

ENVIRONMENTAL IMPACT ASSESSMENT

240kWp Standalone AC-DC Coupled Solar Photovoltaic Based Mini Grid Power Plant

by

Super Star Renewable Energy Limited



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Table of Contents

1	INTRODUCTION	1
1.1	Background	1
1.2	Purpose of the Study	3
1.3	Scope of the Work.....	3
1.4	Extent of the Study	4
1.5	EIA Content.....	4
1.6	Approach and Methodology	5
1.6.1	Approach.....	5
1.6.2	Methodology	5
2	POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK.....	11
2.1	General	11
2.2	Bangladesh Environmental Conservation Act (ECA) 1995, as amended in 2010....	11
2.3	Bangladesh Environmental Conservation Rules, 1997, (amended by Notification SRO 29-Law/2002 of 16 February 2002 and amended in SRO 355-Law/2010).....	12
2.4	Renewable Energy Policy of Bangladesh, 2008	13
2.5	Guidelines for the Implementation of Solar Power Development Program, 2013 ...	13
2.6	Remote Area Power Supply Systems (RAPSS) Guideline of 2007.....	13
2.7	Bangladesh Labor Law, 2006.....	13
2.8	The Japan International Cooperation Agency Requirements.....	14
2.9	World Bank's Guidelines on Environmental and Social Safeguards Policies	14
2.10	ADB Guidelines on Environmental and Social Safeguards.....	15
2.11	Environmental Clearance	16
3	DESCRIPTION OF THE PROPOSED PROJECT	18
3.1	Project Location	18
3.2	Project Description	20
3.3	Rationale of the Project	21
3.4	Land Filling Activities	22
4	TECHNOLOGICAL ASPECTS	23
4.1	Proposed Process and Technology	23
4.2	Adequacy of Solar Irradiation	25
4.3	Plant Capacity Selection.....	26
4.4	Adequacy of Generator Size	28
4.5	Adequacy of Energy Storage Requirement	29
5	DESCRIPTION OF THE BASELINE ENVIRONMENT	31
5.1	General	31
5.2	Physical Environment	31
5.2.1	Climate.....	31
5.2.2	Ambient Air Quality	37
5.2.3	Noise Level	38
5.2.4	Physiography.....	39
5.2.5	Topography	42
5.2.6	Geology.....	44
5.2.7	Water Resources	46
5.2.8	Soil Quality	51
5.2.9	Agro-ecological Zones within the Project Area.....	53
5.2.10	Seismicity.....	55

5.3	Biological Environment	57
5.3.1	Bio-ecological Zones	57
5.3.2	Terrestrial Ecosystem.....	59
5.3.3	Protected Areas and Red Book Species	62
6	DESCRIPTION OF THE SOCIAL CONDITIONS	64
6.1	Socioeconomic Conditions.....	64
6.2	National Context	64
6.3	Administrative Information.....	65
6.4	Demographic Information	66
6.4.1	Household Size	66
6.4.2	Gender Distribution	66
6.4.3	Nutrition.....	66
6.4.4	Religion.....	66
6.4.5	Ethnicity.....	67
6.5	Land Use and Ownership	67
6.5.1	Cropping Patterns.....	67
6.5.2	Project Land	68
6.6	Occupational Patterns.....	68
6.6.1	Occupational Status	68
6.7	Livelihood	68
6.8	Settlement Pattern and Housing	69
6.9	Transports and Communications.....	69
6.10	Poverty	69
6.11	Health	69
6.12	Recreational Aactivities	71
6.13	Archaeological and Cultural Heritage.....	71
6.14	Climate Change and Natural Disaster	71
6.15	Environmental and Social Hotspot.....	72
7	ANALYSIS OF PROJECT ALTERNATIVES	74
7.1	The Proposed Development Alternative	74
7.2	Site Alternatives	74
7.3	The No Action Alternative	74
8	PUBLIC CONSULTATION AND DISCLOSURE.....	76
8.1	General	76
8.2	Objectives.....	76
8.3	Consultation with Various Stakeholders	76
9	ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES.....	80
9.1	General	80
9.2	Impact Magnitude	80
9.3	Sensitivity of Receptor	81
9.4	Summary of Assessed Impacts.....	81
9.5	Corridor of Impact (CoI).....	82
9.6	Pre-construction Phase	82
9.6.1	Land Use / Land-filling.....	82
9.6.2	Flood Hazards	83
9.7	Construction Phase.....	83
9.7.1	Visual Amenity	84
9.7.2	Air Quality	84
9.7.3	Noise	85
9.7.4	Soil	86

9.7.5	Water Resources	86
9.7.6	Terrestrial Ecology.....	87
9.7.7	Waste Generation.....	88
9.7.8	Health and Safety	88
9.7.9	Employment Opportunities	89
9.7.10	Traffic	89
9.7.11	Archaeology and Cultural Resources.....	90
9.8	Operational Phase.....	90
9.8.1	Visual Amenity	90
9.8.2	Air Quality	91
9.8.3	Noise	91
9.8.4	Soil	92
9.8.5	Water Resources	92
9.8.6	Terrestrial Ecology.....	93
9.8.7	Waste Generation.....	93
9.8.8	Health and Safety	94
9.8.9	Employment Opportunities	96
9.8.10	Traffic	96
9.9	Decommissioning Phase	96
9.9.1	Visual Amenity	96
9.9.2	Air Quality	97
9.9.3	Noise	97
9.9.4	Soil	97
9.9.5	Terrestrial Ecology.....	97
9.9.6	Waste Generation.....	98
9.9.7	Health and Safety	99
9.9.8	Employment Opportunities	99
9.9.9	Traffic	100
9.10	Summary of Anticipated Impacts.....	100
10	ENVIRONMENTAL MANAGEMENT PLAN (EMP)	109
10.1	General	109
10.2	Objectives.....	109
10.3	Environmental Management Plan (EMP)	109
10.4	Environmental Monitoring Plan.....	127
10.4.1	General.....	127
10.4.2	Objectives	127
10.5	Environmental Budget.....	132
11	ENVIRONMENTAL AND SOCIAL BENEFIT	134
11.1	Introduction	134
11.2	Energy and Climate Concern	134
11.3	Energy and Livelihood Concern	135
11.4	Energy and Economy Concern.....	135
12	CONCLUSION	137
12.1	Conclusion.....	137
12.2	Recommendations	137
	REFERENCES	138
	APPENDIXES	139

List of Figures

Figure 1.1: Route Map of Environmental Impact Assessment	7
Figure 1.2: Location of Sample Collections	9
Figure 2.1: Government of Bangladesh Environmental Assessment Process	17
Figure 3.1: Accessible Route to Project Site	18
Figure 3.2: Project Location	19
Figure 4.1: Overview of Project Technology	23
Figure 4.2: Single Line Diagram of the Plant	25
Figure 4.4: Estimated Daily Load Profile	28
Figure 4.3: Plant capacity selection	28
Figure 5.1: Climatic Zones of Bangladesh	33
Figure 5.2: Average Monthly Maximum and Minimum Temperature.....	34
Figure 5.3: Average Monthly Total Rainfall	35
Figure 5.4: Average Monthly Relative Humidity	35
Figure 5.5: Average Monthly Maximum Wind Speed	36
Figure 5.6: Average Monthly Maximum Sunshine	36
Figure 5.7: Average Monthly Cloud Coverage.....	37
Figure 5.8: Air Quality Monitoring at Project Site	37
Figure 5.9: Noise Level Monitoring in the Project Area	39
Figure 5.10: Physiographic Sub Regions of Bangladesh.....	41
Figure 5.11: Topographic Elevation of the Project Area	43
Figure 5.12: Geology of Bangladesh	45
Figure 5.13: Water Bodies in the Project Area	46
Figure 5.14: Surface Water Sampling from the Project Location	47
Figure 5.15: Water Bodies and River Network Map	48
Figure 5.16: Water Sampling from the Project Location.....	49
Figure 5.17: Arsenic Concentrations in Groundwater	50
Figure 5.18: General Soil Categories of Bangladesh.....	52
Figure 5.19: Agricultural Practices in the Project Area	53
Figure 5.20: Agro-ecological Zones of Bangladesh	54
Figure 5.21: Seismic Zones within Bangladesh.....	56
Figure 5.22: Bio-ecological Zones of Bangladesh.....	58
Figure 5.23: Flora in the Project Area	59
Figure 5.24: Environmental Protected Areas of Bangladesh.....	63
Figure 6.1: Poverty Map of Bangladesh (BBS/WFP/ World Bank-2010).....	70
Figure 6.2: Cultural and Sensitive Structures within 1 km Radius of the Project Location	73
Figure 8.1: Photos of Focus Group Discussions (FGD)	77
Figure 11.1: Trends of World Solar Energy Growth	136

List of Tables

Table 3.1: Project Key Information	20
Table 4.1: Monthly Average Solar Insolation Incident at 24Degree Tilted Angle.....	25
Table 4.2: Plant Capacity Determination.....	27
Table 4.3: Battery Capacity	29
Table 5.1: Test Results of Ambient Air Quality Analysis	38
Table 5.2: Noise Level at Different Locations of Project Area	39
Table 5.3: Results for Surface Water Field Sample.....	47
Table 5.4: Results for Groundwater Field Sample.....	49
Table 5.5: Seismic Zonation of Bangladesh	55
Table 5.6: List of Plants in the Project Area.....	60
Table 5.7: List of Fauna Identified in and around the Project Area	61
Table 6.1: Key Socio-economic indicators for Bangladesh.....	65
Table 6.2: Demographic Profile of the Project Area	66
Table 8.1: Details of FGDs	77
Table 8.2: Summary of the FGDs	77
Table 9.1: Parameters for Determining Magnitude	80
Table 9.2: Criteria for Determining Sensitivity	81
Table 9.3: Significance of Impact Criteria.....	82
Table 9.4: Summary of Anticipated Impacts during the Planning and Construction Phase..	101
Table 9.5: Summary of Anticipated Impacts during the Operation Phase	103
Table 9.6: Summary of Anticipated Impacts during the Decommissioning Phase	107
Table 10.1: Environmental Management Plan (EMP) of Solar Mini-grid Power Plant Project	110
Table 10.2: Environmental Monitoring Plan	128
Table 10.3: Environmental Budget for Solar Mini-grid Power Plant Project.....	132

List of Appendix

Appendix A: Air Quality Monitoring Methodology.....	139
Appendix B: Air Quality Test Result.....	143
Appendix C: Noise Level Test Result	144
Appendix D: Test Result of Surface Water	145
Appendix E: Test Result of Groundwater.....	146
Appendix F: Important Sensitive Locations in the PIA.....	147
Appendix G: Details of FGDs with Attendance List.....	150

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

The interest in renewable energy has been revived over last few year, especially after global awareness regarding the ill effects of fossil fuel burning. Energy is the source of growth and the mover for economic and social development of a nation and its people. Natural resources or energy sources such as: fossil fuels, oil, natural gas etc. are completely used or economically depleted. Because we are rapidly exhausting, our non-renewable resources, degrading the potentially renewable resources and even threatening the perpetual resources.

Bangladesh is a densely populated country with 160 million people. To meet the increasing population demand the generation of electricity is not produced as expected. The per capita generation is 348 kWh (Power Division, Government of the People's Republic of Bangladesh; Accessed on 19-08-2015). The per capita consumption of power by World Bank estimate in 2009 for India was 571 kWh, for Pakistan was 449 kWh and for China it was 2631 kWh. The Sixth Five Year Plan contains information on demand-supply gap for electricity, source of electricity supply, use of different types of energy, electricity generation program and strategy for power generation.

The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings toward not only meeting the existing power deficiency of the country but also ensuring continuous power in view of the projected future demand. Current undertaking by the Superstar Renewable Energy Limited constructing a Solar Mini Grid Power Plant at Char Bhgutia, Manikganj has been implemented under this policy.

The proposed Project involves setting up of a 240 kWp solar photovoltaic (PV) based AC-DC coupled mini-grid by Superstar Renewable Energy Limited at Char Baghutia, under Baghutia Union, Daulatpur Upazila in Manikganj District. An 100 kVA (87 kW) diesel backup generator will be integrated into the proposed power plant in order to ensure adequate power supply during periods of low solar radiation. Once completed, the Project is expected to go into commercial operation in February 2016 and supply electricity to adjacent 962 households, 96 shops, 16 mosques, madrasahs and school, 4 rice mills, 1 saw mill 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 site of the proposed project is located at Char Baghutia of Baghutia union of Daulatpur upazila in Manikganj district. The Global Positioning System (GPS) coordinate of the project site is 23.93407° N, 89.72073° E. The proposed plant location is bounded by agricultural land in all sides, in addition the North side of the project area is having scattered settlement and the nearest house is 200m far from this proposed project.

The proposed Project involves setting up of a 240kWp standalone AC mini-grid power plant by Superstar Renewable Energy Limited at Char Baghutia in Daulatpur upazila of Manikganj district.

The proposed system will include 201.25kWp on-grid solar PV panels, 38.75kWp off-grid solar panels (dedicated for charging batteries), 288 batteries of 1540 Ah (at 2 V) along with a 100 kVA diesel backup generator to meet the energy demand of the area. The total budget is estimated as BDT- 92,641,806.

DESCRIPTION OF THE BASELINE ENVIRONMENT

The project area is located in the South-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 average minimum temperature in the project area lies within December to February which varies generally from 13.1°C to 16.46°C while the maximum temperature is seen in April which is around 33.99°C. The monthly rainfall generally in the project area is about below 400mm. About 80% of the total rainfall has been recorded during monsoon. The average yearly humidity in the region varied from 60% to 82%. Average wind speed remained maximum with 3.47 knots in April. The minimum wind speed was 1.28 knots in the month of December in the area. The proposed site is presently using for agriculture. Air quality test has been conducted on 19th March 2016 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 the silent zone.

The project area falls in the Old Brahmaputra Floodplain physiographic unit. The topography of the specific project location is 18.83 – 35 m. The project area is surrounded by the mighty river Jamuna. 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 19th March 2016, 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. The result of the surface water sample analyzed by DPHE is included on Appendix C. The ground water sample was also analyzed and all the parameters concentration levels are within the acceptable limit of drinking water quality standard set by DoE. The result of the ground water sample analyzed by DPHE is included on Appendix D.

The soil near the project area is Calcareous Dark Grey & Brown Floodplain soils. As per the seismic zone map, project area falls in the zone II of medium seismic intensity. 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. The literacy rate of this island is 26.50% for both male and female. According to the poverty map of Bangladesh 2010 prepared by BBS/WFP/ World Bank, the project area falls under 16% to 27% in category.

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. According to local people, the highest flood level experienced was around 3.5 feet in 1998. After consultation meeting with the local people during the visit, it was found that the island (Char Baghutia) was formed in 1988. The char is not susceptible to any momentous river-erosion. However, the proposed project site is situated on the lower ground and it needs about 5-feet soil filling.

The land filling material was collected from the nearby private land. The land used for land filling material was occupied by a local family with housing structures. The soil extracted land is neither being used for fishing cultivation nor as 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. The private land owner shifted to other land. No anticipated impact was found. The developer used dredging machine for extracted soil for land filling of the project site. The extracted soil materials were deposited in the project site

through a long pipe. 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. 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. These chemical pollutants must be dumped in a separated place so that unwanted contamination will be reduced. 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. After the life period is ended each battery will be collected by the supplier-manufacturer and will be duly recycled. The supplier will also collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery. 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.

Superstar Renewable Energy 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, manage selection of Contractors, and supervise construction.

Mitigation is the responsibility of Superstar Renewable Energy Limited. 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 (Super Star 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

Being aware of the finite stock of fossil fuels and their negative impact on the environment, countries across the world are now leaning towards renewable energies like solar energy, wind energy, bio-energy, hydropower, geothermal and ocean energy in efforts to ensure energy security. The use of renewable energy has risen considerably in recent times, both in developed and in developing countries. According to the Global Status Report, it indicates that renewable energy provided an estimated 19% of global energy consumption in 2012 compared to 16.7 % in 2010. More than hundred countries now have renewable energy policy of one kind or the other. Keeping pace with the global trend, Bangladesh has also attached due importance to development of renewable energy. National plans - Five Year Plan, Power System Master Plan and policy documents including National Energy Policy, Industrial Policy 2010 underscored renewable energy. Development of renewable energy has been identified as one of the programs of Bangladesh Climate Change Strategy and Action Plan. Renewable energy options are also included in the Bangladesh National Building Code. A dedicated policy, Renewable Energy Policy of Bangladesh, has been in force since 2009, which envisions having 5% power from renewable energy sources by 2015 and 10% by 2020. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency. To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. Those endeavors manifest Bangladesh's commitment towards development of renewable energy.

Increasing economic growth and social development within Bangladesh is placing a growing demand on energy supply. Coupled with the rapid advancement in economic and social development, is the growing awareness of environmental impact, climate change and the need for sustainable development. Whilst Bangladesh relies heavily on gas to meet its energy needs, the country is well endowed with renewable energy resources that offer sustainable alternatives to fossil fuels. Renewable energy harnesses naturally occurring inexhaustible sources of energy, such as solar, wind, biomass, hydro, tidal, wave, and ocean current, to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types. The successful use of renewable energy technology in Bangladesh still requires extensive investigation, however, Concentrating Solar Power (CSP) and Photovoltaic (PV) technologies have been demonstrated to be economically and environmentally viable and capable of being employed on a large scale.

Bangladesh is a densely populated country with 160 million people. Population is increasing but the generation of electricity is not increasing as expected. The per capita generation is 348 kWh (Power Division, Government of the People's Republic of Bangladesh; Accessed on 19-08-2015). The per capita consumption of power by World Bank estimate in 2009 for India was 571 kWh, for Pakistan was 449 kWh and for China it was 2631 kWh. The Sixth Five Year Plan contains information on demand-supply gap for electricity, source of electricity

supply, use of different types of energy, electricity generation program and strategy for power generation. The plan document shows a clear gap between demand and supply and only about 68% have access to electricity.

The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings in view of the projected future demand. Current undertaking by the Superstar Renewable Energy Limited constructing a Solar Mini Grid Power Plant at Char Baghutia under Daulatpur upazilla of Manikganj District has been implemented under this policy.

Due to the increasing demand of electricity the government of Bangladesh has declared its vision 2021 to provide electricity for all. Power Sector Master Plan 2010 (PSMP-2010) has been undertaken to accommodate the government's vision 2021. According to PSMP study the electricity demand would be 34,000MW by the year 2030. The government fully recognizes the fact that public sector investment alone is not sufficient to achieve its target that is why The Government is strongly committed to attract private investment for installing new renewable energy capacity on a build-own-operate (BOO) basis in order to achieve overall economic development targets of the country and avoid looming power shortages. Development of Renewable Energy is one of the important strategies adopted as part of Fuel Diversification Program. In line with the Renewable Energy policy 2009, the Government is committed to facilitate both public and private sector investment in Renewable Energy projects. The Renewable Energy Policy envisions that 5% of total energy production will have to be achieved by 2015 and 10% by 2020. Under the existing generation scenario of Bangladesh, Renewable Energy has a very small share to the total generation. The share of Renewable Energy exceeds more than 1% till now. The present Government is placing priority on developing Renewable Energy resources to improve energy security and to establish a sustainable energy regime alongside of conventional energy sources.

Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m². Encouraged by the availability of solar radiation, Power Division has initiated a programme "500 MW Solar Power Mission" launched by the Government to generate 500 MW of solar-based electricity. Under this programme, projects for electrification of rural health centres, educational institutions, E-centres at union levels, religious establishments and remote railway stations are required to be implemented by authorities concerned. Private sector is expected to implement commercial projects like Solar Irrigation, Solar Mini Grid, Solar Park and Solar Rooftop applications.

The government is gradually meeting part of the lighting and cooling load of public offices by installing solar panels. The national capacity of solar power development currently exceeds 150 MW. Most of the capacity addition is from Solar Home Systems (SHS) implemented by Infrastructure Development Company Limited (IDCOL), a government-owned financial institution. Until recently, more than 3 million SHSs have been installed with aggregated capacity of about 135 MW. The international community recognises Bangladesh's SHSs as the fastest growing solar power dissemination programme in the world.

Superstar Renewable Energy Limited proposed a project of a 240 kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant by Super Star Renewable Energy Ltd. (Super Star) at Char Baghutia under Daulatpur upazilla of Manikganj District. The proposed system will include 201.25 kWp on-grid solar PV panels, 38.75 kWp off-grid solar panels (dedicated for charging batteries), 288 batteries of 1540 Ah (at 2 V) along with a 100 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in February 2016 and supply electricity to the adjacent 962 households, 96 shops, 16 social institutions e.g. mosques, madrasahs and schools, 4 rice mills, 1 saw mill and 20 irrigation pumps.

1.2 Purpose of the Study

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. The main purpose of this EIA are to evaluate the impact of project location from the environmental point of view along with possible measures to be included in an Environmental Management Plan (EMP) to minimize the potential impacts resulting from project activities during the implementation and operation phase of the project.

This EIA 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 240kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant. Superstar Renewable Energy Limited as an implementing agency of 240kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant that illustrates environmental issues in connection with the planning, design and implementation of this project. The EIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The EIA 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 Management Plan (EMP). Extensive public consultations undertaken as part of the EIA work have been considered for identifying the mitigation measures.

1.3 Scope of the Work

This EIA report has been prepared keeping in view the Term of Reference (ToR) as provided by the Client. The scope of the present EIA 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 Management Plan (EMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

1.4 Extent of the Study

This EIA is carried out based on proposed development. The influence of impact has been defined as 1 Km on each side from the project location. However, the study area has been extended up to 1 Km area on each side of the project. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project area for above purposes. 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.

1.5 EIA Content

The report fulfills the requirements of EIA under ECR, 1997 and has been prepared in accordance with the TOR. This EIA 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 eleven chapters and the chapter details are discussed below:

- Chapter 1 describes the introduction containing background, purpose of the EIA study, scope of the study, and approach methodology of EIA study.
- Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the EIA process.
- Chapter 3 contains detailed project description including the all the aspects of the proposed project.
- Chapter 4 describes the technological aspects
- Chapter 5 describes environmental and social baseline condition with details on physical environment, land resources, agricultural resources, fisheries, ecosystem, socio-economic condition and social characteristics of the area.
- Chapter 6 describes analysis of the project alternatives
- Chapter 7 describes public consultation discussion with local stakeholders with their

ideas, views about the project through knowledge sharing

- Chapter 8 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 9 describes the environmental management plan (EMP) and monitoring plan along with the costing of the mitigation measures and monitoring plan.
- Chapter 10 includes the environmental and social benefits.
- Chapter 11 concluding the EIA report along with the recommendations.

1.6 Approach and Methodology

1.6.1 Approach

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 EIA preparation is given in Figure 1.1. 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.

