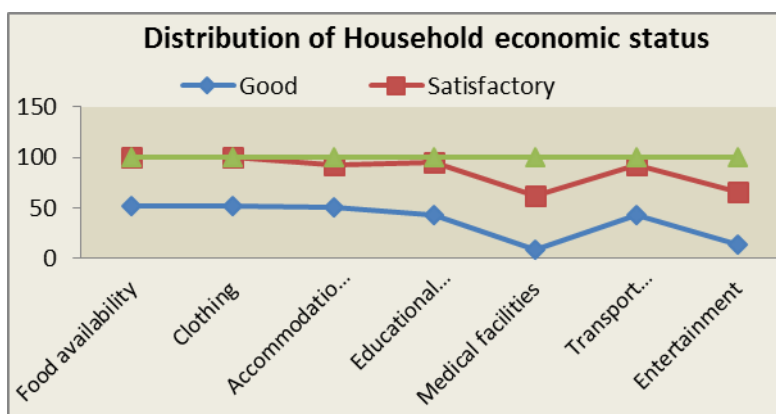
Study Area	Average Annual Income Per Household (Tk.)	Average Annual Expenditure Per Household (Tk.)
High	356,167	143,117
Low	322,525	117,011

(Sources of Household Income)

8.8 Economic Status

The analysis of the households' economic situation has been focused on accessibility and affordability of food, clothing, educational facilities, medical facilities, transport facilities etc.

With respect to availability of food, it is considered “satisfactory” by 46.4% of the households under the survey. Food availability is considered “good” by 52.7% of the households in the study area. The situation with respect to clothing is considered “satisfactory” by 44.4% of the respondents and considered “good” by 54.5% of the respondents in the study area. As for housing /accommodation facilities, they are found “satisfactory” by 38.8% of the respondents, 51.6% of the respondents found them “good” and 5.2% of the respondents found them “unsatisfactory”. Educational facilities are considered “good” and “satisfactory” by 42.6% and 50.8% of the respondents, respectively. Medical facilities are generally considered “satisfactory” by 47.5% of the respondents in the study area whereas 42.4% of the respondents found them “unsatisfactory”. However, transportation facilities were scored as “satisfactory” by 44.5% of the respondents, while only 10.1% considered them as “unsatisfactory”. Entertainment facilities are considered “satisfactory” by 51.8% of the respondents whereas 32.0% of the respondents found them “unsatisfactory” in the study area (Fig 8.5).

**Figure 8.5: Distribution of Household economic status**

8.9 Involvement with NGOs/CBOs

About 94.0% households in the study area are not involved with non-governmental and community-based organizations (NGOs/CBOs) whereas 6.0% family member has involvement in NGOs/CBOs (Table-8.9).

In the high impact zone, 94.0% of households in the study area are not involved with non-governmental and community-based organizations (NGOs/CBOs) compare to 6.0% involvement of the family member. In the low impact zone, 90.0% of households in the study area are not involved with NGOs/CBOs compare to 10.0% involvement of the family member.

Table 8.9: Percentage Distribution of Households Surveyed Having Family Member Involvement in NGOs/CBO

Study Area	Yes	No	Total
High	5 (6.0)	55 (94.0)	60 (100.0)
Low	4 (10.0)	36 (90.0)	40 (100.0)
All	6 (6.0)	94 (93.0)	100 (100.0)

Note: Figures within parentheses represent percentages

8.10 Ownership of Agricultural Lands

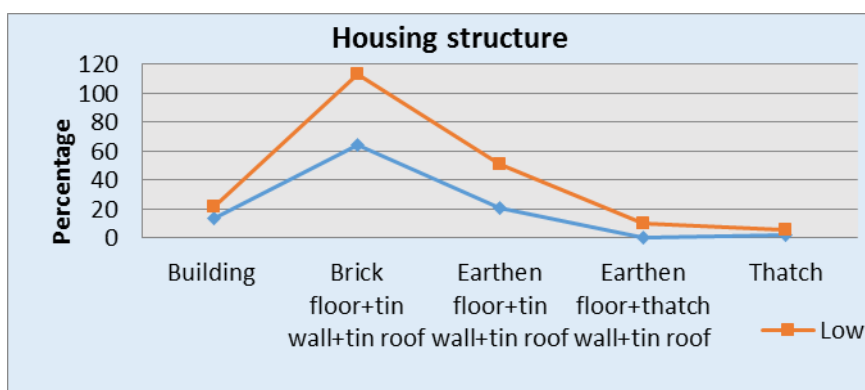
The ownership of agricultural land is described in below table.

Table 8.10: Ownership of Agricultural Land

Study Area	Landowner (%)	Landless (%)	Agricultural Land Owner	
			Urban (%)	Rural (%)
Shibganj Upazilla	51.29	48.71	40.23	52.34

8.10.1 Housing Structures

Housing structures in the project impact area are of different types in terms of construction materials used.

**Figure 8.6: Housing structure in the project site**

Most of the housings (55.3%) are brick floor with tin wall and roof in the study area. Housings with tin roof, tin wall and earthen floor constitute 22.0% of all HHs in the study area (Fig. 8.6). 11.2% of the households are buildings, 2.4% of the households are thatched and 4.4% of the households are made of earthen floor, thatch wall and tin roof in all impact zones of the project area. According to BBS 2011, at the national level the highest 34.6% of the household heads lived in house made of CI sheet/wood in the walls, 16.7% of the households were found living with wall made of mud/brick/wood whereas, same material was found in the roof of 1.32% households, fence/straw/bamboo was observed in the wall of 15.9% households and 2.09% roofs of the households.

In the high impact zone, most of the housings (55.8%) are brick floor with tin wall and roof compare to 46.6% in the low impact zone. 28.5% of the households are with tin roof, tin wall

and earthen floor in the low impact area whereas it is 20.2% for the similar housing structure in the high impact area.

8.11 Transports and Communications

The only accessible route to the project site of Char Paka is using motor boats, locally known as ‘trawlers’ that are taken from ‘Alimnagar Ghat’ located in Chapainawabganj Sadar Upazilla. Chapainawabganj Sadar Upazilla is directly accessible by road transportations from Dhaka city. The journey from Alimnagar Ghat to Char Paka takes about 2 hours in the trawler boat. Upon reaching the island, one has to get off at ‘Char Paka Ghat’ from where the project site is about 3 km and can be reached via motor bike or another motor vehicle locally known as Nosimon. After reaching at Char Paka Chat, motor bike or Nosimon is used to reach project location which is another thirty minutes journey. The selected project site is thus about 11-12 hours away from Dhaka city, considering travel route by road and trawler.

Table 8.11: Transport & Communication Facilities of Shibganj Upazilla

Condition of Transport	Length (Km)
Pucca	44.54
Mud Road	212.37
Waterways	3*

Source: Banglapedia, 2015

*nautical miles

The Project location is on Char Paka, which is an island. Local boat transport to and from Char Paka is only possible by River.

8.12 Poverty

Almost all the families of Char Paka are engaged with some earning activities. During the field visit it was observed that people usually go to the town or further for better income. Female usually remain at home and do the household work. Among the employed people most are working in agricultural field, some work in industry outside char and rest are doing service.

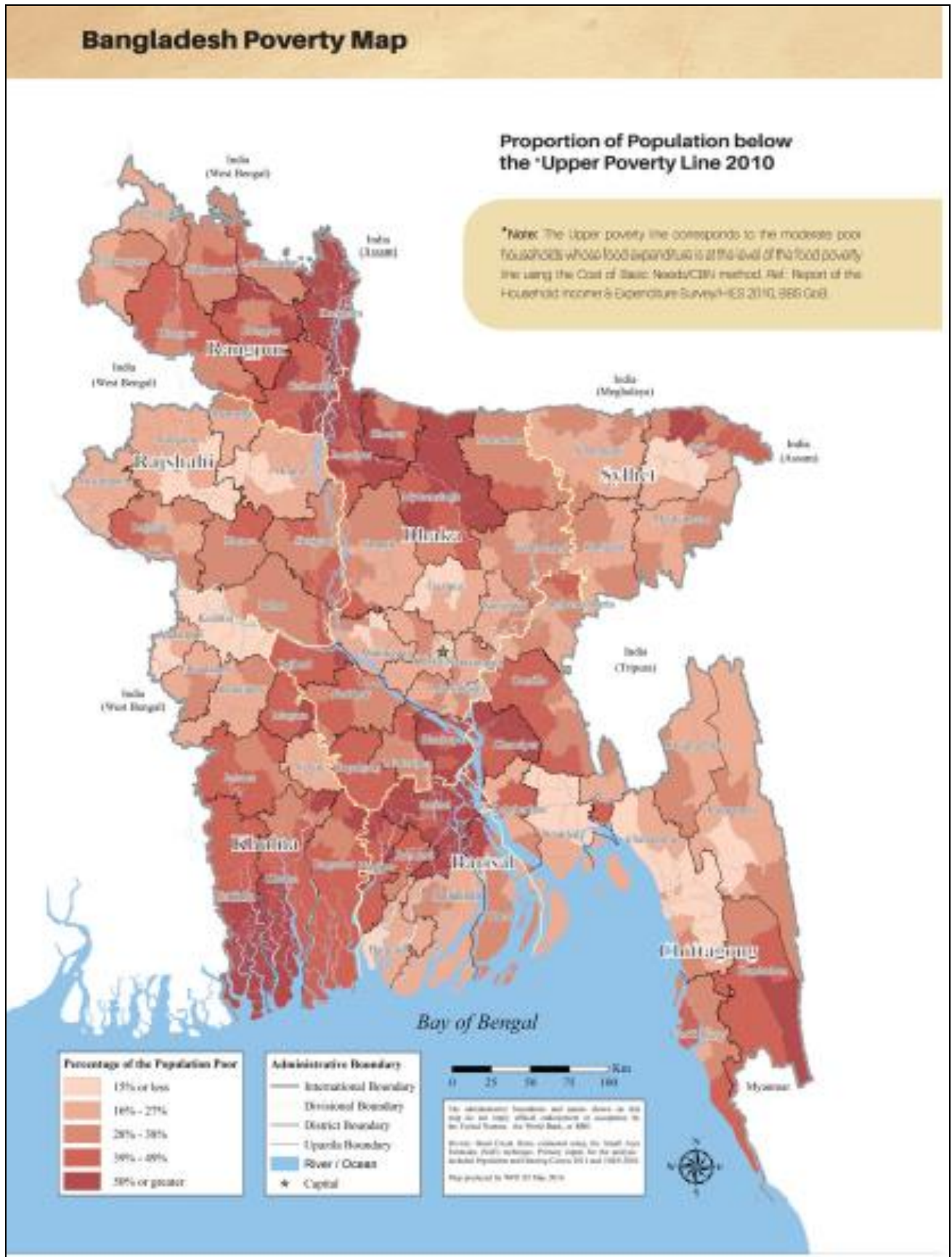


Figure 8.7: Poverty Map of Bangladesh (BBS/WFP/ World Bank-2010)

8.13 Survey of Environmental Issues

Environmental problems that are perceived by the respondents in the study area includes water pollution, air pollution, industrial pollution, noise pollution over population, deforestation, diseases, poor sanitation, arsenic contamination of ground water, sedimentation of water bodies etc.

According to the survey, the most pressing problem is air pollution in terms of the percentages of responses.

The survey reveals that, air pollution have been mentioned by 36.1% followed by industrial pollution (2.5%), water pollution (2.2%), and Burning fuel, trees and agriculture residue (1.6%). Besides, health and sanitation problem and over population have also been mentioned by 95.8% and 92.4% respectively as low status of problem. The survey also reveals that 5.2% of the households mentioned noise pollution as moderately impacted problem in the study area (Fig.8.8).

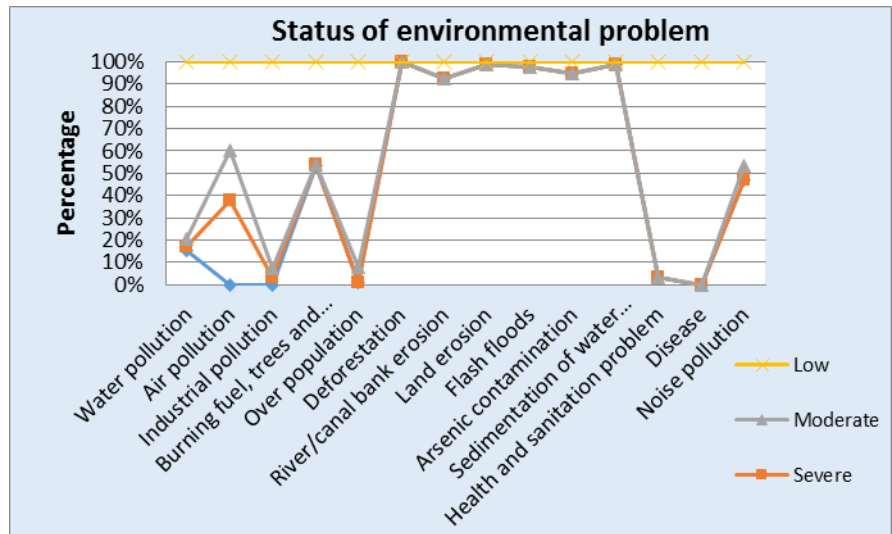


Figure 8.8: Status of environmental problem

8.13.1 Sources of Water Pollution

Respondents attribute water pollution to different sources including human waste, water transport, animal waste etc. Industrial waste has been identified by 1.0% of the respondents as the most pressing source of water pollution in the study area; other sources identified as low by the respondents include human waste (54.5%), urban waste (96.6%) and pollution from water transport is 53.1% in all impact zones of the study area (Fig. 8.9).

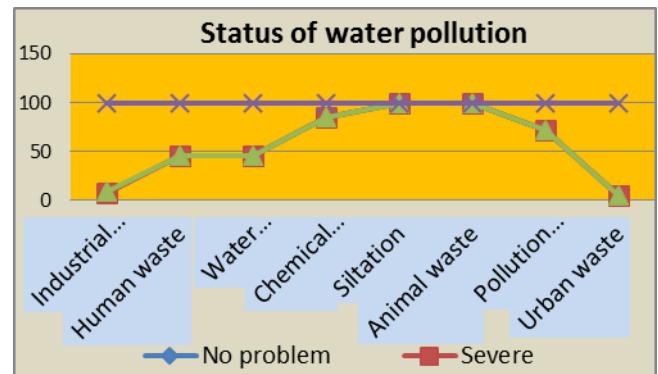


Figure 8.9: Status of water pollution

8.13.2 Sources of Noise Pollution

According to the survey, respondents have attributed noise pollution to different types of vehicles that ply over the roads in all impact zones of the study area. 3.2% of the respondents attributed noise pollution to vehicles, construction work (8.3%) as low impacted sources of noise pollution respectively (Fig.8.10).

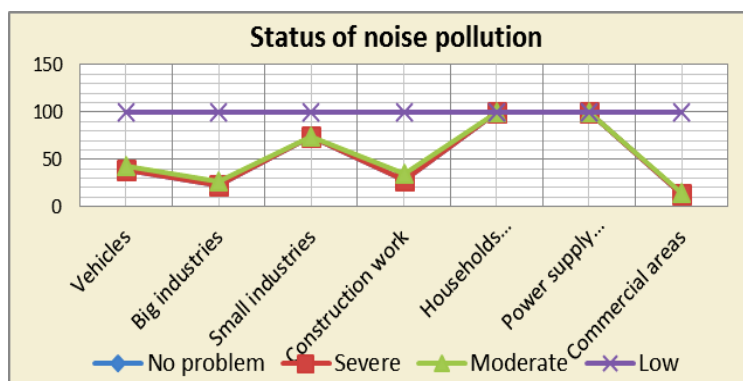


Figure 8.10: Baseline status of noise pollution

8.13.3 Sources of Air Pollution

According to the survey, respondents mentioned there are no big industries as the most pressing source of air pollution in the study area. Various sources which contribute to air pollution, identified as low problem by the respondents, include diesel engine (30%) and construction work (2.2%) has been identified as moderately impacted source of air pollution in all impact zones of the study area.

8.14 Respondents' Awareness and Perception about the Proposed Project

8.14.1 Respondents' Awareness about the Project

The survey reveals that 95.5% respondents in the study area are generally aware and have heard of the project. The survey also reveals that, rests of the 4.5% of the respondents do not have knowledge about the proposed project. In the high impact zone, 96.0% of the respondents have knowledge about the proposed project compare to 94.6% in the low impact zone of the study area (Table 8.12).

Table 8.12: Percentage Distribution of Households having knowledge about the Proposed Project

Study Area	Yes (%)	No (%)	Total (%)
High	95.5	4.5	100.0
Low	96.0	4.0	100.0
All	94.6	3.4	100.0

8.14.2 Project Affected People

According to the survey, 100.0% households would not be affected due to the project activities. 60 households in the high impact zone and 40 households in the low impact zone mentioned that they would not be personally affected due to the project (Table-8.13).

Table 8.13: Percentage Distribution of Households Surveyed Personally Affected due to the Project

Study Area	Yes	No	Total
High	-	60 (100.0)	60 (100.0)
Low	-	40 (100.0)	40 (100.0)
All	-	100 (100.0)	100 (100.0)

8.14.3 Perceived Positive Impacts of the Project

Respondents also perceived that various benefits were expected to result from the implementation of the project. These benefits, as perceived by the respondents, include; creation of employment opportunity, access to roads, enhanced socio-economic conditions, and overall national development in the area.

According to the survey, creation of employment opportunities is perceived as a beneficial effect of the project for 98.0% of the respondents. The implementation of the project will lead to national development, according to the opinion of 87.0% of the respondents. Enhanced local socio-economic activities and access to road infrastructure in the local area have been mentioned as positive outcomes of the project by 36.0% and 94.0% of the respondents respectively. Access to electricity (35.0%) and availability of irrigation water (10.0%) have also been mentioned by the respondents (Table 8.14).

In the high impact zone, creation of employment opportunities have been mentioned by 98.2% of the respondents whereas 97.5% of the respondents expect better access to infrastructure road in the low impact zone.

Table 8.14: Percentage Distribution of Households Surveyed Expecting Positive Impacts

Positive Impact	Study Area		
	High (n=60)	Low (n=40)	All (N=100)
More employment opportunity	98.2	97.5	98.0
Access to electricity	36.7	34.0	35.0
Access to infrastructure road	90.7	97.5	94.0
More local socio economic activities	32.3	40.0	36.0
Availability of irrigation water	15.0	2.5	10.0
National development	85.0	89.0	87.0

8.15 Health

The health facilities of this island are not satisfactory. There was no clinic found in the project influence area. However, as a result people have to go to Upazila health complex or to the district level hospitals or clinics for better medical facilities.

