Initial Environmental Examination Report

PUBLIC

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Bangladesh: Paramount Solar Power Project

PART 2: Main Report

Prepared by Dynamic Sun Energy Private Limited for the Asian Development Bank (ADB).

Chapter 4

4 BASELINE STUDIES

4.1 General Consideration

Baseline condition of environment states the present status of different components of environment i.e. physical, biological, cultural, economic and social environmental characteristics in absence of the project. Environmental baseline study by examining the existing environment, serves as the basis of the project site against which potential impacts from development activities of the project both during implementation and in operation phases can be compared. Mainly there are two principal objectives in examining and defining the existing environment:

- To recognize potential environmental impacts of the project and enable mitigation measures to be identified;
- To provide a base line against which environmental conditions in the future project may be measured and to document conditions which were either existing or developing before the introduction of the project and not due to the project.

The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, soil, ecology, and socio-economic condition.

4.2 Objective and Methodology

The primary objective of the environmental and social baseline condition study is to provide an environmental and social baseline against which potential impacts from the construction and operational phases of the Project can be compared.

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

- Study area of 5 km radial zone from the center of the proposed main power plant location was selected for the baseline studies. In addition to that, 0.5 km on both sides of the transmission line has been considered as area of influence and baseline study has also been carried out along that strip.
- Primary data collection was conducted through environmental monitoring and field survey for water, air, soil, noise, and ecology;
- Social baseline of the study area was captured through primary and secondary data review;
- Secondary data was collected from government reports, academic institutes, websites, published literature etc.

4.3 Physical Environment Surrounding Project Site & Study Area

The land of the proposed project is in Hemayetpur, Pabna Sadar, Pabna. Pabna Sadar Upazila is on the north and west side of the project area and the Padma River is on the east and south side of the project area. Primary and Secondary data has been generated and collected for conducting the Baseline Study.

The immediate surrounding extended area of about 5 km radius around the main power plant area and 0.5 km on both sides of the transmission line has been considered as "Area of Influence (AoI)" for this study. AoI of the proposed project site is shown in **Figure 4.1**. Details of the Baseline study is presented in **Table 4.1**. Landmarks around the project site is given below in **Table 4.2** and shown in **Figure 4.2**.

Table 4.1: Details of Monitoring

SL. No.	Attribute	Parameters	Frequency of Monitoring
1	Ambient air quality	SPM, SO2, NOx, CO, and Particulate matter (PM2.5& PM10)	The monitoring was carried out at 6 locations for 24 hours
2	Noise levels	Noise levels in dB(A)	Once during study period continuously for 24 hours at 6 locations
3	Water quality	Physical, Chemical and Bacteriological Parameters	Once during the study period at 2 locations for surface water and 2 locations for ground water
4	Soil characteristics	Physical, Chemical Parameters	Once during the study period at 1 location
5	Meteorology	Wind Speed, Direction, Temperature, Relative Humidity, Rainfall & duration, and other non- instrumental observations	Data collected from secondary sources like Meteorological Station.
6	Ecology	Existing terrestrial and aquatic flora and fauna	Based on data collected during the site visit
7	Geology	Geological history	Based on data collected from secondary sources
8	Hydrology	History of water level of the river Meghna (maximum, danger level, peak water level) and the existing groundwater level	Based on Data collected from secondary sources
9	Socio-economic aspects	Socio-economic characteristics	Based on primary data collected through socio-economic survey and data published in latest census