1.6.2 Methodology

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

(i) Orientation

Meetings and discussions were held among the members of the EIA 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 EIA 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 1.2 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
- Questionnaire Survey
- Public Consultations
- Laboratory Analysis

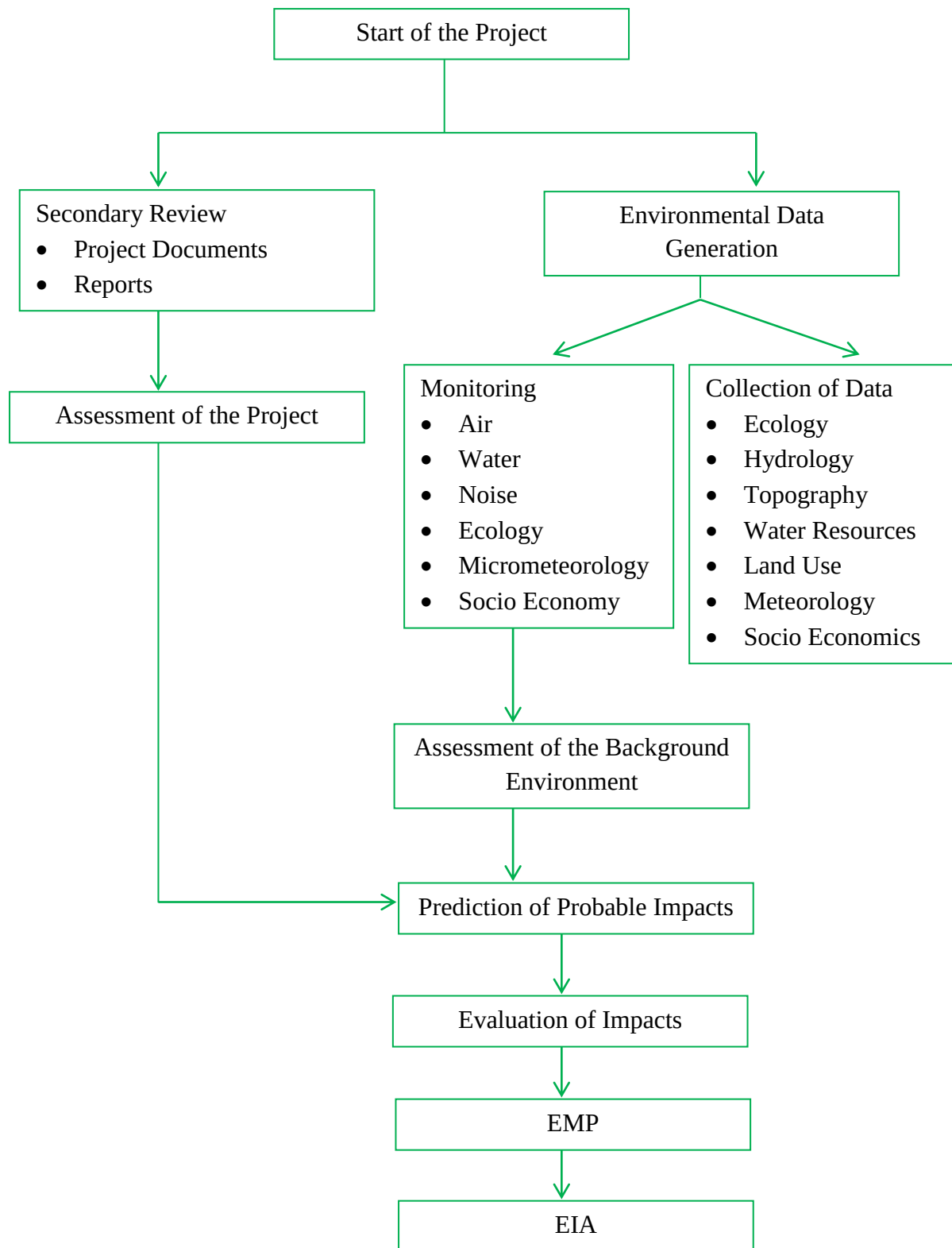


Figure 1.1: Route Map of Environmental Impact Assessment

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 1.2.

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. Analysis of air quality sample was tested by Development Solutions Consultant Limited (DSCL). A methodology for analyzing the air quality sample is described in Appendix A.

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. Analysis of ground/drinking water was performed by DPHE.

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). Analysis of surface water was performed by DPHE.

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.

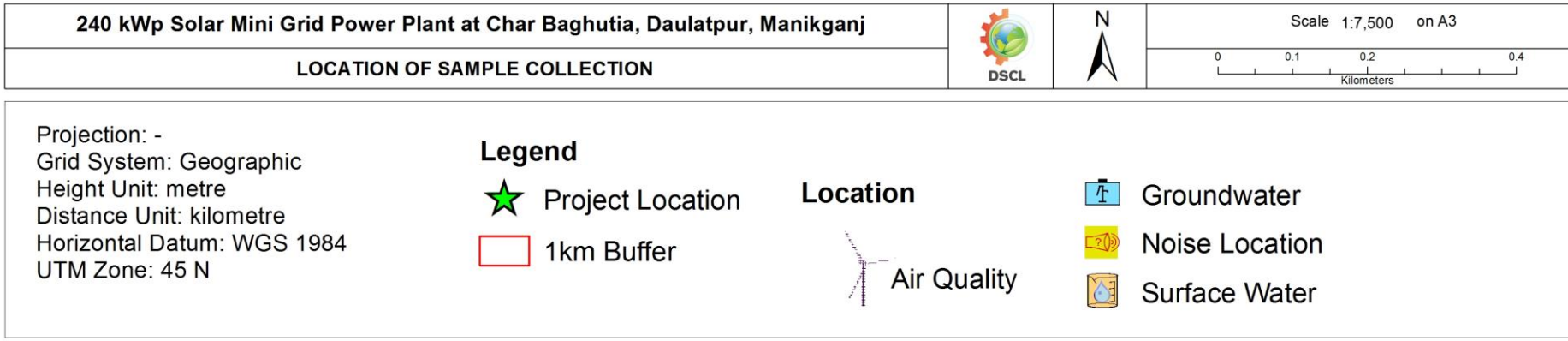
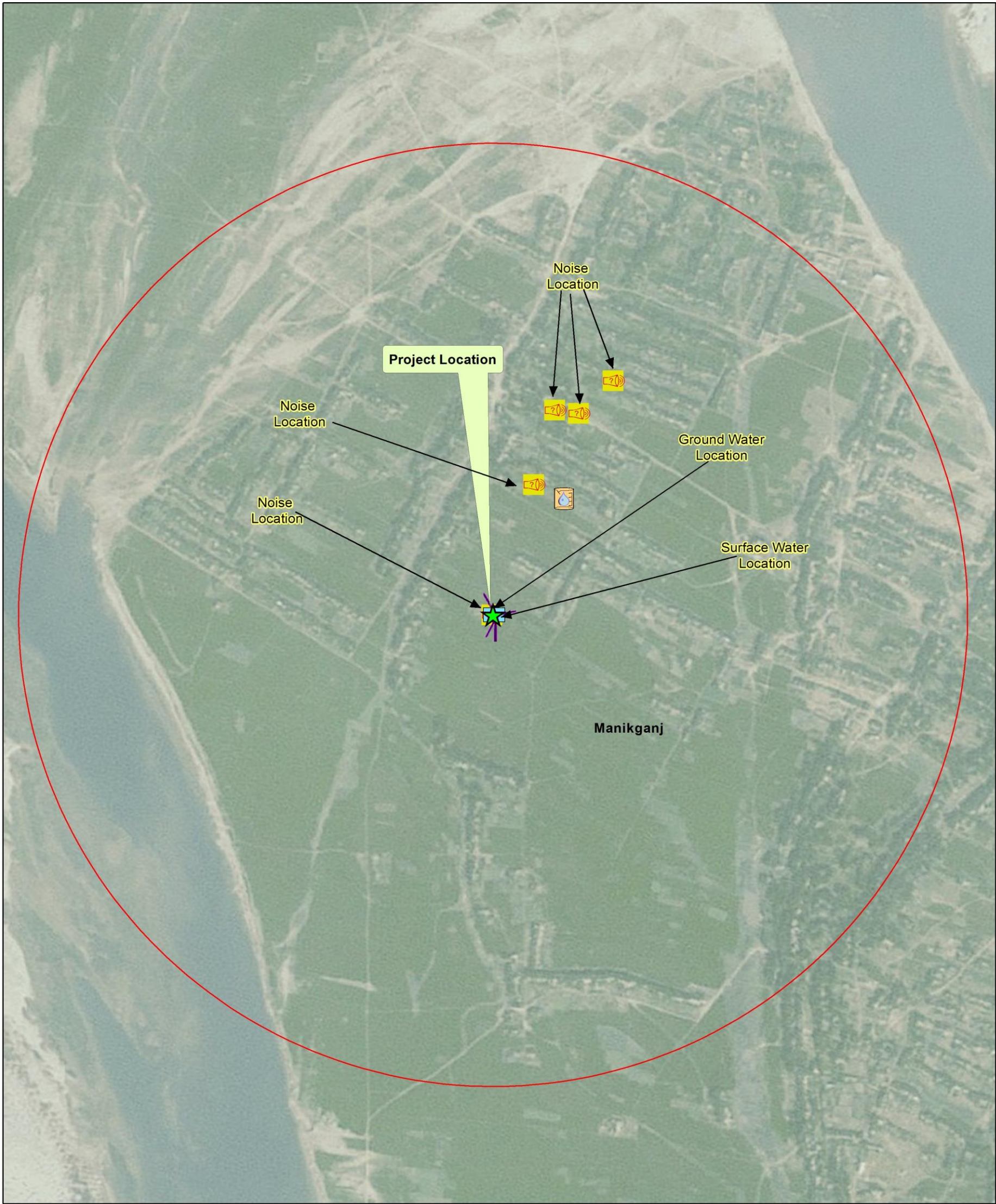


Figure 1.2: Location of Sample Collections

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 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

Public consultation is an important component of the EIA preparation activities. Local knowledge about the ecosystem and problems associated with the project activities were carefully recorded and used in impact assessment and developing mitigation plan. Formal public consultation, in tandem with opportunistic informal ones involving local villagers, and people whose livelihood depends on these project areas, were executed. Detailed description of public consultation has been presented at Chapter 7.

2 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 General

An EIA 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 EIA allows for resolution of the issue(s) reported on in the Scoping and EIA 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.

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.

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, (amended by Notification SRO 29-Law/2002 of 16 February 2002 and amended in SRO 355-Law/2010)

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.

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.

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.

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.

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.

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 EIA 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, siting, 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.

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).

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.

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.

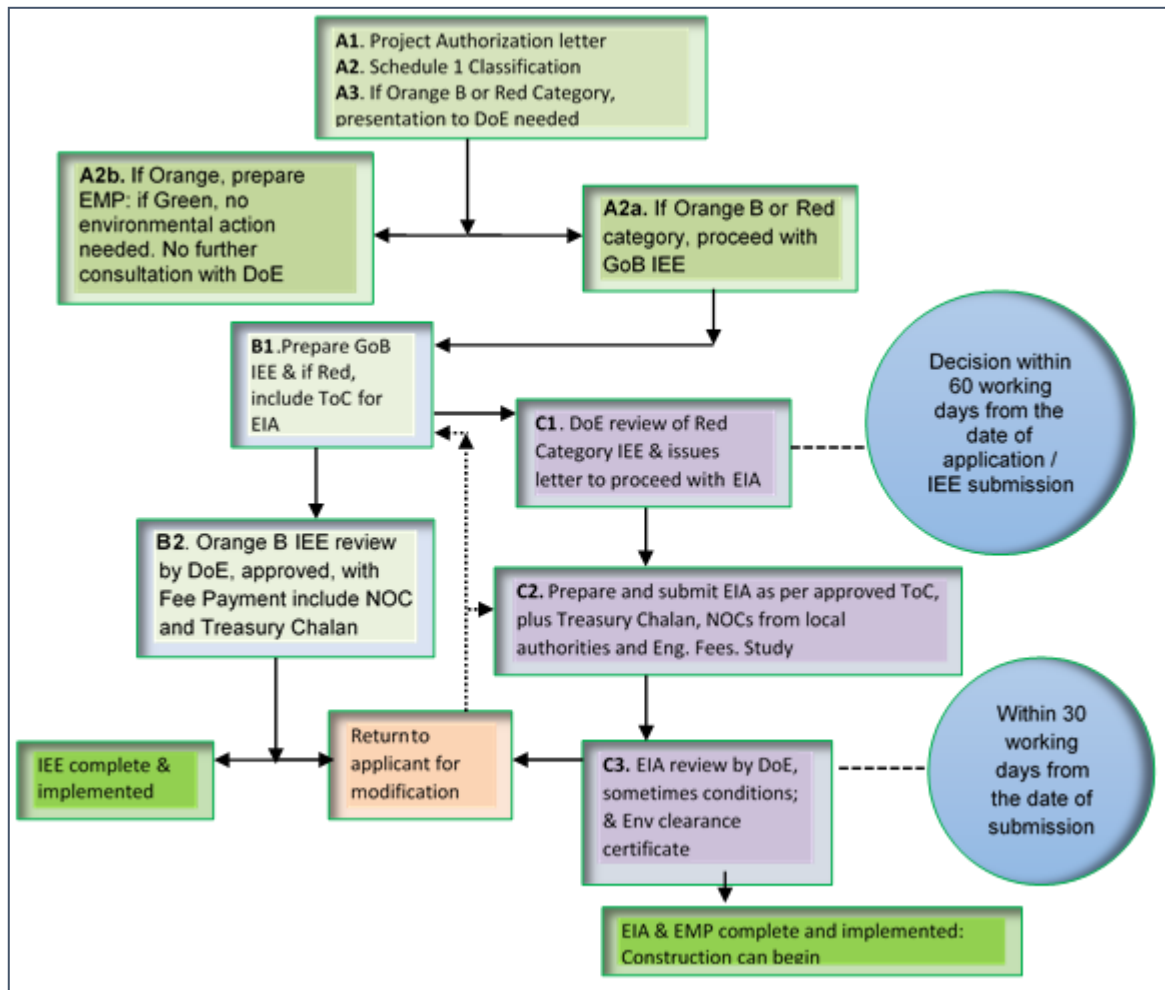


Figure 2.1: Government of Bangladesh Environmental Assessment Process

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 EIA report or in the application.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

The proposed project is located beside Jamuna River at Paruria of Char Baghutia union of Daulatpur upazila of Manikganj district (Figure 3.2). The Global Positioning System (GPS) coordinate of the project site is 23.93407° N, 89.72073° E. The proposed plant is bounded by agricultural land in three sides; in addition the north side of the project area is having some residential dwellings which are 200m far from the project site. The total land of the proposed project is about 5 bighas.

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 generators, and kerosene lamps.

Baghutia char can be accessed by trawler only. Trawler can be taken from Jaforganj Bazar Ghaat which is at Uthuli union under Shibalay upazilla of Manikganj district. It takes around one hour to reach the char from Jaforganj Bazar Ghaat during dry season. However, it takes around 40-45 minutes during rainy seasons to cover the same distance (around 6 km) as the water level rises, making the char more accessible through waterways. However, it takes around 3 hours to reach Jaforganj Bazar Ghaat by road from Dhaka City.

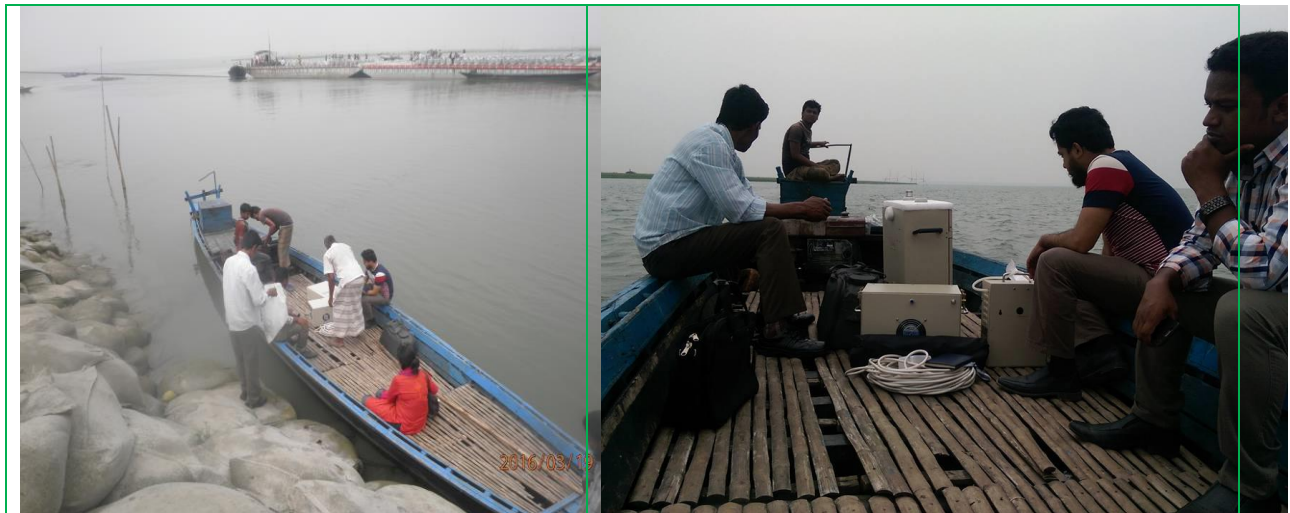


Figure 3.1: Accessible Route to Project Site

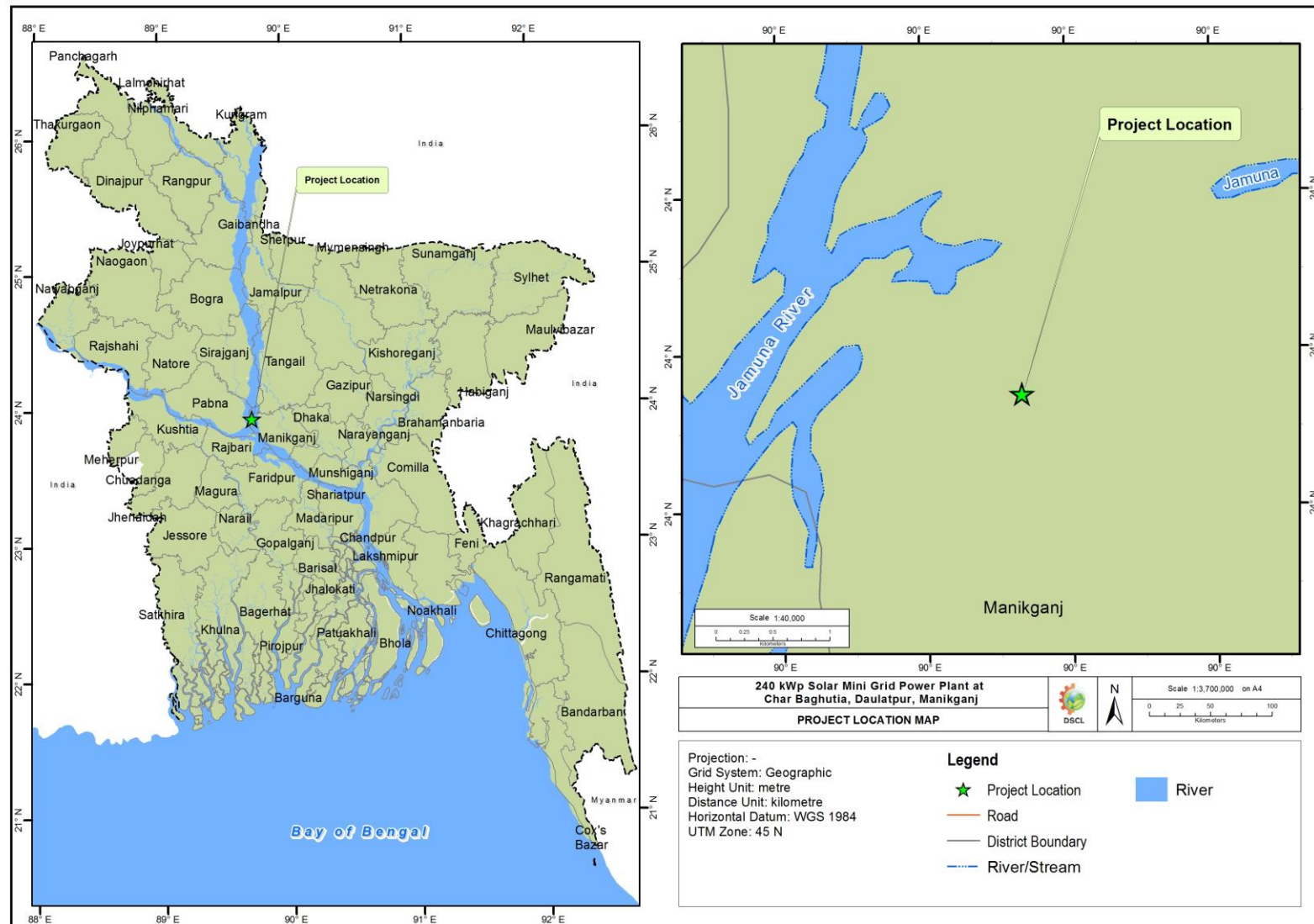


Figure 3.2: Project Location

3.2 Project Description

The proposed Project involves setting up of a 240 kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant by Super Star Renewable Energy Ltd. (Super Star) at Char Baghutia under Daulatpur upazilla of Manikganj district. The proposed system will include 201.25 kWp on-grid solar PV panels, 38.75 kWp off-grid solar panels (dedicated for charging batteries), 288 batteries of 1540 Ah (at 2 V) along with a 100 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in February 2016 and supply electricity to the adjacent 962 households, 96 shops, 16 social institutions e.g. mosques, madrasahs and schools, 4 rice mills, 1 saw mill and 20 irrigation pumps.

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 area, Char Baghutia, is an elongated island located in Jamuna. The length of the island is around 30 km from North to South with maximum width of around 7 km and the closest grid network is around 6 km away from the project area, on the other side of the river. 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 location in the near future. The Power Division also notified in writing that there is no immediate plan for grid extension in the project area in the near future.

The following table presents key Project information:

Table 3.1: Project Key Information

Particulars	Description
Project Company	Super Star Renewable Energy Ltd.
Type of Business	Renewable energy activities
Plant Type and Capacity	240 kWp solar PV based AC-DC coupled mini-grid
Location	Char Baghutia, Daulatpur, Manikganj
Project Land Area	5 Bigha
Major Equipment and Accessories	Solar modules, batteries, grid-tie and bi-directional inverters, backup diesel generator.
Equipment Manufacturers	Solar Module: Phono Solar Technology Co. Ltd., China Battery: Confidence Electric Ltd., Bangladesh Inverter: SMA Solar Technology AG, Germany Genset: Grupel, Portugal (Engine: Perkins, UK Alternator: Stamford, UK)

	Poles and Pole Fittings: Northern Engineering , Bangladesh Cables: BRB Cable Industries Ltd., Bangladesh Energy Meter: Shenzhen CLOU Electronics Co. Ltd., China
Installation and Supervision	Respective supplier except for solar panel
Estimated no. of Customers	962 households, 96 shops, 16 mosques, madrasahs and school, 4 rice mills, 1 saw mill and 20 irrigation pumps
Distribution Network Length (running length)	14 km
Tentative Commercial Operation Date (COD)	February 2016

3.3 Rationale of the Project

Bangladesh is predominantly a rural country with approximately 80 percent of the total population living in villages. Bangladesh's economic and social development is inherently linked to growth in the rural sector. In order to contribute to Bangladesh's overall development, the rural sector must have access to modern forms of energy such as electricity. Despite efforts by the governments in Bangladesh to improve electricity access and services during the last five decades, household electrification levels and electricity availability continues to lag behind the global average. While the global average electrification rate in 2011 was 81.9 percent, the average electrification rate for Bangladesh stood at 62 percent. About 40 percent populations in Bangladesh were living without electricity in 2015.

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.

According to the survey findings of Super Star and IDCOL, the project location has a dynamic population comprising of various income generating people who have capabilities and willingness to pay premium price for electricity connection. The range of profession includes business, farmer, service etc.

IDCOL survey team visited the project site on May 2015. Notably, during the site visit, the local farmers expressed their willingness to avail electricity from the Project for irrigation purposes.

Irrigation is only required during January-June, during which time excess electricity from the Project may be considered to serve the irrigation pumps in the area, which is currently running on diesel. Currently the farmers in the area primarily grow Boro between January-April, and Wheat during September-December. Once completed, the Project will sell electricity to irrigation pumps owner. Notably, the said irrigation pumps will be procured by Superstar Renewable Energy Limited itself and then, sold to the farmers on cash or credit basis.

In view of the above, the proposed Project envisages supplying reliable and grid quality electricity to the households and local shops in villages. 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 saw mills.

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.

3.4 Land Filling Activities

Environmental team visited the project site in March 2016 to physically verify the suitability of project location for implementation. According to local people, the highest flood level experienced was around 3.5 feet in 1998. After consultation meeting with the local people during the visit, it was found that the island (Char Baghutia) was formed in 1988. The char is not susceptible to any momentous river-erosion. However, the proposed project site is situated on the lower ground and it needs about 5-feet soil filling.

The soil filling material was collected from the nearby private land. The land used for land filling material was occupied by a local family with housing structures. The soil extracted land is neither being used for fishing cultivation nor as 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. The private land owner shifted to other land. No anticipated impact was found. The developer used dredging machine for extracted soil for land filling of the project site. The extracted soil materials were deposited in the project site through a long pipe.

For land filling of the project site, anticipated impact will be found on vegetation and agricultural practices. According to the local people no significant vegetation were observed in the land. The land mainly used for agricultural practices. But no significant anticipated impact was found for this activity.