Sanitation 13.73% (rural 12.04% and urban 31.52%) of dwelling households of the upazila use sanitary latrines and 31.52% (rural 47.47% and urban 47.33%) of dwelling households use non-sanitary latrines; 47.33% of households do not have latrine facilities.

Table 8.15: Sources of Drinking Water of Shibganj Upazilla

Sources of Drinking Water	Percentage (%)
Tube-well	94.39
Tap	0.46
Pond	0.15
Others	5

Source: Banglapedia, 2015

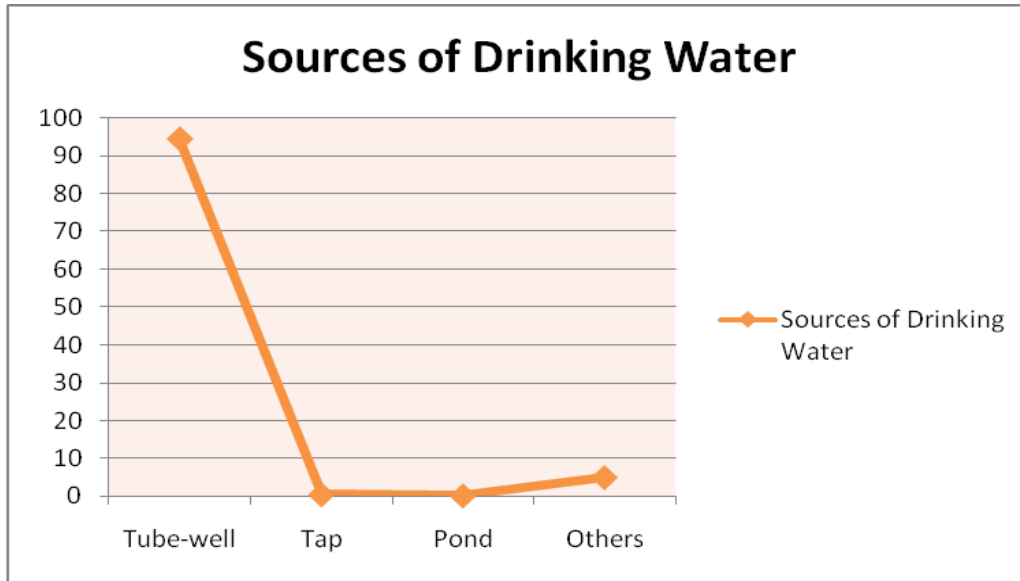


Figure 8.11: Sources of Drinking Water in the Project Area

The table below shows the number of health centers present in the Upazilla.

Table 8.16: Health Centers of Shibganj Upazilla

Health Centers	Number
Upazilla Health Center	1
Union Satellite Center	8
Health and family welfare centre	2
Mother and Child Health Center	1
Family Welfare Center	5
Satellite Clinic	128
Clinic	18

Source: Banglapedia , 2015

8.15.1 Morbidity in the Study Area

The survey has dealt with information on illnesses as experienced by the study population during the last twelve months. It has been found from the survey that the incidence of cold fever is very common among the study population. Cold fever responses came from more than 48.2% of all households during the last year preceding the survey. Other diseases include diarrhoea 6.7%, asthma 30.2%, jaundice 2.6%, hypertension 3.8%, diabetes 6.4%, stroke 0.5% and typhoid 1.8% (Fig.8.12).

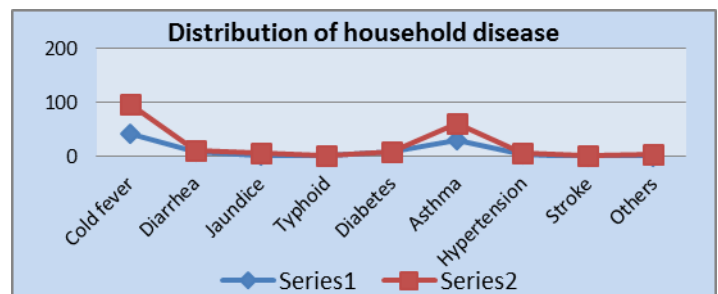


Figure 8.12: Distribution of household affected by different diseases

In the high impact zone, 44.8% of the households are affected by cold fever whereas it is 56.6% for the same disease in the low impact zone. Asthma has been mentioned by 30.4% of the households in the high impact zone compare to 28.8% in the low impact zone of the study area.

8.15.2 Average Number of People Affected by Different Diseases

According to the survey, on an average 1.5 adult male get cold fever whereas 1.2 adult female and 1.1 young boys get affected by the same disease. The survey reveals that on average 1.2 number of young girl get affected by asthma in the study area (Fig 8.13)

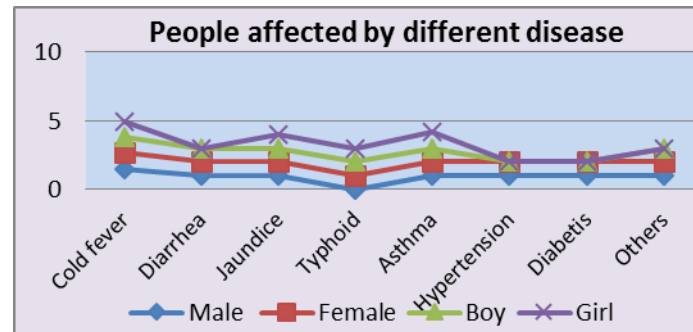


Figure 8.13: People affected by different disease

8.15.3 Sources of Treatment

For the purpose of medical treatment, people in the study area depend on different sources including private practitioner/doctor, upazilla health complex, pharmacy, homeopath etc. The survey shows that medicine shops/pharmacy is the main source of treatment for 47.8% of the households in the study area followed by private practitioner doctor (24.6%). Other sources of medical treatment services are kabiraj (9.4%), homeopathy (3.6%) and Upazila health complex (13.5%) in the study area (Fig.8.14).

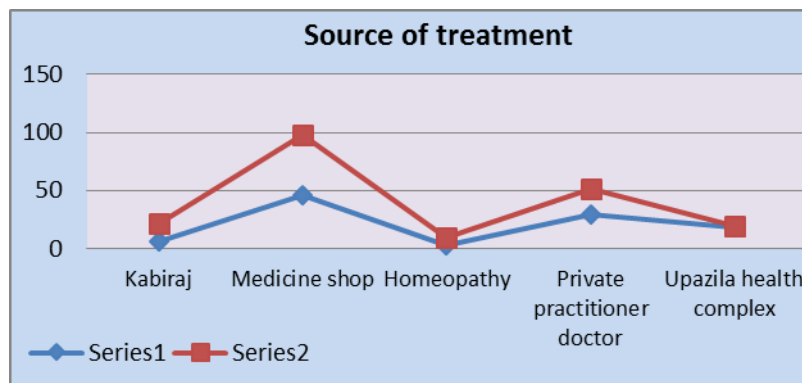


Figure 8.14: Sources of treatment

In the high impact zone, 42.8% of the households mentioned medicine shop as source of treatment compare to 54.2% in the low impact area. 26.8% of the households in the high impact zone mentioned private practitioner doctor as source of treatment whereas it is 24.4% in the low impact zone of the study area.

8.16 Recreational Activities

The social need for recreation has been identified as compulsory. The island people have very limited access to recreational activities. There is no such dedicated place or regular activities as recreational purpose. However, there are some houses have bought television but all the people do not have ability to buy the valuable means of recreation. Additionally, without having access to electricity the available television is not worthy at all in some times. Because of the lacking of electricity people in this area are not interested to establish any recreational center at all. The table below shows the number of cultural organizations present in Shibganj Upazilla.

Table 8.17: Cultural Organizations Present in Shibganj Upazilla

Cultural Organizations	Number
Library	1
Club	34
Theatre Group	4
Cinema Hall	6
Women's Organization	1
Playground	11

Source: Banglapedia, 2015

8.17 Archaeological and Cultural Resources

There is no archeological structure within this project. However, some religious structures are found within the project influence area. A list of such cultural physical properties has been given in Appendix G of this ESIA report.



Figure 8.15: Physical Resources in the Project Area

8.18 Important Environmental and Social Features (IESFs)

The environmental and social features include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, market places, water bodies, etc., few of which would be affected directly and indirectly through implementation of the project. Such sites could be termed as Important Environmental and Social Features (IESFs) in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major IESFs in the project area are shown in the Figure 8.16. A detail list of the IESFs located within 1km radius of the project area is presented in Appendix G.

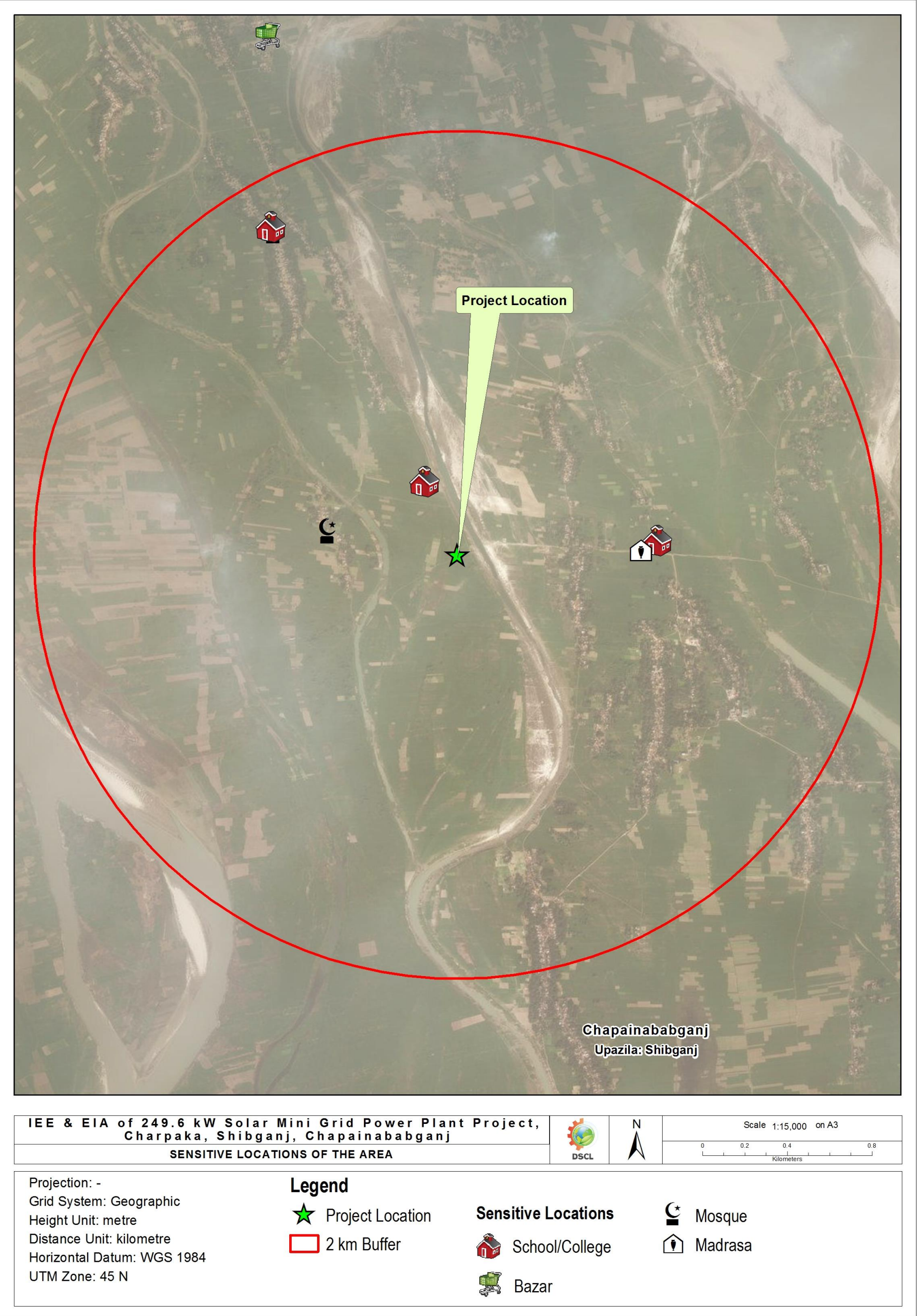


Figure 8.16: Cultural and Sensitive Structures within 1 km Radius of the Project Location

9 PUBLIC CONSULTATION AND DISCLOSURE

9.1 General

Public Consultation is a tool for managing two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement will increase a project's long term viability and enhance its benefits to locally affected people and other stakeholders. Stakeholder engagement is an integral part of ESIA good practice and is a statutory requirement of the national ESIA legal framework in Bangladesh and within the World Bank (WB) Policy on Environmental and Social Safeguards. The consultation program for the Project is based on informed consultation and participation in line with ESIA requirements with affected people, and is designed to be both fair and inclusive. Consultation activities have been conducted during the environmental survey of the ESIA in April 2017.

9.2 Objectives

The objective of stakeholder consultation is to ensure that a participatory approach takes place, which in turn documents concerns of all stakeholder groups and makes sure that such concerns are considered, responded to, and incorporated into the decision making process of the development. Stakeholder consultation needs to be a two-way communication process that imparts information to stakeholders, but also obtains additional and on-the-ground information from them. Stakeholder consultation and engagement must take place at the inception phase of the ESIA process and implemented all through the study period.

The specific objectives of this chapter are to:

- Summarize Developer, national and international legal & policy requirements for stakeholder engagement;
- Describe and identify the stakeholders affected and/or with an interest in the Project;
- Summarize stakeholder engagement and consultation conducted to date;
- Describe how the views and issues raised have informed and influenced the development of the Project; and
- Outline the future plans and approach to stakeholder engagement.

9.3 Consultation with Various Stakeholders

A stakeholder is defined as any individual or group who is potentially affected by the proposed Project or can they affect the proposed Project directly or indirectly. Stakeholder consultation is an inclusive process for sharing information that enables stakeholders to understand the risks, impacts, and opportunities of a development or project, allowing them to express their views and articulate their perceptions towards it.

Through the project preparation stage extensive consultations/FGDs have been arranged during the conduct of the ESIA surveys. The details of FGDs are given in the following Table 9.1. The findings of these FGDs are summarized in Table 8.2 and the details of these FGDs are given in Appendix H.

Table 9.1: Details of FGDs

FGD No.	Type of Participants	No. of Participants
01	Boatman, Social Worker, Farmer, Businessman, Mechanic	15
02	Farmer, Student, Businessman, Teacher	15
03	Doctor, Businessman, Service Holder, Farmer, Student, Imam	16
Total		46



Figure 9.1: Photos of Focus Group Discussions (FGD)

Table 9.2: Summary of the FGDs

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the Solar Mini grid Power Plant project? If yes, what are they?	Yes, the project proponent has shared this information with us. The company will establish Solar Power Plant and will distribute electricity among us. It is a good initiative for the local people.
How the project will impact on surrounding environment? Please mention both positive and negative sites.	The project will help in agriculture by providing electricity to pumps for watering as well as in health centers. It will facilitate in lighting, rice mill activities, and in household use of electricity.
Any air pollution in the area due to the project activities? If yes, how to	The air quality will not anticipate significantly because of construction and operation activities. Though more traffic

Questions to the Groups	Participants opinion, comments and suggestions
mitigate?	will run to carry construction materials which may spread dust around the area but it is not significant. Roads need to be constructed plain for carrying construction materials. As the project site is far away from residential dwellings so there is minor possibility of anticipated impact but proper care about battery, sensitive equipment etc. will minimize the anticipated impact. The proponent needs to take some attention to reduce this impact.
Any noise- impact of the project during construction and operation at the locality? If yes how to mitigate?	No significant noise impact during construction and operation of the project. As the project site is away from residential dwellings, construction noise will not impact much. After the construction is finished, the noise level will return to the previous limit. Boundary wall will reduce the noise produced during operation. The proponent needs to monitor the noise regularly during project operation also.
Any impact on local soil due to the project activities? If yes, how to mitigate?	As it will not harm agriculture anyway, there is no significant impact on local soil because of project activities. But the project proponent should take proper attention regarding any accident and the waste materials should be managed properly.
Any impact on ground/ drinking water quality due to the project? If yes, how to mitigate?	There is no problem with the groundwater quality because of the Solar Power Plant construction. However, the project proponent should confirm that no accidental spillage or washout of hazardous/waste material to surrounding water bodies during construction; particularly in the monsoon.
Any impact on the surface water body (river, pond, khal, beel, canal etc.)? If yes, how to mitigate?	There is no problem with the surface water quality because of the project construction. Although there is a beel beside the project side but that will not be affected by project activities. However, the project proponent should confirm that no accidental spillage or washout of hazardous/waste material to surrounding water bodies during construction; particularly in the monsoon.
Is the proposed area inundated during flood? If yes, how much?	Hence, the area is char land, during monsoon period low lying areas usually get flooded. But the project area may inundate only in very high flood. Moreover, the developer filled the land about 5 feet from the normal plinth level. So there is no risk of flooding of the project site.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	Available wildlife in the area are, birds (Patikak, Pigeon, Shalik, Babui, Chorui, Woodpecker, Maasranga, Duck, Ghughu, Vulture) snakes (Paharia, Daraj, Cobra, Water snake) crabs, fox etc. Among them fox, Vulture, Ghughu are endangered in this area.
Is there any particular sensitive area nearby the project that you think should be protected? If yes, where & how far	No particular sensitive area nearby the project area. But there are schools, mosques, graveyards and bazar within 0.5 to 1 km radius.

Questions to the Groups	Participants opinion, comments and suggestions
from the RoW?	
Are you in favor of this project? Why?	Yes, all the people of this char area appreciate this project initiative. This project in the long run will help to develop business, educational facilities, health facilities, economic and social condition in this area.

10 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

10.1 General

An Environmental Impact Assessment (EIA) presents the key instrument by which it is possible to eliminate these problems, as well as that a special attention within the EIA needs to be paid to:

- Avoid rough estimates, predictions and assessments based only on textual comments;
- The assessment of impacts of the planned project that will be based not only on identification of majority of impacts but also on consideration of different aspects of possible impacts.

This section identifies the overall impacts on the physical, biological and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities.

Here, it is of particular importance to choose a method which is based on the application of MCDM (Multiple Criteria Decision Making) in the field of environmental protection, because the use of the MCDM enables an analysis of different aspects of project impacts necessary for making decisions which optimize effects of certain activities relative to the capacity of space and environmental capacity. Methods based on the MCDM have a wide application in environmental impact assessment of proposed projects.