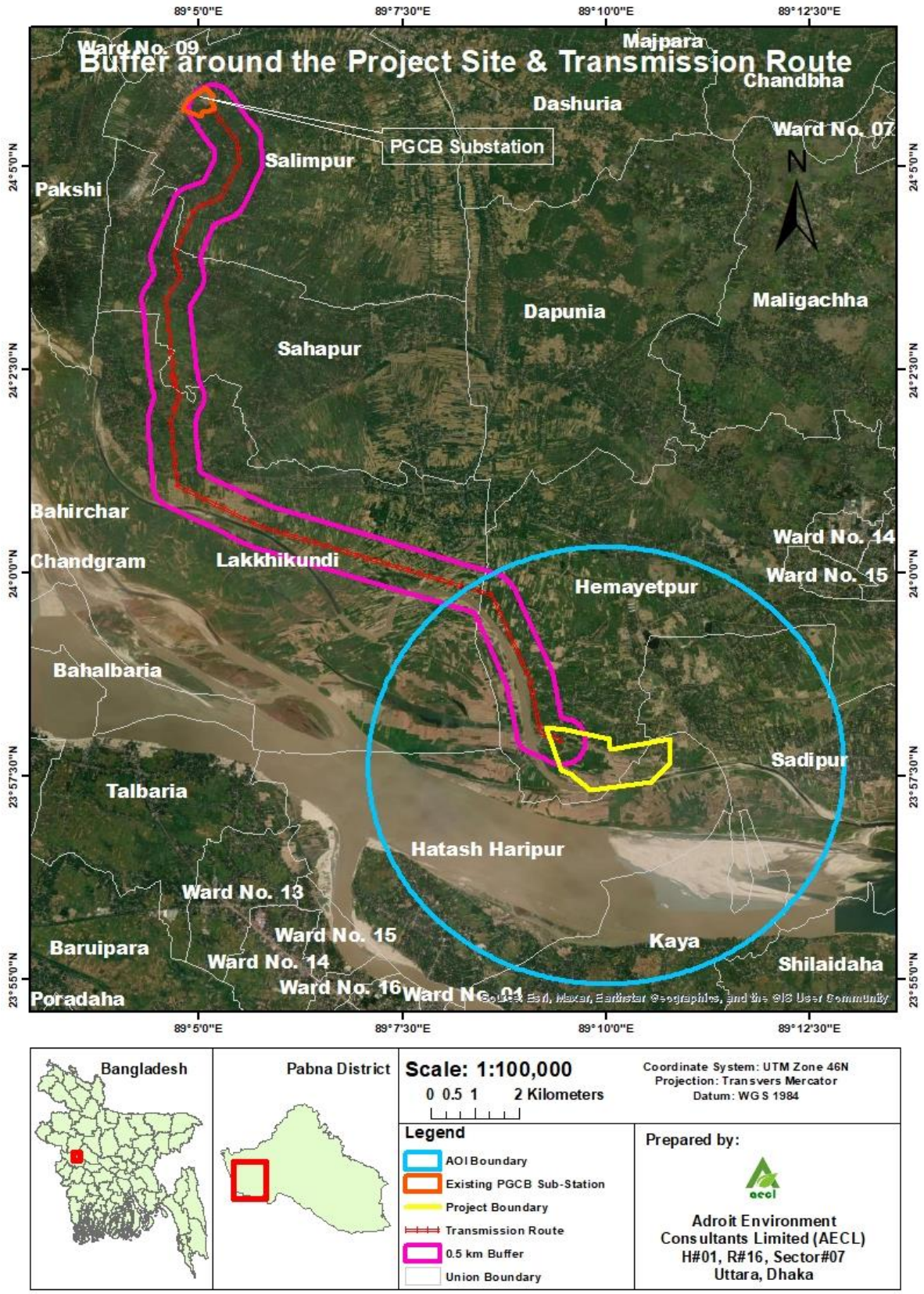


Figure 4.1: AoI of the Proposed Project Site and Transmission Line Area

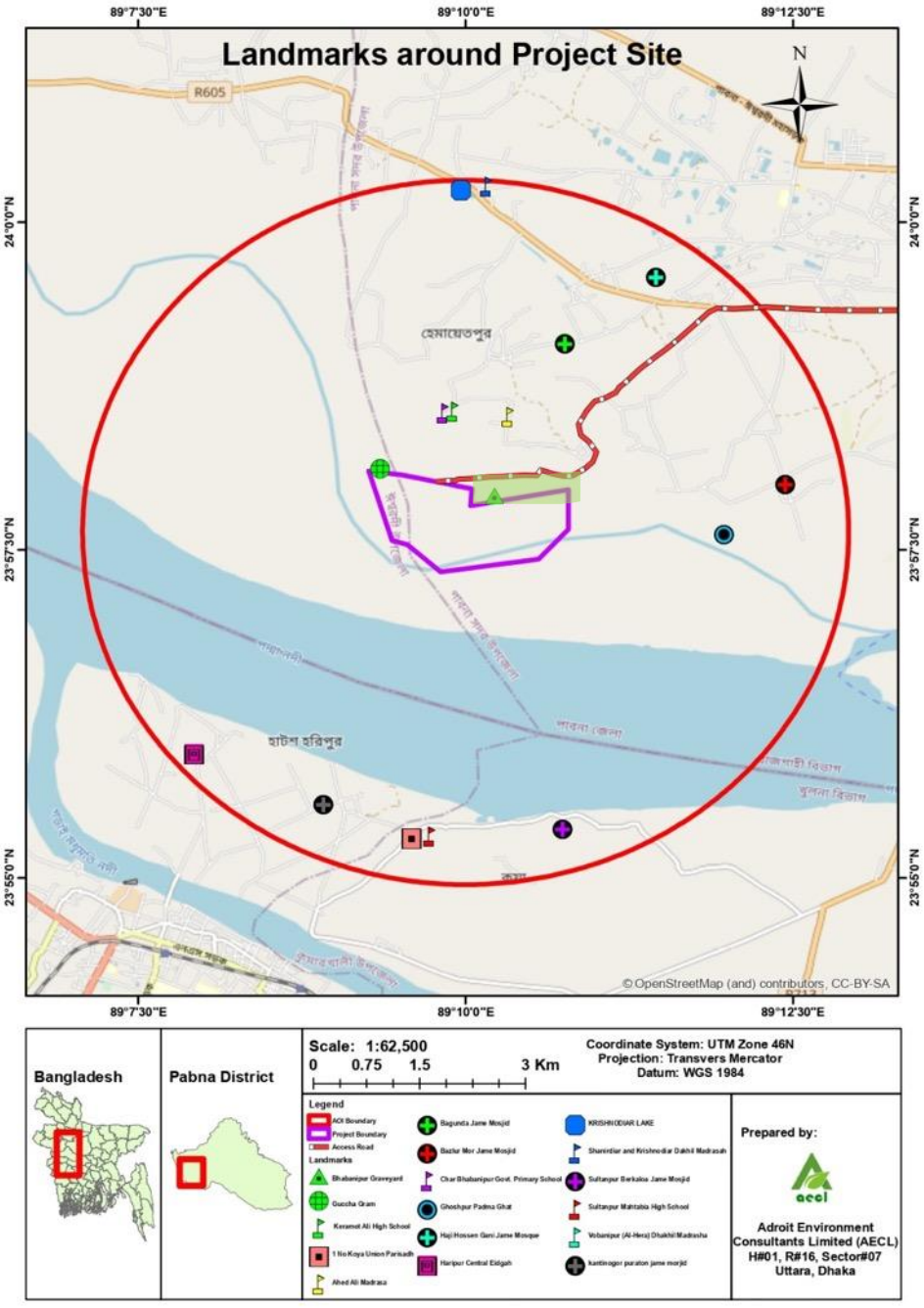


Figure 4.2: Landmark around the Project Area

Table 4.2: Landmarks around the Project Site

Landmarks Name	Latitude	Longitude	Distance (km)	Direction
Keramot Ali High School	23°58'33.31"N	89° 9'54.21"E	1.01	North
Char Bhabanipur Govt. Primary School	23°58'32.69"N	89° 9'49.56"E	0.98	North
Ahed Ali Madrasa (Religious School)	23°58'30.84"N	89°10'19.50"E	1.16	North-East
Bhabanipur (Al-Hera) Dhakhil Madrasha (Religious School)	23°58'54.23"N	89°10'25.13"E	1.8	North-East

Landmarks Name	Latitude	Longitude	Distance (km)	Direction
Bagunda Jame Mosque	23°59'4.67"N	89°10'45.50"E	2.05	North-East
Haji Hossen Gani Jame Mosque	23°59'34.86"N	89°11'26.98"E	3.94	North-East
Krishnodiar Lake	24° 0'14.83"N	89° 9'57.97"E	4.4	North
Shanirdiar and Krishnodiar Dakhil Madrasah (Religious School)	24° 0'16.30"N	89°10'9.61"E	4.5	North
Bazlur Mor Jame Mosque	23°58'0.12"N	89°12'26.32"E	2.8	East
Ghoshpur Padma Ghat (Landing station for boat)	23°57'37.14"N	89°11'58.16"E	1.98	East
1 No Koya Union Parisadh	23°55'17.78"N	89° 9'35.17"E	3.9	South
Sultanpur Mahtabia High School	23°55'18.88"N	89° 9'43.55"E	3.8	South
Kantinogor Puraton Jame Mosque	23°55'33.45"N	89° 8'54.91"E	3.72	South-West
Haripur Central Eidgah[4]	23°55'56.59"N	89° 7'55.72"E	4.02	South-West
Sultanpur Berkaloa Jame Mosque	23°55'22.25"N	89°10'44.42"E	3.9	South-East
Guccha Gram (Village)	23°58'7.15"N	89° 9'20.81"E	1.35	North-West
Bhabanipur Graveyard	23°57'54.82"N	89°10'13.47"E	0.5	North

4.4 Climate

Bangladesh is located in the tropical monsoon region, and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. From the climatic point of view, three distinct seasons can be recognized in Bangladesh and these are:

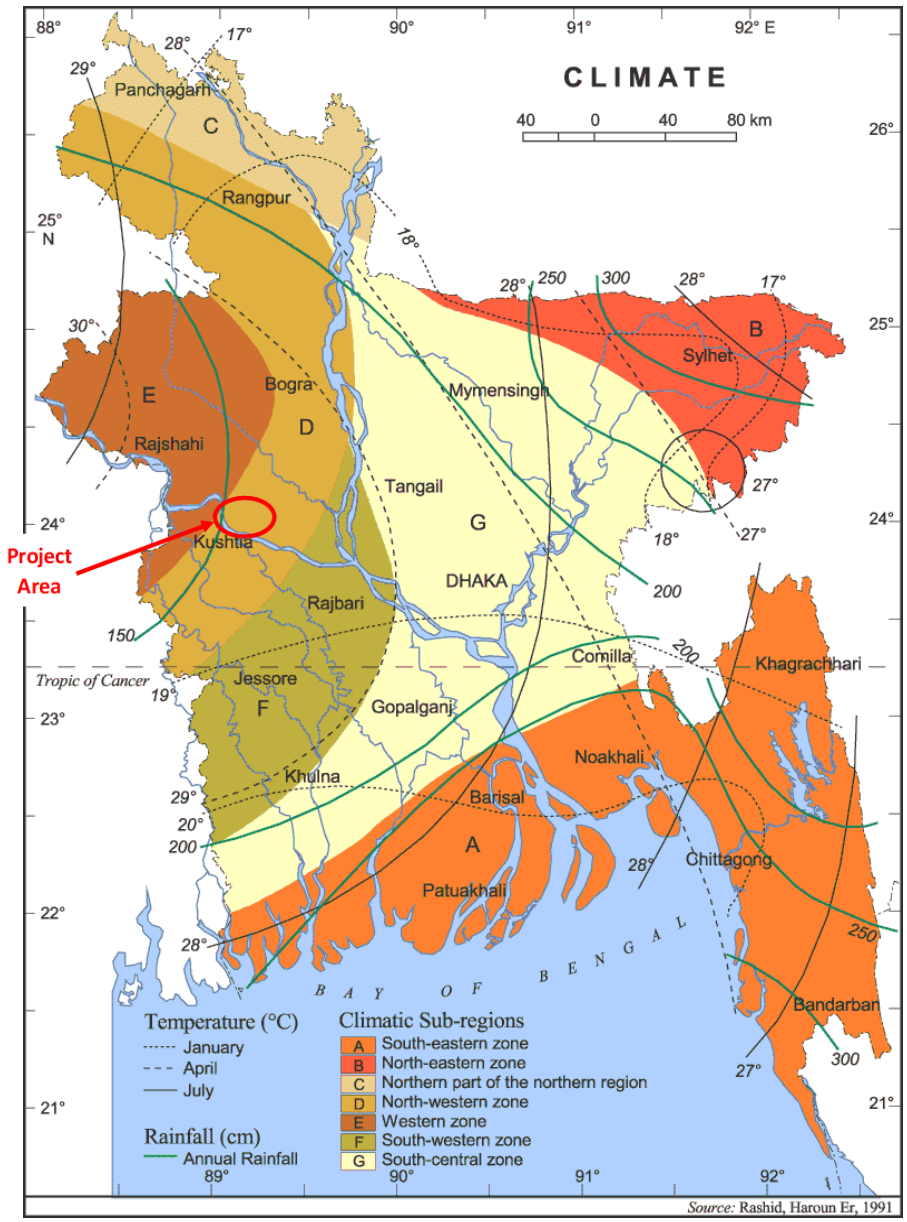
- Summer/pre-monsoon - March to May
- Rainy season/monsoon - June to October
- Winter - November to February