4 TECHNOLOGICAL ASPECTS

4.1 Proposed Process and Technology

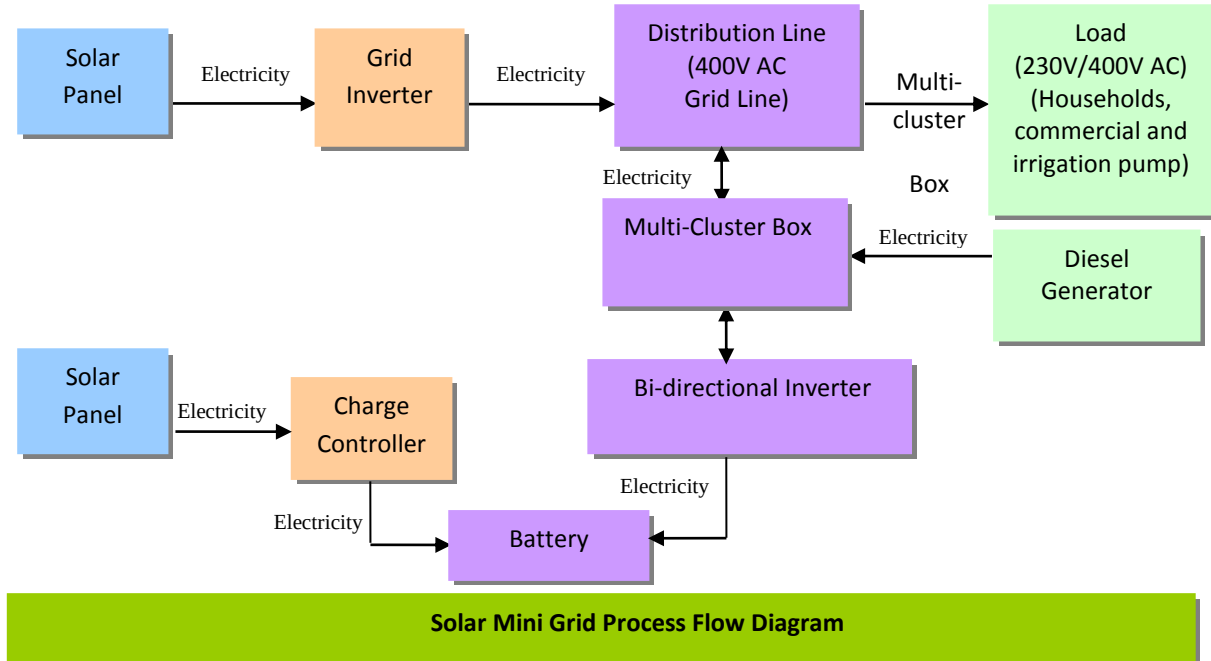


Figure 4.1: Overview of Project Technology

The plant is considered to be composed of the following parts:

(i) Solar PV modules and grid connected inverters:

Grid connected inverters convert the DC output from solar panels to grid quality AC electricity. During daytime, the solar PV modules are the main sources of power generation. PV modules of 201.25 kWp capacity will be connected to seven grid inverters (“Sunny Tri-power”), which will supply AC power at 400V through 3-phase distribution line. However, electricity will be supplied to the customers at 230V using single phase distribution line. Remaining 38.75 kWp PV modules (off-grid) will be used to charge the batteries.

(ii) Battery bank and bi-directional inverters:

Off-grid solar PV modules will charge the batteries through charge controllers. Power generated from off-grid PV module capacity of 38.75 kWp will be stored in the battery banks. Battery banks will be comprised of 288 units of 2V low maintenance lead acid type batteries, each of 1540 Ah capacity. 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. Excess power from on grid PV modules will also be stored in the battery bank using bi-directional inverters. Sunny Island inverters will be automatically synchronized with the generator through a multi-cluster box.

(iii) Multi-cluster box and the charge controllers

There is a multi-cluster box, which is the interface for all the connectors and control. Excess electricity from AC bus will be passed to the battery side to charge them through multi-

cluster box and bi-directional inverters. It is completely wired and fitted at the factory to make all the connections easier.

Charging of the batteries with the electricity from off-grid PV modules will be monitored using charge controllers. Off-grid PV modules will be connected to the charge controllers. Charge controllers to be installed in the proposed Project will be equipped with a MPPT (Maximum Power Point Tracking) system to maximize the energy yield by 15% to 30% than that of conventional charge controllers. Energy will be stored in the battery banks through these charge controllers.

(iv) Diesel generator

Diesel generator is connected to the mini-grid system to provide back-up during periods of low solar radiation. A backup diesel generator will be connected to the mini-grid system to supply electricity in case of electricity shortage from PV modules and the batteries. This scenario might happen 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 generator will be there to supply power to the AC bus in case of shortage of production from solar PV array. Without any back-up generator, the battery bank can be damaged because of prolonged deep discharge and insufficient charge during rainy and foggy days. The generator is turned off when the batteries are fully charged. 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.

A typical single line diagram of plant along with the process mentioned above is provided below Figure 4.2.

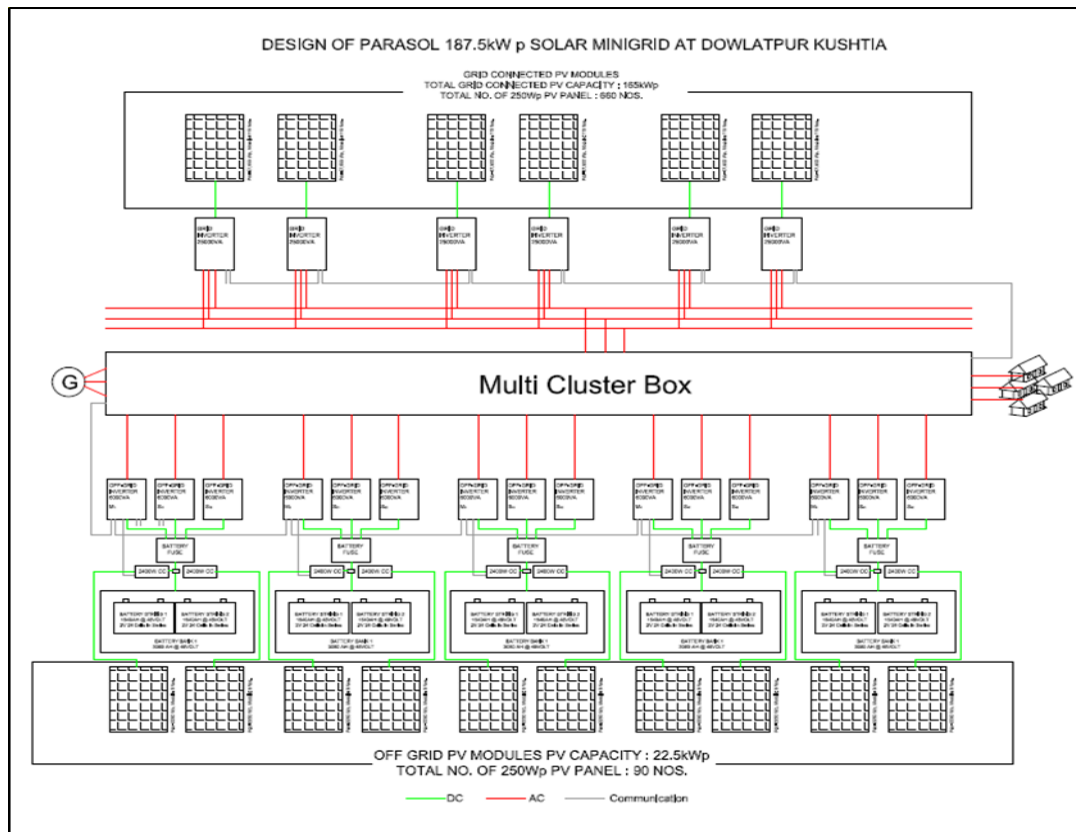


Figure 4.2: Single Line Diagram of the Plant

4.2 Adequacy of Solar Irradiation

The proposed location of the Project is at Paruria, Baghutia Union, Daulatpur, Manikganj. The latitude of the proposed location is 23.93407 ° N and longitude is 89.72073° E. The solar irradiance profile¹ of the project location is as follows in Table 4.1.

Table 4.1: Monthly Average Solar Insolation Incident at 24Degree Tilted Angle

Month	Average irradiation(kWh/m ² /day)
January	5.29
February	5.77
March	5.98
April	5.74
May	5.14
June	4.26
July	3.95
August	4.02
September	4.04
October	4.81
November	5.10
December	5.35

¹ Source: Surface meteorology and Solar Energy website of NASA. Website: <https://cosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?email=ekarim@idcol.org>.

The optimum tilt angle for solar panels in Bangladesh is considered to be 23.7 ± 1 degrees at any place in Bangladesh². Average solar insolation in Bangladesh is considered to be $4.5 \text{ kWh/m}^2/\text{day}$. In the project site, the average insolation is $4.95 \text{ kWh/m}^2/\text{day}$ which is greater than the average of the country by 10%. 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 all through the year and the plant is expected to yield high energy output.

4.3 Plant Capacity Selection

Plant capacity selection is based on the conducted load survey and optimization parameters. Optimization parameters for selecting plant capacity are chosen carefully to ensure satisfactory plant performance. The optimization parameters used by the sponsor are (a) energy supplied by DG, (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 DG

Diesel generator will be used as backup to meet the supply and demand gap throughout the year. The diesel generator will run in cases e.g. lack in stored energy in battery backup, rainy and foggy days. However, under sizing the plant capacity will result in excessive usage of the diesel generator. Purposes of installing a Solar PV based 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:

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

(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, an extreme situation needs 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

² 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.

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:

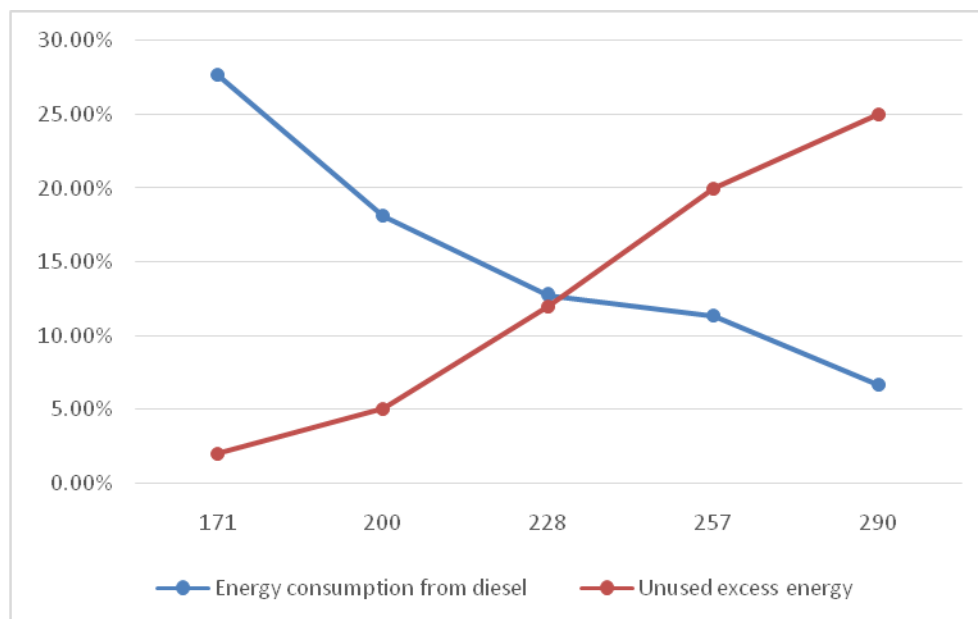
$$\text{Ratio} = \frac{\text{Capacity of a grid tied inverters} \times \text{No of grid tied inverters}}{\text{Rated Capacity of bi-directional inverter} \times \text{No of bidirectional inverters}}$$

(d) Simulation Results:

Performance of the plant and optimization parameters was analyzed based on selection of different capacities. The simulation results and graphical representation is shown below:

Table 4.2: Plant Capacity Determination

Plant Capacity (kWp)	Ratio between grid-tied and bi-directional inverter capacities	Energy supplied by DG(% of total consumption)	Unused solar energy (% of total solar generation)
171	1.15	27.64%	2%
200	1.38	18.10%	5%
228	1.62	12.76%	12%
257	1.85	11.33%	20%
290	1.53	6.65%	25%



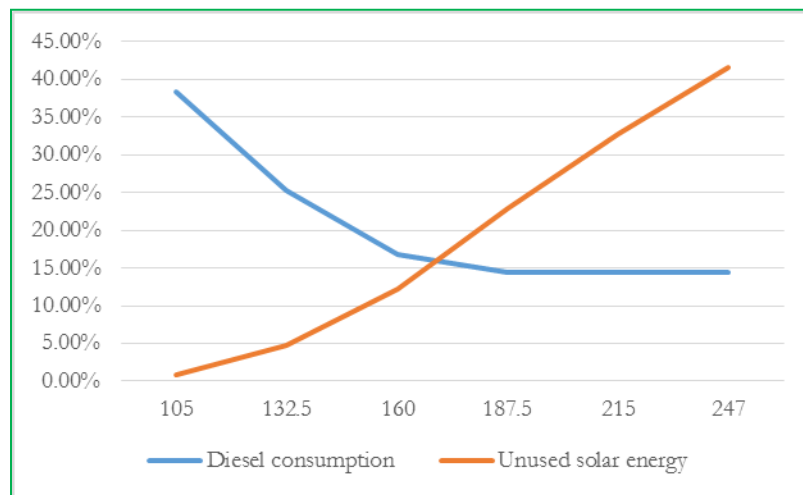


Figure 4.3: Plant capacity selection

According to the simulation results, a plant capacity of 240 kWp was found most suitable. Hence, the plant capacity of 240 kWp was selected for the solar mini grid project.

4.4 Adequacy of Generator Size

Diesel Generator will play a pivotal role in operating solar mini-grid when the generation of electricity from solar plant 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 generator 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, Super Star selected a generator of 100 kVA prime capacity. The justification for selecting 100 kVA generator is explained in the following.

The estimated daily load profile of the Project is shown below Figure 4.4.

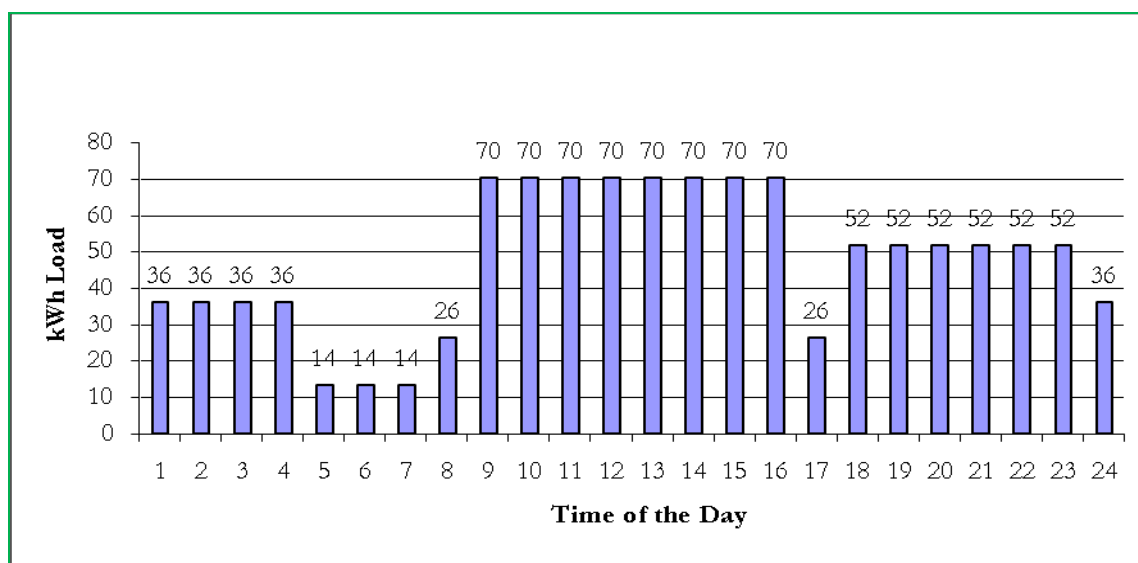


Figure 4.4: Estimated Daily Load Profile

According to the load profile, peak load in 24 hours will be 70 kW during 9am to 4 pm. Prime capacity of the selected generator is 100 kVA or 80 kW which is higher than the peak load. However, anticipating possible extension in near future, connection of rice mill, saw mill and irrigation pumps, Super Star Limited selected a higher capacity generator.

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 to that, 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 provide the peak load even in case of low solar generation, low charged battery bank in rainy and foggy days, system shutdown or to back up high current driven commercial load.

4.5 Adequacy of Energy Storage Requirement

Low maintenance lead acid batteries will be used as energy storage device within the plant which will 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, 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 rainy or foggy days the demand will be met through using generator. Notably, connected loads from 6 pm in the night up to 8 am in the morning will be given electricity from battery banks through bi-directional inverters.

According to the load profile, energy requirement from batteries is 533 kWh per day. Calculation of selection of battery capacity is given below considering all the above mentioned constraints.

Table 4.3: Battery Capacity

Supply from battery (6 pm to 8 am)	: 533 kWh
Battery Depth of Discharge (DOD)	: 50%
Minimum Required Capacity of the Battery (2V, 50% DOD)	: $533000/2/0.5=533000$ Ah
Required no. of batteries (2V, 1540 Ah)	: $533000/1540\sim=346$
No. of battery banks (48V system)	: 14 ³
Suitable no. of battery banks/racks	: 12
Number of batteries	: $12 \times 24=288$
Battery capacity	: $288 \times 1540 \times 2 \times 50\%=444$ kWh

As shown above, the designed battery capacity will not be able to meet the peak demand in night. The difference between the demand and supply from battery is 89 kWh. The next

³ 2 parallel strings of battery will be connected in each bank, each with 24 batteries

battery size which can be adapted is fifteen (15). In that case the battery capacity will be 554.4 kWh against demand of 533 kWh. Increasing battery size would have increased the initial investment due to the cost incurred in inverters, space allocation, civil construction etc. In addition to that, the peak demand is not likely to occur all throughout the year.

The battery capacity is short of 89 kWh from the peak requirement which is equivalent of 71 minutes of runtime from the selected the generator. In a trade-off between increasing battery capacity and using more diesel, minimizing the battery size seems to be more feasible.

5 DESCRIPTION OF THE BASELINE ENVIRONMENT

5.1 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.

5.2 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.

5.2.1 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 South-western region climatic zone (Figure 5.1).

South-Western zone: Here the extremes of the zones to the north are somewhat tempered. Rainfall is between 1,500 mm and 1,800 mm. Mean summer maximum temperature is below 35°C. Dew-fall is heavier than in Western zone (Banglapedia 2014) 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.

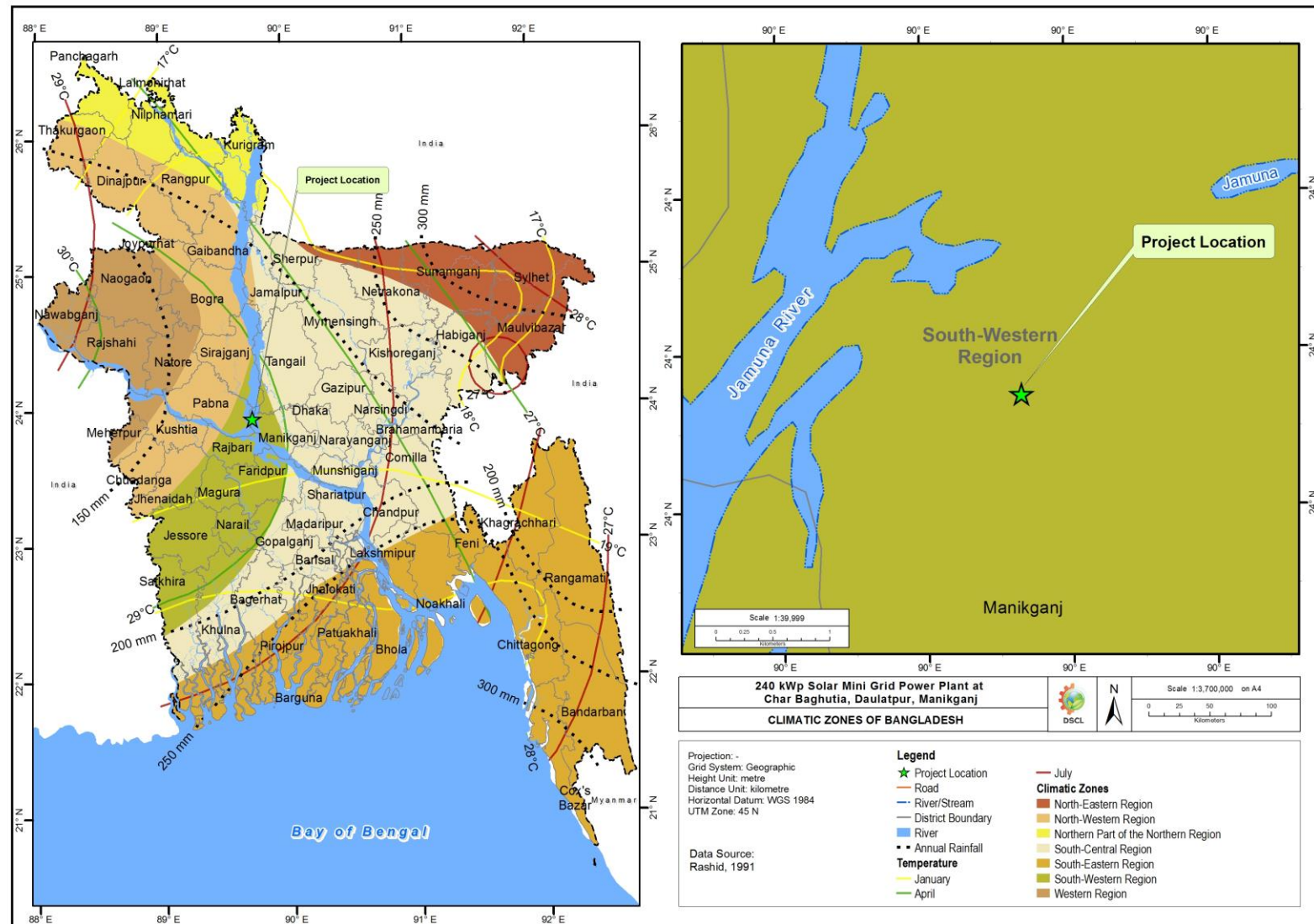


Figure 5.1: Climatic Zones of Bangladesh

Temperature

Long-term average monthly temperature data (1991-2013) collected at Dhaka weather station of Bangladesh Meteorological Department. The highest average recorded temperature in this weather station was 33.99°C in April. The lowest average recorded temperature was found in the month of January which was 13.1°C. Both of the average monthly temperature graphs show that this area faces high temperature from March to June and lowest temperature during winter remains from December to February in the year.

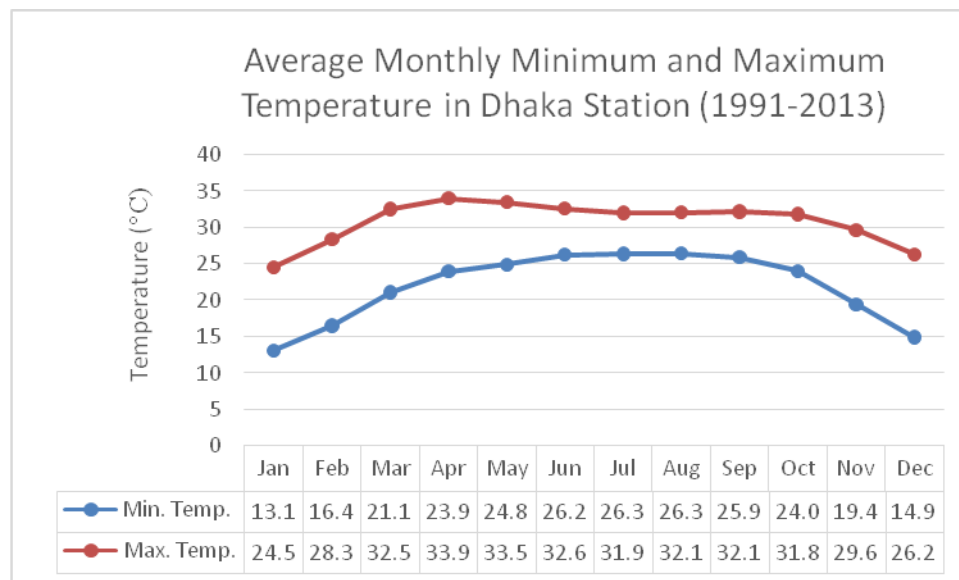


Figure 5.2: Average Monthly Maximum and Minimum Temperature

Rainfall

The rainfall data collected from the above stated station represents that maximum rainfall occurs during June to September and the lowest rainfall occurs in November to February during winter season. Statistical data of 1991 to 2013 shows that Dhaka stations experience almost 400 mm rainfall during monsoon. In the month of December and January of winter season around 12 mm rainfall occurred in the region of Dhaka weather station.