The Leopold matrix has been chosen as a suitable method. There are several major reasons why precisely this approach to EIA has been chosen as appropriate for further development:

- The Leopold matrix presents a framework approach to impact assessment of a project because of which it is possible to creatively work on its further development;
- It is widely applicable in carrying out an EIA for different types of projects. Given that it has been used for many decades now, its major principles are known to scientific and professional circles, thereby implying that the elaboration of the obtained results will be understandable to many scientists and experts;
- The way of presenting the results can be appropriate for overcoming the existing problems in the realization of solar projects in Bangladesh because descriptive and rough assessment of possible impacts is avoided in the practice of carrying out an EIA;
- Leopold matrix fits in the framework MCDM method.

In this EIA, we refer to the Leopold matrix as one of the pioneering and widely used approaches to impact assessment, which was the first comprehensive listing of environmental and socio-economic factors. This matrix is two-dimensional, where the stages of almost any type of construction project (actions) are assessed in relation to the existing environmental characteristics and conditions that may be affected during the execution of those actions.

10.2 Methodology of the Leopold Matrix

According to the Leopold matrix method, ESIA should consist of three basic elements: a) a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects; b) an evaluation of the importance of each of listed effects (e.g., regional vs. local); and c) a summary evaluation, which is a combination of magnitude and importance estimates.

The format of Leopold matrix revolves around 8,800 possible interactions since the number of actions listed on the horizontal axis in the sample matrix is 100, and the number of environmental factors listed on the vertical axis of this matrix is 88. As the authors of this method pointed out, there are, however, only a few of the interactions that would deserve comprehensive consideration due to their expressed magnitude and importance, varying between 25 and 50 interactions on average for a typical project (Leopold, Clarke, Hanshaw, & Balsley, 1971).

There is an opportunity in the Leopold matrix to double count impacts, therefore the method is not mutually exclusive. One of the strongest points of the Leopold matrix is that it draws a clear line and safeguards evaluator's opinion from the value judgments and political interference by policy makers. This is achieved by disaggregated presentation of detailed assessment results, leaving policy makers with full responsibility for the evaluation synthesis and for drawing its policy implications, and such point has been accepted as an evaluation standard for decades.

Potential environmental impacts associated with the proposed project activities of both the projects are classified as:

- (i) Impacts during pre-construction/design phase
- (ii) Impacts during construction phase and
- (iii) Impacts during operation phase.
- (iv) Impacts during decommissioning phase

Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. Impacts are described in the sections below.

10.3 Environmental Impact Assessment Using Leopold Matrix

For the analysis of possible impacts of certain activities and procedures during the construction of the solar mini grid power plant and its exploitation on the environmental elements, 3 possible factors, which are actually activities on the realization of the solar project, have been singled out from a wider list of potential factors of impacts that can be expected for such type of interventions in nature. Although it is possible to partially determine aggregate, i.e. average assessment of impact factors for each of these components, we consider that it is sufficiently appropriate and functional to present them as a whole. The fact is that some of them are synergistic ones, mutually reinforcing their effects, so that this matching of information should be maintained in the analysis. A synthetic presentation of endangering factors is given through mean values and not through aggregate assessment, which will be later scaled.

Impact factors have been evaluated separately for each environmental component relevant for the scope of this study, and scored on a scale from 0 to 5 for impact magnitude, according to the following scale:

- 0 – no observable effect;
- 1 – low effect;
- 2 – tolerable effect;
- 3 – medium high effect;
- 4 – high effect;
- 5 – very high effect (devastation).

In addition to the standard form of the Leopold matrix, the following criteria have also been used: Impact significance with designations from L to M, according to the following scale:

- L – limited impact on location;
- O – impact of importance for the area;
- R – impact of regional character;
- N – impact of national character;
- M – impact of cross-border character.

Impact probability with designations from M to I, according to the following scale:

- M – impact is possible (probability of less than 50%);
- V – impact is probable (probability of over 50%);
- I – impact is certain (100% probability).

Impact duration with designation P (occasional/temporary) and D (long-term/permanent).

Furthermore, physical, biological and socio-cultural environmental characteristics of the subject location have been separated and, within them, 14 environmental components have been defined.

Effects of impact factors have been assessed for environmental components of the subject location. The results of the analysis are shown in the following tables for all environmental components and impact factors in the form of Leopold matrix, and then elaborated in an appropriate way.

10.4 Corridor of Impact (CoI)

The corridor of the proposed Impact (CoI) was delineated as the extent, which has direct or indirect impact of project. All direct impacts are constrained within the project boundary. Indirect impacts could be beyond the project boundary. According to the Department of Environment (DoE) guideline the project impact area is divided into two sections. One, those related to the project. Another section is those related to the background environmental features of the project site. This should cover not only the project site in proper, but generally

an area of 1km radius around the site. In this project the farm area have been considered as core impact zone and 1km as buffer zone for better understanding.

10.5 Pre-construction Phase

Following is the brief description of impacts Envisaged during the Pre-construction/Design Phase:

10.5.1 Land Use / Land-filling

Impact

The Project site location does not conflict with any of the relevant governmental entities formal planning context. The project initiator has bought this land from the owner with a good value so there is no conflict in land use for the project purpose. In addition, the Project site does not provide any major value to local communities. Therefore, there are no anticipated impacts during the planning phase of the Project. However, the proposed solar power plant will be in the agricultural land which might ultimately degrade surrounding agricultural land as well. There will be some major impacts due to land-filling: Pollution from overflow of filled earth (dredged materials); Erosion from the filled materials and side slope of filled lands.

Mitigation

The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental and social management plan (ESMP). For example, the developer should advise contractor to must fenced the proposed area so that the surrounding agricultural land will not be disturbed. Since these activities are to be performed temporarily the minimum impact is expected to be acceptable. Land-filling for side slope of filled lands should be done only within the boundary line of the project to avoid damage to adjacent agricultural land, crops, trees or any other properties. In case of damage by any construction activity, adequate compensation should be paid to the owner in time.

10.5.2 Flood Hazards

Impact

The Project site is subject to potential risk of local flood hazards during the rainy season and especially during flash flood events. Such risks must be taken into consideration throughout the planning phase of the Project as they could inflict damage to the Project and its various components.

Mitigation

The Solar Power Plant area is in a risk of flooding due to its topography, rainfall storm pattern, soil type, etc. and the area needs to be protected from potential floods. The project developer should undertake a flood risk study which will generally aim to determine flood quantities within the Solar Power Plant area and to estimate peak flood to determine the peak flow for the return period of 50 years. The study will identify the required hydraulic design structure which would be able to convey the flows safely and prevent flood risks for the infrastructure elements within the Solar Power Plant under the responsibility of project developer.

10.6 Construction Phase

Environmental effects of the construction phase are expected to be temporary. Construction impacts are considered to be minimal as all the construction works will be carried out within the site boundary of the procured land and will be controlled via the mitigation measures defined in the ESMP section. Following is the brief description of impacts Envisaged during the construction phase.

10.6.1 Impacts of Transmission Line

Impact:

The biggest impact of transmission line is loss of forest cover and destruction of habitat for wildlife. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

However, it may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

Again, if the excavations for the lines are done through agricultural lands, the agricultural production will be hampered. And which in the long run will negatively affect the economy.

And lastly the excavations may cause harm to the utility lines like electric lines, telephone lines, and sewerage distribution lines.

Mitigation

- Before construction commences, undertake a fauna survey (through an ecological expert) to identify the presence of any key faunal species of importance (reptiles and mammals). Should viable populations of such key species exist within the Project site then it should be relocated outside of construction active areas.
- Implement proper management measures to prevent damage to the natural vegetation of the site. This could include establishing a proper code of conduct and awareness raising / training of personnel and good housekeeping.
- Implement proper compensation if any agricultural land is harmed.
- Should plan the layout in such a way that no utility lines are hampered and minimum vegetation and agricultural lands are disturbed.

10.6.2 Visual Amenity

Impact

The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.

The project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees or bushes will need to be removed as part of construction. Also, there are some close communities such as some residences that would be within the visual radius of the project. Therefore, visual intrusions are anticipated to be limited to employees. Hence, the visual effects of the construction will be of low significance within the project area and largely limited to effect only employees living in the company's temporary camp facilities during construction (if any).

Mitigation

The contractor must be careful while doing construction works as though the adjacent agricultural practices and close communities do not hamper.

10.6.3 Noise

Impact

Construction activities for solar power plant will contribute to noise impacts. There are several noise generating activities such as opening access roads to construction personnel camp and facilities (if needed), earthworks, haulage activities, excavation, backfilling, and installation of PV panels, and other equipment within the facility in addition to noise sources generated from machinery and equipment on site.

The project site is far from any cultural, religious site but there are some residences. These are the closest sensitive location to the project area. Hence, it can be said that the project site could not be a potential source of noise. However, some reptiles and mammals, within the project area can potentially be driven away from the site due to the sound levels.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor / Eastec Ltd. during the construction phase and which include:

- Apply adequate general noise suppressing measures. This could include the use of well maintained mufflers and noise suppressants for high noise generating equipment and machinery, developing a regular maintenance schedule of all vehicles, machinery, and equipment for early detection of issues to avoid unnecessary elevated noise level, etc.
- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented etc.; and

Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high noise levels, workers are equipped with proper Personal Protective Equipment (e.g. Earmuffs).

10.6.4 Water Resources

Impact

Surface water quality in the adjacent rivers, channels and ponds might insignificantly degrade during construction stage due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, and noxious chemicals. The problem will be more dangerous if the construction work will continue even in the monsoon

when the flood occurrence is very high. There will have no major impacts on ground water quality due to the construction of solar power plant.

Mitigation

In order to minimize the adverse impact on water quality, the following mitigation measures are proposed:

- The contractor will dispose of the debris material to a designated disposal site.
- All reasonable measures will be taken to prevent the wastewater produced in construction from entering into creek and stream.
- Contractor's camp will be provided with sanitary latrines that do not pollute surface waters.
- The ground water in the project area has been used for different purposes like drinking and irrigation, hence proper mitigation measures must be ensured at construction site to avoid any spillage and leakage of oil. All the staffs at construction areas must be refrained of discharge any liquid wastes on the ground.

10.6.5 Air Quality

Impact

The main impacts associated with construction activities will be:

- 1) Exhaust emissions:** Exhaust emissions of SO₂, NO_x, CO, CO₂, and PM₁₀, PM_{2.5} will be attributed predominantly to the operation of the construction plant and road vehicles such as movement of vehicles during construction works. These emissions will be limited to the project area and are anticipated to be generated in small concentrations and dispersed rapidly within the area leading to an impact of low significance. This means that these effects are localized and temporary which implies that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient.
- 2) Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase (to prevent impacts caused by their construction activities and which are within their control) and which include:

- Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high dust levels, workers are equipped with proper Personal Protective Equipment (e.g. masks, eye goggles, breathing equipment, etc.);
- Apply basic dust control and suppression measures which could include:
- If dust or pollutant emissions were found to be excessive, construction activities should be stopped until the source of such emissions have been identified and adequate control measures are implemented;

- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Regular watering of all active construction areas.
- Develop a regular inspection and scheduled maintenance program for vehicles, machinery, and equipment to be used throughout the construction phase for early detection of issue to avoid unnecessary pollutant emissions.
- Proper management of stockpiles and excavated material (e.g. watering, containment, covering, bunding).
- Proper covering of vehicles transporting aggregates and fine materials

10.6.6 Terrestrial Ecology

Impact

It may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, asphaltting, paving and the operation of construction machinery and equipment. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase and which include:

- Implement proper management measures to prevent damage to the natural vegetation of the site. This could include establishing a proper code of conduct and awareness raising / training of personnel and good housekeeping which include the following:
 - Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off roading to minimize disturbances
 - Prohibit hunting at any time and under any condition by construction workers onsite
 - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures Ensure proper storage, collection, and disposal of waste streams generated
- Before construction commences, undertake a fauna survey (through an ecological expert) to identify the presence of any key faunal species of importance (reptiles and mammals). Should viable populations of such key species exist within the Project site then it should be relocated outside of construction active areas;

- Ensure that the fencing constructed for the Project site allows for the natural movement of small faunal species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30cm);

10.6.7 Soil

Impact

Impact to soil is waste generation from construction material, accidental leakage of fuel, oil, or chemicals stored within a bounded area causing direct contamination to soil which may degrade lower layers of soil depending on the amount of spills.

Construction activities are expected to result in significant soil loss. The excavation, leveling and other earthworks are the possible source to disturb the soil due to the removal of top soil, which could trigger soil erosion process. Additionally, the proposed project area is flood prone and needs huge amount of land filling. The total area is 99 decimal.

Mitigation

The filling material should be collected from the approved source dredging location with proper care so that no spillage will be happen. Retention wall or water proof boundary with plastic material should be constructed before the dredged material placement to prevent the spillage from site to adjacent agricultural land.

Assuming that spill response plans shall be in place by the contractor, it is anticipated that impacts to soil resulting from these activities will be likely, with a marginal consequence, yielding medium impact significance.

10.6.8 Waste Generation

Impact

Non-hazardous waste includes paper, wood, plastic, scrap metals, glass and mud.

Improper management of non-hazardous and hazardous waste generated during construction may lead to impacts on soil, water, visual environment, in addition to health and safety of workers.

Hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

Mitigation

All waste generated at construction site will be managed as per Contractor's Waste Management procedures. Domestic wastewater generated at site will be collected in septic tanks. These shall be transported to the nearest approved municipal wastewater handling facility, and solid wastes shall be disposed of in a secured area for trash.

10.6.9 Traffic

Impact

Vehicle traffic can cause congestion on road networks around and within the site and thereby leading to potential accidents.

During the construction phase traffic is expected to increase to a certain degree due to the nature of activities that will take place such as the transport of equipment and materials to and from the site through the surrounding road network. Additional traffic load will be evident at certain times during the day, especially if there are slow moving heavy vehicles transporting material to and from the site.

The above potential traffic impacts can possibly occur during the construction, especially during working hours. However, this is considered a short-term impact. This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment.

Mitigation

Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction and follow it strictly. However, minimum numbers of vehicles will be used for carrying construction materials and most of them will be non-motorized vehicle. Hence, the accidental loss is expected at the lowest. Moreover, the project authority will try to carry the construction materials during post monsoon when the water level remains the maximum so that the boat can reach at the closest point of the project location.

10.6.10 Archaeology and Cultural Resources

Impact

The field visits conducted and it is found that there are schools, madrashas, mosques, and bazars present at the project site. So, it is concluded that there is no anticipated impact from construction on these receptors; therefore the impact assessment process for this receptor has yielded the low significance.

Mitigation

This impact is temporary and minor negative in nature. Mitigation measures will include:

- Establishment of construction site camp and labour camp must maintain proper distance from the cultural sites.
- Timely completion of the construction work and provision of alternative routes during the construction;

10.6.11 Employment Opportunities

Impact

Positive benefits of the project may arise either from short-term job opportunities during construction, or long-term job opportunities during operation. It is important that construction and operation jobs to be targeted to the local people within *Char Paka* where feasible.

Recommendation

Contractor as far as practicable will recruit construction workers from amongst the locals where possible, and shall maintain gender equity while employing the locals. Priority shall always be given to people from amongst the PAPs and from those unemployed and belong to the lower income group. Additional benefits will be derived by setting aside-areas within contractor camps/labour shed for local people to sell their products or to provide additional

services to the workers. Replacement on a suitable location in a better form will be done with the help and consent of the affected local community.

10.6.12 Health and Safety

Impact

The construction activities include site preparation, infrastructure utilities installation, building structures. Therefore, there will be potential impacts on workers' health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. Construction works and activities bear frequent accident and health risks for both the laborers and the public general, with varying direct and indirect consequences. Therefore, the project authority needs to make provision for specific medical services, workers insurance policies and indemnities, emergency provisions and a rescue/evacuation plans in case of major accidents.

Mitigation

The project authority will be requested to prepare an approved Construction Environmental Action Plan (CEAP), which will, among others, delineate all work safety aspects he intends to apply. Focal points of the CEAP will relate to means, type and number of protective clothing, safety precautions at specific work sites, first aid, rescue plans, work hours, and all intended measures for avoiding or proper clearance of hazardous substances, including fueling operations, transport and handling of hazardous materials and explosives, securing measures etc. The CEAP will further explain methods and volumes for using any local resource, and how to address common risks associated with public safety. The project authority will disclose the CEAP with the local stakeholders for further developments on the health and safety issue.

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

10.7 Operational Phase

Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. In order to achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, in order to reap the full environmental benefits of the activities and ensure environmental enhancement it would be necessary to implement the following which are beyond the purview of this project and may require national level involvement.

10.7.1 Visual Amenity

Impact

The presence of a large area of PV panels is not expected to constitute a risk for glare since it is situated far from any significant areas, nor residential dwellings, moreover, no potential visual disturbance to birds are expected given the fact, and as a result, there is no migratory birds fly way over the project area.

Mitigation

It is essential to point out that the intensity of light reflected from a PV module surface depends on factors such as the amount of sunlight reaching the surface and will therefore vary based on, among others, geographic location, time of year, cloud cover, and PV module orientation.

It is not anticipated that visual impacts will be generated due to the PV system design, which is specifically designed to include dark, light-absorbing materials and covered with an anti-reflective coating (ARC) for glass surfaces, which reduces the reflectance from PV panels to 2.5%-2.6% while at the same time improving their efficiency.

10.7.2 Water Resources

Impact

Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster infrastructure development near the project area. This will exert stress on the availability of groundwater in the project area.

The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/runoff from plant area. The pollutants associated with the plant activities include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from plant chemicals such as batteries etc.

Mitigation

The following mitigation measures are proposed to attenuate water quality related impacts:

- Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared.
- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.
- The surface water quality monitoring will also be carried out at defined intervals and for environmental quality monitoring parameters suggested in the Environmental Monitoring Plan. If these parameters are above the prescribed limits, suitable control measures will be taken;

10.7.3 Air Quality

Impact

It is worth mentioning that solar power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and

the greenhouse gas carbon dioxide during operations compared to fossil fuel power generation facilities, since solar power plants do not involve combustion processes.

No emissions are expected to be released during the operation phase, due to the fact that solar PV power plants do not release greenhouse gases or any toxic pollutants during their operation, as a result, no impacts on ambient air quality are anticipated during the operation phase. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance.

Mitigation

Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery.

The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the ESMP included in this report.

Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally.

10.7.4 Noise

Impact

Noise generated from inverters is only heard when distance is close (i.e. within 1-2 m, however, as distance increases, noise will be greatly reduced, not to mention that they do not generate noise during night time. The most significant noise source of this solar power plant is from the backup diesel generator (150 kVA). To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants. Photovoltaic (PV) systems make no noise and cause no pollution in operation. Solar energy is clean, silent, and freely available.