January is the coolest month, and April is the warmest. Most places receive more than 1,525 mm of rain a year, and areas near the hills receive 5,080 mm per year. Most rains occur during the monsoon (June-September) and a very little occurs in winter (November-February). Climate map of Bangladesh is presented in **Figure 4.3.** According to the Climate map, the project area falls in North-western zone (D).

North-western zone (D) comprises Dinajpur, Bogra, Pabna, Sirajganj, Kushtia and a strip of land extending from northwest Khulna Division to the west of Thakurgaon zila. This is an area of less extremes. In summer the mean maximum temperature is well above 32°C whereas in winter the mean

[4] Eidgah or Idgah, also Eid Gah or Id Gah is a term used in South Asian Islamic culture for the open-air enclosure usually outside the city or an area reserved for Eid prayers offered in the morning of Eid al-Fitr and Eid al-Adha. It is usually a public place that is not used for prayers at other times of the year.

minimum is below 10°C. The lower rainfall makes this area both atmospherically and pedologically drier. In winter dew fall is heavy.



(Rashid, 1991)

Figure 4.3: Climate Map of Bangladesh

4.5 Rainfall

The rainfall follows the general climate pattern with the highest rainfall in the summer month of June to September and minimum rainfall in the cooler and drier months of November to March. Total monthly rainfall values of Ishwardi are given in **Table 4.3.** Rainfall variability map of Bangladesh is presented in **Figure 4.5.** In the wet season, rainfall ranges from 200 to 400 mm and in dry season it ranges from 0 to 30 mm at Ishwardi region.

Table 4.3: Monthly Total Rainfall in Ishwardi (2010- 2022)

Year	Total Rainfall in mm											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	0	4	0	46	100	163	174	127	109	105	3	63
2011	4	1	30	96	155	253	289	645	261	2	0	0
2012	12	0	5	51	69	177	215	97	178	157	86	15
2013	1	14	0	69	182	264	130	218	121	130	0	0
2014	3	33	32	19	129	525	182	249	179	89	0	0
2015	0	8	38	111	147	332	394	254	213	82	3	2
2016	30	12	112	52	177	136	240	132	381	42	2	0
2017	1	0	21	118	111	159	456	274	278	323	19	39
2018	0	9	47	220	190	149	426	90	73	94	4	19
2019	0	53	8	82	126	286	300	148	179	220	36	6
2020	23	0	21	29	380	237	437	157	264	165	0	3
2021	0	0	1	41	179	396	315	324	182	114	18	16
2022	23	46	0	28	183	104	55	210	290	144	0	0

(Bangladesh Meteorological Department)

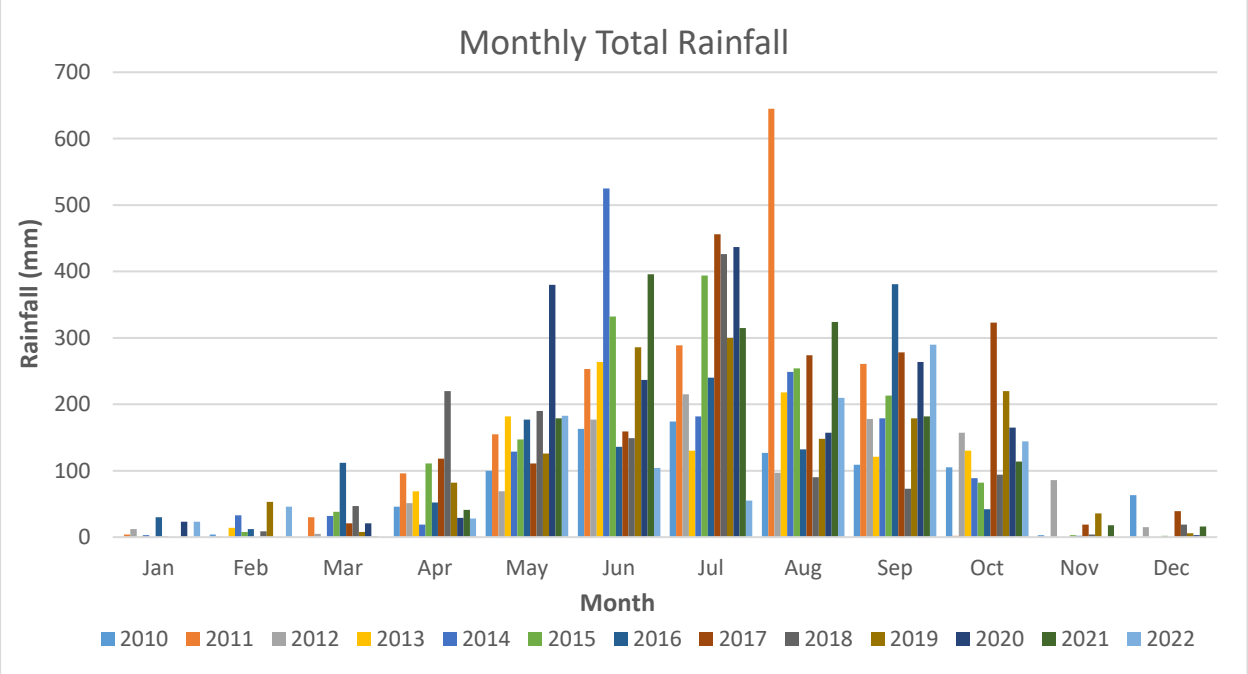
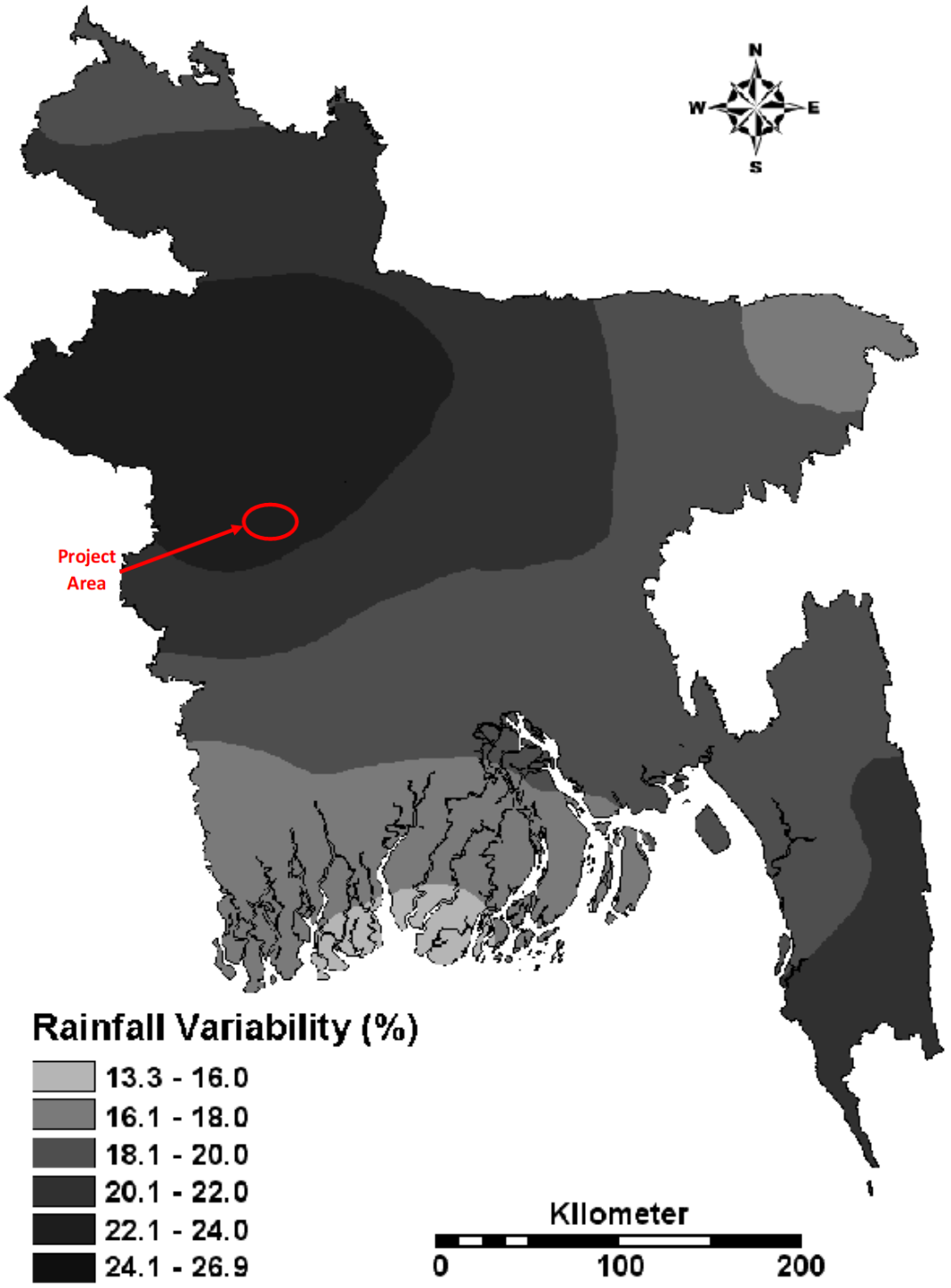