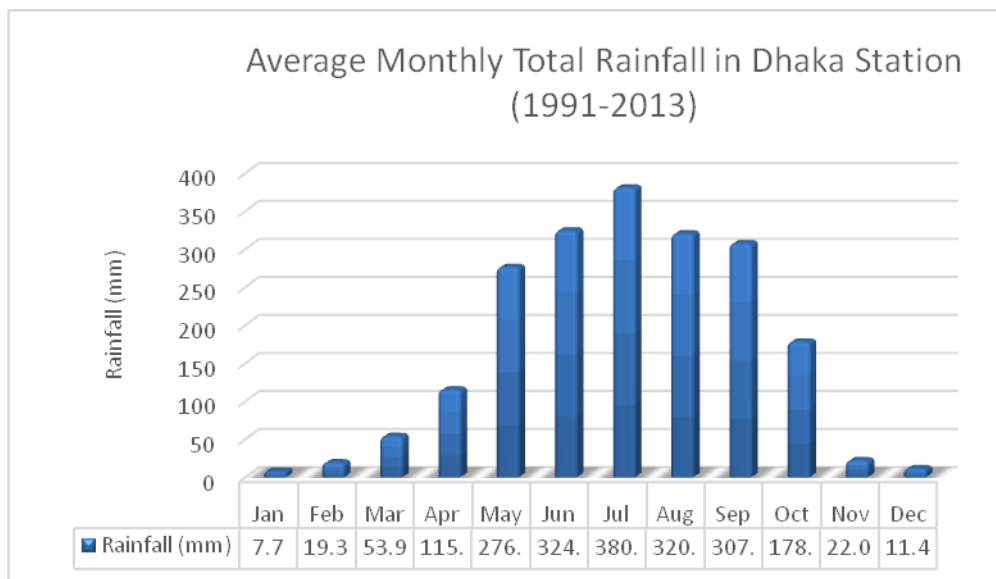


Figure 5.3: Average Monthly Total Rainfall

Humidity

Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2013 indicates that humidity in the above two stated areas maximized in June to October in the year which is ranges from 75% to 82%. On the other hand, humidity falls 60.5% in February, March and April during the winter season in the Dhaka station area (Figure 5.4).

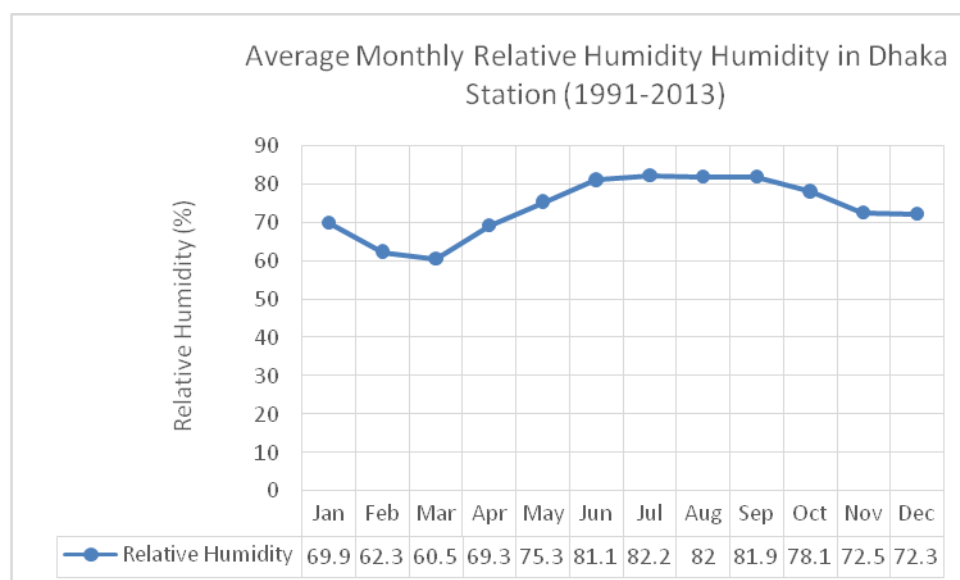


Figure 5.4: Average Monthly Relative Humidity

Wind Speed

The statistical wind speed data from 1991 to 2013 (Figure 5.5) shows that average wind speed remained maximum with 3.47 knots in April. The minimum wind speed was 1.17 knots in the month of November in the area of Dhaka weather station.

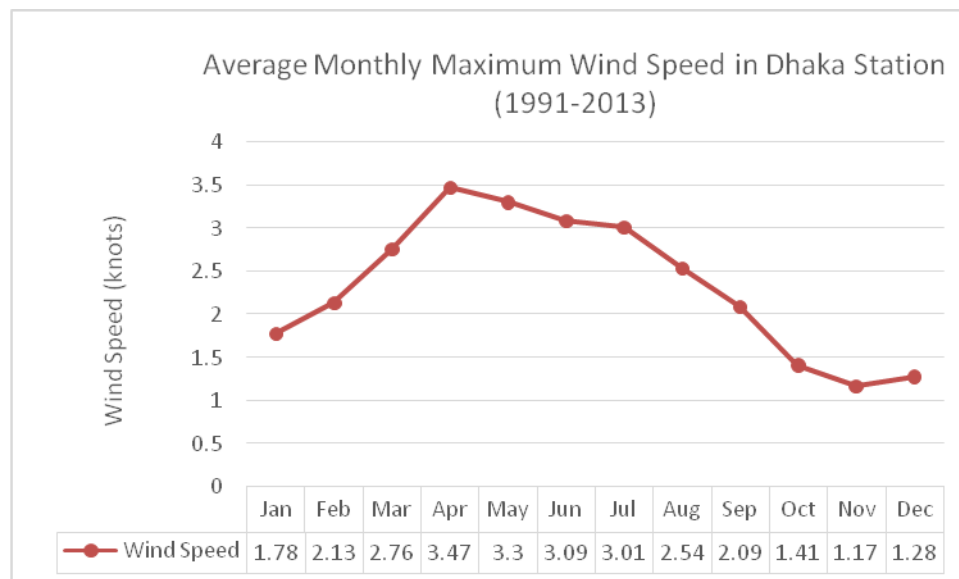


Figure 5.5: Average Monthly Maximum Wind Speed

Sunshine

The statistical sunshine data from 1991 to 2013 (Figure 5.6) shows that average sunshine remained maximum with 7.7 hours in both March and April. The minimum sunshine was 3.25 hours in the month of December in the area of Dhaka weather station.

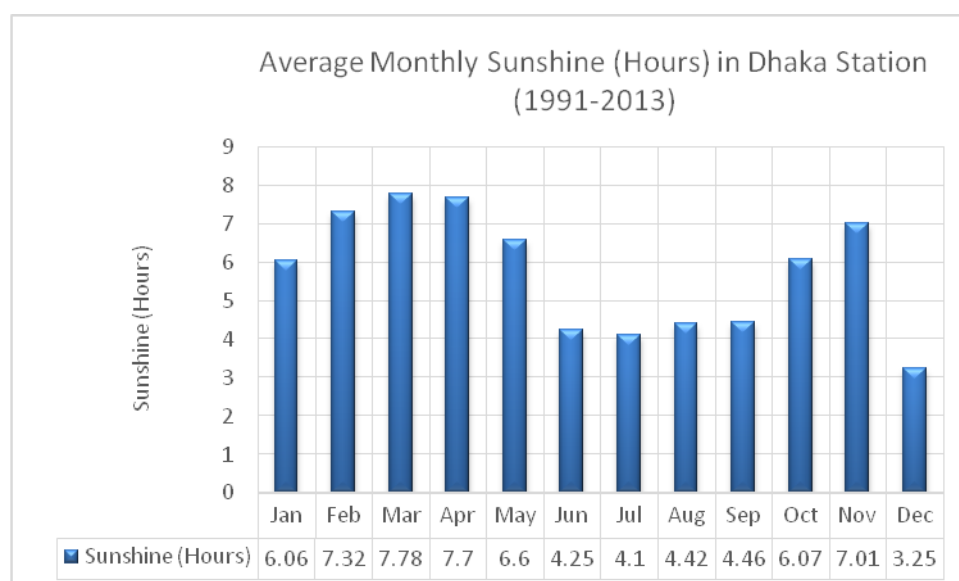


Figure 5.6: Average Monthly Maximum Sunshine

Cloud Coverage

The statistical cloud coverage data from 1991 to 2013 (Figure 5.7) shows that average cloud coverage remained maximum from 6 octas to 7 octas during June to September. The minimum cloud coverage was 1.2 octas in the month of December in the area of Dhaka weather station.

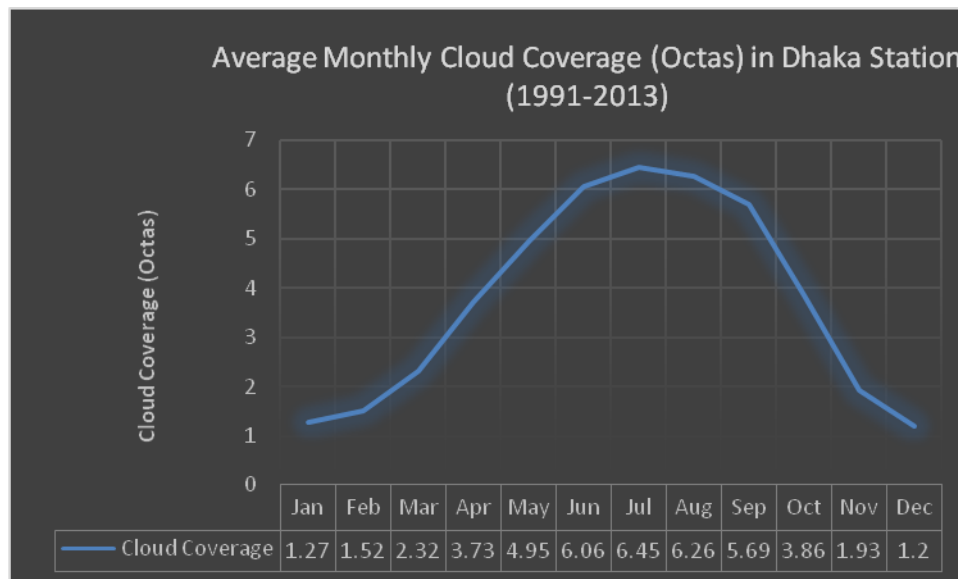


Figure 5.7: Average Monthly Cloud Coverage

5.2.2 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 5.8: 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 19th March 2016 at the proposed project site and the test was performed by DSCL. The test results (see Appendix B) is given in the below Table 5.1. A methodology for analyzing the air quality sample is described in Appendix A. According to Bangladesh National Ambient Air Quality Standards from the Environmental Super Star Renewable Energy Ltd.

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 5.1: Test Results of Ambient Air Quality Analysis

Parameter	Unit	Project Site	Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
PM _{2.5}	µg/m ³	29.76	65	24	Cloudy	Gravimetric
PM ₁₀	µg/m ³	125.43	150	24		Gravimetric
SPM	µg/m ³	146.60	200	24		Gravimetric
SO ₂	µg/m ³	13.22	365	24		West- Geake
NO _x	µg/m ³	42.03	100	24		Jacob and Hochheiser
CO*	mg/m ³	<1	10	8		CO Meter

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DSCL

Note:

* CO concentrations and standards are 8-hourly only.

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

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

5.2.3 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 2) during day time (Figure 5.9). Results of the noise level monitored along with details of the sampling locations

Super Star Renewable Energy Ltd.

have been showed in Table 5.2. 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.



Figure 5.9: Noise Level Monitoring in the Project Area

Table 5.2: Noise Level at Different Locations of Project Area

Location	GPS Location	Land Use Category	Time	Noise Level (dBA)
Project Site	23.93407°N 8.720739°E	Residential area	12:50 pm	43.78
2 No. Paruria Govt. Primary School	23.9379°N 89.7226°E	Residential area	2:00 pm	53.57
West Paruria Mosque	23.93797°N 89.72211°E	Residential area	2:08 pm	52.40
Beside Jahangir Member's House	23.93655°N 89.72164°E	Residential area	2:31 pm	46.61
Baghutia Bazar	23.93851°N 89.72333°E	Commercial	4:22 pm	60.22

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 55 dBA , for silent area 50 dBA and for commercial area 70 dBA at day time
- Noise Level is the average noise recorded over the duration of the monitoring period

5.2.4 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 Jamuna River for freshwater supply. The project area falls in the Ganges River Floodplain physiographic unit (Figure 5.10).

- **Old Brahmaputra floodplain:** A remarkable change in the course of the Brahmaputra took place in 1787. In that year, the river shifted from a course around the eastern edge to the western side of the Madhupur tract. This new portion of the Brahmaputra is named the Jamuna. The old course (old Brahmaputra) between Bahadurabad and Bhairab shrank through silting into a small seasonal channel only two Km broad. The old river had already built up fair high levees on either side over which the present river rarely spills. The Old Brahmaputra floodplain stretching from the southwestern corner of the Garo Hills along the eastern rim of the Madhupur Tract down to the Meghna River exhibits a gentle morphology composed of broad ridges and depressions. The latter are usually flooded to a depth of more than one metre, whereas the ridges are subject to shallow flooding only in the monsoon.

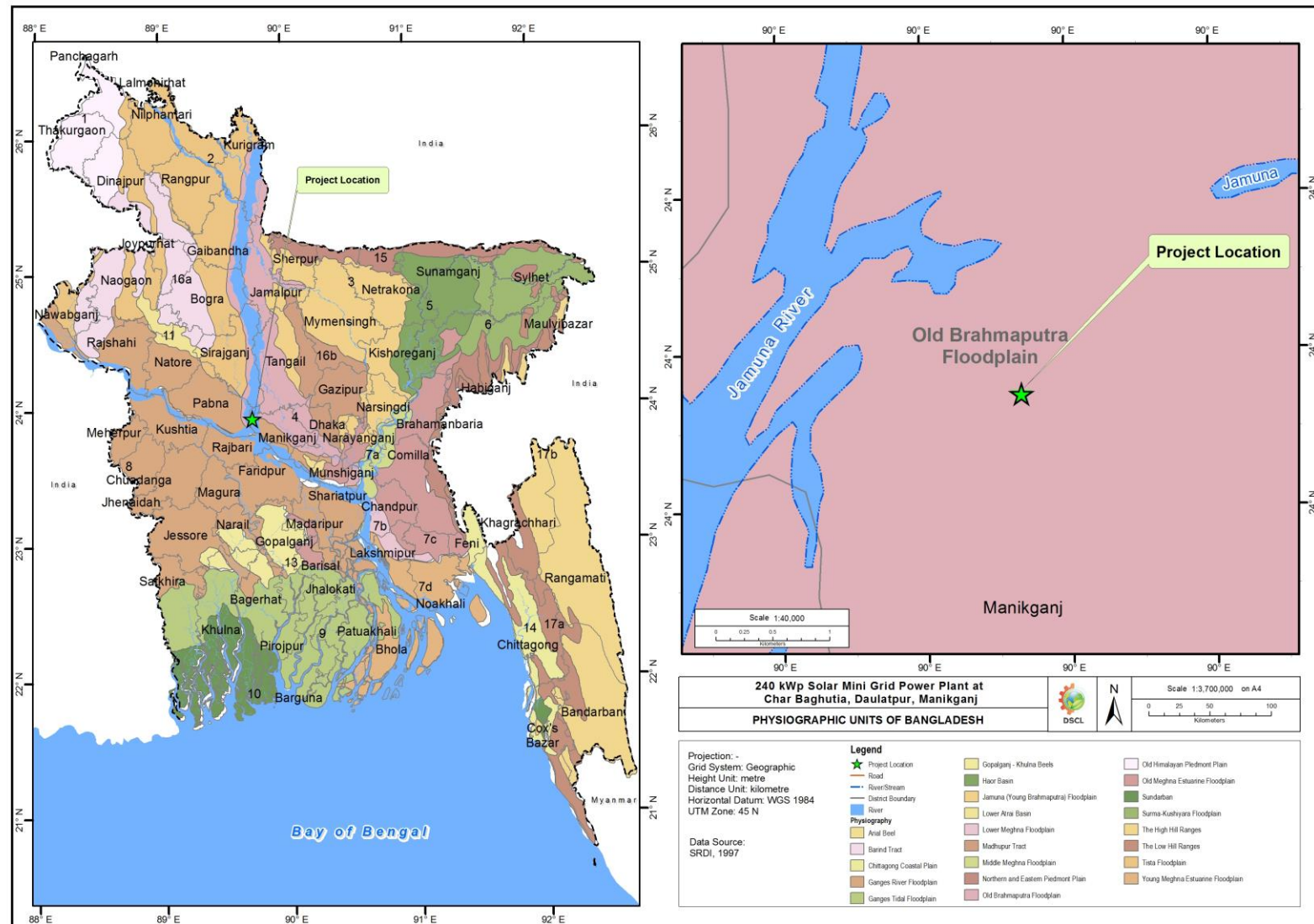


Figure 5.10: Physiographic Sub Regions of Bangladesh

5.2.5 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 general topography of the project area is relatively flat. The topography of the specific project location is 18.83 – 35 m a.m.s.l (Figure 5.11). Topographically the cluster of the project location is almost flat, with many depressions, natural water bodies, bounded by the Rivers.

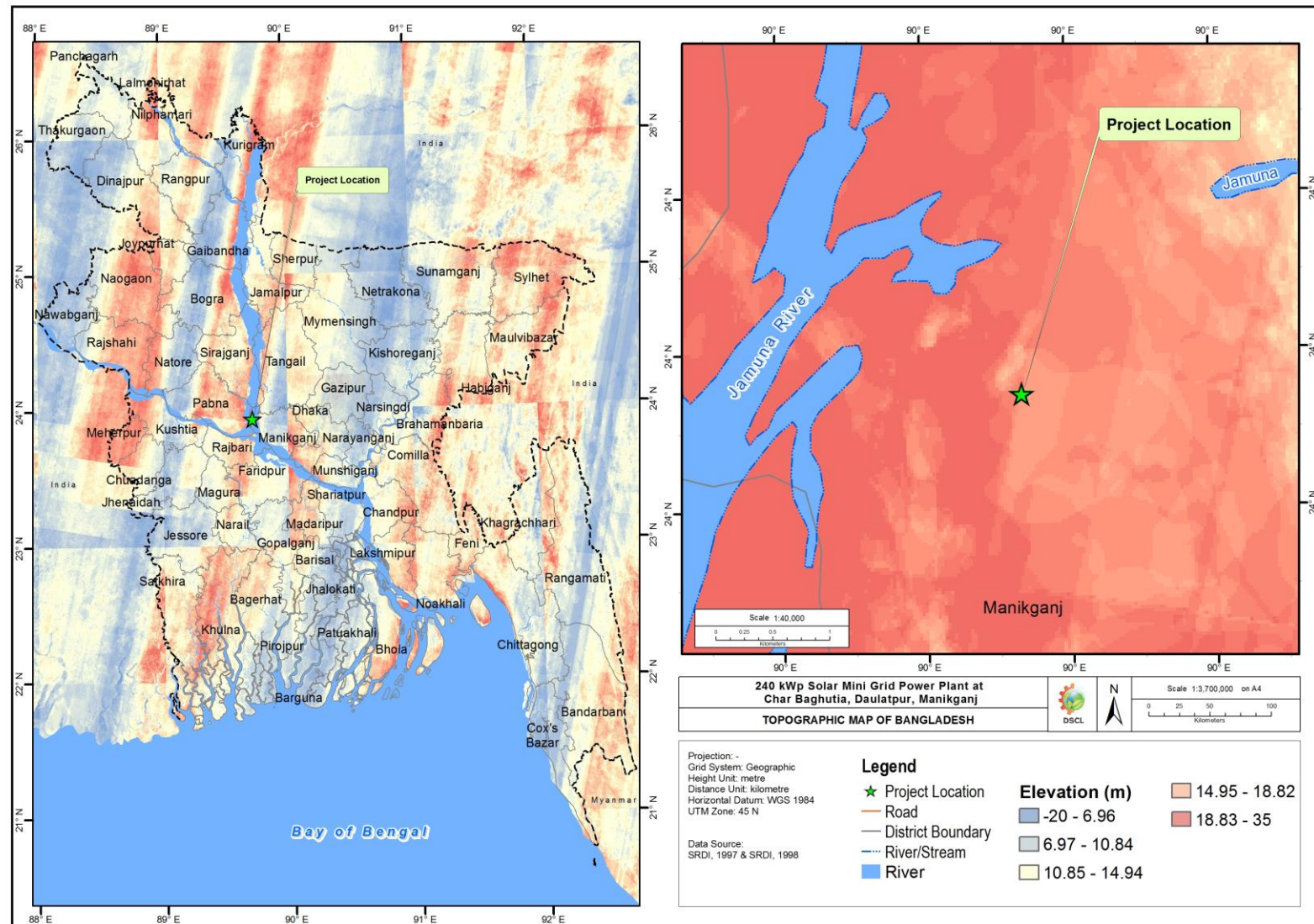


Figure 5.11: Topographic Elevation of the Project Area

5.2.6 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 Arakan Yoma 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 Faridpur Trough.

- **Faridpur Trough** situated adjacent to Hinge Zone is characterised by a general gravity low with development of Neogene sequence. Sylhet Limestone is 6500 m deep in area south of the confluence of the Padma and the Jamuna. Chalna and Bagerhat are the notable structural highs of very low amplitude (Banglapedia, 2014). The generalized geological feature of the project area is shown in the geological map of Bangladesh (Figures 5.12).

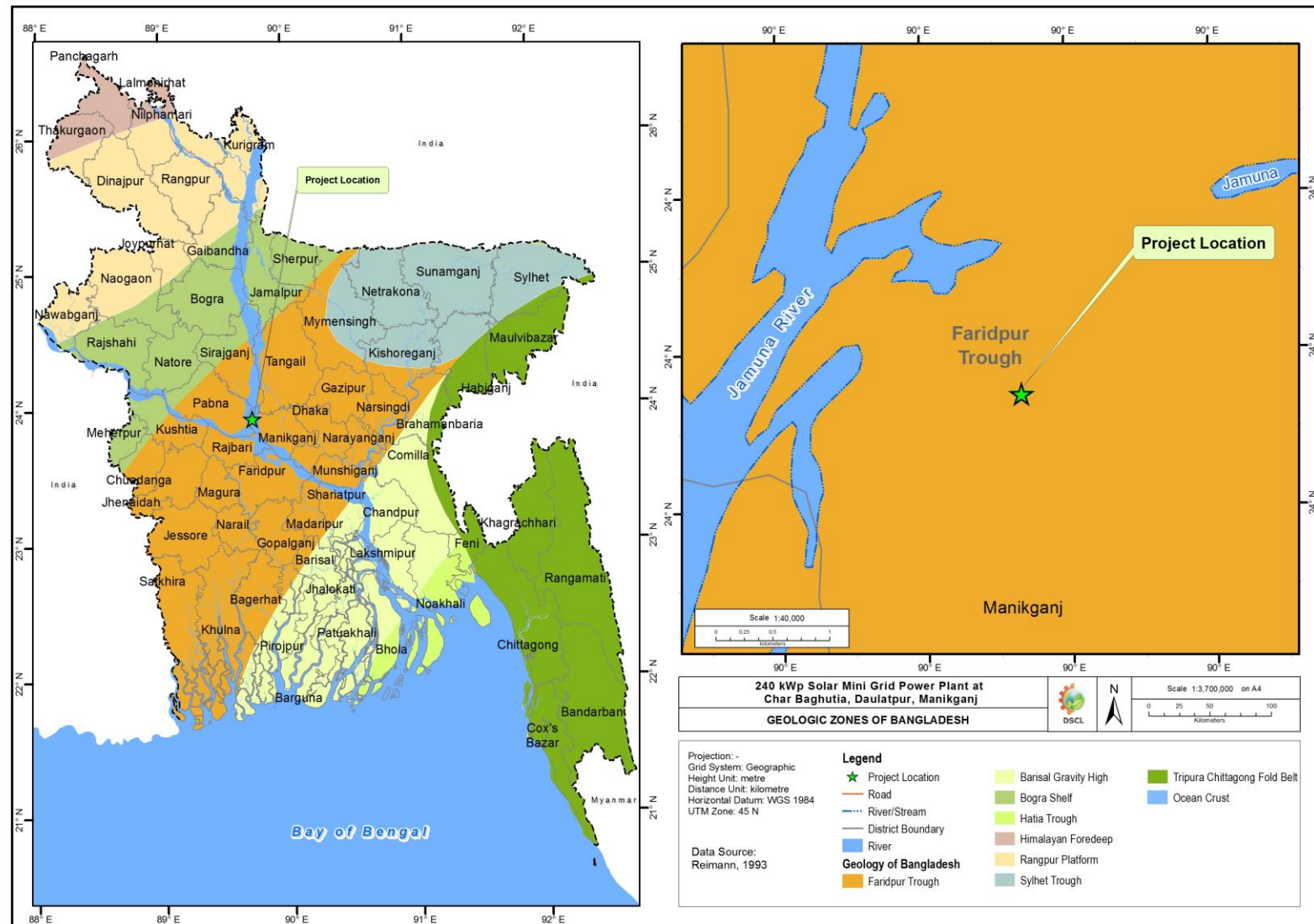


Figure 5.12: Geology of Bangladesh

5.2.7 Water Resources

Bangladesh is located over a subsiding basin of tectonic origin overlain with a great thickness of sedimentary strata. This sedimentary stratum is an unconsolidated alluvial deposit of recent age overlaying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface Quaternary alluvium contains good aquifer characteristics (transmission and storage coefficients). The groundwater (GW) storage reservoir has three divisions: upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand. Drinking water is generally taken from deep tube wells with strainers set between depths of 200 meters to around 400 meters (DPHE, 2011). The Ground water level is at or very close to the surface during the monsoon; whereas, it is at maximum depth during the months of April and May (Banglapedia, 2014).