The solar power as a facility is not considered to exhibit any significant noisy operations, although the facility's inverters and transformers may produce noise, but this is not considered a serious issue, since they will not generate any significant noise. In addition, there are some close by sensitive receptors such as a school and some residential dwellings within the project site.

Mitigation

The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. The increased noise levels are considered occupational noises that require occupational health and safety measures. These

noise impacts are not considered to significantly harm animals nor cause impacts on a population level. However, the noise from diesel generator needs to take action for mitigation. The worker inside the project area should use earmuffs during the operation of diesel generator.

10.7.5 Terrestrial Ecology

Impact

The project area does not encompass any natural systems. The anticipated impacts on terrestrial ecology is considered low, however, activities such as vehicular movement, may cause disturbance to resident birds and their ground nests.

Mitigation

The anticipated impacts on terrestrial ecology are considered low and hence no particular mitigation measure should be followed. However, the vehicular movement should be very limited and proper attention should be given to minimize the disturbance on surrounding ecological environment.

10.7.6 Soil

Impact

Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. However, since the project area is designated for solar projects near roadside and settlements area, they do not have any agricultural significance. Another most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality.

Mitigation

Through implanting spill response procedures, and proper storage and handling of any chemicals on site, the impact probability will be reduced. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.

10.7.7 Waste Generation

Impact

PV modules: Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide (CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

PV modules wastes are the other waste besides the lead-acid battery and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Lead-Acid Battery: One of the most important components of solar mini-grid power plant is Lead-acid battery. Improper disposal and recycling of lead acid storage batteries result in lead sulfate contamination in lands and water bodies. Through percolation, lead sulfate can contaminate groundwater and transfer up the food chain.

Waste generated during operation phase will be limited to wastewater from maintenance and cleaning activities in addition to domestic waste (due to workers domestic activities).

Others: Waste generation during the operation phase is considered part of daily operations, therefore, it is not considered to have any significant impacts to the environment or health of personnel present on site.

Mitigation

Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery.

The lead-acid battery which will be used in the project has a 7-years warranty. During entire life-time these will only need to be refilled with water sometimes. After the life period is ended each battery will be collected by the supplier-manufacturer and will be duly recycled. However, a proper temporary storage facility is needed for the wasted batteries to avoid potential lead contamination.

10.7.8 Traffic

Impact

Impacts from traffic are not expected to occur during the operation phase due to minimal number of personnel present within the project site. Therefore, increased traffic load is not considered a significant impact.

Mitigation

This impact is temporary and minor negative in nature and can be mitigated by providing proper alternative traffic management plan during operation of the power plant.

10.7.9 Employment Opportunities

Impact

During the operation phase job opportunities will be created for executing the project activities. Local people can be involved in the project activities as per their skill.

Mitigation

During the recruitment of workers and other professionals, local poor and distressed people followed by project affected people and poor women should be given priority as per their competence and skill. While recruiting and giving wage gender equity must be maintained.

10.7.10 Health and Safety

Impact

There are many hazards associated with a solar PV power plant if sufficient precautions are not taken during the operation stages. The impact origins are in the following sectors:

- Leaching of materials from broken or fire damaged PV modules
- Entering of lead (Pb) into human body from lead-acid battery
- Electrocuting of workers
- Acid hazard during battery handling
- Electromagnetic radiation from PV modules
- Emergency Fire Hazard

Leaching of materials from broken or fire damaged PV modules: The potential for chemical releases appears to be small since the chemicals are present in the sealed PV modules when completed installations of photovoltaic systems for power generation. Releases are likely to occur only due to fires or other unusual accidents. Cadmium could be a potential concern in this setting with thin-film technologies, as would arsenic and zinc to a lesser extent. Other chemicals that have inhalation toxicity factors are present only during the manufacturing process. Solar PV modules may contain heavy metals like lead, mercury, cadmium, chromium, polybrominated biphenyls (PBBs), or brominated diphenylethers (PBDEs) etc. Leaching of metals from the installed modules is not likely to be a concern, as documented in a study by Steinberger (1998). Leaching from small cells used in electronic devices is also unlikely to be a concern, given the small amounts of chemicals present and the sealed nature of the devices.

Entering of lead into human body from lead-acid battery: Lead can enter body in two ways: by breathing or by swallowing it. Lead Sulfide dust enters the body through breathing. Very fine lead particles may penetrate into the lungs result in absorption in the bloodstream. In addition, there is an impending threat for the workers due to the inhalation of lead fumes. Long exposure to lead pollution may result the adverse impact to nervous system and causes headaches, dizziness, irritability, memory problems, and disturbance in sleep. It can affect the digestive system and cause nausea, vomiting, constipation, appetite loss, and abdominal pain. Lead also affects formation of blood and can result in anemia. Too much lead can also cause miscarriages and stillbirths when pregnant women are exposed to lead. In men, the sperm can be affected and this may result in infertility.

Electrocution of Workers: Risk of electrocution of workers during performing duties in a power plant is always present. Faulty electrical equipment, electric short circuits, exposed electrical wires may be the chief sources of electrocution. Damaged PV modules with exposed high voltage conductor also present high risk of electrocution.

Acid hazard during battery handling: The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. Eastec Ltd. will not store any acid in the project site as the batteries will need only to be refilled with water sometimes. However, acid spilling during watering process or acid splash on to the workers body is not deniable.

Electromagnetic radiation from PV modules: The strength of electromagnetic fields produced by photovoltaic systems do not approach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. Moreover the small electromagnetic fields produced by photovoltaic systems rapidly diminish with distance and would be indistinguishable from normal background levels within several yards.

Emergency Fire Hazard: Since this is a power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. In the event of fire catching a solar module, it is theoretically possible for hazardous fumes to be released and inhalation of these fumes could pose a risk to human health. However, researchers do not generally believe these risks to be substantial given the short-duration of fires and the relatively high melting point of the materials present in the solar modules. Moreover, the risk of fire at ground-mounted solar installations is remote because of the precautions taken during site preparation including the removal of fuels and the lack of burnable materials mostly glass and aluminum contained in a solar panel.

Mitigation

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

The project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks during operation phase including all safety prevention and mitigation measures to avoid non-conformance events.

10.8 Decommissioning Phase

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, some of the major impacts are described below.

10.8.1 Visual Amenity

Impact

During the dismantling of the solar power plant, removal of ancillary facilities, and the rehabilitation of the project area (if needed), visual intrusions will be likely.

Mitigation

Their consequence will be negligible due to fact that such impact would be temporary (over a short period). Moreover, the actual dismantling of the solar power plant will reduce or remove the visual impacts witnessed during the operation phase.

10.8.2 Air Quality

Impact

Similar to construction, the decommissioning phase is anticipated to generate dust and exhaust emissions. Decommissioning activities will involve site preparation, dismantling and disassembling of the components of the solar power plant facility, clearance of the site, and rehabilitation if needed.

Mitigation

The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the environmental management plan (EMP) included in this report.

10.8.3 Noise

Impact

The decommissioning activities of dismantling the solar power plant and removing the ancillary facilities are associated with potential increased noise levels. The receptors of the increased noise level will be only the workers of decommissioning activities.

Mitigation

As the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the solar power plant, these increased noise levels are considered occupational noises that require occupational health and safety measures.

10.8.4 Terrestrial Ecology

Impact

The activities associated with decommissioning will involve dismantling of the solar power plant and removal its facilities. This is a temporary phase that could result in some additional noise and dust disturbances. These activities are not anticipated to harm any flora elements due to absence or scarcity of vegetative cover within and around project area, provided dust suppression measures and other procedures are followed. On the other hand, decommissioning activities may cause disturbance to bird species.

Mitigation

The mitigation measures should be the same as it was considered during the construction phase since the decommissioning activities will be same as construction phase.

10.8.5 Soil

Impact

During the decommissioning phase, the decommissioning activities are anticipated to have an impact of medium significance to soil. This is due to possible accidental leakage of fuel, oil, or chemicals during demolition activities.

Mitigation

Proper environmental protection measures should be followed to prevent or control the occurrence of such incidences. Take proper attention in removing the PV panels to prevent any damage as it contains chemicals and might be harmful for soil quality.

10.8.6 Waste Generation

Impact

It is not expected that hazardous wastes will be generated from dismantling the solar power plant since the project developer will opt for recycling PV panels of the facility.

Waste generated during decommissioning limited to non-hazardous and inert wastes such as scrap metals, paper, wood, plastic, given that the contractor will adhere his waste management procedures.

Similar to the construction phase, potential generation of hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

End-of-Life Solar Panels: While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module.

The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies.

PV modules and others: Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide (CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

PV modules wastes are the other waste besides the lead-acid battery and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Mitigation

The following identifies the mitigation measures to be applied by all involved entities:

- If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste;

- Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.
- Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another.
- Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for;

10.8.7 Traffic

Impact

The anticipated impacts during decommissioning are similar to those for the construction phase, where the heavy machinery that transports disassembled parts of the project solar power plant facility might be of more significance than normal vehicles and pickups.

Mitigation

Proper management actions with adequate mitigations can reduce significantly such anticipated impacts.

10.8.8 Employment Opportunities

Impact

Short-term job opportunities may be arise during decommissioning, however, this can negatively impact permanent personnel at the solar power plant since the facility will cease its operations, therefore permanent staff may lose their jobs.

Although this impact is very unlikely given that fact that an upgrade is expected for the facility during its post-design life, however, the consequence is considered critical to permanent personnel if the facility underwent decommissioning, yielding a low impact significance.

Recommendation

Preference should be given to employing the local communities in various positions.

10.8.9 Health and Safety

Impact

The decommissioning activities will include equipment dismantling and demolishing facilities at project site. As all project components will be recycled after decommissioning, the prospect risks from decommissioning phase will be limited to dismantling and demolishing activities including moving all recyclable components to their final destination.

There will be potential impacts on workers' health and safety due to exposure to risks through decommissioning activities.

Mitigation

The project developer will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The developer shall ensure all prospect risks during decommissioning phase are assessed and all prevention and mitigations measures are in place accordingly.

10.9 Elaboration of the Assessed Effects of Impact Factors on Environmental Components

10.9.1 Physical Components

Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster infrastructure development near the project area. This will exert stress on the availability of groundwater in the project area.

Geological impacts are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation.

Certain negative effects of the plant can occur in the phase of the solar mini grid power plant construction as a result of the realization of certain planning concepts. These impacts include air pollution caused by construction equipment and vehicles, as well as by created dust. The total average value of magnitudes of expected impacts of construction phase of the subject project on air quality is within low effects of local character. The total average value of magnitudes of expected impacts of the project on noise levels is within medium effects (2).

10.9.2 Biological Components

The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, asphaltting, paving and the operation of construction machinery and equipment. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

The project area does not encompass any natural systems. The anticipated impacts on terrestrial ecology is considered low, however, activities such as vehicular movement, may cause disturbance to resident birds and their ground nests. The total average of magnitude of expected impacts of the subject project on flora and fauna is within negligible effects (0.67).

10.9.3 Socio-Cultural Components

The total average impact factor for these components falls into the category of low effects. The reason for this is because the location is isolated. The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.

The project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees or bushes will need to be removed as part of construction. Also, there are some close communities such as some residences that would be within the visual radius of the

project. Therefore visual intrusions are anticipated to be limited to employees. Hence, the visual effects of the construction will be of low significance within the project area and largely limited to effect only employees living in the company's temporary camp facilities during construction (if any). The total average of magnitude of expected impacts of the subject project on the landscape is within low effects (1.33).

The Project site location does not conflict with any of the relevant governmental entities formal planning context. The project initiator has bought this land from the owner with a good value so there is no conflict in land use for the project purpose. In addition, the Project site does not provide any major value to local communities. Therefore, there are no anticipated impacts of the Project. However, the proposed solar power plant will be in the agricultural land which might ultimately degrade surrounding agricultural land as well. There will be some major impacts due to land-filling: Pollution from overflow of filled earth (dredged materials); Erosion from the filled materials and side slope of filled lands. The total average of magnitude of expected impacts of the subject project on land use is within negligible effects (0).

Table 10.1: Matrix of Magnitude of the Impact Factors on Environmental Components

	Envisaged Impact Factors	PROJECT ACTIVITIES			Sum of IF Values by Types	Average Values
		Planning & Construction Phase	Operation Phase	Decommissioning Phase		
Physical Components	Land filling/Earthworks	4	0	0	4	1.33
	Infrastructure & Utilities	0	0	4	4	1.33
	Transmission Line	1	0	0	1	1
	Geology & Hydrology	4	2	2	8	2.67
	PV Panels, Battery	0	4	0	4	1.33
	Backup Generator	0	3	0	3	1
	Air Quality	1	1	2	4	1.33
	Noise	2	2	2	6	2
	Waste Generation	4	0	0	4	1.33
Biological Components	Diversity of Flora	1	1	0	2	0.67
	Diversity of Fauna	1	1	0	2	0.67
Sociocultural Components	Socioeconomic Conditions	0	0	0	0	0
	Landscape and Visual	3	1	0	4	1.33
	Land Use	0	0	0	0	0
	Health & Safety	2	1	2	5	1.67
Cumulative Values of IF according to Environmental Factors		23	16	12		
Average		.53	1.14	0.86	IF = 1.18	

Table 10.2 Matrix of Significance of the Impacts of Factors on Environmental Components

	Envisaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	L		
	Infrastructure & Utilities			L
	Transmission Line	L		
	Geology & Hydrology	L	L	L
	PV Panels, Battery		L	
	Backup Generator		L	
	Air Quality	L	L	L
	Noise	L	L	L
	Waste Generation	L		
Biological Components	Diversity of Flora	L	L	
	Diversity of Fauna	L	L	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	L	L	
	Land Use	L		
	Health & Safety	L	L	L

Table 10.3: Matrix of Probability of the Impact of Factors on Environmental Components

	Envisaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	V		
	Infrastructure & Utilities			M
	Transmission Line	M		
	Geology & Hydrology	M	M	M
	PV Panels, Battery		V	
	Backup Generator		I	
	Air Quality	V	V	V
	Noise	V	V	V
	Waste Generation	M		
Biological Components	Diversity of Flora	M	M	
	Diversity of Fauna	M	M	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	M	M	
	Land Use			
	Health & Safety	M	M	M

Table 10.4: Matrix of Duration of the Impact of Factors on Environmental Components

	Envisaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	P		
	Infrastructure & Utilities			D
	Transmission Line	P		
	Geology & Hydrology	P	P	P
	PV Panels, Battery		D	
	Backup Generator		D	
	Air Quality	D	D	P
	Noise	D	D	P
	Waste Generation	P		
Biological Components	Diversity of Flora	P	P	
	Diversity of Fauna	P	P	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	P	D	
	Land Use			
	Health & Safety	P	P	P

10.10 Effects of Cumulative Impact Factors on Environmental Components

In Table 10.1, the activities in the implementation of the project, most impact will occur on the geology and hydrology of the area.

The biological components are vulnerable primarily. However, their effects range low. The average assessment of effects of cumulative impact factors on environmental components is 1.18. This impact factor value is within low effects.

10.11 Discussions & Conclusion

All the above mentioned is the standard procedure in using the Leopold matrix which is a procedure for quantitative expert evaluation of planned activities related to the magnitude (intensity) of impact. However, by applying such approach, the spatial dispersion of identified impacts, and probability of identified impacts actually occurring and, finally, the duration of identified impacts, still remain unclear. In this context, the idea was to additionally build the additional aspects into the Leopold matrix in form of a group of criteria that would be used in additional evolution of the planned project activities, assuming that the presentation and elaboration of obtained results would give to the public a complete picture of real impacts that could be expected in the realization of the project.

The presented results that have been obtained using multicriteria analysis and evaluation have been surprisingly well received in the procedure of discussion and public insight in EIA for the project. The reason lies in the fact that adverse reaction of a part of the public has changed when it has been proven that certain identified negative effects will be micro-localized and that they will be only of a temporary character, as well as that they will occur only in a short period of time, which is, for example, the case with possible pollution during the wind farm construction. Or, when it has been shown that increased levels of noise caused by the plant will be dominant only near the sound source, as well as that spatial dispersion of noise levels will exclude the possibility of exposure to higher levels of noise of the people living in the closest residential buildings considering their distance from the solar power plant.

It can be concluded that the applied approach has yielded good results in overcoming the problems in the realization of the project and that it is also possible to successfully use this approach for other similar projects in the field of implementation of renewable energy (RE) sources. In addition, the use of multicriteria analysis and evaluation provide to decision makers the possibility of considering possible effects of the project on the environment, as well as make the decision-making regarding the choice of optimal solutions a lot simpler. This is particularly important for Bangladesh because this will enable easier realization/implementation of renewable energy projects from the aspect of environmental conservation.

Future research directions for the EIA method, as well as for its development, could be also reflected in highlighting the positive implications of projects in the field of implementation of renewable energy (RE) sources, actually that the multi-criteria evaluation should not be based only on the identification and dominant presentation of negative effects of a planned project, but also on a balanced presentation of both the positive and negative effects, in this way bringing greater objectivity to the process of impact assessment. In this process, a special attention is to be dedicated to the use of: GIS tools; and mathematical methods and

models in the process of environmental impact assessment in order to minimize subjectivity in this process, as well as in the decision-making process.

11 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

11.1 General

The Environmental and Social Management Plan (ESMP) aims to ensure the compliance of all activities undertaken during the implementation and the operation of the proposed project with the environmental safeguard requirements of the Donor and Government of Bangladesh. Furthermore, it aims at integrating the environmental components of the project with existing initiatives and programs in these fields. The plan consists of mitigation, monitoring and institutional measures to be taken during implementation and operation to eliminate adverse environmental impacts, offset them, or reduce them to acceptable levels. The plan also includes the actions needed to implement these measures.

11.2 Objectives

This Environmental and Social Management Plan (ESMP) aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

The key objectives of the ESMP are summarized below:

- Conducting all project activities in accordance with relevant Bangladesh Legislation and applicable World Bank guidelines.
- Minimizing any adverse environmental, social and health impacts resulting from the project activities;
- Ensure that all stakeholder concerns are addressed. Implementation of on-going environmental monitoring programs;
- Periodic review of the Environmental Management programs to allow for iterative improvement;

Overall, this ESMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

11.3 Environmental and Social Management Plan (ESMP)

On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Solar Mini-grid Power Plant project activities, an ESMP has been prepared which will be followed at the pre-construction, construction, operation and decommissioning stages. While preparing the ESMP, medium and significant impacts are taken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by JICA Guidelines for Environmental and Social Considerations / World Bank Safeguard Policies, and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied.