Figure 4.4: Monthly Total Rainfall data of Ishwardi (2010- 2022)



(Bangladesh Agricultural Research Council)

Figure 4.5: Rainfall variability map of Bangladesh

4.6 Relative Humidity

Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. The monthly average relative humidity from year 2010 to year 2022 of project area (Ishwardi) are given in **Table 4.4.** In the dry season the average humidity ranges from 75 - 83% and in wet season it ranges from 80 - 86% at Ishwardi.

Table 4.4: Average Monthly Relative Humidity of Ishwardi (2010- 2022)

Humidity in %	Monthly Average Humidity											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	80	70	61	68	76	83	83	83	86	83	78	78
2011	79	71	65	71	78	82	83	87	85	81	79	84
2012	79	66	60	68	71	81	87	86	86	83	80	86
2013	81	74	63	63	81	83	82	85	84	85	78	81
2014	83	76	64	61	69	83	85	84	83	82	77	83
2015	82	77	65	75	77	82	85	85	82	81	80	80
2016	82	77	69	70	77	82	88	84	86	82	79	83
2017	77	71	70	72	77	82	87	85	85	85	80	83
2018	82	73	67	77	81	80	85	82	81	80	77	75
2019	75	74	65	75	75	81	83	83	85	84	81	82
2020	83	75	70	70	79	83	85	83	86	83	77	81
2021	82	72	66	65	77	83	83	84	83	82	78	79
2022	82	77	67	74	79	81	79	81	85	82	77	79

(Bangladesh Meteorological Department)

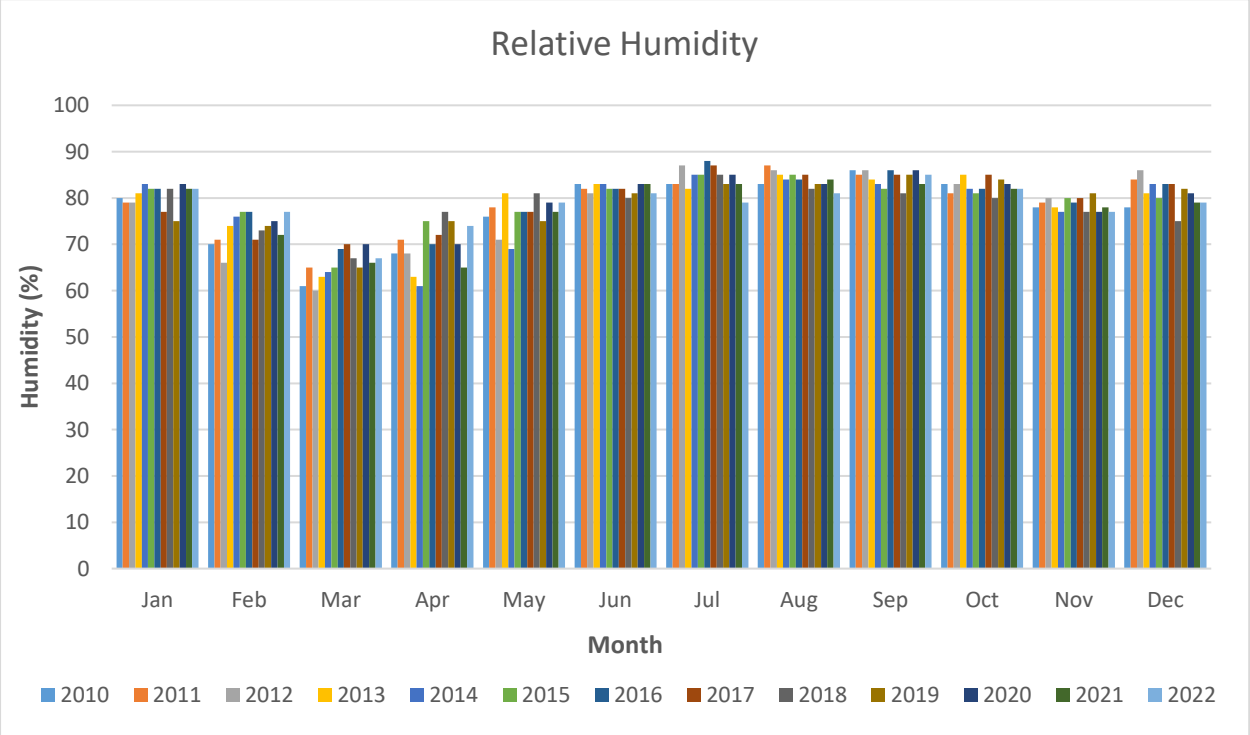


Figure 4.6: Average Monthly Relative Humidity of Ishwardi (2010-2022)

4.7 Wind Speed

According to Bangladesh Meteorological Department the average wind speed at Ishwardi Upazila since 2010 to 2022 are given in **Table 4.5.** Wind speed ranges from 1.2 – 2.5 knots in dry season and 1.5 – 2.9 knots in wet season at Ishwardi. A wind rose diagram of Pabna Sadar Upazila has been added in **Figure 4.8** to get the intensity and direction of wind around the project site.