Figure 5.13: Water Bodies in the Project Area

▪ Surface Water

The project area is surrounded by the mighty river Jamuna. 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 19th March 2016, 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 result (Appendix C) of the surface water sample and the GoB standards for fishing water (ECR, 1997) are shown in Table 5.3. 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.



Figure 5.14: Surface Water Sampling from the Project Location

Table 5.3: Results for Surface Water Field Sample

Water Quality Parameters	Unit	Concentration Present	Inland Water Standard for Fish, DOE	Method of Analysis
pH*	---	7.5	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	340	-	TDS Meter
Dissolved Oxygen (DO)	mg/l	3.61	5 or more	Multimeter
Chemical Oxygen Demand (COD)	mg/l	08	NYS	CRM
Biochemical Oxygen Demand (BOD)	mg/l	2	6 or less	5 Days Incubation

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

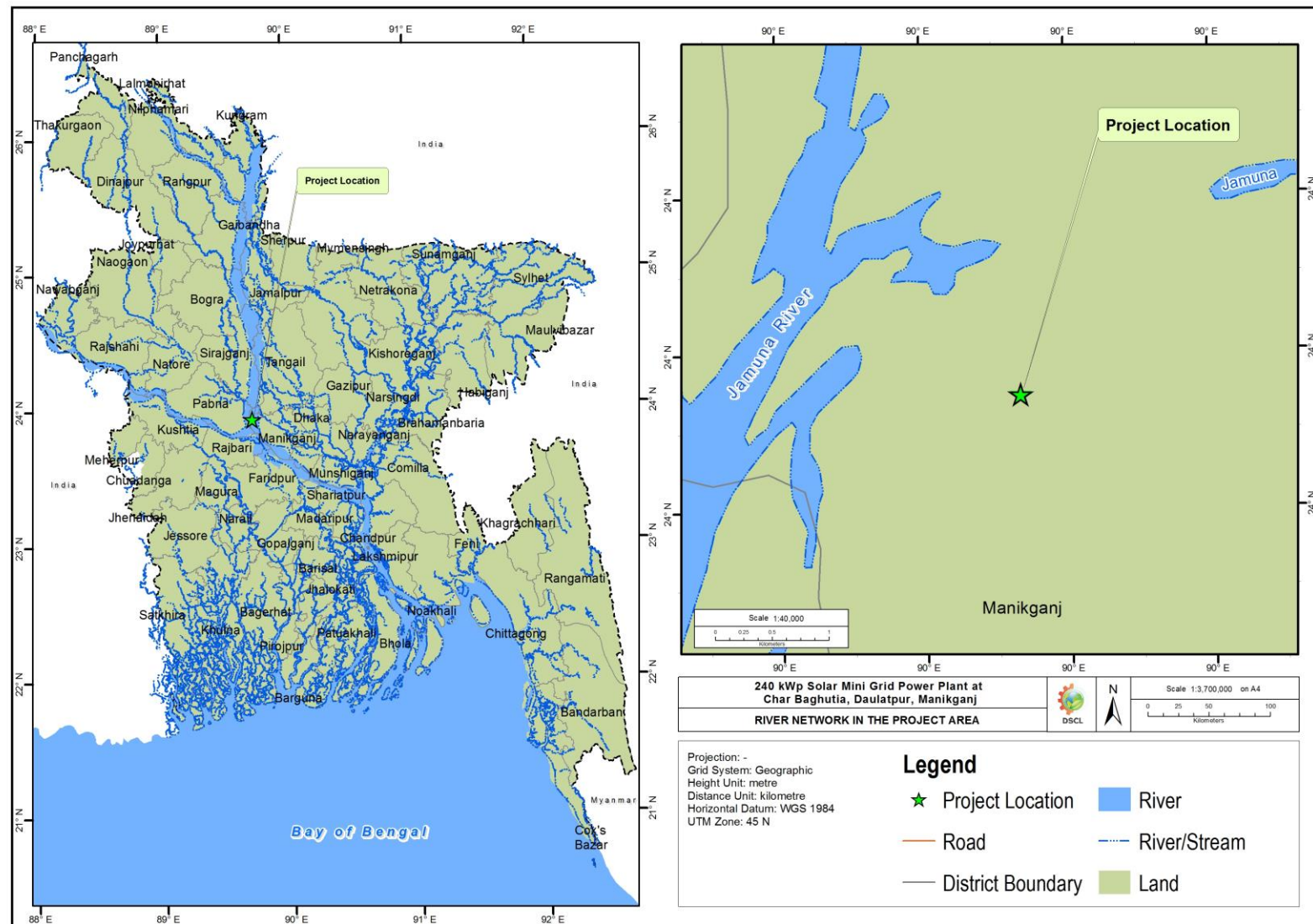


Figure 5.15: Water Bodies and River Network Map

Groundwater

Arsenic is a problem in large part of Bangladesh ground water. The project area also has 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 5.17).

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 19th March 2016, 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 D) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 5.4. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE.



Figure 5.16: Water Sampling from the Project Location

Table 5.4: Results for Groundwater Field Sample

Parameters	Unit	Concentration Present	Drinking Water Quality Standard, DOE	Method of Analysis
pH*	---	6.8	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	360	1000	TDS Meter
Alkalinity	mg/l	390	-	Trimetric
Chloride (Cl ⁻)	mg/l	10	150-600	Trimetric
Iron (Fe)	mg/l	0.43	0.3-1.0	AAS
Arsenic (As)	mg/l	0.001	0.05	AAS

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

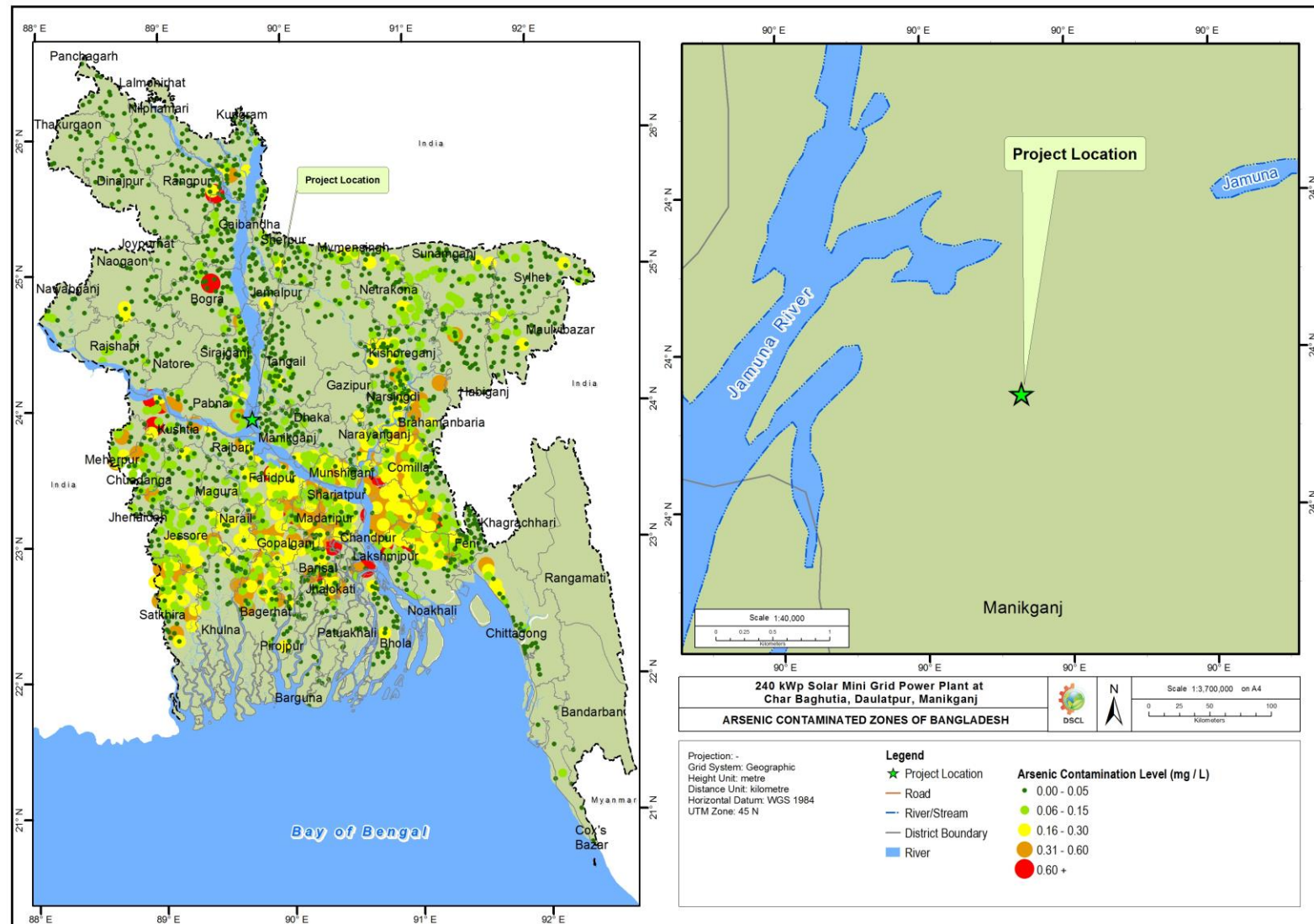


Figure 5.17: Arsenic Concentrations in Groundwater

5.2.8 Soil Quality

The soil of the project area is yet not classified and does not fall any of the category of Bangladesh soil types. However, the category of soil near the project location includes the following (Figure 5.18):

- ***Calcareous Dark Grey & Brown Floodplain soils (8):*** Soils occur extensively on the Ganges floodplain and locally on the soils that comprise cambic B-horizon and lime in part or throughout the solum and with a dark grey topsoil and/or upper subsoil. There are continuous dark grey gleans as well in the Ganges tidal floodplain. They are Calcaric Gleysols. On the other hand, Calcareous Brown Floodplain soils have cambic B-horizon that is predominantly oxidized, containing lime in the profiles. They comprise pale brown to olive brown, friable, loamy and clay soils occurring on the upper parts of ridges on the Ganges river floodplain and on the river bank of the Ganges tidal floodplain. Most of these soils belong to Calcaric Gleysols (Banglapedia, 2014).

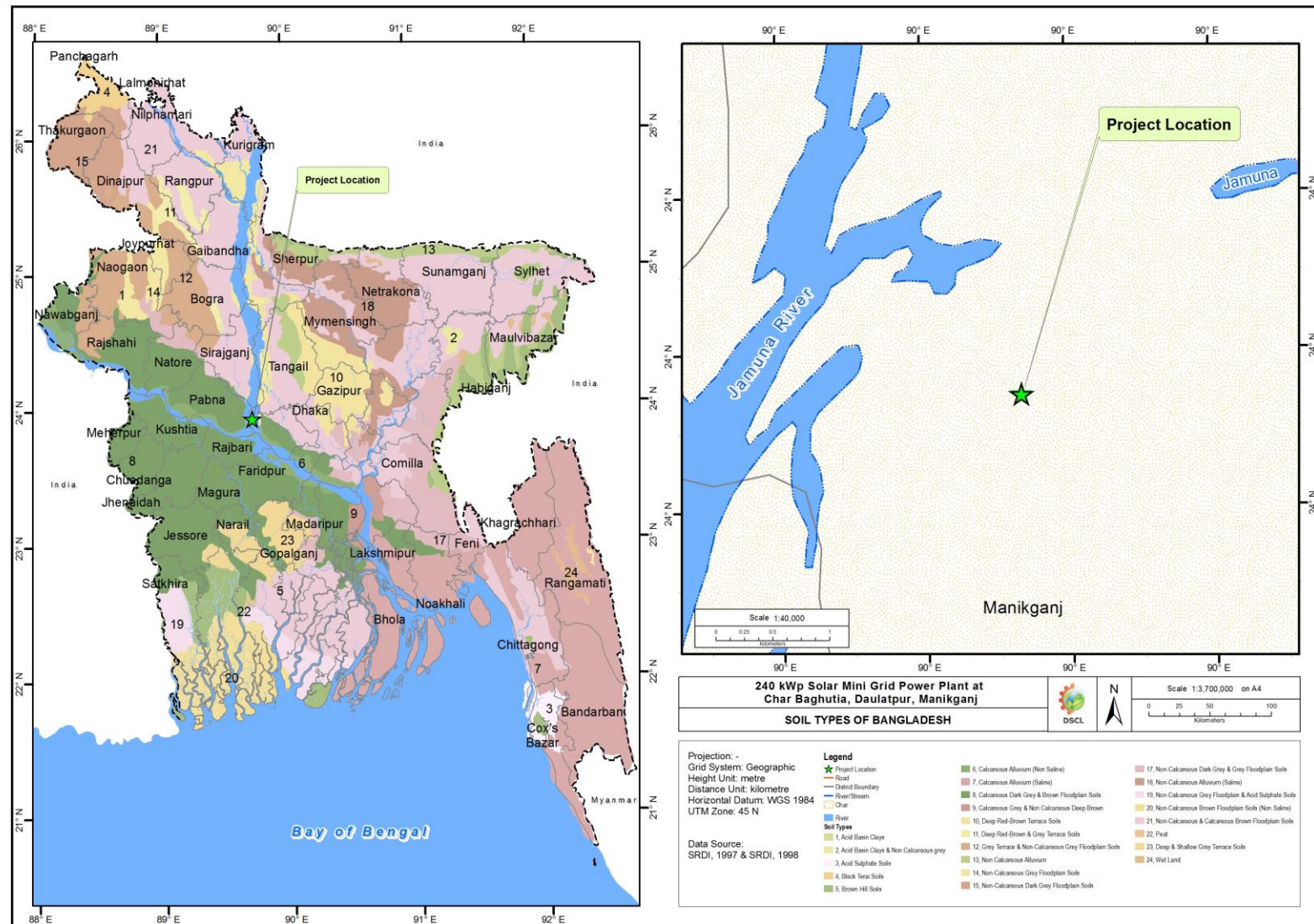


Figure 5.18: General Soil Categories of Bangladesh

5.2.9 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 5.20), namely:

- i. **Active Brahmaputra-Jamuna Floodplain** (3,190 sq km) this region comprises the belt of unstable alluvial land along the Brahmaputra-Jamuna rivers where land is constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandy and silty alluvium, rich in weatherable K minerals that are slightly alkaline in reaction. Six general soil types occupy the area. Organic matter status is low and fertility status is low to medium. (Banglapedia, 2014).

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



Figure 5.19: Agricultural Practices in the Project Area

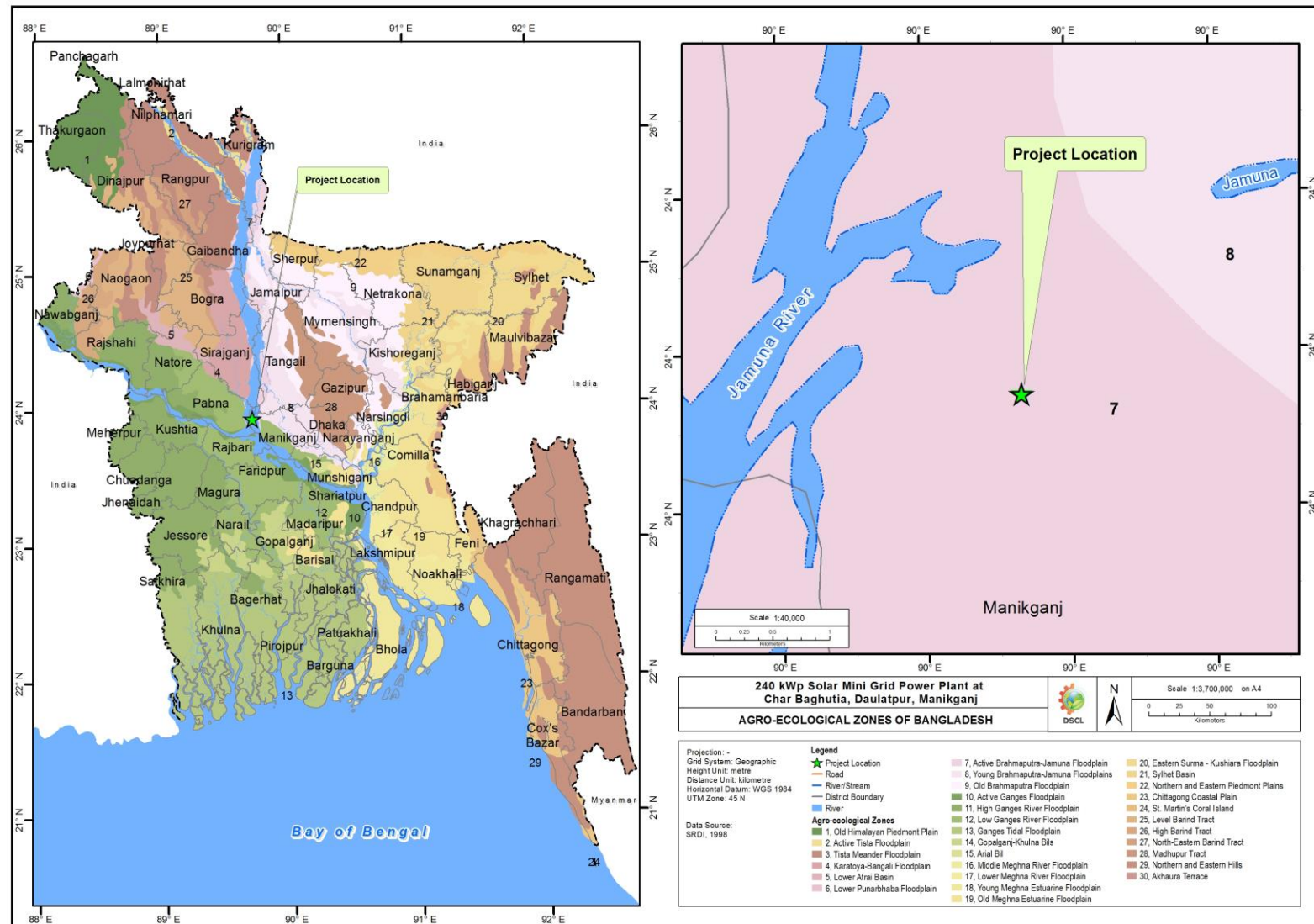


Figure 5.20: Agro-ecological Zones of Bangladesh

5.2.10 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 5.5), 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 5.21), project area falls in the zone II comprising the central part of Bangladesh represents the regions of recent uplifted Pleistocene blocks of the Barind and Madhupur Tracts, and the western extension of the folded belt. It means the project area is prone to medium seismic intensity. There is no evidence of major earthquakes in the project areas in the recent past.

Table 5.5: 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

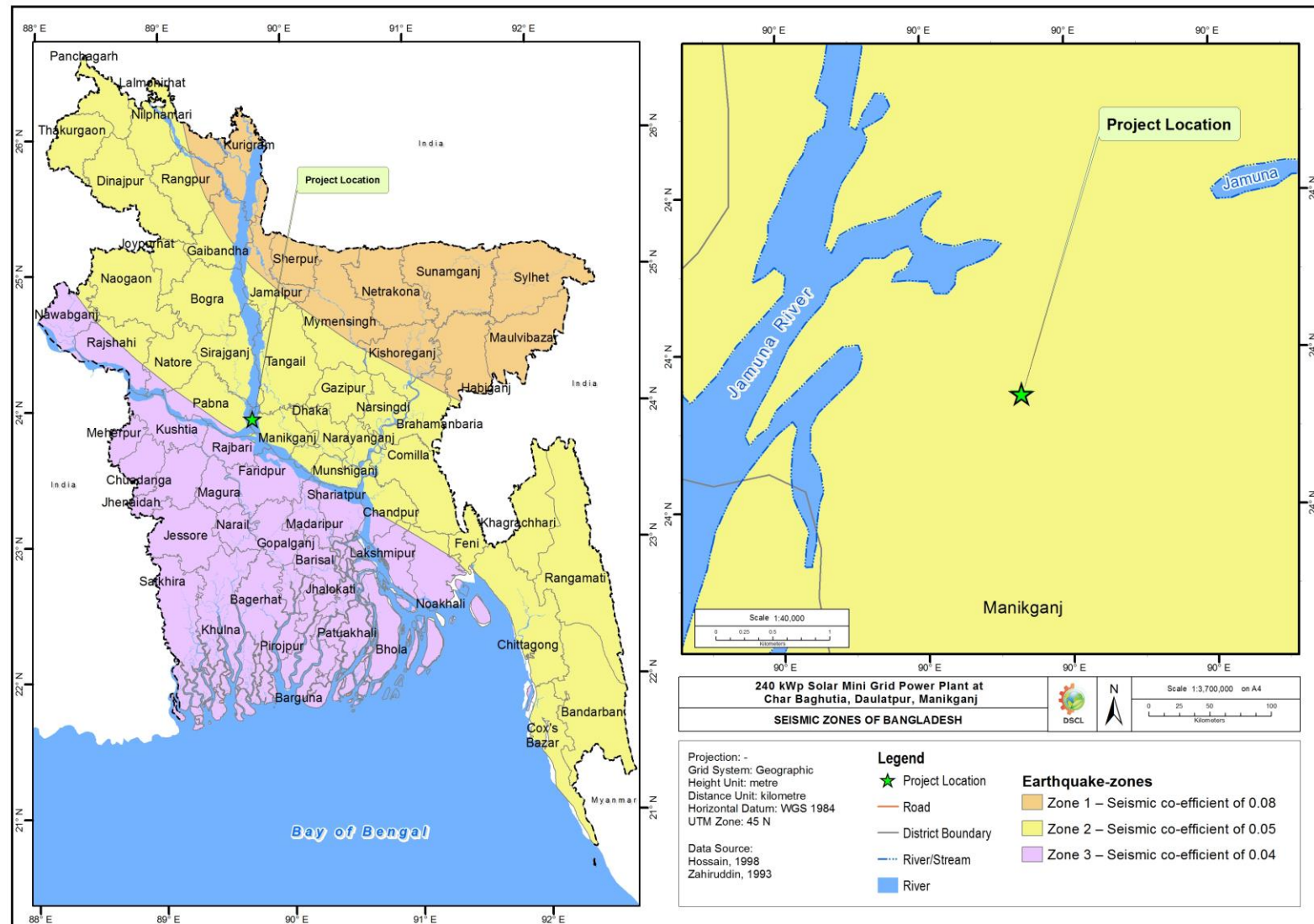


Figure 5.21: Seismic Zones within Bangladesh
 (Source: Hossain, 1988 & Zahiruddin, 1993)

5.3 Biological Environment

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).