Table 11.1: Environmental and Social Management Plan (ESMP) of Solar Mini-grid Power Plant Project

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction Phase						
Land Use / Land-filling	The proposed plant will degrade surrounding agricultural land.	Land-filling for side slope of filled lands should be done only within the boundary line of the project to avoid damage to adjacent agricultural land, crops, trees or any other properties. In case of damage by any construction activity, adequate compensation should be paid to the owner in time Fence the proposed area so that the surrounding agricultural land will not be disturbed.	Quantity of land use	Consideration of minimum use of agricultural land.	Project developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995 ▪ Industrial Policy, 1986 ▪ Private Sector Power Generation Policy of Bangladesh, 1996 ▪ Policy Guideline for small Power Plants in Private Sector, 1997
Flood Hazards	Flood may damage the Project and its various components.	Should undertake a flood risk study to determine flood quantities within the plant area and to estimate peak flood to determine the peak flow for the return period of 50 years.	no. of flood	Consideration of flood hazard in project design	Project developer	
Construction Phase						
Transmission Line	Impact on vegetation, agricultural lands and utility lines	▪ Minimum forest covers and agricultural lands should be used. ▪ Planning in such a way that no utility line is hampered.	Weekly	Consideration of minimum forest covers and agricultural land use and consideration of not overlapping the utility lines.	Contractor	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						Plan, 1995 ■ Industrial Policy, 1986 ■ Private Sector Power Generation Policy of Bangladesh, 1996 ■ Policy Guideline for small Power Plants in Private Sector, 1997 ■
Earthworks	Soil erosion from the fill material, changes in existing landscape.	■ Construct the retention wall properly so that erosion will not happen. ■ The contractor shall ensure that the fill material is collected from only the approved sources and not from any illegal dredging site. ■ Make sure that the filling material is not collected from the agricultural land.	Weekly	The fill material is collected from the approved sources.	Contractor	■ Environmental Pollution Control Ordinance, 1977 ■ Environmental Conservation Rules (ECR), 1997
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, Backfilling	The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times.	Daily	■ Good housekeeping and tidiness of work areas within the project site. ■ The fill material is maintained in a clean and tidy manner.	Contractor	■ National Land use Policy, 2001 ■ National Environmental Policy, 1992 ■ National Environmental Management Action Plan, 1995
Air Quality	■ Exhaust Emissions due to operation of construction plant and machinery. ■ Dust generation due to construction activities.	■ During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an “as needs” basis. ■ Unnecessary handling of dusty materials will be avoided such as minimizing drop heights when loaders	Daily	■ Regular machineries maintenance records. ■ No visible dust plumes originating From construction sites.	Contractor	■ Environmental Pollution Control Ordinance, 1977 ■ Environmental Conservation Rules (ECR), 1997 ■ Environment Court

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		dump soils into trucks. ▪ Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary. ▪ Train workers to handle construction materials and debris during construction to reduce fugitive emissions. ▪ Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces.				Act, 2000 ▪ Bangladesh Climate Change Strategy and Action Plan (2008)
Noise	Increased noise levels during to construction & machinery	▪ The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions. ▪ The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. ▪ The contractor shall perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions.	Every week and after receiving any complaints from worker or third parties.	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Noise Pollution Control Rules (2006)
Terrestrial Ecology	Potential disturbance to birds	▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site. ▪ Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds.	Daily	N/A	Contractor	▪ Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft) ▪ National Forest Policy and Forest Sector Review (1994, 2005) ▪ The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) ▪ National Biodiversity Strategy and Action

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						Plan (2004)
Soil	Soil disturbance due to removal of top soil, potential accidental spillage	- Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. - Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and MSDS. - A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. - To control soil erosion surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows - Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage.	Weekly	- Training records of Personnel trained in spill response procedures must be filed - Number of spills or incidents to be recorded during onsite audits.	Contractor	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	- Chemical waste shall be stored in accordance with the provisions of Material Safety Data Sheets (MSDS). The contractor shall keep MSDS onsite. - The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous	Daily	- Compliance with Waste management procedures. - Current and Complete records of regular waste pickup and disposal.	Contractor	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995 - Environmental

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		recyclable construction material, plastic, paper, etc. to facilitate proper disposal. ▪ The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. ▪ The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly. ▪ The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures.				Conservation Rules (ECR), 1997
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network	▪ Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits ▪ Presence of flagman at the entrance and exit of the project site in order to control vehicles and truck movement. ▪ Ensure adequate maintenance and inspection of vehicles ▪ The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators.	Continuously	▪ No incidents or accidents (collisions) are recorded. ▪ No complains or concerns from traditional users of the area's roads routes are received during the construction activities.	Contractor	
Health and Safety risks	▪ Exposure to health events during construction activities such as manual handling and musculoskeletal disorders, hand-arm vibration, temporary	▪ Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. ▪ All construction equipment used for the execution of the project works shall be fit for purpose and carry valid	Continuously	▪ Total Recordable Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency ▪ Fatal Accident Rate ▪ Number of safety		▪ Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	or permanent hearing loss, heat stress, and dermatitis. Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installation, mobile plant and vehicles, and electrical shocks.	inspection certificates and insurance requirements. - Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. - Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. - Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards; - Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. - Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. - Arrest a fall with equipment to minimize the distance and consequences of a fall, e.g. safety nets, where work at height cannot be avoided or the fall prevented. - Establish and communicate emergency response plan (ERP) with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan		Training performed - Number of nonconformance events Reports. - Medical Treatment Case (MTC) - HSE Training Hours		

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		- Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. - Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. - Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate plant machines and vehicles. - Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/ heights...etc. - Adequate number of staff and first aiders shall be on site in accordance with Bangladesh Labor Law requirements. - Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. - Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. - Emergency evacuation response shall be prepared by the contractor and				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		relevant staff shall be trained through mock-up drills. - Only competent authorized persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks. - Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. - Ensure all equipment is suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc.), provide the lowest vibration tools that are suitable and can do the works. - Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. - Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, dehydration. - Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given thorough training in how to protect themselves and there should be effective supervision to ensure				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		that the correct methods are being used. ▪ As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers, etc. ▪ Ensure adequate quantities of drinking water are available at different locations within the site, ▪ Provision of sun shades at different locations within the site. ▪ Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities.				
Occupational Health & Safety	▪ Contractor does not provide adequate Personal Safety Equipment (PSE) or properly enforces its use, leading to accidents	▪ Workers will be provided with appropriate personal protection equipment, such as safety boots, helmets, gloves, protective clothing, goggles and ear protection, and contractor will enforce its use, so long as safety does not suffer due to this action	Continuously	▪ Total Recordable Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency ▪ Fatal Accident Rate ▪ Number of safety Training performed ▪ Number of nonconformance events Reports. ▪ Medical Treatment Case (MTC) ▪ HSE Training Hours		▪ Bangladesh Labour Law, 2006
Labor Standards	• Labour standards	• No use of child labour permitted	Continuously	▪ Total Recordable		▪ Bangladesh Labour

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	ignored or not complied with leading to infractions of basic labour standards as defined by ILO conventions as listed in Item 1.8 above.	that no workers under the age of 14 may be hired as general labours, and no workers under the age of 17 are to be hired for hazardous jobs such work on scaffolding, and structures elevated above the ground, etc. • No Bonded labour-All forms of bonded labour and forced labour, as defined by ILO Conventions 29 & 105 • Equal treatment, equal opportunity- as defined by ILO Conventions 100 & 111 and ILO Code of Practice for HIV/AIDS 85. No discrimination based on race, caste, origin, religion, disability, gender, sexual orientation, union or political affiliation, or age; no sexual harassment • Minimum wage- LGED expects the contractor to pay all employees according to Bangladesh Labour Act standards.		Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency ▪ Fatal Accident Rate ▪ Number of safety Training performed ▪ Number of nonconformance events Reports. ▪ Medical Treatment Case (MTC) ▪ HSE Training Hours		Law, 2006
Operation Phase						
Visual Amenity	Potential glare from PV panels	The used technology has Anti-Reflective coating (ARC) that significantly reduces the reflectance of the Panels (from 2.5% to 2.6% only).	N/A	N/A	Project Developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
PV panels, Battery	The most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance. Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally. Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Backup Generator	The most significant noise source of this solar power plant is from the backup diesel generator. To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants.	However, the noise from diesel generator needs to take action for mitigation. The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Additionally, the generator should be upwardly enclosed with the noise reduction canopy. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. The increased noise levels are considered occupational noises that require occupational health and safety measures. The worker inside the project area should use earmuffs during the operation of diesel generator.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000
Air Quality	Very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide.	- Check regularly to identify potential source of air pollutants. - Replace the damaged and expired tools, equipment, PV panels and batteries as soon as it is notices.	Daily	- No visible dust plumes originating from project site. - Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000 - Bangladesh Climate Change Strategy and Action Plan (2008)
Noise	Significant sound pollution from backup generator	- The worker inside the project area should use earmuffs during the operation of diesel generator. - Establish the generator inside an insulated room and use noise reduction	Every week and after receiving any complaints from worker	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Noise Pollution Control Rules, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		canopy to keep the environment free from sound pollution. ▪ Noise barrier should also be given around the generator room.	or third parties.			
Terrestrial Ecology	Potential disturbance and harm to birds	▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site. ▪ Ground nests found on site shall be translocated outside the project boundary. ▪ Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds.	Weekly	No reported harm to birds.	Project Developer	▪ Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft) ▪ National Forest Policy and Forest Sector Review (1994, 2005) ▪ The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) ▪ National Biodiversity Strategy and Action Plan, 2004
Waste Generation	▪ Expired lead-acid battery and potential threat to environment. ▪ Solid wastes from PV modules which contains toxic metals. ▪ Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV	▪ Collected the lead-acid battery for recycling after the warranty period. ▪ A proper temporary storage facility is needed for the wasted batteries to avoid potential lead contamination. ▪ Collect the domestic waste in septic tanks to treat according to the approved procedure.	Continuously	▪ Compliance with Waste management procedures. ▪ Current and Complete records of regular waste pickup and disposal.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ The Environment (Pollution Control) Act, 1995

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	modules, electrical wastes, metallic wastes and stationary wastes of office works etc.					
Soil	Potential spillage of stored oil and chemicals	- Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved disposal facilities. - Proper storage for chemicals and fuel within confined areas on site and adopting proper safety measures when handling those chemicals to prevent their leakage and infiltration into the soil.	- Post rainfall Event - Weekly	Maintain readily available records of all workers training on spill response procedures.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995
Health and Safety	- Entering of lead into human body from lead-acid battery - Acid hazard during battery handling - Leaching of materials from broken or fire damaged PV modules - Emergency Fire Hazard - Electrocution of workers - Electromagnetic radiation from PV modules - Slipping and	- Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. - Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. - Signpost any slippery areas, provide proper footwear during working within slippery areas. - Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. - Set up a system to alert workers on	Continuously	- Total Recordable Incidence Rate (TRIR) - Lost Time Incidence Frequency - Number of safety Training performed - Number of nonconformance events.	Project Developer	Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	tripping, working at height activities - Lead can enter body in two ways: by breathing or by swallowing it. Lead Sulfide dust enters the body through breathing. Very fine lead particles may penetrate into the lungs result in absorption in the bloodstream. - The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. - As a power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. - Risk of electrocution of workers during performing duties in a power plant is always present.	site. This may be temporary or permanent mains operated fire alarm. - Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. - Establish and communicate emergency response plan with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel's. - Adequate first aiders shall be on site in accordance with Bangladesh Labour Law requirements. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site.				
Decommissioning Phase						

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
▪ The solar power plant facility is considered a large scale long-term investment that will contribute to economic benefits to the country through provision of power supply, designed in accordance with best practice, taking into account all relevant national and internal codes and legislation. ▪ The design life of the facility will be approximately 20 years. Therefore, the post-design life is expected to involve rehabilitation, upgrading and modernization of the facility, with a possible expansion (retrofitting and addition of new technology). As a result, impacts from decommissioning are not expected to arise in the near future unless retrofitting and upgrade of the facility was not feasible. However, this, EIA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations. ▪ As can be noted from the impact assessment chapter 8, no impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed, solar power plant decommissioned, and PV panels will be dismantled and sent for recycling or disposal. ▪ The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. ▪ Therefore, to avoid repetition, please refer to Table 9.1 for detailed mitigation measures that are overlap with decommissioning as well. ▪ The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies. ▪ While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module. ▪ Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.						

11.4 Environmental and Social Monitoring Plan

11.4.1 General

An Environmental and Social Monitoring Plan will be prepared to provide guidelines for environmental management plan during the construction and operation phases of the solar mini grid Power Plant. The environmental components that will be monitored are those that will be positively or negatively affected, or expected to be affected, by construction activity. Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment for the maintenance of the preservation of natural resources and the prevention or reduction of damage to the environment. The major environmental impact, monitoring method, responsible organization, and expense for each environmental item in the construction and operation phases for the proposed development are listed in Table 11.2.

11.4.2 Objectives

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. The main objectives of the pre-construction, construction and operation phase monitoring plans will be to:

- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the EIA;
- Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project area for indicating the adequacy of the EIA;
- Ensure the safe disposal of excess construction materials.
- Ensure compliance with legal and community obligations including safety on construction sites;
- Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;
- Appraise the adequacy of the EIA with respect to the project's predicted long-term impacts on the physical, biological and socio-economic environment;

Table 11.2: Environmental & Social Monitoring Plan

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Pre-Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	EL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	EL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Surface water quality standard by DoE, Bangladesh	Once	Contractor	EL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Groundwater quality standard by DoE, Bangladesh	Once	Contractor	EL
Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	EL
Dust	Dust control	Air quality standard by DoE, Bangladesh	Once	Contractor	EL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	EL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	EL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF, Bangladesh	Once	Contractor	EL
Soil Pollution	- Check liquid waste is carried out by experienced personnel and in proper way - Careful and proper handling of oil and other hazardous liquids	Monitoring	Regularly	Contractor	EL
Waste	- Check storage, transportation, disposal, handling of hazardous waste - Waste and effluents to be collected and disposed safely from camp. - Wastes and garbage from construction sites to be disposed safely	Monitoring	Weekly	Contractor	EL
Health and Safety	- Check quality of food and accommodation at construction camp; - Check safe water supply, hygienic toilet at camp, construction of drain at camp site; - Check toilets are close to construction site; - First Aid Box with required tools and medicines; - The heavy construction material to be handled and stored safely putting due care on public safety; - Heavy construction materials at construction site to be stored and handled safely; and - Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	EL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Occupational Health & Safety	- Check quality of food and accommodation at construction camp; - Check safe water supply, hygienic toilet at camp, construction of drain at camp site; - Check toilets are close to construction site; - First Aid Box with required tools and medicines; - The heavy construction material to handled and stored safely putting due care on public safety; - Heavy construction materials at construction site to be stored and handled safely; and - Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	EL
Labour Standards	Random check of 10% of the labour force, and check that labourers have contract letters and check age, working conditions and documentation	Monitoring	Regularly	Contractor	EL
Operation Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	1/year (5 year)	EL	DOE/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	1/year (5 year)	EL	DOE/IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by DOE, Bangladesh	1/year (5 year)	EL	DOE/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by DOE, Bangladesh	1/year (5 year)	EL	DOE/IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	-----	EL	DOE/IDCOL
PV panels, and Battery	Chemicals		1/year (5 year)	EL	DOE/IDCOL
Soil Quality	Heavy metals		1/year (5 year)	EL	DOE/IDCOL
Decommissioning Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	Once	Contractor	EL /IDCOL
Dust	Dust control	Air quality standard by DOE, Bangladesh	Once	Contractor	EL /IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	EL /IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	EL /IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF, Bangladesh	Once	Contractor	EL /IDCOL
Soil Pollution	- Check liquid waste is carried out by experienced personnel and in proper way - Careful and proper handling of oil and other hazardous liquids - Careful and proper handling of PV panels and batteries	Monitoring	Regularly	Contractor	EL /IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Waste	▪ Check storage, transportation, disposal, handling of hazardous waste ▪ Careful and proper handling of PV panels and batteries ▪ Waste and effluents to be collected and disposed safely from camp. ▪ Wastes and garbage from worker sites to be disposed safely	Monitoring	Weekly	Contractor	EL /IDCOL
Health and Safety	▪ Check quality of food and accommodation at worker camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site; ▪ First Aid Box with required tools and medicines; ▪ The heavy construction material to be handled and stored safely putting due care on public safety; and ▪ Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	EL /IDCOL

11.5 Environmental Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the ESMP is presented in Table 10.3. The overall costs of the ESMP will comprise:

- Environmental monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental damage;
- Designing and implementing all mitigating and enhancement measures;

The total budget is estimated as BDT. 8,42,600. This budget does not include the decommissioning stage since the minimum operation period is 20 year and the rate will vary largely from the present cost.

Table 11.3: Environmental Budget for Solar Mini-grid Power Plant Project

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
PRE-CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	55,000	55,000
Noise	Measuring ambient noise level	No.	6	8,000	48,000
Water Quality	Surface water quality measurement	No.	1	7,000	7,000
	Groundwater quality measurement	No.	1	9,000	9,000
SUB TOTAL (PRE-CONSTRUCTION STAGE)					119,000
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	55,000	55,000
Noise	Measuring ambient noise level	No.	6	8,000	48,000
Water Quality	Surface water quality measurement	No.	1	7,000	7,000
	Groundwater quality measurement	No.	1	9,000	9,000
Soil	Maintenance cost in soil conservation	Lump sum			35,000
Dust Management	Water sprayer / watering	Covered in Engineering Cost			
Waste disposal and management	Disposal and management of construction waste and solar panels of individual households	Lump sum			45000

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
Construction Safety	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum			12,000
Health	Health check-up camps for construction workers	Camp	-	7,000	7,000
SUB TOTAL (CONSTRUCTION STAGE)					218,000
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	5 (1/year)	55,000	2,75,000
Noise	Monitoring ambient noise level	No.	5 (1/year)	8,000	40,000
Water	Monitoring surface water quality	No.	5 (1/year)	7,000	35,000
	Monitoring ground water quality and levels	No.	5 (1/year)	9,000	45,000
SUB TOTAL (OPERATION STAGE)					3,95,000
ESTABLISHMENT and TRAINING					
Training	Environmental training and awareness	Lump sum	As per training details	22,000	22,000
Management Information System		Lump sum	-	12,000	12,000
SUB TOTAL (ESTABLISHMENT and TRAINING)					34,000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					7,66,000
CONTINGENCIES @ 10 % on total Environmental Costs					76,600
GRAND TOTAL (in BDT)					8,42,600

12 ENVIRONMENTAL AND SOCIO-ECONOMIC BENEFITS

12.1 Introduction

Energy is one of the most important basic ingredients required to alleviate poverty and to bring about socio-economic development of a country. Fossil fuel, sunlight, air, water source and nuclear power plant are the sources of energy throughout the world. Major energy source is still fossil fuel but the reserve is declining. Fossil fuel is being used though it emits greenhouse gases for global warming which is a threat to climate change and sustainable development. In this situation sustainable and secure energy are the major concern worldwide. Under these circumstances there is a transition underway in the energy sector. It is happening due to decline in fossil fuel availability, reduction of global emissions for mitigating climate change and energy security. Under the changed perspective renewable energy especially solar energy is becoming popular for its significance in contribution to global climate change and carbon trading prospect. United Nations Framework Convention on Climate Change (UNFCCC) has taken initiative for Clean Development Mechanism (CDM). In this context, solar energy is becoming widespread source of energy throughout the world. To meet the growing demand for power in the industries, transportation and household use many developed countries are already using solar energy as renewable sources. This is not only meeting the bigger portion of energy demand but also providing significant socio-economic benefit and helping to maintain clean environment.