Table 4.5: Monthly Prevailing Wind Speed and Direction in Ishwardi (2010-2022)

Year	Wind Speed in Knots with Direction											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	2.6N	2W	2.4SW	3.9S	3.1S	2.8S	2.8SE	2.7SE	2.5SE	2N	2.2N	2.1N
2011	2.6N	2.4NW	3.4S	2.3S	2.4SE	2.4SE	1.9S	2.4SE	2.3SE	1.9N	2.1NW	2N
2012	2.3NW	2.9NW	2.4W	2.4S	2.7S	2.7S	2.6SE	2.5SE	2.4SE	2N	2N	1.4NW
2013	2.2N	2.1NW	2.1W	2.4S	3SE	1.5S	2.6SE	2.5SE	1.6S	3.3SE	2.6N	2.3N
2014	2.7N	2.2NW	2.8NW	2.1S	3S	2.1S	3.1SE	2.2S	2.3S	1.8E	2.2N	1.8N
2015	1.6N	1.6N	1.8S	2.4S	2.3S	2.3S	1.8S	2.3S	1.6S	1.5SE	1.7N	2N
2016	2N	1.6N	2.2S	2.5S	2.2S	1.7S	2S	2.2S	1.8S	2N	1.6N	2N
2017	2.1N	1.9N	2S	2.4S	1.7S	2S	2.3SE	2S	1.5S	1.7S	2N	2N
2018	1.9N	1.9N	1.8S	2.1S	2.1S	2.1S	2.4SE	2.4SE	1.8S	1.6N	1.2N	2.4NW
2019	2.3NW	2.7NW	2.4W	2.3S	2.4S	2.1SE	2.4SE	2.6SE	2.3SE	1.8N	2.1N	2.2NW
2020	1.9N	2.3NW	3.1NW	2.5E	3.2S	2.4SE	2.1S	2.9SE	2.3S	2.3N	2.7N	2NW
2021	2.3NW	2.4NW	2.9NW	2.6S	2.9SE	2.3SE	2.4SE	2.1S	2.4SE	2.2NW	2.1NW	2.6NW
2022	2.4NW	2.8NW	3S	3.1S	3.1S	3.1S	2.7SE	3.7SE	2.5SE	2.6N	2.3NW	2.5N

(Bangladesh Meteorological Department)

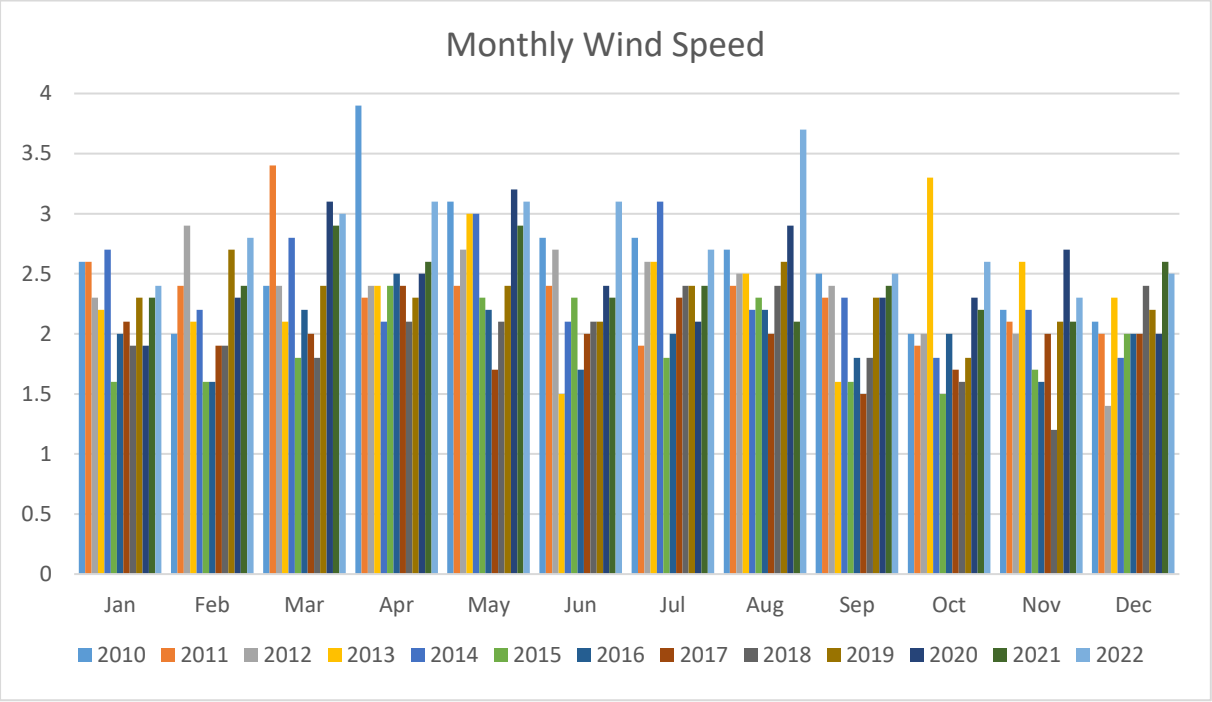


Figure 4.7: Monthly Prevailing Wind Speed of Ishwardi (2010- 2022)

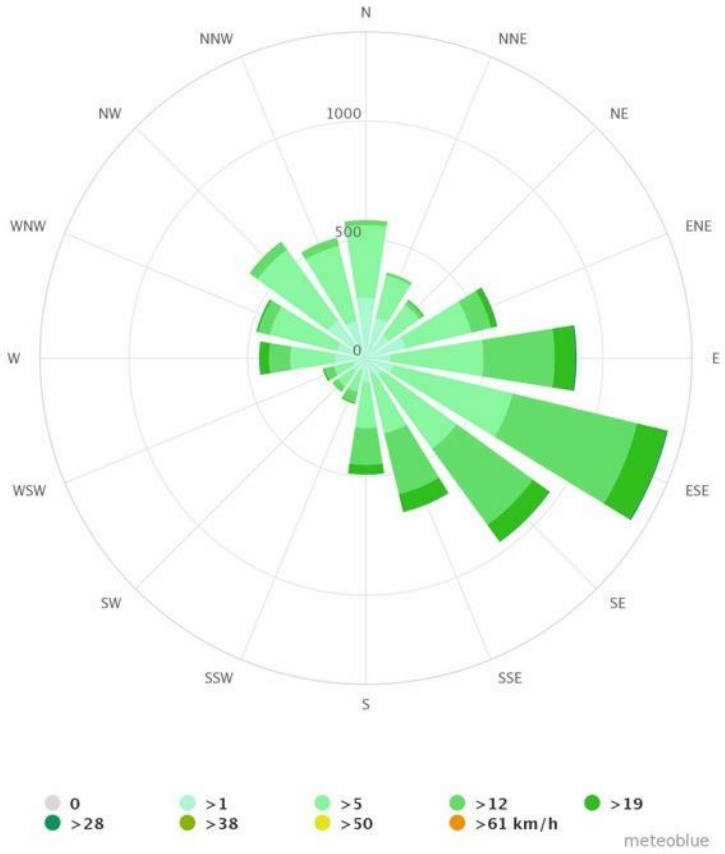


Figure 4.8: Wind Rose Diagram of Pabna Sadar Upazila.

4.8 Ambient Air Temperature

In general, cool seasons coincide with the period of lowest rainfall. **Table 4.6 - Table 4.8** shows the Monthly average, Maximum and minimum Temperature in degree Celsius for the period 2010 to 2022. The average bulb temperature ranges from 16.5-22.5 Degree Celsius in dry season and 29-30 Degree Celsius in wet season at Ishwardi.

Table 4.6: Monthly average Dry Bulb Temperature in Degree Celsius of Ishwardi (2010-2022)

Year	Monthly Average Temperature in degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	14.8	20.2	27.5	30.7	29.8	29.6	29.5	29.5	28.5	27	23.1	17.4
2011	14.5	19.5	25.2	27.3	28.5	29.3	29.2	28.4	28.5	27.1	21.9	16.9
2012	16.6	19.6	25.2	28.9	30.7	30.2	28.9	29.2	28.9	25.8	20.9	16.2
2013	14.7	19.5	25.3	28.6	28.2	29.7	29.4	28.6	28.8	26.3	21.2	17.5
2014	15.5	18.4	24.2	29.6	30.5	29.5	29.4	29	28.8	26.1	21.4	16.8
2015	16.2	20.4	24.6	27	29.7	29.4	28.7	29.1	29.1	26.8	22.9	18.2
2016	16.3	21.6	25.9	30.6	28.6	29.7	28.7	29.4	28.8	27.6	22.6	18.5
2017	16.8	20.4	24.3	28.1	29.4	29.6	28.6	29.4	29.1	27.3	22.4	19.2
2018	14.2	20.7	25.5	26.7	27.7	29.9	29.1	29.7	29.3	26	22.1	17.5