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

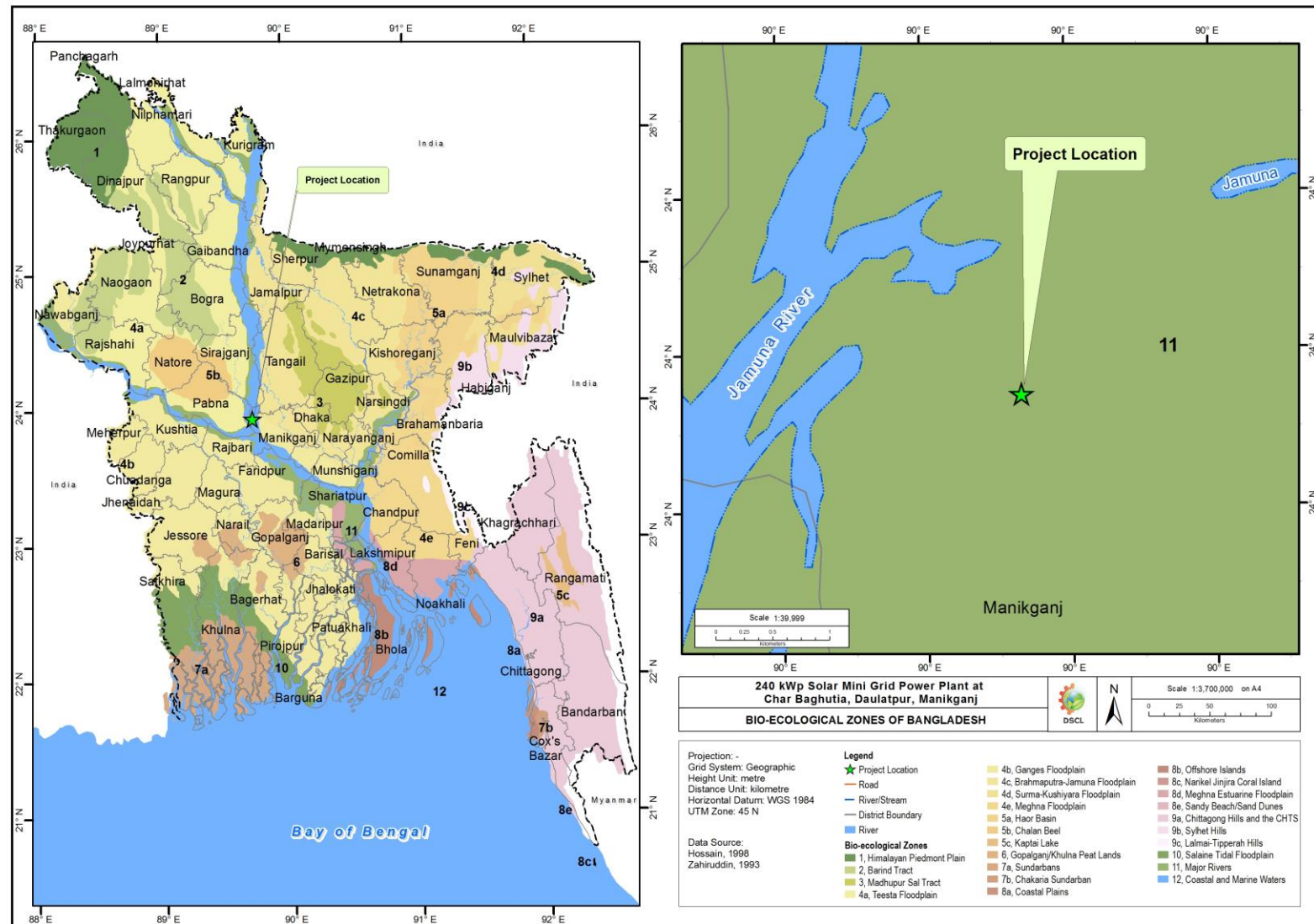


Figure 5.22: Bio-ecological Zones of Bangladesh

5.3.2 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 5.23: Flora in the Project Area

5.3.2.1 Flora

The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, rabi crops and variety of homestead vegetables. A sizeable number of fruit trees with economic value have been observed in the PIA. The fruit trees include jackfruit, mango, litchi, banana, coconut, blackberry etc. and timber trees include mehegoni, neem, koroï etc. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. 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 5.6.

Table 5.6: List of Plants in the Project Area

Common Name	Scientific Name	English Name	Family
Aam	<i>Mangifera indica</i>	Mango	Anacardiaceae
Amra	<i>Spondias mombin</i>	Hog plum	Anacardiaceae
Akashmoni	<i>Acacia auriculiformis</i>	Auri	Fabaceae
Ata	<i>Annona squamosa</i>	Sugar apple	Annonaceae
Bel	<i>Aegle marmelos</i>	Wood apple	Rutaceae
Boroi	<i>Zizyphus mauritiana</i>	Chinese date	Rhamnaceae
Bot	<i>Ficus benghalensis</i>	Indian banyan	Moraceae
Banana	<i>Musa sapientum</i>	Banana	Musaceae
Bamboo	<i>Bambusa vulgaris</i>	Bamboo	Poaceae
Beli	<i>Jasminum sambac</i>	Arabian Jasmine	Oleacea
Bangi	<i>Cucumis melo</i>	Muskmelon	Cucurbitaceae
Dhan	<i>Oryza sativa</i>	Rice	Poaceae
Dhaincha	<i>Sesbania bispinosa</i>	Danchi	Fabaceae
Debdaru	<i>Polyalthia longifolia</i>	False ashoka	Annonaceae
Golap	<i>Rosa sp.</i>	Rose	Rosaceae
Jolpai	<i>Elaeocarpus serratus</i>	Ceylon olive	Elaeocarpaceae
Joba	<i>Hibiscus rosa-sinensis</i>	China Rose	Malvaceae
Jaam	<i>Syzygium cumini</i>	Java Plum	Myrtaceae
Jarul	<i>Lagerstroemia speciosa</i>	Giant crape-myrtle	Lythraceae
Kamranga	<i>Averrhoa carambola</i>	Starfruit	Oxalidaceae
Kachuripana	<i>Eichhornia crassipes</i>	Water hyacinth	Pontederiaceae
Kolmi	<i>Polygonum</i>	Knotweed	Polygonaceae
Koroi	<i>Albizia procera</i>	Silk Plant	Fabaceae
Kathal	<i>Artocarpus heterophyllus</i>	Jackfruit	Moraceae
Kadam	<i>Neolamarckia cadamba</i>	Burflower Tree	Rubiaceae
Lau	<i>Lagenaria siceraria</i>	Bottle Gourd	Cucurbitaceae
Litchi	<i>Litchi chinensis</i>	Litchi	Sapindaceae
Morich	<i>Capsicum annuum</i>	Chilli	Solanaceae
Maan Kochu	<i>Alocasia macrorrhiza</i>	Giant Taro	Araceae
Mehogoni	<i>Swietenia mahagoni</i>	West Indian Mahogany	Meliaceae
Mandar	<i>Erythrina variegata</i>	Tiger's claw	Fabaceae
Neem	<i>Azadirachta indica</i>	Neem	Meliaceae
Orchid	<i>Orchis</i>	Orchid	Orchidaceae
Peyara	<i>Psidium guajava</i>	Guava	Myrtaceae
Pui Shak	<i>Basella alba</i>	Vine Spinach	Basellaceae
Pata Bahar	<i>Codiaeum variegatum</i>	Garden Croton	Euphorbiaceae
Pepe	<i>Carica papaya</i>	Papaya	Caricaceae
Rain Tree	<i>Albizia saman</i>	Rain Tree	Fabaceae
Shapla	<i>Nymphaea pubescens</i>	Water lily	Nymphaeaceae
Sajna	<i>Moringa oleifera</i>	Drumstick Tree	Moringaceae
Shim	<i>Lablab niger</i>	Hyacinth Bean	Leguminosae
Shimul	<i>Bombax ceiba</i>	Cotton Tree	Malvaceae
Shishu	<i>Dalbergia sissoo</i>	Indian Rosewood	Fabaceae
Shorisha	<i>Brassica nigra</i>	Mustard Seed	Brassicaceae

Common Name	Scientific Name	English Name	Family
Tetul	<i>Tamarindus indica</i>	Fabaceae	Tamarind
Topa pana	<i>Pistia stratiotes</i>	Water cabbage	Araceae
Tagar	<i>Tabernaemontana coronaria</i>	Crape jasmine	Apocynaceae

5.3.2.2 Fauna

The diversified habitat and ecosystem in the project area support various types of animals as given in Table 5.7. 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 38 species are identified during field survey among them 1 Amphibian, 3 Reptilian, 16 Avian faunas and 18 Mammalian faunas.

Table 5.7: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name
Class: Amphibia		
<i>Bufo melanostictus</i>	Common toad	Kuno bang
Class: Reptilia		
<i>Hemidactylus frenatus</i>	Common house gecko	Tiktiki
<i>Varanus bengalensis</i>	Bengal monitor	Gui shap
<i>Xenochrophis piscator</i>	Checkered keelback	Dhora shap
Class: Aves		
<i>Gallus gallus</i>	Chicken	Murgi
<i>Anas platyrhynchos</i>	Duck	Hash
<i>Corvus splendens</i>	House crow	Pati kak
<i>Acridotheres tristis</i>	Common myna	Bhat shalik
<i>Pycnonotus cafer</i>	Red-vented bulbul	Bulbuli
<i>Copsychus saularis</i>	Oriental magpie-robin	Doel
<i>Ploceus philippinus</i>	Baya weaver	Babui
<i>Alcedo atthis</i>	Common kingfisher	Choto maachranga
<i>Phalacrocorax niger</i>	Little cormorants	Pankouri
<i>Ardea alba</i>	Great Egret	Bok
<i>Columba livia</i>	Domestic Pigeon	Kobutor
<i>Passer domesticus</i>	House sparrow	Charui
<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Dholabuk dahuk
<i>Eudynamys scolopacea</i>	Asian cuckoo	Kokil
<i>Tyto alba</i>	Barn owl	Laxmi Pencha
<i>Dicrurus macrocercus</i>	Black drongo	Fingey
Class: Mammalia		
<i>Bos taurus</i>	Cow	Goru
<i>Bubalus arnee</i>	Wild Water Buffalo	Mohish
<i>Capra aegagrus</i>	Goat	Chagol
<i>Ovis aries</i>	Sheep	Bhera
<i>Bandicota indica</i>	Large bandicoot	Dhari indur

Scientific Name	English Name	Local Name
<i>Vulpes bengalensis</i>	Bengal fox	Sheyal
<i>Herpestes edwardsii</i>	Common mongoose	Beji
<i>Viverricula indica</i>	Small Indian civet	Khatash
<i>Felis catus</i>	Cat	Biral
<i>Felis chaus</i>	Jungle cat	Bon biral
<i>Canis familiaris</i>	Dog	Kukur
<i>Macaca mullata</i>	Rhesus monkey	
<i>Funambulus pennati</i>	Indian five striped squirrel	Dora kathbiral
<i>Oryctolagus cuniculus</i>	Rabbit	Khorgosh
<i>Hystrix indica</i>	Indian porcupine	Shojaru
<i>Lutra perspicillata</i>	Common otter	Bhodor
<i>Rattus rattus</i>	Common house rat	Indur
<i>Equus caballus</i>	Horse	Ghora

5.3.3 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 5.24 shows that no environmental sensitive area is present around the project region.

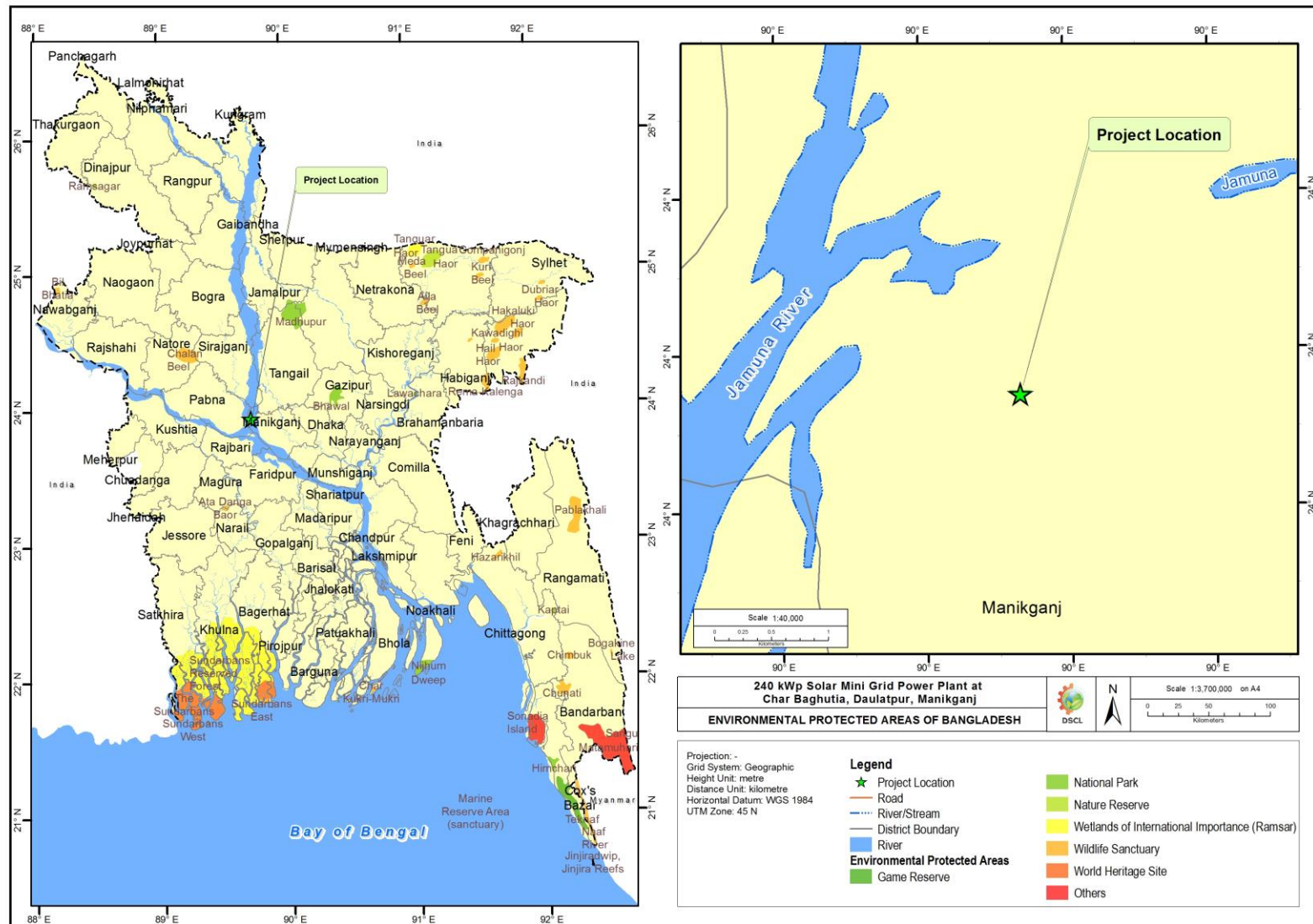


Figure 5.24: Environmental Protected Areas of Bangladesh

6 DESCRIPTION OF THE SOCIAL CONDITIONS

6.1 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).

There are two local markets (Haat) within 2 km of the proposed project site. As per survey, there are 194 shops, 6 rice mills and 1 saw mill in the local markets. There are also schools, madrasahs and mosques in the proposed location. The range of profession includes business, farmer, service etc.

It is to be noted from survey that, 71.41% currently have electricity by SHS. It has been also observed in the results of the surveys that 98.15% shops and 99.48% households are interested in having electricity from the proposed solar mini-grid project. Besides, 41.47% of the respondents earn less than BDT 10,000 per month and another 44.47% 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.

6.2 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 are provided in **Table 6.1**

Table 6.1: 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)

6.3 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 EIA document.

The project is located at Baghutia Union of Daulatpur Upazila of Manikganj district. The total area of the Daulatpur upazila is 216.24 Km². It is bounded by Chauhali and Nagarpur upazilas on the north, Shivalaya and Ghior upazilas on the south, Saturia upazila on the east, Jamuna River on the west. However, the total area of the Baghutia union is 45.02 Km².

The literacy rate of this island is 19.70 % for both male and female (BBS, 2011).

6.4 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 5.9). The demographic information is collated from Population Census, 2011 by Bangladesh Bureau of Statistics (BBS).

Table 6.2: Demographic Profile of the Project Area

Upazila	District	Households	Population			Sex Ratio	Population Density
			Both	Male	Female		
Daulatpur Upazila	Manikganj	37045	160108	77116	82992	93	740
Baghutia Union	Manikganj	4346	20726	9981	10745	93	460

Source: BBS, 2011

6.4.1 Household Size

Comparison of the data collected during household surveys found that the average household size of these villages was 4.6 members per household. The majority of households were headed by males (92%).

6.4.2 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 bracket (BBS 2003).

The sex ratio of the population in the villages surveyed within the Project Area was 101.7 females per 100 males. This ratio is similar to the National rural sex ratio of 106.6 given above. Of the total 468 persons living within the 84 households surveyed, 236 (50.4%) were males and 232 (49.6%) were females.

6.4.3 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.

6.4.4 Religion

Bangladesh is a predominantly Muslim nation, with nearly 90 percent of the population recorded as Muslim in the 2001 Population Census (BBS, 2006). The predominance of the

Muslim faith was reflected in the results of the household survey, with 98.9 percent of persons surveyed recorded as Muslim, and the remaining 1.11 percent being Hindu.

6.4.5 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.

6.5 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 70 percent of the land use. Other major non-agricultural land uses include rural settlements (11%), water bodies (9%) and mud flats (7%)

Approximately 19.5 percent of households surveyed were found to own arable land, and of these landowners 6.5 percent owned less than 1 acre and 6.1 percent owned between 1 and 2 acres. Of the 32.1 percent of households that own homesteads, more than 98.7 percent own less than 1 acre. Approximately 12.6 percent of households surveyed owned land used for ponds, and 27.2 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.

6.5.1 Cropping Patterns

The Project area is located in the Jamuna 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). Paddy potato, sweet potato, onion, pulses, vegetables, arum, till (sesame), betel leaf, betel nut, wheat, sugarcane, mustered, bottle gourd are also grown within the Project area. Fruits like jackfruit, litchi, palm, banana, lemon, black berry and water melon are often grown in smaller amounts and in close proximity to dwellings.

Of the household surveyed approximately 61 percent grew some form of paddy, with Amon being the most commonly grown (48%). Crop rotation was seen to be prominent with 56% either having a rotation twice or three times a year. Further, based on the primary crop intensity and pattern 3.6% do not have a crop rotation pattern with a singular crop dominated by Amon. Of those who crop rotated twice (11.3%), 4.8% was of Amon and Aus and 47.6% of people surveyed rotated their crop three time, which 46.4% was made up of Amon, Aus and Rabi.

6.5.2 Project Land

The proposed project land is bounded by agricultural land in three sides; in addition the north side of the project area is having some residential dwellings which is 200m far from the project site. The total land of the proposed project is about 5 bighas.

6.6 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.

6.6.1 Occupational Status

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.”*

For the majority of the surveyed people and their household members, their place of occupation is within their own land in the project area.

6.7 Livelihood

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.

Commercial energy consumption in Bangladesh is approximately 71 percent based on natural gas, with the remainder almost entirely oil (and limited amounts of hydropower and coal). Whilst electricity consumption is on the increase, this is mostly apparent in urban areas with rural areas remaining reliant on non-commercial forms of energy such as wood, animal wastes, and crop residues.

Results from household surveys found that no households in the Project area had access to electricity. In terms of actual energy or fuel usage, and 100 percent of households surveyed used leaves and straw as the primary energy source.

6.8 Settlement Pattern and Housing

The settlement patterns observed during field visits reflected the rural nature of the Project area, with scattered villages surrounded by agricultural fields and seasonally surrounded by floodplain. In the villages, a homestead is often occupied by an extended family and typically consists of a few houses and outbuildings, surrounded by fruit trees.

The majority of households surveyed within the Project Area owned their own home (94.0%). Of those not owning their own home, alternative arrangement included living in a house owned by relatives or being a tenant.

6.9 Transports and Communications

The project area is connected with the main land by waterways. The modes of transport in the island are motorbike, van, and horse cart. People of this island are connected with mobile network for regular communication.

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

6.10 Poverty

Almost all the families of Char Baghutia 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.

6.11 Health

The health facilities of this island are not satisfactory. There is only two non-government satellite clinic was found in the project influence area. However, these clinics are not open for the day long. As a result people have to go to Upazila health complex or to the district level hospitals or clinics for better medical facilities.

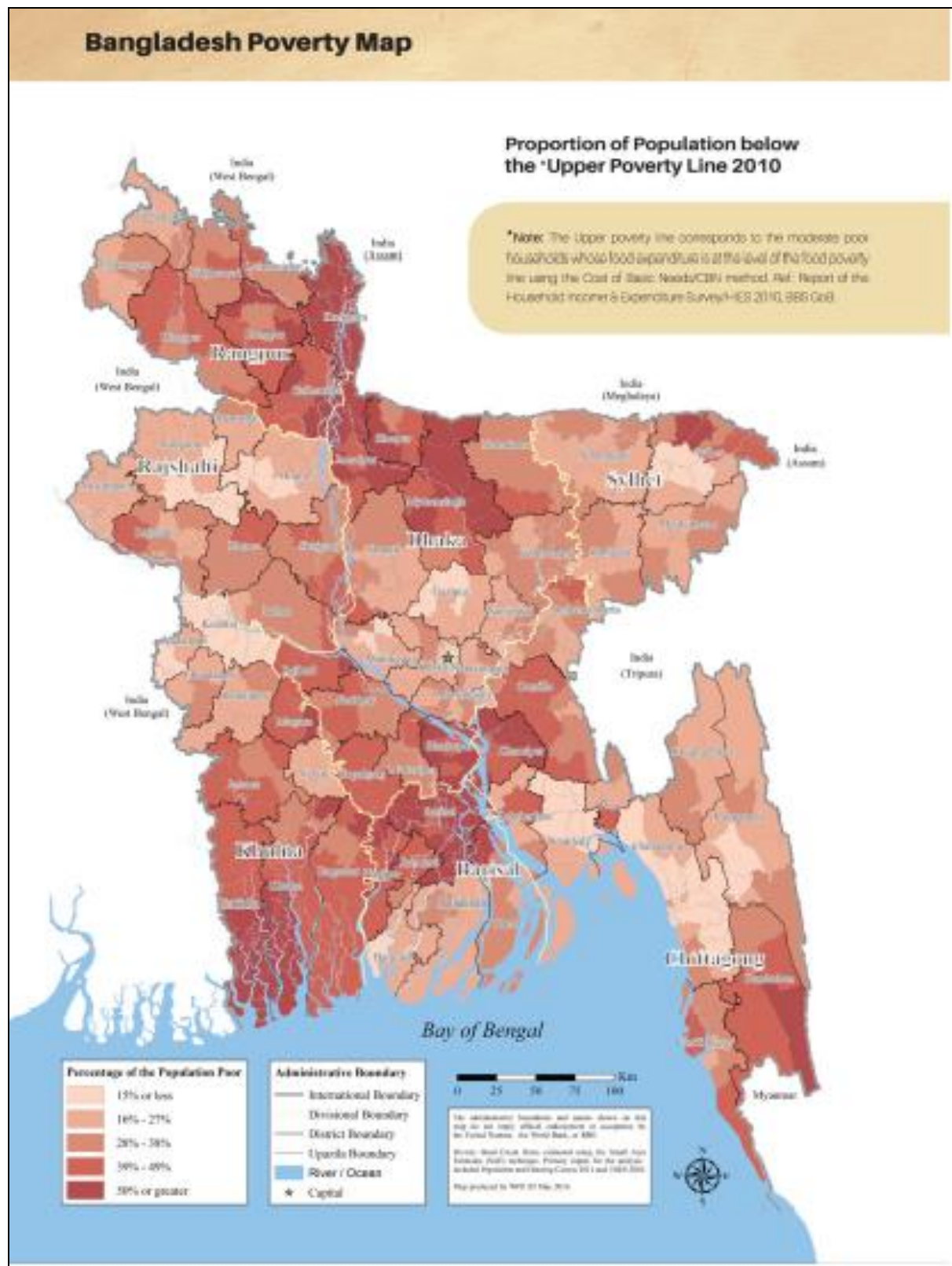


Figure 6.1: Poverty Map of Bangladesh (BBS/WFP/ World Bank-2010)

6.12 Recreational Aactivities

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.

6.13 Archaeological and Cultural Heritage

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 F of this EIA report.

6.14 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 Intergovernment 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.