Renewable energy technologies have experienced rapid deployment over the past few years, mainly driven by the ambition to improve energy security, enhance energy access and mitigate climate change. Many countries are now exploring ways to stimulate social and economic growth through the development of the renewable energy sector. Investment in renewable energy can generate new sources of growth, increase income, improve trade balances, contribute to industrial development and create jobs. While such socio-economic benefits are increasingly gaining prominence in the global renewable energy debate, specific analytical work and empirical evidence on this important subject remain relatively limited.

Bangladesh is a densely populated tropical country which has no sufficient supply of energy. At present around 62 percent (including renewable energy) of population has access to electricity, the per capita energy consumption is only 321 KWh per annum (Website: Power Division, GOB). Remaining 38 percent of the population depends on costly kerosene and natural sources. Bangladesh is still very centralized to its capital city. Many locations outside the capital do not get proper attention. Poor people cannot afford to have electricity for their daily activities. Many remote islands and highlands are not connected to national grid lines. Since expanding the national grid in those isolated areas is very expensive and are not cost effective, solar energy could be an effective alternative to fulfill the electricity requirement in these off-grid areas. Recently use Solar Home System (SHS) is growing fast for solar electricity, though it has high initial cost. As a developing country Bangladesh and its people are suffering from power and electricity shortages. But the geographical situation and favorable climate conditions provide tremendous opportunity to utilize solar power for almost every aspect of our rural, urban, semi urban livelihood of Bangladeshi population.

Solar energy based rural electrification begun in the country in 1988 at Norshingdi. Power Development Board (BPDB), Rural Electrification Board (REB), Local Government Engineering Directorate (LGED), Infrastructure Development Company Limited (IDCOL) and a significant number of private sector agencies including Non Government Organizations (NGO) are involved in solar electricity development. Solar electricity is increasingly being used in a wide range of off-grid applications. Since the introduction of SHS, Bangladesh has installed more than 2.2 million units. The present study is intended to identify the factors associated with the implementation of solar energy and solar power system and how far it has been succeeded in reducing poverty in rural area of the country.

12.2 Environmental Benefits

The technological innovation of solar energy enables solar panels to capture the heat of the sun and utilize the energy to generate power and electricity for homes, buildings and cities. Solar panels help maximize the earth's resources and conserve energy. However, many environmental benefits can result from the use of solar energy including,

Solar reduces air pollution: Harmful carbon dioxide and methane emissions from fossil fuels, our traditional energy source, are leading contributors to global warming and decreased air quality. But generating electricity with solar panels produces no greenhouse gasses whatsoever. In fact, the solar capacity currently installed across the United States is expected to offset as much as 16.8 million metric tons of carbon dioxide a year. That's a huge step towards mitigating the human impact of climate change.

Solar reduces water pollution: While all manufacturing processes require some water, solar photovoltaic cells don't need water to generate electricity. This is one of the biggest, yet least talked about environmental benefits of solar. Traditional biomass and geothermal power plants, such as natural gas and coal-fired facilities, require massive amounts of water to facilitate their vital cooling requirements. With solar energy there is no pollution of local water resources, nor does their operation (which again requires NO water) strain local supplies through the competition with agriculture, drinking systems, and other vital water needs.

Solar reduces the need for finite resources: Solar energy is renewable. The sun is the world's most abundant energy source, producing an amazing 173,000 terawatts of solar energy every second. That's more than 10,000 times the world's total combined energy use, and it can be used over and over again. In contrast, fossil fuels are non-renewable and while they may seem in abundance today, there will come a time when the world will run out. Or, the cost of finding and extracting these sources will become too expensive. By that time, the resulting damage to our financial infrastructure and environment may be unrepairable. Switching to solar today is the best way to hedge against the reality of finite fuel resources.

12.3 Social Benefits

Less investment during installation: Apart from the initial investment in solar panels, there is no other cost involved in the generation of solar power. The savings made from going off-grid can easily be invested in other projects. This can not only be done by different industries,

but also individuals. Commercial solar projects can be profitable for many industries as these ensure the use of solar energy for powering different machines and equipment.

Power in remote areas: There are many areas like mountains, forests and islands, which do not receive power, owing to their remote location. Solar power is certainly a blessing in disguise for these areas. Remote and rural areas are now taking advantage of power to initiate different development projects in their areas. Consequently, education and medical facilities have increased in these areas by the introduction of solar power.

Lower power costs: The ever increasing cost of fuel and power has become a big issue for many under-developed and developing countries. The socio-economic condition of people living in these areas is not as per the normal standard. Hence, it becomes imperative to provide these people with cheap power and energy. The governments in these areas look for options, like solar energy, to initiate a better and proper distribution of power. This has also helped these people to grow and develop themselves so that they can erase the economic inequality in the country.

Power in the hand of the masses: The control of energy and manufacturing is still in the hands of the capitalists, which is increasing the exploitation of the masses. The biggest weapon in the hands of the capitalists is energy and power. Solar energy shifts this power in the hands of the masses as communities and smaller groups can easily go off the power grid.

12.4 Project Specific Benefits

The project once completed, it is expected to go into commercial operation on 30 September 2017 and supply electricity to the adjacent 970 households, 160 shops, 17 social entities including schools, mosques, madrasas, offices, government and non-government institutions etc., 4 rice mills, 5 husking mills and 20 irrigation pumps.

After getting supply of electricity the livelihood and the socioeconomic conditions of the local people will improve a lot. During the project implementation period, a huge number of manpower will be required. The project proponent wants to hire a percentage of the manpower from the local people. This will bring some temporary economical benefit to the area. Getting continuous electricity supply in a low cost in the houses and shops will improve the living standard of the local people. Schools and madrasahs after getting continuous electricity supply will help to provide quality education to the students.

As the main source of income of the local people is agriculture. After getting continuous supply of electricity to the irrigation pumps, husking mills and rice mills, agricultural production rate will increase. As a result the economical condition of the local people will improve. This in the long run will help in improve the national economical condition.

13 CONCLUSION AND RECOMMENDATION

13.1 Conclusion

An environment and social analysis has been carried out looking at various criteria such as topology, air, noise, water resources and water quality, ecology, demography of the area, climate and natural habitat, community and employee health and safety etc. The impact analysis, found that due to careful consideration of environmental and social aspects during route and site selection by Eastec, no major adverse impacts are expected. There is no adverse impact on the migration of habitat, any natural existing land resources and effect in the regular life of people. The environment and social impact associated with solar power plant project is limited to the extent of construction phase and can be mitigated through a set of recommended measures and adequate provision for environment and social impacts which cover monitoring, measuring and mitigation. ESMP has been prepared. Most impacts are expected to occur during the construction phase and are considered to be of a temporary nature. The project site was carefully selected after undergoing an options assessment. The main project impacts are associated with clearing of shrub vegetation, waste management and excavation and movement of soils. From this perspective, the project is expected to have a small "environmental footprint". No endangered or protected species of flora or fauna are reported at any of the subproject sites. Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures.

Mitigation measures related to construction, as specified in the ESMP, will be incorporated into civil works contracts, and their implementation will be primarily the responsibility of the contractors. Hence, the proposed project has limited adverse environmental and social impact which can be mitigated following the ESMP & shall be pollution free Renewable source of Power.

13.2 Recommendations

The ESMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor shall be responsible for the implementation of the requirements of the ESMP through his own Site Specific Environmental Management Plan which will adopt all of the conditions of the ESMP. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. The potential cumulative and residual impacts of the project classify as not a highly sensitive or complex.

The ESMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the ESMP a legal requirement according to the contract. To ensure

compliance with the ESMP the contractor should employ an environmental specialist to monitor and report project activities throughout the project construction phase.

REFERENCES

- Banglapedia, 2015. National Encyclopedia of Bangladesh Online [Online]. Available at <http://www.banglapedia.org>
- Brammer, H., 1996. The Geography of the Soils of Bangladesh. Dhaka: University Press Limited.
- International Union for Conservation of Nature (IUCN), 2002. Bio-ecological zones of Bangladesh. Dhaka: IUCN Bangladesh.
- International Union for Conservation of Nature (IUCN), 2002. Bio-ecological zones of Bangladesh. Dhaka: IUCN Bangladesh.
- IPCC (Intergovernmental Panel on Climate Change), 2007. Climate change 2007: Synthesis Report. Contribution of Working Groups I, II, III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland.
- IUCN Bangladesh. ed. 2002f. Bio-ecological Zones of Bangladesh. Dhaka: IUCN-The World Conservation Union.
- IUCN Bangladesh. ed. 2002f. Bio-ecological Zones of Bangladesh. Dhaka: IUCN-The World Conservation Union.
- MoEF, 2009. Bangladesh Climate Change Strategy and Action Plan 2009, Ministry of Environment and Forest, Bangladesh.
- MoEF/UNDP, 2005. National Adaptation Programme on Action (NAPA). Final Report. Ministry of Environment and Forests, GOB, Bangladesh.
- Rashid, H. E. (1991). "Geography of Bangladesh". University Press Limited, Dhaka.
- Soil Resource Development Institute (SRDI), 1998. Agro-ecological regions of Bangladesh. Dhaka: SRDI, Ministry of Agriculture.
- United Nations Population Fund (UNFPA), 2010. State of World Population 2010- From Conflict and Crisis to Renewal: generations of change [Online]. Available at: http://www.unfpa.org/webdav/site/global/shared/swp/2010/swop_2010_eng.pdf
- Wahab, A., (2008), Bangladesh Introduction (Ramsar Wetland Information). [Online] Available at: <http://ramsar.wetlands.org/Portals/15/Bangladesh.pdf>

APPENDIXES

Appendix A: Air Quality Test Result



Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	Eastec Limited 249.6-kWp AC coupled solar photovoltaic based mini-grid Power Plant at Char Paka, Shibganj, Chapainawabganj.
Project address	Village: Char Paka, Union: Paka, Upazila: Shibganj, District: Chapainawabganj.
Description of sample	Ambient Air Quality Test Result
Sample Collector	Collected by DSCL Personnel
Sampling Date	10 th April, 2017

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Project Site	Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
PM _{2.5}	µg/m ³	30.29	65	24	Sunny	Gravimetric
PM ₁₀	µg/m ³	85.77	150	24		Gravimetric
SPM	µg/m ³	109.23	200	24		Gravimetric
SO ₂	µg/m ³	7.85	365	24		West- Geake
NO _x	µg/m ³	10.63	100	24		Jacob and Hochheiser
CO*	mg/m ³	<1	10	8		Indicator tube

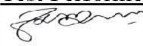
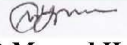
Note:

* CO concentrations and standards are 8-hourly only.

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

Note:

- PM_{2.5} – Fine Particulate Matter.
- PM₁₀ – Respirable Dust Content
- SPM – Suspended Particulate Matter
- SO₂ – Sulphur Di-oxide
- NO_x – Oxides of Nitrogen.
- CO – Carbon Monoxide

Test Performed By:  1) Md. Atiqur Rahman Jr. Environmental Specialist	Approved By:  Israt Jahan Director
 2) Moynul Hasan Jr. Environmental Specialist	

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House-734 (5-B), Road-10, Avenue-04, DOHS Mirpur,
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Appendix B: Noise Level Test Result



Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	Eastec Limited 249.6-kWp AC coupled solar photovoltaic based mini-grid Power Plant at Char Paka, Shibganj, Chapainawabganj.
Project address	Village: Char Paka, Union: Paka, Upazila: Shibganj, District: Chapainawabganj.
Description of sample	Noise Level
Sample Collector	Collected by DSCL Personnel
Sampling Date	10 th April, 2017

Noise Level Analysis

ID	Location	Zone	GPS Location	Noise Level dB(A) at Day Time	Bangladesh Standard at Day Time dB (A)**	Remarks
NM-01	Project Site	Residential	24.57311°N, 88.09890°E	55.01	55	High
NM-02	Char Bishroshia Kalupur Primary School	Residential	24.57611°N, 88.09739°E	44.32	55	Low
NM-03	Jamnia para, Narayanpur	Residential	24.57238°N, 88.09984°E	51.58	55	Low
NM-04	Narayanpur Adarsha College	Residential	24.57352°N, 88.10818°E	52.62	55	Low
NM-05	Kalupur, Narayanpur	Residential	24.57406°N, 88.09286°E	46.01	55	Low
NM-06	Bishroshia Char paka jama Mosque	Residential	24.58686°N, 88.09047°E	59.74	55	High

Notes:

- Land use category is based on the classification provided in the Noise Pollution Control Rules (2006)
- Shaded cell indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area
- The sound level standards for residential area are 55 dBA, for silent area 50 dBA and for commercial area 65 dBA at day time
- The sound level standards for residential area 45 dBA, for silent area are 40 dBA and for commercial area 55 dBA at night time

Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

Test Performed By: 1) Md. Atiqur Rahman Jr. Environmental Specialist 2) Moynul Hasan Jr. Environmental Specialist	Approved By: Israt Jahan Director
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Development Solutions Consultant Ltd.

Appendix C: Surface Water Test Result (On Site)



Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	Eastec Limited 249.6-kWp AC coupled solar photovoltaic based mini-grid Power Plant at Char Paka, Shibganj, Chapainawabganj.	
Project address	Village: Char Paka, Union: Paka, Upazila: Shibganj, District: Chapainawabganj.	
GPS Coordination	Latitude- 24.57266°N	Longitude- 88.09563°E
Description of sample	On-Site Surface Water Test	
Sample Collector	Collected by DSCL Personnel	
Sampling Date	10 th April, 2017	

Surface Water Test Analysis (On-Site)

Water Quality Parameters	Unit	SWJ-01	Inland Water Standard for Fish, DOE	Method of Analysis
pH	---	8.5	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)	mg/l	18	1000	TDS Meter

Notes:

* Environmental Conservation Rule (ECR) '97

TDS – Total Dissolved Solids

Source: Field Survey, Cells in Grey Color Shed Indicate the expedience the limit of DoE Standard

SWJ-01- Nearest Beel from the project site (24.57266°N, 88.09563°E)



<u>Test Performed By:</u> <i>[Signature]</i> 1) Md. Atiqur Rahman Jr. Environmental Specialist <i>[Signature]</i> 2) Moynul Hasan Jr. Environmental Specialist	<u>Approved By:</u> <i>[Signature]</i> Israt Jahan Director
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Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix D: Test Result of Surface Water (DPHE)

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
Lab Memo: 522/ CC, DPHE, CL, Dhaka.		Date: 03-05-2017

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2017040214	Sample Receiving date: 12-04-2017
Ref. Memo No: DSCL/2017/Nil & Dated: 12-04-2017	Sample Source: Surface Water
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka-1213.	Dist: Chapai Nababganj, Upa: Shibganj
Care Taker: DSCL (SWC-01)	Union:, Vill.: Chorpaka
Sample Collection date: 11-04-2017	Date of Testing: 12/04/2017-03/05/2017

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	3	mg/L	5 days Incubation	0.20
2	Chemical Oxygen Demand (COD)	4.0	8	mg/L	CRM	-
3	Dissolved Oxygen (DO)	6.0	6.41	mg/L	Multimeter	-

Comments: Sample was collected & Supplied by client.
 N.B: CRM-Closed Reflex Methods, LOQ - Limit of Quantitation.

Test Performed by: _____ Signature _____ 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer <i>Motin</i> 03-05-17 2.) Name: Taslima Akhter Designation: Sample Analyzer <i>Taslima</i> 03.05.2017 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাশাহী, ঢাকা	Countersigned/Approved by: _____ Signature _____ 1.) Name: Md. Biplab Hossain Designation: Chief Chemist <i>B Hossain</i> 03/05/2017 2.) Name: _____ Designation: _____ মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাশাহী, ঢাকা।
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Appendix E: Test Result of Groundwater (On Site)



Multidisciplinary Development Consultants

DSCCL Environmental Laboratory

Name of the Project	Eastec Limited 249.6-kWp AC coupled solar photovoltaic based mini-grid Power Plant at Char Paka, Shibganj, Chapainawabganj.	
Project address	Village: Char Paka, Union: Paka, Upazila: Shibganj, District: Chapainawabganj.	
GPS Coordination	Latitude- 24.57299°N	Longitude- 88.09875°E
Description of sample	On-Site Groundwater Test	
Sample Collector	Collected by DSCCL Personnel	
Sampling Date	10 th April, 2017	

Groundwater Test Analysis (On-Site)

Water Quality Parameters	Unit	GWJ-01	Drinking Water Quality Standard, DOE	Method of Analysis
pH	---	7.7	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)	mg/l	41	1000	TDS Meter

Notes:

* Environmental Conservation Rule (ECR) '97

TDS – Total Dissolved Solids

Source: Field Survey, Cells in Grey Color Shed Indicate the expedience the limit of DoE Standard

GWJ-01: Near project site (24.57299°N, 88.09875°E)

Depth of the tube well: 73ft



<u>Test Performed By:</u> 1) Md. Atiqur Rahman Jr. Environmental Specialist	<u>Approved By:</u> Israt Jahan Director
 2) Moynul Hasan Jr. Environmental Specialist	

Development Solutions Consultant Ltd.

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 Dhaka-1216, Bangladesh. Tel: +8804478035444
 Email: dsccl@dscclbd.com Web: www.dscclbd.com

Appendix F: Test Result of Groundwater (DPHE)

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 522/ CC, DPHE, CL, Dhaka.