Year	Monthly Average Temperature in degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	16.7	19.5	24.4	27.7	30.3	30	29.4	29.7	28.5	26.2	22.9	17.1
2020	16.2	18.4	23.9	27.1	28.2	29.4	29.4	29.7	29.2	28.3	22.5	17.7
2021	16.4	19.8	26	29.2	28.6	29	29.4	29.3	29.2	27.9	22.1	18.9
2022	16.7	18.3	26.1	29.9	28.6	29.7	30.2	29.7	28.8	26.9	22.2	18.6

(Bangladesh Meteorological Department)

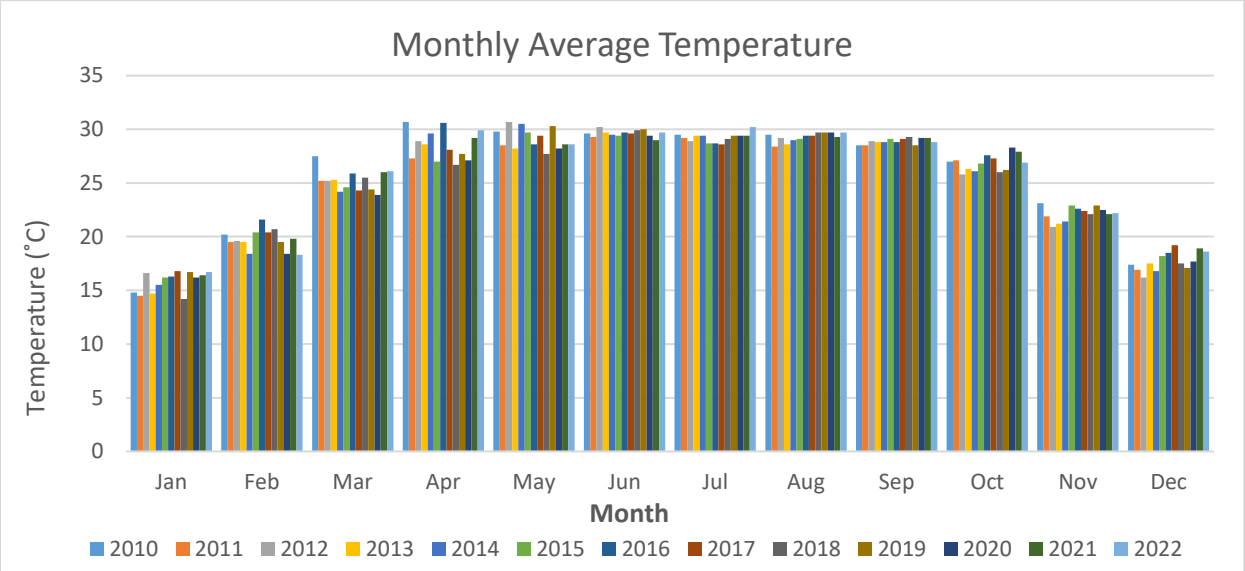


Figure 4.9: Monthly Ambient Average Temperature of Ishwardi (2010- 2022)

Table 4.7: Monthly Maximum Temperature in degree Celsius of Ishwardi (2010-2022)

Year	Monthly Maximum Temperature in degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	27.2	33	40.2	42.5	39.7	37.4	36	37.5	35.5	36.4	33.2	28.8
2011	26.8	32.5	38	37.5	36.3	37.5	35.8	35.5	36.4	35	31.2	30
2012	27.5	32.5	38.8	40.2	41.8	40.8	35.7	35.6	36.8	34.5	30.8	27.6
2013	27	31.6	37.2	40	38	36.8	35.5	36.2	35.6	34.2	32	29.4
2014	27.7	29.5	38.4	41	42	38	36	35.4	36.6	34.6	33	28.5
2015	29.5	33.7	36.5	36.5	39.2	37.5	36.2	35.2	36.5	35.7	32.4	30
2016	28	33.5	36	40.2	39	37.5	35	36.2	35	35.8	33.6	29.5
2017	29.3	33.1	36.8	38	37.2	37	36	35.5	36.2	35.8	32.5	28.8
2018	26.8	32.5	35.3	36.2	35.8	39	37.2	37	36.3	36	33	28.2
2019	28	32	36.5	39	39	38	36.3	36	36	34	31.7	30.2
2020	28.6	30.2	36	38.7	37.4	36.6	36	36.7	35.8	35.8	33.1	29.3
2021	29.2	35	37.5	40	38.5	37.7	36.4	35.8	36.2	36	31	29.7
2022	27.2	29.8	37	41	37	37	37	36.7	35.7	35.3	32.8	29.5

(Bangladesh Meteorological Department)

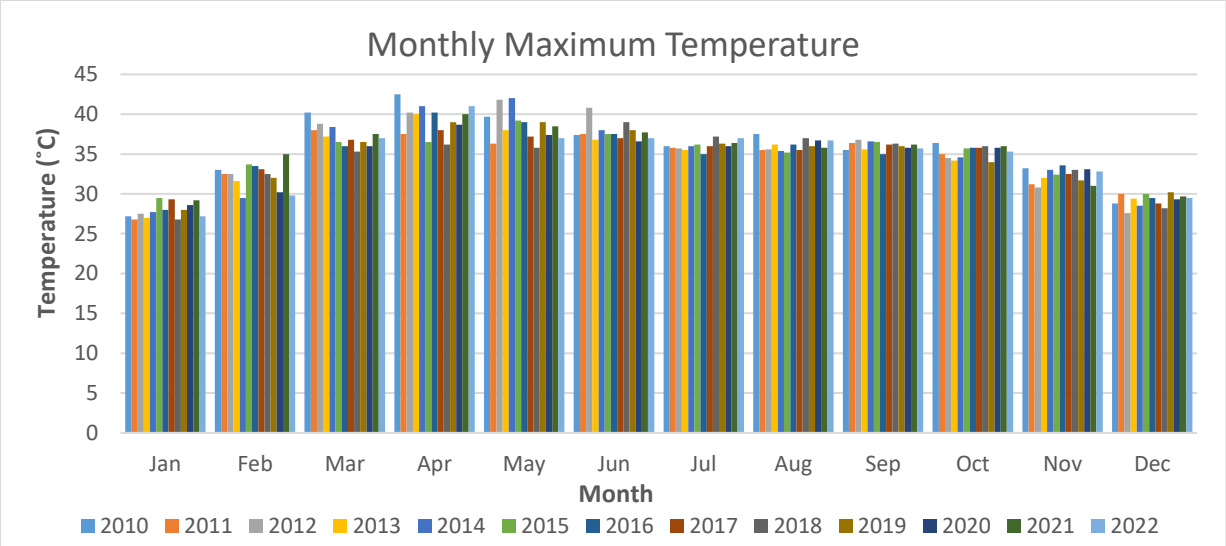


Figure 4.10: Monthly Maximum Temperature of Ishwardi (2010- 2022)

Table 4.8: Monthly Minimum Temperature in degree Celsius of Ishwardi (2010-2022)

Year	Monthly Minimum Temperature in degree Celsius											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	6.3	8.5	15	20	21.4	23.5	25.6	24.6	23	18.5	13.5	7.4
2011	4.6	9.5	10	19.5	21.2	23.6	24.5	24.2	25	17.5	13.8	7.5
2012	6.5	7.5	13.5	18	19.4	22.8	25.2	25.5	24.5	16.5	11	7.8
2013	3.9	9.2	11.5	19	21.5	23	24.6	25	24.5	18.4	12.4	8.5
2014	6	8.8	13	19	19.5	22.8	25	24.4	24.4	17.5	11.4	7.2
2015	7.2	7	12.4	18.6	20.5	23.3	24.4	24.5	24	18.5	15	8.8
2016	6.8	10.2	15.5	18	21.2	23.5	25.3	23.5	24.8	21.7	14	9.4
2017	5.5	10.8	12.8	18.7	20.6	23.5	24.8	25	23.5	18.5	12.5	11
2018	5.5	11	14.2	19	19.8	23.5	25	26	24.5	16.6	13.6	7
2019	7.5	9	10	17.5	21.7	21.5	24.4	25	24	19.6	14.5	8
2020	8.2	6.8	14.2	18	20	24.3	25.2	26	25	22	11.5	7.6
2021	6.2	6.4	14.8	16.7	21	24	23	24.5	25	18.7	14.4	9
2022	8	9.4	14.5	21	20.8	23	25.3	24	22.3	18.7	14	9.3