6.15 Environmental and Social Hotspot

The socio-cultural aspects 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 Environmental Hotspots in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major environmental hotspots in the project area are shown in the Figure 5.26. A detail list of the cultural and sensitive areas located within 1 km radius of the project area is presented in Appendix F.

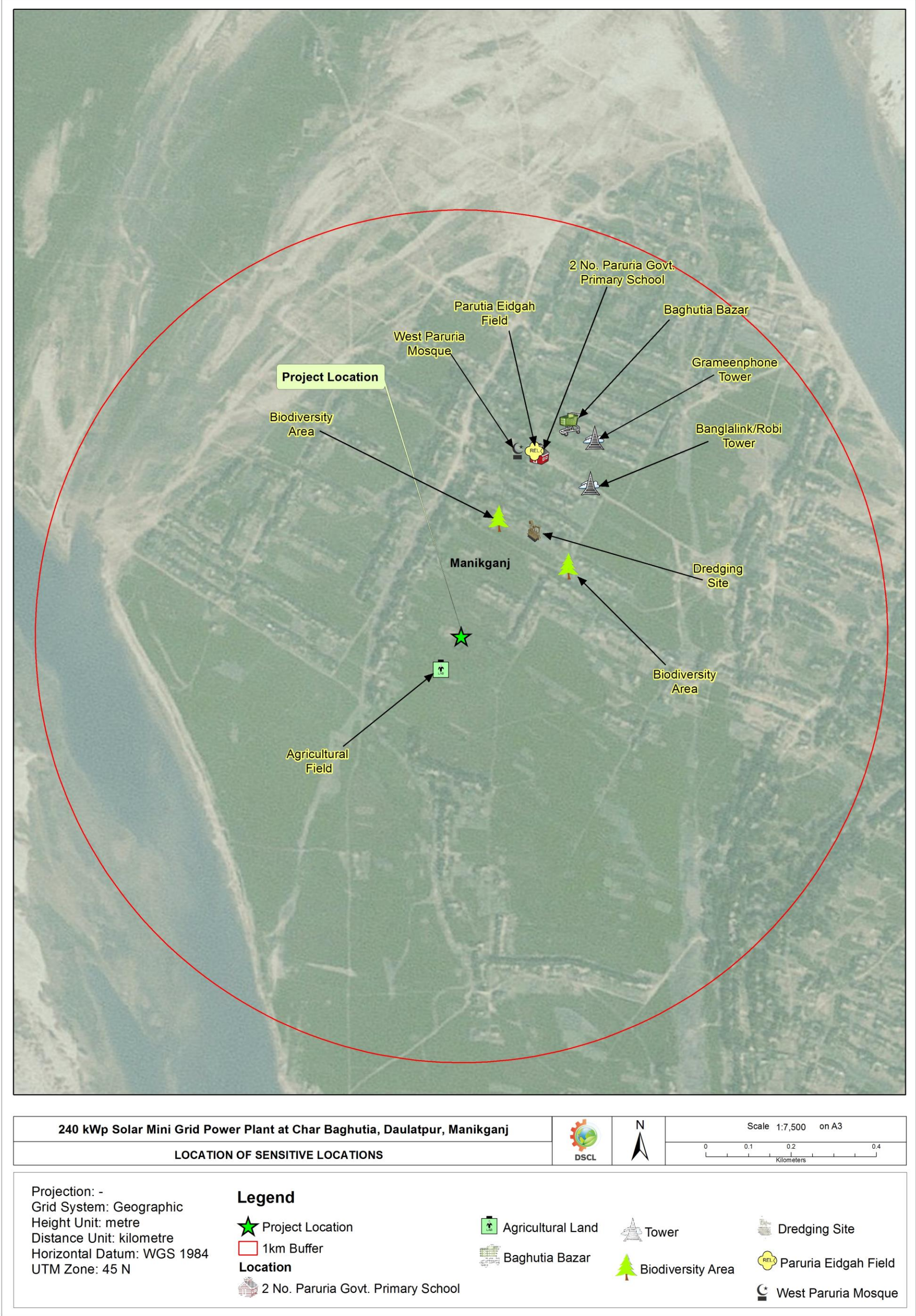


Figure 6.2: Cultural and Sensitive Structures within 1 km Radius of the Project Location

7 ANALYSIS OF PROJECT ALTERNATIVES

7.1 The Proposed Development Alternative

It is assessed from the impact study that majority of the impacts will cause during construction phase of the project and would be of temporary in nature. Some Positive impacts on socio-economic status are being revealed during operation phase. All the negative impacts can be mitigated through adoption of appropriate mitigation measures, and adopting sound engineering designs. This report will be presented to the Department of Environment (DoE). After the evaluation the proposed development alternative and Environmental Clearance Certificate (ECC) would be issued. However, the development has to ensure that all environmental measures are complied with during the construction period and during occupation and operation.

The alternative consists of the proponent's final proposal with the inclusion of the DoE guidelines and regulations and procedures. This is as stipulated in the Environmental Conservation Rule (ECR) of 1997, which aims at reducing environmental impacts to minimum extent practicable.

7.2 Site Alternatives

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.

7.3 The No Action Alternative

The No Action 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.

From the analysis above, it becomes apparent that the No Project Alternative is not the appropriate alternative to the local people, Bangladeshis, and the Government of Bangladesh.

8 PUBLIC CONSULTATION AND DISCLOSURE

8.1 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 EIA good practice and is a statutory requirement of the national EIA 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 EIA requirements with affected people, and is designed to be both fair and inclusive. Consultation activities have been conducted during the environmental survey of the EIA in March 2016.

8.2 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 EIA 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.

8.3 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 EIA surveys. The details of FGDs are given in the following Table

7.1. The findings of these of these FGDs are summarized in Table 7.2 and the details of these FGDs are given in Appendix E.

Table 8.1: Details of FGDs

FGD No.	Type of Participants	No. of Participants
1	Local People	12
2	Local People	9
Total		21



Figure 8.1: Photos of Focus Group Discussions (FGD)

Table 8.2: Summary of the FGDs

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the project? If yes, what are they?	Yes, the project proponent has shared this information with us. The owner will establish Solar Power Plant and will distribute electricity among us.
Any air pollution in the area due to the project area due to the project activities? If yes, how to mitigate?	The air quality will not anticipate significantly because of construction activities. Through more traffic will run to carry construction materials which will increase dust around the roadside but this would not be harmful to local people. Construction of building for workers shed and other facilities will decrease the local air quality temporarily. As the project site is beside some residential dwellings so there is minor possibility of anticipated impact but proper care about battery, sensitive equipment etc. should 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?	The noise level will increase because of running construction machineries and movement of workers. The effect will be temporary. After the construction is finished, the noise level will come back to the previous limit. Still, there should be proper noise barrier or boundary wall at the noise source.

Questions to the Groups	Participants opinion, comments and suggestions
Any impact on local soil due to the project activities? If yes, how to mitigate?	Agricultural land will decrease because of the implementation of this project. However, the selected land was leased from the land owner for 20 years with good value. The implementation of this project will hamper the agricultural practices of the proposed plant area. Any spillage of chemicals and toxic materials will degrade the soil quality of the project site. The project proponent should take proper attention regarding this accident. The waste materials should be maintained properly and it should not be kept at open place.
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 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.
Is the proposed area inundated during flood? If yes, how much?	Hence, the area is char land. The area is flood affected area especially during high flood time. During monsoon period low lying areas are flooded. But the developer filled the land about 5 feet from the normal plinth level. So there is no risk of flooding of the project site.
Are any Environmental Protected Area (EPA) / Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	No.
Will the project impact on your social and economic sector? If yes, how?	Yes, by this project unskilled and poor women can develop their skills. They will help their family by earning money as well as help to national economy. The local economy will develop after having the access of electricity. The education status of this area will develop. The educational institution will be able to teach computer lesson to their students after having the electricity which is now not possible.
Do you have any recommendation before the implementation of this project?	The project proponent should consider more households under the grid as well as the electricity generation should be increased. They have to give attention on business sector such as electricity in market area and for irrigation rather than

Questions to the Groups	Participants opinion, comments and suggestions
	to households. Most of the households in this area are using solar panel individually for electricity generation. After going to the grid of new solar power plant our present solar panel would be a concern. As we do not know much about it so it is not possible for us to treat the waste properly. Some of us would be able to sell this to other households but the project proponent could take necessary actions on it particularly for the old panels. Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.
Are you in favor of this project? Why?	Yes, we appreciate the initiative. This will influence the other people to take initiative of such kind project. In the long run it will help to develop the economic and social condition in this area.

9 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

9.1 General

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.

9.2 Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. These magnitude categories are defined in table 8.1.

Table 9.1: Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Nominal
Duration of Potential Impact	Long term (more than 35 years)	Medium term lifespan of the project (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project Boundary	Specific location within project component or site boundaries with no detectable
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and	Breaches national standards and or international	Complies with limits given in	Meets minimum national	Not applicable

established professional criteria	guidelines/obligations	national standards but breaches international lender guidelines in one or more parameters	standard limits or international guidelines	
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

9.3 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in Table 8.2.

Table 9.2: Criteria for Determining Sensitivity

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

Assigning Significance: Following the determination of impact magnitude and sensitivity of the receiving environment or potential receptors, the significance of each potential impact has been established using the impact significance matrix shown below in Table 8.3

9.4 Summary of Assessed Impacts

The project's potential impacts on the key environmental parameters have been assessed and their significance determined using the methodology described in Section 8.2 above. A

summary of the potential impacts of the project on the key environmental parameters and significance of these impacts are presented in Table 8.4, 8.5 and 8.6 for different phases of this project; the potential impacts are discussed in the subsequent sections.

Table 9.3: Significance of Impact Criteria

Magnitude of Potential Impact	Sensitivity of Receptors			
	Very Severe	Severe	Mild	Low/Negligible
Major	Critical	High	Moderate	Negligible
Medium	High	High	Moderate	Negligible
Minor	Moderate	Moderate	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

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.

9.5 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.

9.6 Pre-construction Phase

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

9.6.1 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 the 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. The proposed project site is situated on the lower ground and it needs about 5-feet soil filling.

Mitigation

The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental management plan (EMP). 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

9.6.2 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.

9.7 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 EMP section. Following is the brief description of impacts envisaged during the construction phase.

9.7.1 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 a school and 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.

9.7.2 Air Quality

Impact

The main impacts associated with construction activities will be:

- 1) Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions.
- 2) 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.

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:

- 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;
- 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:
- Regular watering of all active construction areas.
- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Proper management of stockpiles and excavated material (e.g. watering, containment, covering, bunding).
- Proper covering of vehicles transporting aggregates and fine materials
- 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.

9.7.3 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 is a close educational site and some residences. These are the closest sensitive location to the project area almost 15 m far from the proposed power plant. 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 / Super Star Renewable Energy Ltd. during the construction phase and which include:

- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented;
- 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.; 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).

9.7.4 Soil

Impact

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.

The other source of 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.

Mitigation

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.

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.

9.7.5 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, bentonite 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.

9.7.6 Terrestrial Ecology

Impact

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.

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.

Mitigation

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

- 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);
- 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:
 - Prohibit hunting at any time and under any condition by construction workers onsite
 - Ensure proper storage, collection, and disposal of waste streams generated
 - 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
 - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.

9.7.7 Waste Generation

Impact

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.

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

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.

9.7.8 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 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 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.

9.7.9 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 Bhagutia* 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.

9.7.10 Traffic

Impact

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.

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

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.

9.7.11 Archaeology and Cultural Resources

Impact

The field visits conducted at the project site and 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:

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

9.8 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.

9.8.1 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 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.

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.

9.8.2 Air Quality

Impact

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.

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.

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.

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.

9.8.3 Noise

Impact

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.

In addition, 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 (80 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.

Mitigation

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 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. The worker inside the project area should use earmuffs during the operation of diesel generator.

9.8.4 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.

9.8.5 Water Resources

Impact

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 infrastructure development near the project area. This will exert stress on the availability of groundwater in the project area.

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.

- 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;
- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.

9.8.6 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.

9.8.7 Waste Generation

Impact

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).

PV modules: 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.

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.

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

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.

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.

9.8.8 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:

- Entering of lead (Pb) 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

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 penetrates 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 results in the adverse impact in 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.

Acid hazard during battery handling: The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. Super Star Renewable Energy 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.

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.

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.

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.

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.

Mitigation

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.

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.

9.8.9 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.

9.8.10 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.

9.9 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.

9.9.1 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.

9.9.2 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.

9.9.3 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.

9.9.4 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.

9.9.5 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.

9.9.6 Waste Generation

Impact

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.

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.

PV modules and others: 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.

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.

End-of-Life Solar Panels: 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.

Mitigation

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

- 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;
- 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.

9.9.7 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.

9.9.8 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.

9.9.9 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.

9.10 Summary of Anticipated Impacts

Table 8.4, Table 8.5, and Table 8.6 below present a summary of the anticipated impacts during the planning and construction, operation, and decommissioning phase of the Project.

Table 9.4: Summary of Anticipated Impacts during the Planning and Construction Phase

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Land-filling/ Earthworks	Soil erosion from the fill material, changes in existing landscape.	Short term	Local	Reversible	Certain	Medium	Severe	High Negative	Moderate Negative
Landscape and Visual	Visual and landscape impacts due to presence of elements typical of a construction site such as equipment and machinery.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Land use	Project could conflict with formal land use set at the planning level for the area. In addition, project could conflict with actual land use as it could provide value to locals.	No anticipated impact.							
Geology and Hydrology	The Project site is a <i>Char</i> land and surrounded by rivers and thus there is a potential risk of local flood hazard within the site during the rainy season and especially during flash flood events	Long term	Local	Irreversible	Likely	Medium	Severe	High Negative	Moderate Negative
	Risk of soil and groundwater contamination during the various construction activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater.	Could be long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	High Positive
Biodiversity	Construction activities could disturb existing habitats (flora,	Long term	Local	Irreversible	Certain	Minor	Mild	Low Negative	High Positive

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	fauna, and avifauna) and any threatened or endangered species which might be present within the Project site. In addition, other impacts could be from improper management of the site (e.g. improper conduct and housekeeping practices).								
Air Quality	Construction activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Noise	Possible noise emissions to the environment from the construction activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	Short term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Socioeconomic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their	Not applicable.							

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	standards of living, and bring social and economic prosperity to local communities.								
Health and Safety	There will be some generic risks to workers health and safety from working on construction sites, as it increases the risk of injury or death due to accidents.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

Table 9.5: Summary of Anticipated Impacts during the Operation Phase

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Landscape and Visual	The Project is expected to be visible within the immediate vicinity and up to some long distance around the Project site only and thus is likely to create visual impacts related to interaction with surrounding landscape.	Long term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
	Potential for glare caused by minimal sunlight reflected off the PV panel modules which in turn could affect nearby receptors.	Long term	Local	Reversible	Likely	Medium	Mild	Low Negative	Low Negative
PV panels, Battery	The most significant source of soil pollution is the damage of	Long term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	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.								
Backup Generator	The most significant noise source of this solar power plant is from the backup diesel generator (100/110 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.	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Geology and Hydrology	Risk of soil and groundwater contamination during the various operational activities from improper housekeeping activities, spillage of hazardous material, random discharge of	Long term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low negative

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	waste and wastewater. However, most significant sources of soil and water pollution are the chemicals from PV panel's damage and from the expired batteries.								
Biodiversity	Impacts limited to improper management of the site (e.g. improper conduct and housekeeping practices).	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	Moderate Positive
Air Quality	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.	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	High Positive
Noise	The only significant noise source from the operation activities which will likely include the use of backup generators to ensure continuous power supply.	Long term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Socio-economic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their standards of living,	Not applicable.							

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	and bring social and economic prosperity to local communities.								
Occupational and Community Health and Safety	There will be some risks to workers health and safety during the operation and maintenance activities of the Project.	Long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	Moderate Positive
	Trespassing of unauthorized personnel into the Project site could result in potential risks from several hazards of the various Project components (e.g. electric shock, thermal burn hazards, exposure to chemicals and hazardous materials, etc.). 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.	Long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	Moderate Positive

Table 9.6: Summary of Anticipated Impacts during the Decommissioning Phase

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Geology and Hydrology	Risk of soil and groundwater contamination during the various decommissioning activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater.	Short term	Local	Could be irreversible	Likely	Medium	Low	Moderate Negative	Low Positive
Air Quality	Decommissioning activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Short term	Local	Reversible	Certain	Medium	Low	Moderate Negative	Low Negative
Noise	Possible noise emissions to the environment from the decommissioning activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Infrastructure and utilities	Of particular importance related to infrastructure and utilities is the final disposal of the panels at the end of their lifetime. Final disposal of panels, which may contain hazardous material, needs to ensure that existing waste facilities would be able accept such solar modules. In addition, it	Long term	Local	Reversible	Likely	High	Severe	High Negative	Low Negative

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	is also important to investigate other disposal options such as buy back and recycling programs.								
Health and Safety	There will be some generic risks to workers health and safety from working on decommissioning sites, as it increases the risk of injury or death due to accidents.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

10 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

10.1 General

The Environmental Management Plan (EMP) 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.

10.2 Objectives

This Environmental Management Plan (EMP) 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 EMP are summarized below:

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

Overall, this EMP 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.

10.3 Environmental Management Plan (EMP)

On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Solar Mini-grid Power Plant project activities, an EMP has been prepared which will be followed at the pre-construction, construction, operation and decommissioning stages. While preparing the EMP, 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 10.1: Environmental Management Plan (EMP) 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. The proposed plant will degrade surrounding agricultural land. The overflowed and eroded filled materials as well as the side slope of the filled land may harm the surroundings. The total area of land-filling: 5 Bigha. Amount of sand required for land-filling: 87260sft. Height of land-filling is 5ft. the sources of sand from pond and underground sand	Fence the proposed area so that the surrounding agricultural land will not be disturbed. 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.	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	Should undertake a flood risk study to determine flood quantities within the plant area and to estimate peak	no. of flood	Consideration of flood hazard in project design	Project developer	

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	components.	flood to determine the peak flow for the return period of 50 years.				
Construction Phase						
Earthworks	Soil erosion from the fill material, changes in existing landscape.	▪ The contractor shall ensure that the fill material is collected from only the approved sources and not from any illegal dredging site. ▪ Construct the retention wall properly so that erosion will not happen. ▪ 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	▪ Dust generation due to construction activities. ▪ Exhaust Emissions due to operation of construction plant and machinery.	▪ Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. ▪ 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	Daily	▪ No visible dust plumes originating From construction sites. ▪ Regular machineries maintenance records.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules (ECR), 1997 ▪ Environment Court Act, 2000 ▪ Bangladesh Climate Change Strategy and

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		materials will be avoided such as minimising drop heights when loaders dump soils into trucks. ▪ Train workers to handle construction materials and debris during construction to reduce fugitive emissions. ▪ Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary.				Action Plan (2008)
Noise	Increased noise levels during to construction & machinery	▪ 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. ▪ The contractor shall limit idling of engines when not in use to reduce its contribution to 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	▪ Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds. ▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						Forests and Social Forestry) ▪ National Biodiversity Strategy and Action Plan (2004)
Soil	Soil disturbance due to removal of top soil, potential accidental spillage	▪ 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. ▪ 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. ▪ 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	▪ Number of spills or incidents to be recorded during onsite audits. ▪ Training records of Personnel trained in spill response procedures must be filed	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ The Environment (Pollution Control) Act, 1995

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		To control soil erosion surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows				
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	- The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous 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. - 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 establish regular intervals for waste collection and disposal as per contractor's waste management procedures. - The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.	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 Conservation Rules (ECR), 1997
Traffic	Additional traffic load due to	The contractor to ensure that all trucks and vehicles accessing the	Continuously	No complains or concerns from	Contractor	

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	transport of equipment and materials to and from the site through the surrounding road network	facility are operated by licensed operators. ▪ Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits ▪ Ensure adequate maintenance and inspection of vehicles ▪ Presence of flagman at the entrance and exit of the project site in order to control vehicles and truck movement.		traditional users of the area's roads routes are received during the construction activities. ▪ No incidents or accidents (collisions) are recorded		
Health and Safety risks	▪ 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. ▪ Exposure to health events during construction activities such as manual handling and musculoskeletal disorders, hand-arm vibration,	▪ All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. ▪ Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. ▪ Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. ▪ Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. ▪ Avoid work at height where it reasonably practicable to do so, e.g.	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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	temporary or permanent hearing loss, heat stress, and dermatitis.	by assembly at ground level. ▪ 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; ▪ 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. ▪ 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. ▪ Set up a system to alert workers on 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 (ERP) with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		and evacuation procedure, in addition to training for personnel and drills to test the plan ▪ 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. ▪ Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. ▪ 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. ▪ Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. ▪ Adequate number of staff and first aiders shall be on site in accordance with Bangladesh Labor Law requirements. ▪ First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		gloves, scissors, thermometer, etc. shall be made available by the contractor on site. - Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills. - 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. - 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. - 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. - Awareness training sessions				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		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 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. ▪ 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 that the correct methods are being used.				
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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						Management Action Plan, 1995
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.	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
	These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.					
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,	▪ 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	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide.			maintenance records.		(ECR), 1997 ▪ Environment Court Act, 2000 Bangladesh Climate Change Strategy and Action Plan (2008)
Noise	Significant sound pollution from backup generator	▪ Establish the generator inside an insulated room and use noise reduction canopy to keep the environment free from sound pollution. ▪ Noise barrier should also be given around the generator room. ▪ The worker inside the project area should use earmuffs during the operation of diesel generator.	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.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ Noise Pollution Control Rules, 2006
Terrestrial Ecology	Potential disturbance and harm to birds	▪ Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds. ▪ Ground nests found on site shall be translocated outside the project boundary. ▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	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,

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						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 modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	- 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
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	- 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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		into the soil.				
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 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	▪ 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 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	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
	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.	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

- 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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
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.						

10.4 Environmental Monitoring Plan

10.4.1 General

An Environmental 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 9.2.

10.4.2 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:

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

Table 10.2: Environmental 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	SSREL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Surface water quality standard by DoE, Bangladesh	Once	Contractor	SSREL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Groundwater quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Dust	Dust control	Air quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL
Soil Pollution	▪ Check liquid waste is carried out by experienced personnel and in proper way	Monitoring	Regularly	Contractor	SSREL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	Careful and proper handling of oil and other hazardous liquids				
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	SSREL
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	SSREL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
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)	SSREL	DOE/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	1/year (5 year)	SSREL	DOE/IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by DOE, Bangladesh	1/year (5 year)	SSREL	DOE/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As		1/year (5 year)	SSREL	DOE/IDCOL
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	-----	SSREL	DOE/IDCOL
PV panels, and Battery	Chemicals		1/year (5 year)	SSREL	DOE/IDCOL
Soil Quality	Heavy metals		1/year (5 year)	SSREL	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	SSREL /IDCOL
Dust	Dust control	Air quality standard by DOE, Bangladesh	Once	Contractor	SSREL /IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL /IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL /IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL /IDCOL
Soil Pollution	▪ Check liquid waste is carried out by	Monitoring	Regularly	Contractor	SSREL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	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				/IDCOL
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	SSREL /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	SSREL /IDCOL

10.5 Environmental Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the EMP is presented in Table 9.3. The overall costs of the EMP 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. 8,27,200. 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 10.3: 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.	5	8,000	40,000
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)					111,000
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	55,000	55,000
Noise	Measuring ambient noise level	No.	5	8,000	40,000
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			40,000
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			50,000
Construction Safety	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum			10,000
Health	Health check-up camps for construction workers	Camp	-	5,000	5,000
SUB TOTAL (CONSTRUCTION STAGE)					216,000

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
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	20,000	20,000
Management Information System		Lump sum	-	10,000	10,000
SUB TOTAL (ESTABLISHMENT and TRAINING)					30,000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					7,52,000
CONTINGENCIES @ 10 % on total Environmental Costs					75,200
GRAND TOTAL (in BDT)					8,27,200

11 ENVIRONMENTAL AND SOCIAL BENEFIT

11.1 Introduction

Renewable energy is recognized internationally as a major contributor in protecting our climate, nature, and the environment as well as providing a wide range of environmental, economic, and social benefits that will contribute towards long-term global sustainability.

Solar mini-grids are an ideal alternative to grid electricity in remote villages that do not have grid connectivity. And because mini-grids are independent entities, they can also be controlled and managed without presenting threats to the conventional grid. Such distributed energy systems also provide more reliable electricity, as any outages or interruptions to electricity supply can be quickly identified and corrected. One of our most effective power generation solutions is the Mini-Grid. It is a very reliable, independent, cost effective solution with low operation and maintenance costs.