Date: 03-05-2017

Physical /Chemical/ Bacteriological Analysis of Water Sample

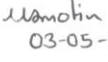
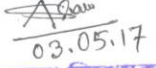
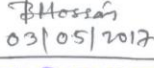
Sample ID: CEN2017040215	Sample Receiving date: 12-04-2017
Ref. Memo No: DSCL/2017/Nil & Dated: 12-04-2017	Sample Source: Tube Well
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka-1213.	Dist: Chapai Nababganj, Upa: Shibganj
Care Taker: DSCL (GWC-01)	Union:, Vill.: Chorpaka
Sample Collection date: 11-04-2017	Date of Testing: 12/04/2017 - 03/05/2017

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	385	mg/L	Titrimetic	-
2	Arsenic (As)	0.05	0.094	mg/L	AAS	0.001
3	Chloride	150-600	12	mg/L	Titrimetic	-
4	Iron (Fe)	0.3-1	0.73	mg/L	AAS	0.05

Comments: Sample was collected & Supplied by client.

N.B: AAS- Atomic Absorption Spectrophotometer, LOQ - Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	Signature  03-05-17  03.05.17 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Chief Chemist 2.) Name: Designation:	Signature  03/05/2017 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
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Appendix G: Important Sensitive Locations in the PIA

Name	Location		Description	Photo
	°N	°E		
Char Bishroshia Kalupur Primary School	24.57611	88.09739	This primary school is one storied building.	
Narayanpur Adarsha College	24.57351	88.10820	One storied tin-shed building.	

Name	Location		Description	Photo
	°N	°E		
Narayanpur Darul Huda Alim Madrasha	24.57311	88.10745	One storied tin-shed building.	
Kalupur Mosque	24.57406	88.09286	One storied tin-shed mosque.	
Char Paka Mosque	24.58686	88.09045	One storied tin-shed mosque.	
Uttarpaka Govt. Primary School	24.58702	88.09031	This primary school is one storied building.	

Appendix H: Details of FGDs with Attendance List

CONSULTATION NO- 1

SITE: CHAR PAKA, UNION: PAKA, UPAZILA: SHIBGANJ, DIST: CHAPAINAWABGANJ.

GPS Coordination: 24.57315°N, 88.09880°E

DATE: 10thApril 2017

TIME: 12:00 PM TO 12:30 PM.

Outcome of the Consultation

A consultation meeting was held during 12:00 pm to 12:30 pm on 10thApril 2017 at Char Paka beside the proposed project site. All the participants were local people from several professions. Total 15 (fifteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

During the consultation the participants appreciated the new project explaining their desires and expectations. The project will increase and improve the quality of their life. No major impact will take place due to the implementation of this project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of this project which they believe will improve their livelihood.

Suggestions:

- There should be effective management system in order to maintain noise pollution. Improved technology might mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of hazardous or chemical waste materials to the surroundings.
- Air pollution from the constructional materials and machineries will create minor problem. Contractor should spray water during material transportation and use cover for air pollution sources if possible.
- Waste management during project operation should be monitored regularly and the proponent has to take responsibility of this management.
- More local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

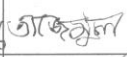
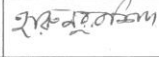
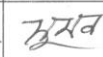
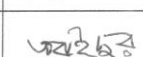
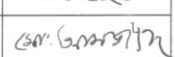
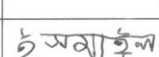
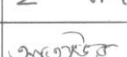
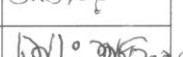
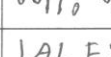
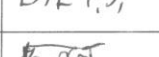
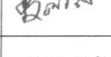
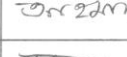
IEE & EIA of 249.6 kW Solar Mini Grid Power Plant Project

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 01 Date 10.04.17 Time 12.00 Pm

Location: 12, Paka Union, Shibganj GPS: N 24.57315° E 088.09880°

Sl No.	Name	Occupation	Telephone No.	Signature
1	Md. Tajimul Haque	Boatman	01790537076	
2	Md. Haroon-ur-rashid	Social worker	01750296682	
3	Md. Sumon	Farmer	01776742737	
4	Md. Kabir Hossen	Farmer	01722630029	
5	Md. Jakaria	Teacher	01796469465	
6	Md. Obaidur	Business	01736405817	
7	Md. Anzad Hossen	Farmer		
8	Md. Ismail	Business	01723985874	
9	Md. Ataur Rahman	Farmer		
10	Md. Shariful Islam	Farmer		
11	Md. Lal Mohammad	Farmer	01715270229	LAL F.S,
12	Md. Dulal	Farmer	01736147302	
13	Ahammad Ali	Farmer		
14	Lalbor	Mechanic	01733264755	
15	Rabiqul Islam	Farmer	01774919601	

Prepared By: Mejnuul Hasan

Signature: 

CONSULTATION NO- 2

SITE: BISHROSHIA, CHAR PAKA, UNION: PAKA, UPAZILA: SHIBGANJ, DIST: CHAPAINAWABGANJ.

GPS Coordination: 24.58718°N, 88.09009°E

DATE: 10thApril 2017

TIME: 05:00 PM TO 05:25 PM.

Outcome of the Consultation

A consultation meeting was held during 05:00 pm to 05:25 pm on 10thApril 2017 at Bishroshia, Char Paka not so far from the project site. The consultation meeting was conducted with local people from several professions. Total 15 (fifteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about electricity supply process, employment of local youth in the project etc. issue relevant to the project. They expect good management practice to minimize the problem and involvement of local people to facilitate employment opportunities.

Additionally, they discuss about electricity will play a vital role to develop and increase this Char's literacy rate, health facilities.

Suggestions:

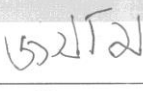
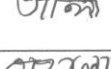
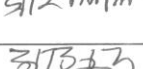
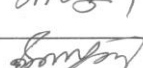
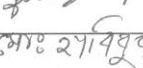
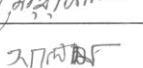
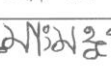
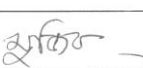
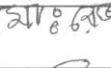
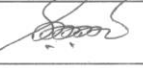
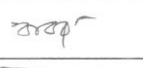
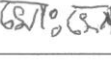
- This project should ensure most feasible electricity supply cost for all classes of people.
- There should be effective management system in order to maintain noise pollution. Improved technology might mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- The capacity of this project should be extended to add more business and agricultural entities into the grid connection.
- More local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

IEE & EIA of 249.6 kW Solar Mini Grid Power Plant Project

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 02 Date 10.04.17 Time 5.00 PM
 Location: Char paka Bishnoria, Shripaonj GPS: N 24.58718° E 88.09009°

Sl No.	Name	Occupation	Telephone No.	Signature
1	Md. Jashim	Farmer		
2	Md. Sentu	Farmer		
3	Md. Alim Hossen	Farmer	01753022385	
4	Md. Shalal Islam	Student	01744880341	
5	Masud Rana	Farmer	01709003853	
6	Md. Isarul Haque	Business	01733121768	
7	Habibur Rahman	Business	01726642121	
8	Md. Abdul Malek	Teacher	01726377459	
9	~~Md.~~ Md. Abdus Salam	Farmer		
10	Md. Monglu Haque	Farmer		
11	Musibur Rahman	Farmer		
12	Md. Rezaul Karim	Farmer	01753124341	
13	Md. Mamun-ar-Rashid	Student	01751631188	
14	Md. Babar Ali	Farmer	01797686705	
15	Md. Sohul Haque	Farmer	01719943655	

Prepared By: Moydul Hasan

Signature: 

CONSULTATION NO- 3

SITE: DOSHROSHIA BAZAR, CHAR PAKA, UNION: PAKA, UPAZILA: SHIBGANJ,

DIST: CHAPAINAWABGANJ.

GPS Coordination: 24.59513°N, 88.09024°E

DATE: 10thApril 2017

TIME: 05:30 PM TO 06:00 PM.

Outcome of the Consultation

A consultation meeting was held during 05:30 pm to 06:00 pm on 10thApril 2017 at Doshroshia Bazar, Char Paka; within 1 km radius from the project site. The consultation meeting was conducted with the local people from different occupations. Total 16 (sixteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect proper management practice to minimize the problem and equitable supply of electricity among all with reasonable cost.

Additionally, some of the participants emphasized twenty four hours electricity service on business improvement, irrigation through water pump, rice mills. They emphasized on health facilities which can be ameliorated by electricity supply from the project. Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.

Suggestions:

- There should be effective management system in order to maintain noise pollution. Improved technology might mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- The capacity of this project should be extended to add more business and agricultural entities into the grid connection.
- More local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

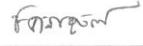
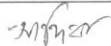
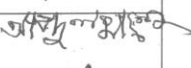
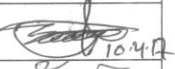
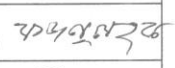
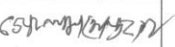
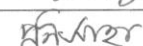
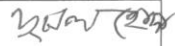
IEE & EIA of 249.6 kW Solar Mini Grid Power Plant Project

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 03 Date 10.04.17 Time 5.30

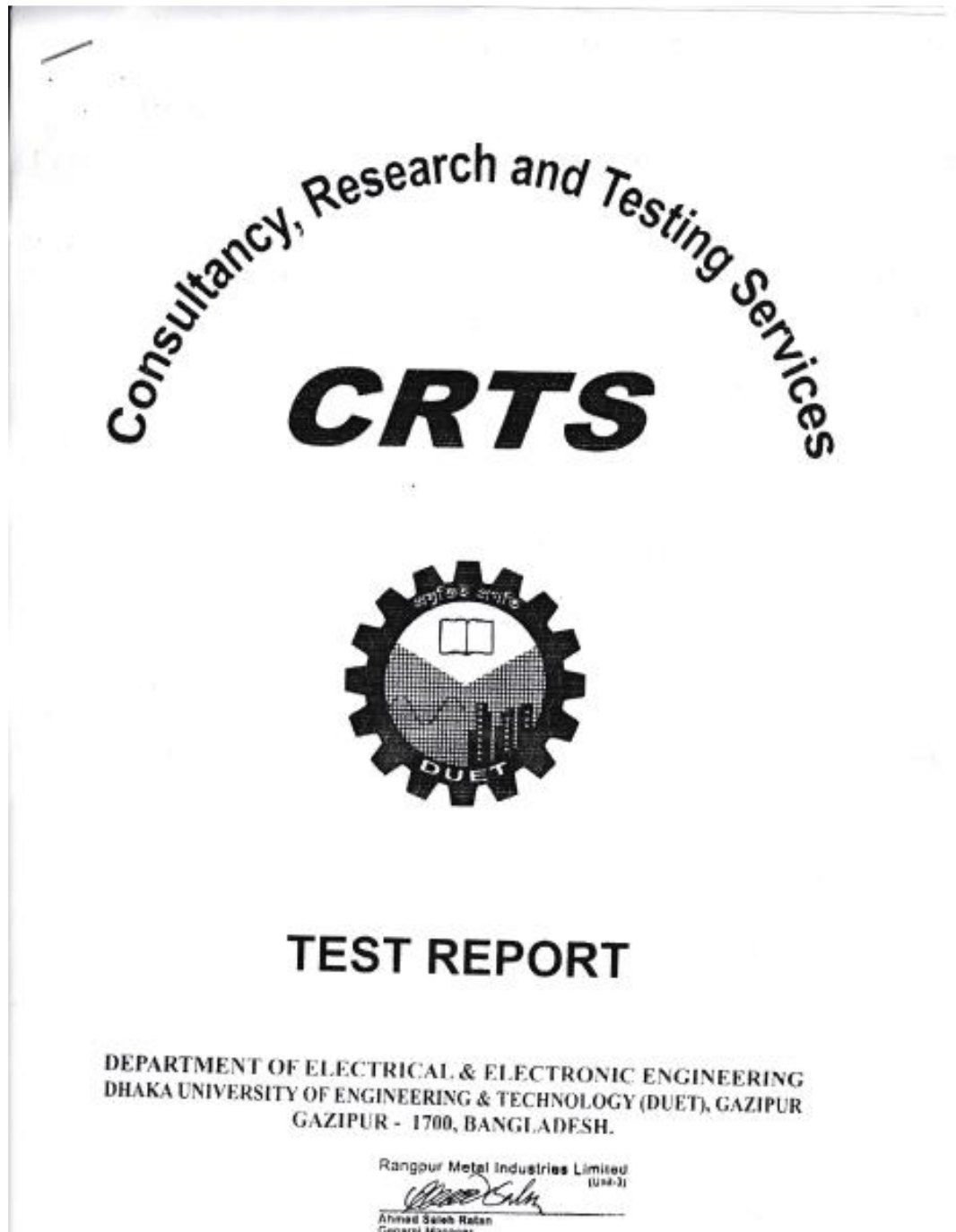
Location: Char paka Doshrovia Bazar, Shibganj GPS: N 24.59.51.3° E 88.09.02.4°

Sl No.	Name	Occupation	Telephone No.	Signature
1	Md. Zenarul Hogue	Business	01713764072	
2	Md. Sadiqul Islam	Farmer	01732766036	
3	Abdul Malek	Farmer	01751521551	
4	Mamunur Rastid	Business	01733129620	
5	Dr. Md. Ziaur Rahman	Doctor	01728708829	
6	Md. Fazlul Hogue	Farmer	01757923386	
7	Md. Mizanur Rahman	Service	01781396144	
8	Md. Tabazz Hossen	Farmer		
9	Md. Jewel Rana	Student	01797926977	
10	Md. Sadiqul Hossen	Business	01781727790	
11	Md. Golam Mostafa	Business	01730853844	
12	Md. Obidur Rahman	Student	01741071383	
13	Md. Humayun Kabir	Farmer	01737037605	
14	Sri Purno Saha	Doctor	01717924605	
15	Md. Nurul Hoda	Farmer	01772935708	
16	Md. Mizanur Rahman	Business	01734027504	

Prepared By: Mojibur Hasan

Signature: 

Appendix I: Test Results of AAC Insulated Conductor



DEPARTMENT OF ELECTRICAL and ELECTRONIC ENGINEERING
Dhaka University of Engineering & Technology, Gazipur
Gazipur-1700, Bangladesh



তড়িৎ ও ইলেকট্রনিক কৌশল বিভাগ
ঢাকা প্রকৌশল ও প্রযুক্তি বিশ্ববিদ্যালয়, গাজীপুর
গাজীপুর-১৭০০, বাংলাদেশ

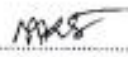
Tel : +88-02-9204709, PABX : 9204734-53/Ext. 3011, Fax : +88-02-9204709, E-mail: head_eee@duet.ac.bd, Web: http://www.duet.ac.bd

Test Results of AAC ANT Insulated Conductor

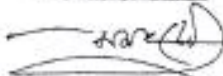
Ref. No.	:	DUET/EEE/2017/38 (xi)	Date : 27/02/2017
CRTS Ref. No.	:	CRTS/EEE/2017/11	Date : 22/02/2017
Client's Ref. No.	:	RMIL/DUET/EEE/2017/019	Date : 18/02/2017
Client's Name and Address	:	Rangpur Metal Industries Limited (Unit-3) PRAN-RFL CENTER, 105 Middle Badda, Dhaka-1212, Bangladesh	
Manufacturer	:	Rangpur Metal Industries Limited (Unit-3) HOBIGANJ INDUSTRIAL PARK, Olipur, Shahjibazar, Shaistaganj, Hobiganj, Bangladesh. Brand Name: Bizli Cables	
Description of Sample	:	AAC ANT Insulated Conductor	
Quantity	:	01	
Nature of Test	:	Type Test	
Test Conducted	:	As per ASTM B 193, B 396 & B 531 Standards	
Average Ambient Temperature	:	26.8°C	
Date of Test	:	23/02/2017-27/02/2017	
Total No. of Pages in this Report	:	02 (Two)	

Test Conducted by:


Dr. Ruma
Assoc. Prof., EEE, DUET


Dr. Masuma Akter
Asstt. Prof., EEE, DUET

Counter Signed by:


Prof. Dr. Md. Shaheen Hasan Chowdhury
Head
Dept. of EEE, DUET, Gazipur

Rangpur Metal Industries Limited
(Unit-3)


Page 1 of 2

DEPARTMENT OF ELECTRICAL and ELECTRONIC ENGINEERING
Dhaka University of Engineering & Technology, Gazipur
Gazipur-1700, Bangladesh



তড়িৎ ও ইলেকট্রনিক কৌশল বিভাগ
ঢাকা প্রকৌশল ও প্রযুক্তি বিশ্ববিদ্যালয়, গাজীপুর
গাজীপুর-১৭০০, বাংলাদেশ

Tel : +88-02-9204709, PABX : 9204734-53/Ext. 3011, Fax : +88-02-9204709, E-mail: head_eee@duet.ac.bd, Web: http://www.duet.ac.bd

Ref. No.: DUET/EEE/2017/38 (xi)

Date : 27/02/2017

Test Results of AAC ANT Insulated Conductor

Sl. No.	Description of Tests	Unit	Measured/Calculated Value
01.	Nominal Aluminium Area	mm ²	53
02.	Number of strands in the Conductor	No.	7
03.	Average Diameter of each Strand	mm	3.112
04.	Average Diameter of Bare Conductor	mm	9.336
05.	Average Thickness of Insulation (Minimum)	mm	1.132
06.	Overall Diameter of Insulated Conductor	mm	11.58
07.	Direction of Lay	--	Right Hand
08.	Lay Length	mm	120
09.	Lay Ratio	--	12.85
10.	Test of Aluminium Wire		
	a) Tensile Strength (Minimum)	N/mm ²	173
	b) Wrapping Test	--	No Crack
	c) DC Resistance of at 20°C (Maximum)	Ω/km	0.357
11.	Calculated Breaking Load of Complete Conductor	kgf	938
12.	Total Weight of Conductor	kg/km	217

Rangpur

Rangpur Metal Industries Limited
(Unit-3)

Chandra Saha

M. A. S.

Appendix J: Adequacy Certificate for Design of SPC Pole



BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY, DHAKA
 SCHOOL OF RESEARCH, TESTING AND CONSULTATION
 DEPARTMENT OF CIVIL ENGINEERING

BRTC No.: 1108-8888/15-16 dated: 04/11/2015 Date of Issue: 08 November 2015

ADEQUACY CERTIFICATE FOR DESIGN OF SPC POLE: 7.6m Class N7

DESIGN SUBMITTED BY: Akota Pole Industries Limited, Flat no-2B, House no-01, Rd no-28, Sect-07, Uttara Model Town, Dhaka 1230

A. GENERAL REB SPECIFICATION (RED Spec., Pub. 488-2003/Rev. 1 of RED 450-1994, June 2003)

1. LENGTH OF POLE	7.6 m or 26'
2. SETTING DEPTH	5.524 m
3. DESIGN ULTIMATE LOAD	3.32 MN
4. DESIGN WORKING LOAD (Applied at 600 mm below Pole Top)	1.6 MN
5. FACTOR OF SAFETY (Clause 13.3)	2.2
6. LIFTING AND HANDLING (Clause 11)	

Concrete must attain adequate strength so that cracking (where) capacity is not exceeded based on strength at the time of handling and lifting. The manufacturer shall show on the poles the points at which the poles are to be lifted and supported.