(Bangladesh Meteorological Department)

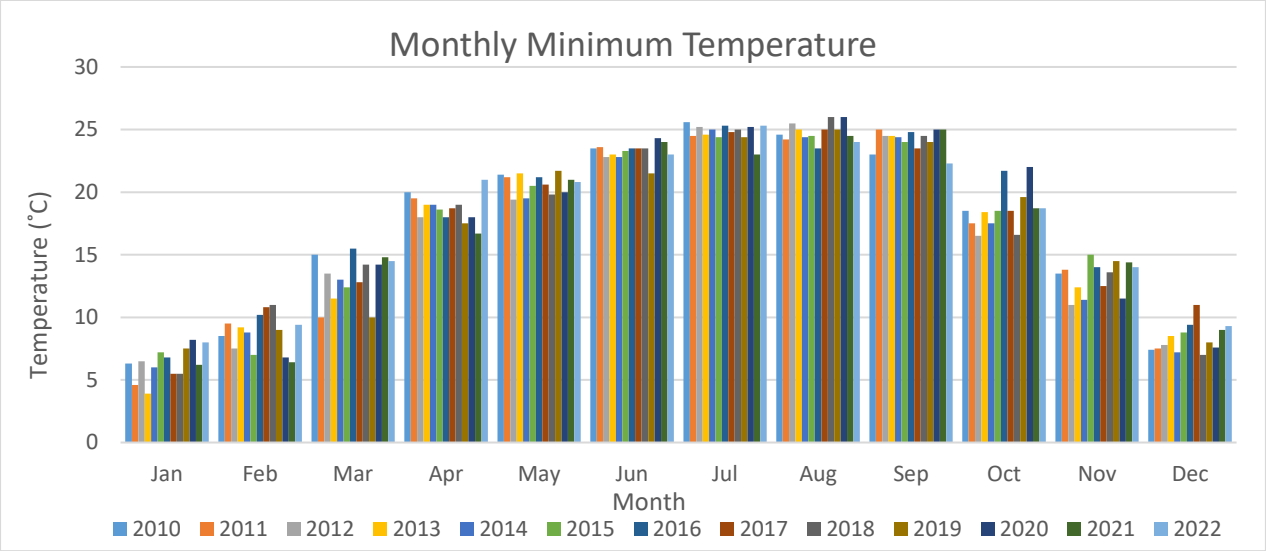


Figure 4.11: Monthly Minimum Temperature of Ishwardi (2010- 2022)

4.9 Land Use/ land Cover

Land use/ land cover inventories are an essential component in land resource evaluation and environmental studies due to the changing nature of land use patterns. By proper analysis of Land use, existing land use pattern can be known easily. The land use study for the proposed Project Site and its 5 km buffer is undertaken with the following objectives:

- To study the land use/cover in the 5 km area of the Proposed Project Site and provide inputs for environmental planning of the proposed plant by analyzing the existing land use/land cover scenario;
- To establish the existing base line scenario using a GIS database for incorporation of thematic information on the different physical features including Agricultural Land, Settlements, Water Body, Sandy Area, Mangrove Forest.

4.9.1 Process of Analysis

Land use analysis is carried out using Google Earth and ArcGIS 10.8 software. A multi-step task has been followed in analyzing the images. A series of tasks were followed for analyzing after receiving the images from image provider. On screen digitization techniques are used to extract required land use and land cover data from the satellite images. A land sat 8 images (Resolution 30m*30m) has been used to make the detail analysis of Existing land use Pattern.

4.9.2 Land Use Interpretation of the Study Area

The evaluation of the existing environmental status of the study area is conducted within 5 km buffer zone area. This revealed that the land use/land cover consists mainly of Char Land, Settlements, Water Body, Sandy Area and Brick Fields. **Figure 4.12** presents existing land use map.

4.9.2.1 Land Use Analysis

Among 19407 acres (5 km around Project site) about 25.57% (4962.25 Acres) area is Agricultural Land. From land use map, it is found that scattered settlements are there around the project area. About 12.19% (2367.51 Acres) land is Settlements within 19407 acres of land. About 31.43% land is water body, mainly the Padma river and its branches are surrounding the project site from west and south side. Some local canals and ponds are located within 5 km area of the project site. At the north of the project side, there are few of brick fields covering about 248.54 acres of land. The project site is mainly char land. Char land covers 29% (5729.38 Acres) of the 5km buffer zone.

Table 4.9: Area Calculation of Existing Land use for 5 km Buffer Area

Land Type	Area (Acres)	Percentage
Agricultural Land	4962.25	25.57
Char Land	5729.38	29.52
Water Body	6099.32	31.43
Urban & Settlement Area	2367.51	12.20
Brick Field	248.54	1.28
Total	**19407**	**100**

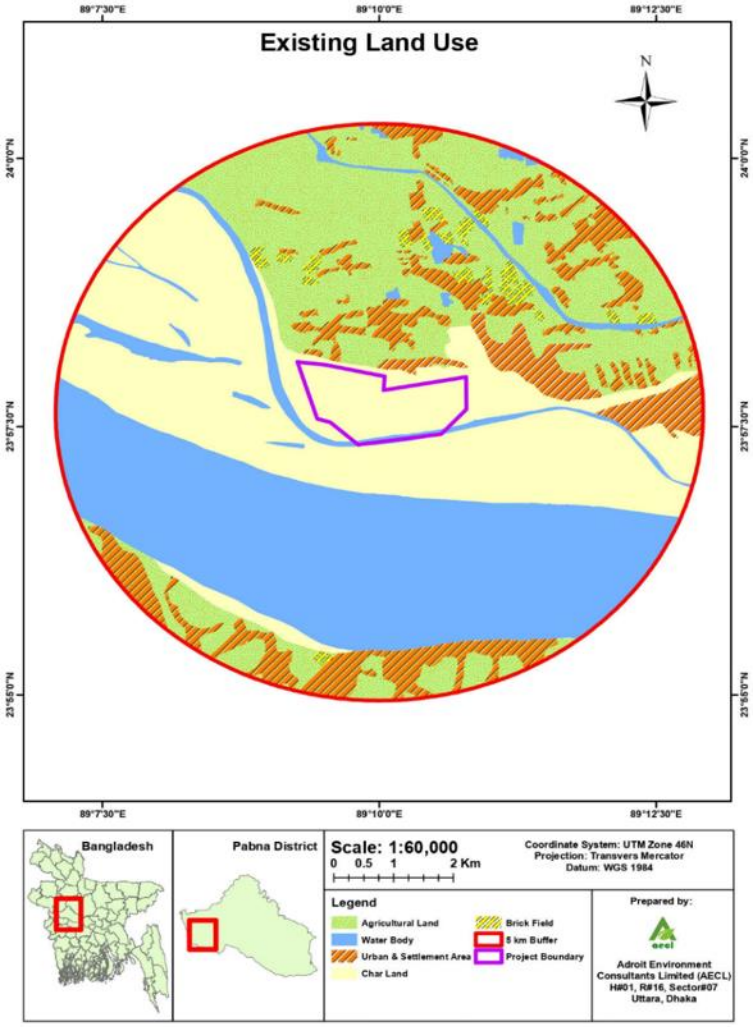


Figure 4.12: Existing Land Use Map for 5 km Buffer Area

4.9.3 Physical and Cultural Heritage

The project area as such, does not encompass any key cultural heritage or resource of national or regional value. Moreover, there is no key cultural heritage or resource of national or regional value within the 5 km radial zone. **Table 4.10** denotes the distance of other Physical and Cultural Heritage from the project site.