It is also a centralized solution, which means it acts like a small power plant, utilizing a local electricity distribution network and saving the hassle of installing and maintaining hundreds of small consumer systems. This makes it a very efficient and convenient solution for municipalities, governments, NGOs and investors who want to transform the lives of people in remote communities.

It is a particularly beneficial solution for areas lacking access to national grid electricity or where chances of connecting to the grid are low. Indeed, a hybrid Mini-Grid power system functioning as an autonomous entity can provide almost the same quality and services as the national grid. The solution is for 24 hours a day, 365 days a year, using battery storage to provide service at night and on rainy days.

Increasing the supply of renewable energy would allow replacing carbon-intensive energy sources and significantly reducing global warming emissions. Generating electricity from renewable energy offers significant public health benefits. The air and water pollution emitted by coal and natural gas plants is linked to breathing problems, neurological damage, heart attacks, and cancer.

Solar mini-grid systems generate electricity with no associated air pollution emissions. While solar mini-grid energy systems emit some air pollutants, total air emissions are generally much lower than those of coal and natural gas-fired power plants. In addition, solar energy requires essentially no water to operate and thus do not pollute water resources or strain supply by competing with agriculture, drinking water systems, or other important water needs.

11.2 Energy and Climate Concern

The negative environmental impacts from generating electricity through conventional fossil fuel burning at thermal power plants are very well known. This most importantly includes air pollutant emissions such as ozone, sulfur dioxide (SO₂), Nitrogen Dioxide (NO₂), particulate

matter, and other gases which are the cause of some serious environmental concerns such as smog, acid rain, health effects, and many others.

In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities which contributes to global warming. The main human activity that emits CO₂ is the combustion of fossil fuels for electricity production and transportation. Concurrently, global climate change has become an issue of concern and so reducing greenhouse gas emissions have also emerged as primary issues to be addressed as the world searches for a sustainable energy future.

Electricity produced using solar energy emits no greenhouse gases (GHGs) or other pollutants. As with any electricity-generating resource, the production of the PV systems themselves requires energy that may come from sources that emit GHGs and other pollutants. Since solar PV systems have no emissions once in operation, an average traditional PV system will need to operate for an average of four years to recover the energy and emissions associated with its manufacturing. A thin-film system currently requires three years. Technological improvements are anticipated to bring these timeframes down to one or two years. Thus, a residential PV system that can meet half of average household electricity needs is estimated to avoid 100 tons of carbon dioxide (CO₂) over a 30-year lifetime.

11.3 Energy and Livelihood Concern

The belief that the provision of electricity in rural areas can bring about desired socio-economic changes (increased economic opportunities, improved health and education facilities). First, it is argued that electrification only brings changes to resource-rich households, and second, that it drains the resource-scarce rural economy. However, changes in electrified areas might demonstrate some positive outcomes. In response to the availability of electricity, village people could find various productive uses for it.

The development of micro-enterprises in rural areas is linked with the increase in access and use of grid electricity services, leading to changes in micro-enterprises, and changes in livelihood characteristics of entrepreneurs, employees and community members in areas where these enterprises are located. Micro-enterprises are important in their role as contributors to the economy of the rural poor especially women, technological development of rural people and in their potential for employment creation.

11.4 Energy and Economy Concern

Energy is a foundation stone of the modern industrial economy. Energy provides an essential ingredient for almost all human activities: it provides services for cooking and space/water heating, lighting, health, food production and storage, education, mineral extraction, industrial production and transportation. Modern energy services are a powerful engine of economic and social development, and no country has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for a broad section of its population. Throughout the world, the energy resources available to them and their ability to pay largely determine the way in which people live their lives. Nevertheless, it is critical to recognize that what people want are the services that energy provides, not fuel or

electricity per se. Many factors play a role in influencing energy supply, not least of which is its availability, price and accessibility. The regional endowment of energy sources and the pace at which they are developed and distributed are not uniform around the world.

The last two centuries have seen massive growth in the exploitation and development of energy sources, and the world has gained many benefits from these activities. The magnitude of energy consumed per capita has become one of the indicators of development progress of a country, and as a result, energy issues and policies have been mainly concerned with increasing the supply of energy. This approach is now seen as a vision that needs challenging.

In the last two years, countries around the world have added almost as much new solar photovoltaic (PV) capacity as had been added since the invention of the solar cell. Nearly 38,000 megawatts of PV came online in 2013, a new annual record. In all, the world's installed PV generating capacity is now close to 140,000 megawatts. Falling costs and effective policies continue to drive tremendous growth in solar power.

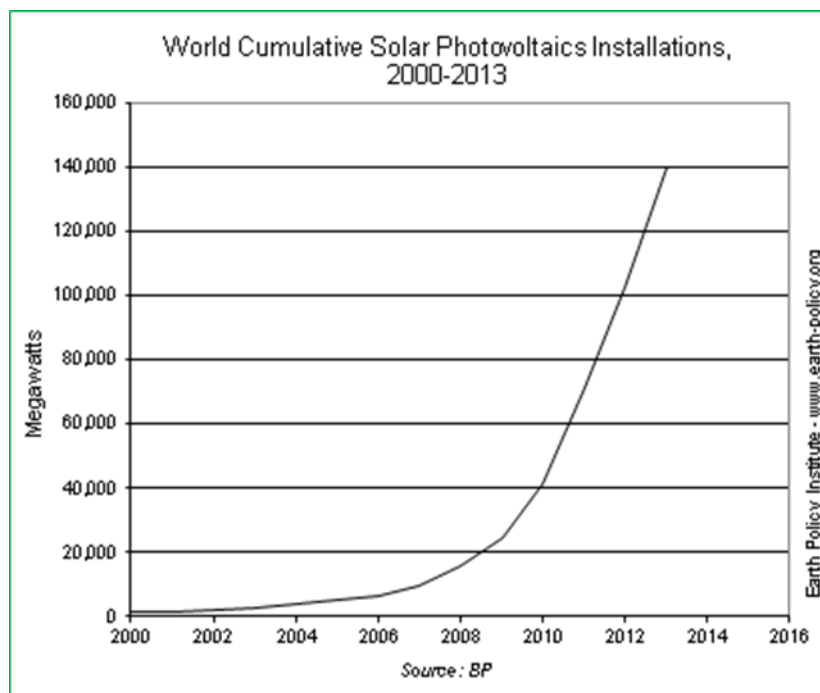


Figure 11.1: Trends of World Solar Energy Growth

PV remains the most rapidly growing energy technology by a wide margin. Indeed, global PV installations for 2014 should reach at least 40,000 megawatts, expanding world PV capacity by another 30 percent. As concerns about climate change grow, solar PV has firmly established itself as an integral player in the transition from fossil fuels.

12 CONCLUSION

12.1 Conclusion

According to the above analysis, we can conclude that, if the recommended mitigation measures and environmental management processes are adopted properly, the project will be environmentally sound and sustainable.

Primarily the national economy will be benefitted by the project. Benefits in the project area will be in significant except for some short terms employment and business opportunities during the construction phase. However, the needs of the solar photovoltaic power plant are obvious and for that the livelihood of the area will be developed. Developed livelihood will directly influence the growth of economy of the area.

During the construction stage, there will be some negative impacts of the project. There are no significant cumulative adverse impacts during operation that are identifiable at this stage. The construction impacts should be very predictable and manageable, and with appropriate mitigation few residual impacts are likely. Additional human and financial resources will be required to improve environmental capability, and to progress and achieve necessary statutory compliance and environmental clearance certification for the project or associated activities that also require environmental assessment and environmental permits under the environmental laws of Bangladesh.

The project is expected to have a small "environmental footprint". No endangered or protected species of flora or fauna are reported at the project site. The proposed project activities have no significant adverse environmental impact so far as a time bound execution program with application of advanced construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the proposed project.

12.2 Recommendations

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 EMP, 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 EMP through his own Site Specific Environmental Management Plan which will adopt all of the conditions of the EMP. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

The EMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the EMP a legal requirement according to the contract. To ensure compliance with the EMP the contractor should employ an environmental specialist to monitor and report project activities throughout the project construction phase.

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APPENDIXES

Appendix A: Air Quality Monitoring Methodology

Air Quality Parameter	Equipment
Suspended Particulate Matter (SPM)	LATA Envirotech APM 250 Combined PM-10/ PM-2.5 Sampler
Respirable Suspended Particulates (RSP) - PM ₁₀	LATA Envirotech APM 250 Combined PM-10/ PM-2.5 Sampler
Oxides of Nitrogen (NO _x)	LATA Envirotech LES 411
Sulfur Dioxide (SO ₂)	LATA Envirotech LES 411
Carbon Monoxide	HTC Carbon Monoxide Meter CO-01
Measured Parameters	
AIR Suspended particulate matter (SPM)	
PM ₁₀	
Oxides of Nitrogen (NO _x)	
Sulfur dioxide (SO ₂)	
Carbon monoxide (CO)	

A. Procedure

- The aerosol masses of both Suspended particulate matter (SPM) and coarse particle (PM₁₀) will be determined by the weighing (Gravimetric measurement) (after moisture equilibration at 22 degree temperature and 50% moisture) the filter papers before and after the exposure. For weighing, a five decimal OHAUS analytical balance, model AR 1140 will be used.
- The gaseous air pollutants (NO_x and SO₂) will be collected by passing the air through particular absorbent solutions in individual impinger at a constant flow rate (100 to 200 ml/min). The absorbent solutions finally analyze and determine in UV-Visible Recording Double Beam Spectrophotometer (A Shimadzu UV visible model UV-160A). Individual wavelength will be used as a UV source for NO_x and SO₂. 560 nm wavelength passes through absorbent reagent for SO₂ and 540 nm wavelength for NO₂. The parameters SPM, PM₁₀, SO₂ and NO_x are expressed in microgram/m³.
- For the determination of CO, HTC Carbon Monoxide Meter CO-01 will be used and value is expressed in ppm.

		
High Volume Sampler	Gaseous Sampling Attachment LES 411	HTC Carbon Monoxide Meter CO-01

B. Sample preparation for the analysis in SPM/PM₁₀

Digestion procedure for glass micro fiber & Millipore filter paper

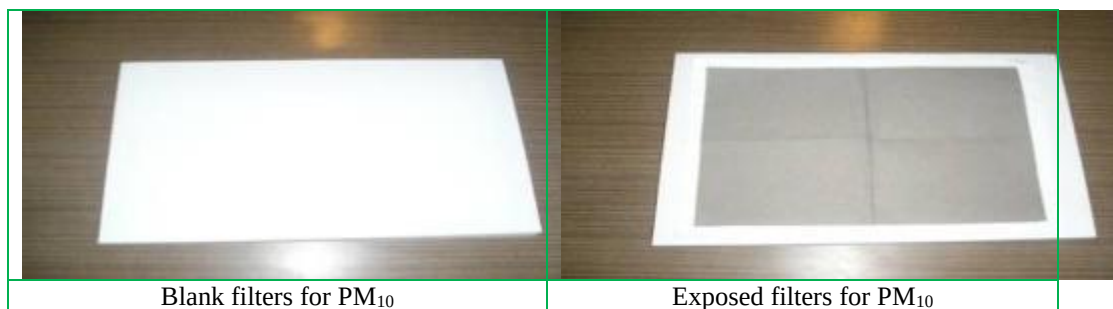
- The Millipore filter paper (for PM₁₀) will be placed in a 150 mL squat beaker. Added 0.5 g solid potassium chlorate followed by 100 mL of 20% v/v HNO₃. Covered the beaker with a watch glass and simmer the contents for 15 min on a hot plate. Then move the beaker to the edge of the hot plate after it will cool somewhat and evaporated the liquid to dryness overnight. Cooled the beaker and contents and added 20.00 mL concentrated HCl. Warmed the beaker to about 80°C and added 80.0 mL of the 0.4% EDTA solution. Allowed the mixture to stand for 30 min and then stirred well with a glass rod. Elemental determination will be made as described above. Acid, reagent, and filter paper blanks must be carried through the complete procedure.

Sample dissolution procedure

- The beaker will be removed from the hot plate and allows cooling. The mixture will be filtered to a 10 mL volumetric flask and dilute to the mark with di-ionized water.

Blank solution preparation

- One unexposed glass fiber filter paper will be digested and prepared the blank solution by following the same procedure as an exposed filter.



C. Analysis of Gaseous Pollutants

Analysis of SO₂:

- **Step – 1: Preparation of reagents for sampling**
 - Absorbing reagent (TCM, 0.04) – Dissolved 10.86 gm mercuric chloride + 0.066 gm EDTD = 6.0 gm potassium chloride in 1000 ml distilled / deionized water
 - Caution: - Highly poisonous if spilled on skin, flush off water immediately
- **Step -2 : Analysis**
 - For preparation of calibration curve
 - Stock iodine solution (0.1N) → Working iodine solution (0.01N) → Starch indicator → Primary standard potassium iodate solution → Stock sodium thiosulphate solution (0.1N)

$$\bullet \text{ SO}_2 \text{ concentration } (\mu\text{g}/\text{m}^3) = \frac{C \times A \times 1000 \times D}{V \times B}$$

Where,

C = SO₂ Curve Value (μg in 25 ml)
 A = Absorbing reagent Taken for Sampling (ml)
 V = Volume of air Passed (lit)
 B = Volume taken for sampling analysis (ml)
 1000 = Conversion factor liter to m₃
 D = dilution factor

Analysis of NO_x

- **Step – I Preparation of reagent**
 - For sampling
 - Absorbing Reagent:
 - Dissolved 4.0 gm Sodium Hydroxide + 1.0 gm Sodium Arsenite in 1000 ml deionized/distilled water.
 - Caution: Arsenic Compound is highly toxic Avoid contact with skin and especially with eyes. Do not take internally
- **Step – II Than analysis**
 - Solution 'A':

- Dilute 5.0 ml of stock Nitrite Solution (1000 $\mu\text{g NO}_2/\text{ml}$) to 500ml with Deionized Water.
- This Solution 1 ml = 10 $\mu\text{g NO}_x$
- *Solution 'B' :*
- Dilute 25ml of solution 'A' (10 $\mu\text{g/NO}_2$) to 250 ml absorbing Reagent.
- This Solution 1 ml = 1 $\mu\text{g NO}_x$
- *Note :* Prepare fresh daily
- This solution used for NO_x calibration curve preparation.

- Step - III Chemical analysis of sample

Analysis of CO

- Preparation for the analysis of CO
 - The CO will be measured from the real time data collected shows in the monitoring device's LCD monitor.

Appendix B: Air Quality Test Result



Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	240kWp Solar Mini Grid Power Plant at Char Baghutia, Manikganj
Project Address	Village - Paruria, Union - Baghutia, Upazila - Daulatpur, District - Manikganj.
GPS Location	23.93407°N, 89.72073°E
Description of sample	Ambient Air Quality Test Result
Sample Collector	Collected by DSCL Personnel
Sampling Date	19 th March, 2016

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	29.76	65	24	Cloudy	Gravimetric
PM ₁₀	µg/m ³	125.43	150	24		Gravimetric
SPM	µg/m ³	146.60	200	24		Gravimetric
SO ₂	µg/m ³	13.22	365	24		West- Geake
NO _x	µg/m ³	42.03	100	24		Jacob and Hochheiser
CO*	mg/m ³	<1	10	8		CO Meter

Note:

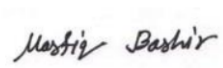
* CO concentrations and standards are 8-hourly only.

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

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



<u>Test Performed By:</u>  Masfiq Bashir Jr. Environmental Specialist	<u>Approved By:</u>  S.M. Sanaul Kafi General Manager (Water & Environment)
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Appendix C: Noise Level Test Result



Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	240kWp Solar Mini Grid Power Plant at Char Baghutia, Manikganj
Project Address	Village - Paruria, Union - Baghutia, Upazila - Daulatpur, District - Manikganj
Description of Sample	Noise Level
Sample Collector	Collected by DSCL Personnel
Sampling Date	19 th March, 2016

Noise Level Analysis

SL#	Sampling Location	GPS Location	Zone*	Noise Level dB (A)	Bangladesh Standard at Day Time dB (A)**	Remarks
1.	Project Site	23.93407°N 89.72073°E	Residential Area	43.78	55	Low
2.	2 No. Paruria Govt. Primary School	23.9379°N 89.7226°E	Residential Area	53.57	55	Low
3.	West Paruria Mosque	23.93797°N 89.72211°E	Residential Area	52.40	55	Low
4.	Beside Jahangir Member's house	23.93655°N 89.72164°E	Residential Area	46.61	55	Low
5.	Baghutia Bazar	23.93851°N 89.72333°E	Commercial Area	60.22	70	Low

Note:

* According to Environmental Quality Standard 1997 and subsequent amendment in 2006

** Bangladesh Standard for Noise Level at different types of areas (as per Noise Pollution (Control) Rules, 2006)

S.M. Sanaul Kafi

S.M. Sanaul Kafi
General Manager (Water & Environment)

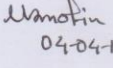
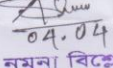
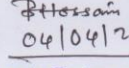
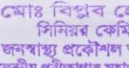
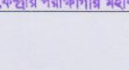
Masfiq Bashir

Masfiq Bashir
Jr. Environmental Specialist

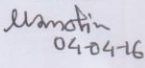
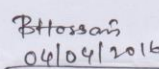
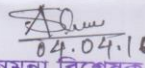
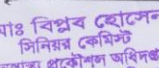
Development Solutions Consultant Ltd.

House-35 (A-2), Road-15, Nikunja-2 R/A,
Khilkhet, Dhaka-1229, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix D: Test Result of Surface Water

	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: 362/ Sr. Chemist, DPHE, CL, Dhaka.		Date: 04/04/2016				
Physical /Chemical/ Bacteriological Analysis of Water Sample						
Sample ID: CEN2016040069	Sample Receiving date: 20/03/2016					
Ref. Memo No: DSCL/Nil/2016 & Dated: 20/03/2016	Sample Source: Surface Water					
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka.	Dist: Manikganj, Upa: Daulatpur					
Care Taker: SW Manikganj	Union: Baghutia, Vill.: West Paruria					
Sample Collection date: 19/03/2016	Date of Testing: 20/03/2016 - 28/03/2016					
LABORATORY TEST RESULTS:						
Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	2	mg/L	5 days Incubation	-
2	Chemical Oxygen Demand (COD)	4.0	08	mg/L	CRM	-
3	Dissolved Oxygen (DO)	6.0	3.61	mg/L	Multimeter	-
Comments: Sample was collected & supplied by client. CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.						
Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  04.04.16 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  04.04.16 নমুনা বিশ্লেষক নব্বাহা প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা		Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Senior Chemist Signature:  04/04/2016 2.) Name:  Designation:  মোঃ বিপ্লব হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।				

Appendix E: Test Result of Groundwater

	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: 362/ Sr. Chemist, DPHE, CL, Dhaka.		Date: 04/04/2016				
Physical /Chemical/ Bacteriological Analysis of Water Sample						
Sample ID: CEN2016040070	Sample Receiving date: 20/03/2016					
Ref. Memo No: DSCL/Nil/2016 & Dated: 20/03/2016	Sample Source: Tube Well					
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka.	Dist: Manikganj, Upa: Daulatpur					
Care Taker: GW -Manikganj	Union: Baghutia, Vill.: West Paruria					
Sample Collection date: 19/03/2016	Date of Testing: 20/03/2016 - 28/03/2016					
LABORATORY TEST RESULTS:						
Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	390	mg/L	Titrimetric	-
2	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
3	Chloride	150-600	10	mg/L	Titrimetric	-
4	Iron (Fe)	0.3-1	0.43	mg/L	AAS	0.05
Comments: Sample was collected & supplied by client. AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.						
Test Performed by:		Countersigned/Approved by:				
1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer  04.04.16		1.) Name: Md. Biplab Hossain Designation: Senior Chemist  04/04/2016				
2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer  04.04.16 নমুনা বিশ্লেষক নবাবগঞ্জ প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা		2.) Name: Designation:  মোঃ বিপ্লব হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।				

Appendix F: Important Sensitive Locations in the PIA

Name	Location		Description	Photo
	N	E		
Mobile Network Tower	23.93727°	89.72377°	A mobile netowrk tower is run by solar power.	
2 no. Paruria Govt. Primary School	23.9379°	89.7226°	This is a one storied govt. Primary school.	
Agricultural land	23.93337°	89.72024°	Agricultural land beside the site.	

Name	Location		Description	Photo
	N	E		
Floral Biodiversity area-1	23.93551°	89.72322°	It is situated at the east side road of the project. There are several floral species and roosting and nesting sites of faunal species.	
Paruria Eidgah field	23.93796°	89.72249°	This is an Eidgah field established in 2013.	
West Paruria mosque	23.93797°	89.72211°	A tinshade mosque at the west side of Paruria.	

Name	Location		Description	Photo
	N	E		
Floral Biodiversity area-2	23.93655°	89.72164°	It is situated beside Jahangir member's house. This is also a place of floral and faunal diversity.	
Dredging site	23.93627°	89.72245°	Near the project site, from where sand is collected for land filling work.	
Mobile Network/Grameenphone Tower	23.93823°	89.72389°	A tower provided for mobile network.	

Appendix G: Details of FGDs with Attendance List

CONSULTATION NO- 1

SITE: CHAR BAGHUTIA, UNION: BAGHUTIA, DAULATPUR, MANIKGANJ.

DATE: 19th March 2016

TIME: 01:00 PM TO 01:30 PM.

Outcome of the Consultation

A consultation meeting was held during 1:00 pm to 1:30 pm on 19th March 2016 at Baghutia Char beside the proposed project site. All the participants were local people from several professions. Total 12 (twelve) 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 mitigation measures in order to reduce 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 because of the project implementation should be monitored and the proponent has to take responsibility of this management.
- 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 Solar Mini Grid Power Plant Project

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 01 Date 19.03.2016 Time 1:00 pm

Location Char Baghutia; Union: Baghutia

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	Md. Mizanur	16	Student	X	
2	Almas	20	Student	0175737005	
3	S.M. Mahabub Alam	20	Student	0173538327	S.M. Mahabub Alam
4	Abdul Kader	22	Student	01722072710	Kader
5	S.M. Syjayet Alam	19	Student	01763676784	
6	Md. Jasimuddin	22	Dredger labour	01756806076	
7	Nazmul Hossain	32	Business	01717567825	
8	Abdul Malek	19	Student	01743962909	
9	Md. Saiful	45	Farmer	017478835436	
10	Md. Delowar Hossain	26	Business	01708004014	
11	Md. At Amin	21	Business	01798419813	
12	Rony	21	Guard	01751307375	
13					
14					
15					

CONSULTATION NO- 2

SITE: WEST PARURIA, CHAR BAGHUTIA, UNION: BAGHUTIA, DAULATPUR, MANIKGANJ

DATE: 19th March 2016

TIME: 02:30 PM TO 03:00 PM

Outcome of the Consultation

A consultation meeting was held during 02:30 pm to 03:00 pm on 19th March 2016 at West Paruria Village; almost 1 Km far from the project site. The consultation meeting was conducted with the local people (e.g., businessmen, farmers, fishermen etc.). Total 09 (nine) 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 improved technology and good management practice to minimize the problem.

Additionally, some of the participants are not included in to the grid line and will not be benefited because of the project implementation. They want the project proponent to extend their capacity so that the non-privileged families will get the facilities. Some other participants were worried about the monthly charge of using electricity of this project. If the charge is more than theirs afford, most of them will continue using their own solar panel those they are currently using.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might and proper management plan would help to 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.
- The existing solar panel of every individual household should be collected sometimes with little payments from the owner for proper disposal or management by the project proponent or any responsible authority.
- Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.

- 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 Solar Mini Grid Power Plant Project

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 02 Date 19.03.2016 Time 2:30 PM

Location West Paraunia, Union: Baghutia

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	Md. Jannat Alam	14	Student		Jannat Alam
2	Moksel Molla	58	Fisherman		
3	Md. Mazmul Alam	17	Student		MAJMAL
4	Sumon	17	Student	01748287456	SUMON
5	Mohammad Hossain	17	Student	01761668614	Mohammad
6	Md. Yakub Ali	55	Farmer		
7	Md. Sagor Molla	50	Business	01726471919	Sagor Molla
8	Vasin	15	Student	01742386239	Vasin
9	Fozlul Haque	55	Farmer		
10					
11					
12					
13					
14					
15					