B. GENERAL POLE CHARACTERISTICS OF Akota Pole Industries Limited

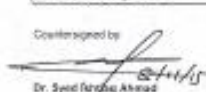
a) Length of Pole	7.6 m
b) Outside Pole Diameter at Top / Bottom	140 mm / 241.33 mm
c) Wall Thickness of Pole at Top / Bottom	26 mm / 38 mm
d) Weight of Pole	332.4 kg
e) Taper of Pole at Outside / Inside Face	13.335 mm/m / 13.333 mm/m
f) Dia. and No. of Reinforcing Steel Used	6 mm HTS size-8 Nos.
g) Dia. and No. of Working Steel / Underlaid Prestressing Steel Used	None
h) Dia. and Grade of Spiral Steel Reinforcement Used	3 mm dia steel wire with f_y 5.443 MPa
i) Angular Spacing between Adjacent Prestressed Steel	40° Minimum, 48° Maximum
j) Angular Spacing between Adjacent Prestressed / Nonprestressed Steel	As Req.

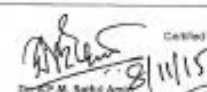
C. PARTICULAR COMPLIANCE TO SPECIFIC REB REQUIREMENTS

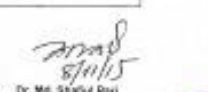
REB Specification	Value Used in the Design by Akota	Findings of Design Check	Remarks	
Concrete Properties				
28 day Cube Strength, f_{cu}	48 MPa (min)	50 MPa	58 MPa	
Cube Strength at Transfer, f_{ct}	27 MPa (min)	30 MPa	30 MPa	
Compressive Stress at Transfer	0.45 f_{cu}	18.9 MPa	15.5 MPa	O.K.
Compressive Stress after All Losses	0.4 f_{cu}	19.2 MPa	25 MPa	
Tensile Stress after All Losses	0.45 f_{cu} (f_{ct}) $\times 1.7$	4.98 MPa	4.80 MPa	
Prestressing Steel Properties				
Ultimate Strength, f_{pu}	1620 MPa (min)	1675 MPa	1670 MPa	
Prestress in Tendon during jacking	0.8 f_{pu}	252 kN	250 kN	O.K.
Initial Prestress in Tendon at Transfer	0.75 (Pole Class 1)	252 MPa	1622 MPa	
Effective Prestressing Force at Transfer	N/A	106.82 kN	157.20 kN	
Nonprestressing Steel Properties				
Yield Strength, f_y / UTS Strength, f_u	275 MPa (min) / N/A	N/A	N/A	O.K.
Yield, f_y / UTS Strength, f_u of Spiral	440 (min) / 550 MPa	440 (min)	440 / 550 MPa (min)	O.K.
Rebarring from Top	As reqd.	7 mm at 0.8 m	Checked	O.K.
Service Condition (Temp./Wet.)	25/3, 18-1.7 MPa	19.523/42 MPa	16.45/2.08 MPa	O.K.
Zero Tension at 33% of Ultimate Load (Comp./Tens.)	250 MPa	No Cal.	10.93/0.13 MPa	O.K.
Ultimate Moment Capacity	19.28 kN-m	19.12 kN-m	19.70 kN-m	O.K.
at Ground Line (Transverse Direction)				
Ultimate Moment Capacity	19.28 kN-m	19.12 kN-m	19.70 kN-m	O.K.
at Ground Line (Longitudinal Direction)				
Deflection at Working Load (Maximum)	183.8 mm (3% of height)	No Cal.	51 mm	O.K.
Longitudinal Stress (Compression)	Clause 11	13.24/-2.08 MPa	14.26/-2.23 MPa	O.K.
Crackement	As Reqd.	N/A	N/A	O.K.
Shear Strength (Setup Requirement)	As Reqd. 1200mm (shear length: 600 mm)	Normal spiral @ 140 mm (16 mm dia spiral)	Normal spiral @ 140 mm (16 mm dia spiral)	O.K.

FINAL COMMENTS ON DESIGN ADEQUACY: The design of the 7.6m Class N7 SPC pole of Akota Pole Industries Limited, was checked against requirements of RED Specification Pub. 488-2003, June 2003/ Rev. 1 of RED 450-1994, and is certified to be **ADEQUATE**.

This Certificate of Design Adequacy is based on the design calculations and drawings submitted by Akota Pole Industries Limited and are attached herewith duly signed with seal of the CE (Inst. for BRTC, GUST). This certificate is valid only when produced along with these certified design sheets.

Contersigned by

 Dr. Syed Faruk Ahmad
 Professor
 Dept. of Civil Engg.
 BUET, Dhaka

Certified by

 Dr. M. S. Sakil Ahmad
 Professor
 Dept. of Civil Engg.
 GUST, Dhaka

Certified by

 Dr. Md. Shahul Bari
 Professor
 Dept. of Civil Engg.
 BUET, Dhaka






BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY, DHAKA
BUREAU OF RESEARCH, TESTING AND CONSULTATION
DEPARTMENT OF CIVIL ENGINEERING

BRTC No.: 1109-85508/CE/15-16/ dated: 8/11/2015 Date of Issue: 08 November 2015

ADEQUACY CERTIFICATE FOR DESIGN OF SPC POLE

9.0m Class N6

DESIGN SUBMISSION BY: Akota Pole Industries Limited, Flat no.-20, House no.-01, Rd.no.-28, Sect.-07, Uttara Model Town, Dhaka 1230

A. GENERAL REQ SPECIFICATION (REQ Spec., Pub. 459-2003/Rev. 1 of REG-459-1995, June 2003)

1. LENGTH OF POLE	9 m or 30'
2. SETTING DEPTH	1.675 m
3. DESIGN ULTIMATE LOAD	4.4 kN
4. DESIGN WORKING LOAD (Applied at 900 mm below Pole Top)	2 kN
5. FACTOR OF SAFETY (Clause 13.3)	2.2
6. LIFTING AND HANDLING (Clause 14)	

Concrete must attain adequate strength so that stacking moment capacity is not exceeded based on strength at the time of handling and lifting. The manufacturer shall show on the poles the points at which the poles are to be lifted and supported.

B. GENERAL POLE CHARACTERISTICS OF Akota Pole Industries Limited

a) Length of Pole	9.0 m
b) Outside Pole Diameter at Top / Bottom	160 mm / 160 mm
c) Wall Thickness of Pole at Top / Bottom	30 mm / 30 mm
d) Weight of Pole	520.9 kg
e) Taper at Pole at Outside / Inside Face	13.333 mm/m / 13.333 mm/m
f) Dia. and No. of Prestressing Steel Used	7 mm HTS, 6 Nos.
g) Dia. and No. of Reinforcing Steel / Unreinforced Prestressing steel Used	None
h) Dia. and Grade of Spiral / Spiral Reinforcement Used	3 mm dia steel wire with 13.445 MPa
i) Angular Spacing between Adjacent Prestressing Steel	45° Minimum, 45° Maximum
j) Angular Spacing between Adjacent Reinforcing / Nonprestressing Steel	N/A

C. PARTICULAR COMPLIANCE TO SPECIFIC REQ REQUIREMENTS

REQ Specification	Value Used in the Design by Bidder	Findings of Design Check	Remarks
Concrete Properties			
28 day Cube Strength, f_{cu}	40 MPa (min)	50 MPa	50 MPa
Cube Strength at Transfer, $f_{cu,t}$	27 MPa (min)	30 MPa	30 MPa
Compressive Stress at Transfer, $0.85 f_{cu,t}$	23.0 MPa	25.5 MPa	25.5 MPa
Compressive Stress after All Losses	$0.85 f_{cu}$	33.8 MPa	33.8 MPa
Tensile Stress after All Losses	$0.45 \sigma_{ps}(f_{cu,t})+1.7$	4.48 MPa	4.88 MPa
Prestressing Steel Properties			
Ultimate Strength, f_{pu}	1650 MPa (min)	1670 MPa	1670 MPa
Prestress in Tendon during Jacking, $0.6 f_{pu}$	990 kN	970.2 kN	970.2 kN
Initial Prestress in Tendon at Transfer, $0.7 f_{pu}$ (Relax. Class I)	1155 kN	1021.5 kN	1021.5 kN
Effective Prestressing Force in Tendon, P_e	N/A	221.81 kN	221.81 kN
Nonprestressing Steel Properties			
Yield Strength, f_y or $f_{0.2}$	275 MPa (min)	N/A	N/A
Yield to ULS Strength, f_u of Spiral	440 mm (min) 550 MPa	440 mm	440 mm 550 MPa (min)
Reinforcing from Top	As reqd	2 wires at 1.2 m	Checked
Service Condition (Comp./Tens.)	25.12 MPa / 7.68 MPa	15.15 MPa / 5.88 MPa	15.15 MPa / 5.88 MPa
Stress Tension at 32% of ultimate Load (Comp./Tens.)	25.0 MPa	No Cal.	13.19 MPa / 4.44 MPa
Ultimate Moment Capacity at Strand Line (Transverse Direction)	28.99 kN-m	33.35 kN-m	34.40 kN-m
Ultimate Moment Capacity at Strand Line (Longitudinal Direction)	28.99 kN-m	33.35 kN-m	34.40 kN-m
Deflection at Working Load (Maximum)	206.2 mm (5% of height)	No Cal.	51 mm
Cracking at Working Load (Clause 11)	10 MPa / 0.47 MPa	10 MPa / 0.47 MPa	10 MPa / 0.47 MPa
Cracking at Ultimate Load (Clause 11)	As Reqd	N/A	N/A
Shear Strength/Strut Requirement	As Reqd	1200 mm (min) (at top) 112 mm (at base)	1200 mm (min) (at top) 112 mm (at base)

FINAL COMMENTS ON DESIGN ADEQUACY: The design of the 9.0m Class N6 SPC pole of Akota Pole Industries Limited, was checked against requirements of REQ Specification Pub. 459-2003, June 2003/ Rev. 1 of REG-459-1994, and is certified to be ADEQUATE.

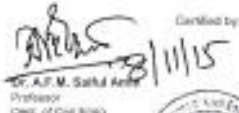
(This Certificate of Design Adequacy is based on the design calculations and drawings submitted by Akota Pole Industries Limited and are attached herewith duly signed with seal of the CC Dept. for BRTC, BUET. This certificate is valid only when produced along with these certified design sheets.)

Countersigned by



Dr. Syed Hossain Akbar
Professor
Dept. of Civil Engg
BUET, Dhaka

Certified by



Dr. A.T.M. Saifur Arif
Professor
Dept. of Civil Engg
BUET, Dhaka

Certified by



Dr. Md. Shahid Bari
Professor
Dept. of Civil Engg
BUET, Dhaka




Appendix K: Membership Certificate

11 March 2017.


URS Bangladesh Limited
15/A, Bowra, District-1
Dhaka 1212
Bangladesh
T +880 2 8849 589
F +880 2 8833 503
E info@ursbd.com
W www.urscertification.com

To Whom It May Concern

This is confirming that **Rangpur Metal Industries Ltd (Unit 3)** has registered with us for ISO 9001:2015 certification under the Client reference no- 81663 and registration of ISO 9001:2015 is recommended. The process of certification to ISO 9001:2015 has commenced and the company is soon expected to receive their certificate for ISO 9001:2015.


MD Najmul Hasan
Operations Department
URS Bangladesh Ltd


Rangpur Metal Industries Limited
(Unit-3)
Ahmed Saleh Hatan
General Manager
Tender-Sales (Cables)

United Registrar of Systems Ltd

BOOK NO. 13

SL NO. 0625



**The Habiganj Chamber of Commerce & Industry
Habiganj, Bangladesh.**

Registered in the year 1984-85. Under certificate No. TD-192/20
(Approved by the Federation of Bangladesh Chambers of Commerce & Industry)

Membership Certificate

This is to certify that M/S. RANGPUR METAL INDUSTRIES LTD. UNIT-3
Managing Director/ Director /Proprietor : AHSAN KHAN CHOWDHURY.
of OLIPUR P.O. SHAHJIBAZAR P.S. SHAISTAGANJ.
District : Habiganj, Bangladesh is a member of this Chamber.
His Membership is an Ordinary/Associate Number 1631
This Membership Certificate shall remain valid up to 31st Decembe- 2017 given under
the common seal and signature of the Habiganj Chamber of Commerce & Industry.
This 28TH day of JANUARY, 2017.

22/02/23
Secretary
MD. ARJU MIAH MAJUMDER
Secretary
Habiganj Chamber of Commerce and Industry
Habiganj.

Rangpur Metal Industries Limited (Unit-3)
Ahmed Saleh Ratan
General Manager
Tender-Sales (Cables)

MUTASIRUL ISLAM
President
Habiganj Chamber of Commerce And Industry
Habiganj.

Appendix L: Battery Recycling Agreement



BATTERY RECYCLING AGREEMENT

For

(249.6 kWp Solar Mini Grid Project
at Char Paka, Paka, Shibgonj, Chapainawabganj)

Between

Eastec Ltd.

And

Confidence Electric Ltd

Date: 24 Oct 2017



Confidence Electric Limited

Dhaka Trade Center (12th Floor), 99, Kazi Nazrul Islam Avenue,
Kawran Bazar, Dhaka-1215, Tel: +88 02 5503261-2, Fax: +88 02 5503263
Factory: Brahamonbagha, Mohjompur, Sonargaon, Narayanganj

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THIS AGREEMENT is made on the 24 day, 2017, (the Agreement) between **Eastec Ltd.**, having its registered Head Office at H/N-31/A, Road-8, Dhanmondi, Dhaka-1205, represented by its Managing Director, Md. Morshedul Islam (the Buyer) and Confidence Electric Ltd. Having its registered corporate office at Dhaka trade center(12th Floor), 99, Kazi Nazrul Islam Avenue, Karwan Bazar, Dhaka-1215.

WHEREAS:

- A. The Buyer is going to set up a 249.6 kWp Solar Mini Grid Project (the Project) at Char Paka, Paka, Shibgonj upozila of Chapainawabganj District (the Project Site) for which it requires 336 nos. of 1540 Ah, 2V Battery (the Batteries) and the Supplier has been selected for supplying the Batteries through a competitive process.
- B. With a view to recycling the Batteries, the Buyer and the Supplier have decided to enter into an agreement to determine the terms and condition of collection and recycling of the Batteries.

NOW THE PARTIES HEREBY AGREE THAT

Section 1: Warranty Service of the Supplier

The Supplier shall provide warranty services of 7 (seven) years to the Buyer for the Batteries subject to the terms and conditions mentioned in the quotation submitted by the Supplier at the time selection.

Section 2: Collection of Batteries

The Supplier shall collect the Batteries from the Project Site at its own cost and arrangement within 30days from the date of being informed of damage of Battery/expiry of Warranty Period:

- a. If the Batteries are damaged during the Warranty Period; or
- b. Upon expiry of the Warranty Period.

Section 3: Recycling of the Batteries

After collection from the Project Site, the Supplier shall recycle every damaged or warranty expired Batteries in environment friendly way.

Section 4: Compliance with Environmental Social Management Framework (ESMF)

During the collection and the recycling of damaged or warranty expired Batteries, the Supplier shall follow the environmental, health and social compliances, under the Environmental Social Management Framework (ESMF) of IDCOL.



Confidence Electric Limited

Dhaka Trade Center (12th Floor), 99, Kazi Nazrul Islam Avenue,
Karwan Bazar, Dhaka-1215, Tel: +88 02 5503261-2, Fax: +88 02 5503263

Factory: Brahmonbagha, Mohjompur, Sonargaon, Narayanganj



Section 5: Price of warranty expired Batteries

The Supplier shall pay the Buyer for the warranty expired Batteries and the Supplier shall pay the price on or before the collection of warranty expired Batteries on the basis of 30% of LME (London Metal Exchange for Lead) price for dry weight which shall be followed on average of the week.

Section 6: Liquidated damages for delay in collection of damaged/warranty expired Batteries

The Supplier shall be liable to pay liquidated damages at the rate of 14 (fourteen) days of delay in collection of Batteries as mentioned in section 2.

Section 7: Sale of the damaged/warranty expired Batteries to any third party

If the Buyer sells the damaged/warranty expired Batteries to any third party, the Supplier shall be discharged from its liabilities for collection and recycling of damaged/warranty expired Batteries under this Agreement and the Buyer shall be responsible to enter into necessary arrangements for collection and recycling of the damaged/warranty expired Batteries with that third party.

Section 8: Dispute Resolution

- 8.1. *Negotiation.* Any dispute that may arise between the Buyer and the Supplier in connection with or under this Agreement shall be tried to be amicably resolved through mutual negotiation of both parties.
- 8.2. *Mediation.* If any dispute referred to in paragraph (8.1) above arises and cannot be resolved through negotiation, it will be referred to a third party mediator selected by both parties for a mediated resolution; and the cost of such mediation will be shared jointly by both parties.
- 8.3. *Arbitration.* In case a dispute is not resolved through methods as per paragraphs (8.1) and (8.2) above, it shall be referred to arbitration under the Arbitration Act 2001 (the “Act”) of Bangladesh as the last resort; the arbitral award thereon shall be final and binding; and the cost of such arbitration shall be shared jointly by the parties or as may otherwise be determined under the Act.

IN WITNESS WHERE OF, the parties have caused this Agreement to be signed in their respective names on the date first above written.



Confidence Electric Limited

Dhaka Trade Center (12th Floor), 99, Kazi Nazrul Islam Avenue,
Kawran Bazar, Dhaka-1215, Tel: +88 02 55013261-2, Fax: +88 02 55013263
Factory: Brahmonbagha, Mohjompur, Sonargaon, Narayanganj

3



For Eastec Ltd.

By: Md. Morshedul Islam, Managing Director

For Confidence Electric Ltd.

By: A F Muahammad Tuaha, Head of Sales,
OEM& Third Brand

Witness: D, M, Abu Bakar Siddique

Witness: Abul Kalam, Sr. Officer



Confidence Electric Limited

Dhaka Trade Center (12th Floor), 99, Kazi Nazrul Islam Avenue,
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Factory: Brahmanbagha, Mohjampur, Sonargaon, Narayanganj

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