Table 4.10: Physical and Cultural Heritage from the project site

SL No.	Physical and Cultural Heritage	Distance from Project site (approx.)
1.	Sree Sree Thakur Anukul Chandra Ashram	5.69 km
2.	Hardinge Bridge	17.90 km
3.	Ishwardi Railway Junction	21.56 km
4.	Chatmohor Shahi Jame Masjid	32.06 km
5.	Khetupara Zamindar Bari	33.53 km

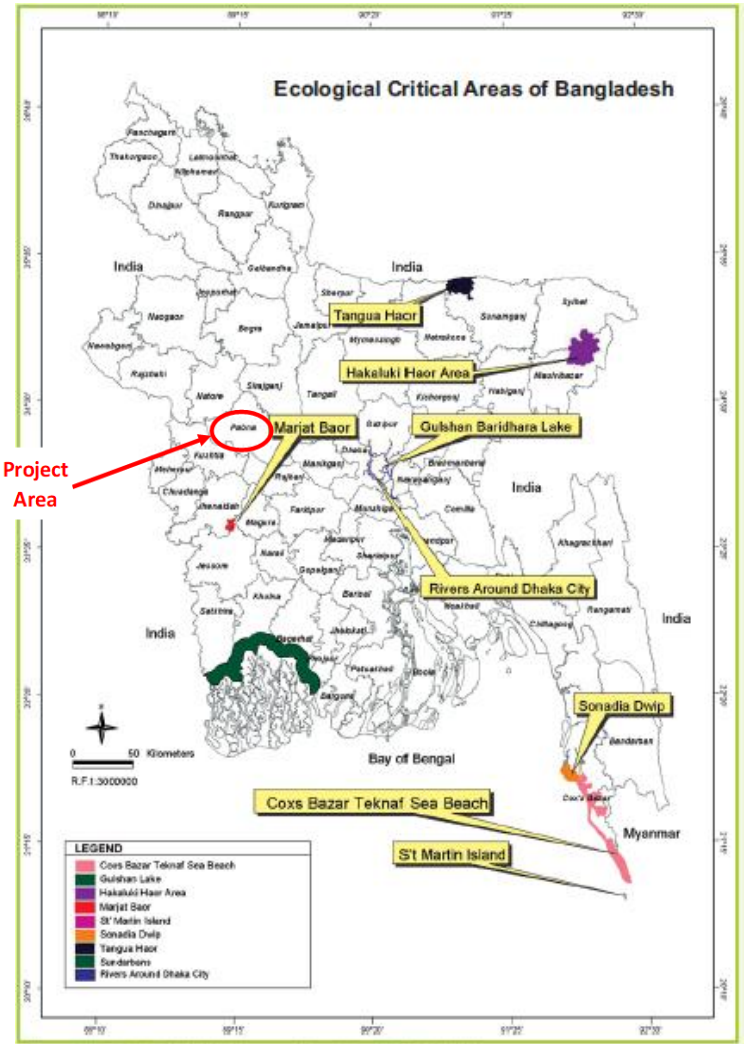
4.9.4 Ecologically Critical Area

Bangladesh Government declared 8 areas as Ecologically Critical area (ECAs) in Bangladesh (1999), i.e., Cox's Bazar, Teknaf Peninsula, St. Martin's Island, Sonadia Island, Hakaluki Haor, Tanguar Haor and Marjat Baor, Gulshan-Baridhara Lake and Sundarbans. **Table 4.11** shows the ECA and their distance from the project site. According to the list, there is no ecologically critical area within 5 km of the project site.

Figure 4.13 and Figure 4.14 shows the location of the project site in relation to the country's ecologically critical area and Protected Areas, Eco Parks & Safari Park of Bangladesh respectively. The maps illustrate that no ecologically critical area or Protected Areas, Eco Parks & Safari Park falls within 5 km area of the project site.

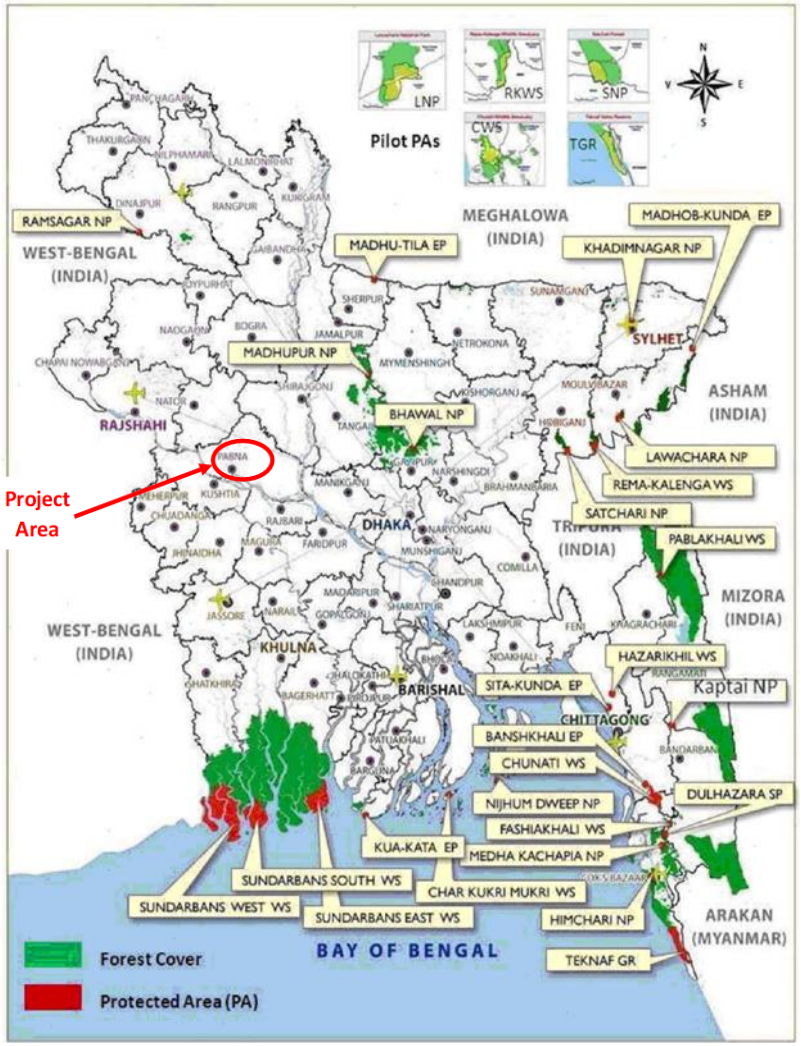
Table 4.11: Ecologically Critical areas (ECA) of Bangladesh and their distance from project site

No.	Name of the ECA	Type of Ecosystem	Location	Areas (ha)	Year of Declaration	Distance from Project site
1.	Cox's Bazar-Teknaf Peninsula	Coastal-Marine	Cox's Bazar	20,373	1999	471.22 km
2.	Sundarbans (10 km landward periphery)	Coastal-Marine	Bagerhat, Khulna, Barguna, Pirojpur and Satkhira	292,926	1999	224.38 km
3.	St. Martin's Island	Marine Island with coral reefs	Teknaf Upazila, Cox's Bazar	1,214	1999	493.3 km
4.	Hakaluki Haor	Inland Freshwater Wetland	Sylhet and Moulvibazar	40,466	1999	302.72 km
5.	Sonadia Island	Marine Island	Moheshkhali, Cox's Bazar	10,298	1999	390.63 km
6.	Tanguar Haor	Inland Freshwater Wetland	Tahirpur, Sunamganj	9,727	1999	234.35 km
7.	Marjat Baor	Oxbow Lake	Kaliganj Upazila of Jhenaidah and Chaugacha Upazila of Jessore	325	1999	75.15 km
8.	Gulshan-Baridhara Lake	Urban Wetland	Dhaka city	101	2001	130.56 km
9.	Buriganga	River	Around Dhaka	1336	2009	130.71 km
10.	Turag	River	Around Dhaka	1184	2009	120.6 km
11.	Sitalakhya	River	Around Dhaka	3771	2009	145.39 km
12.	Balu including Tongi canal	River	Around Dhaka	1315	2009	133.69 km
13.	Jaflong-Dawki	River	Jaflong, Sylhet	1493	2015	320.5 km



(Green & Islam, 2012)

Figure 4.13: Ecologically Critical Areas of Bangladesh

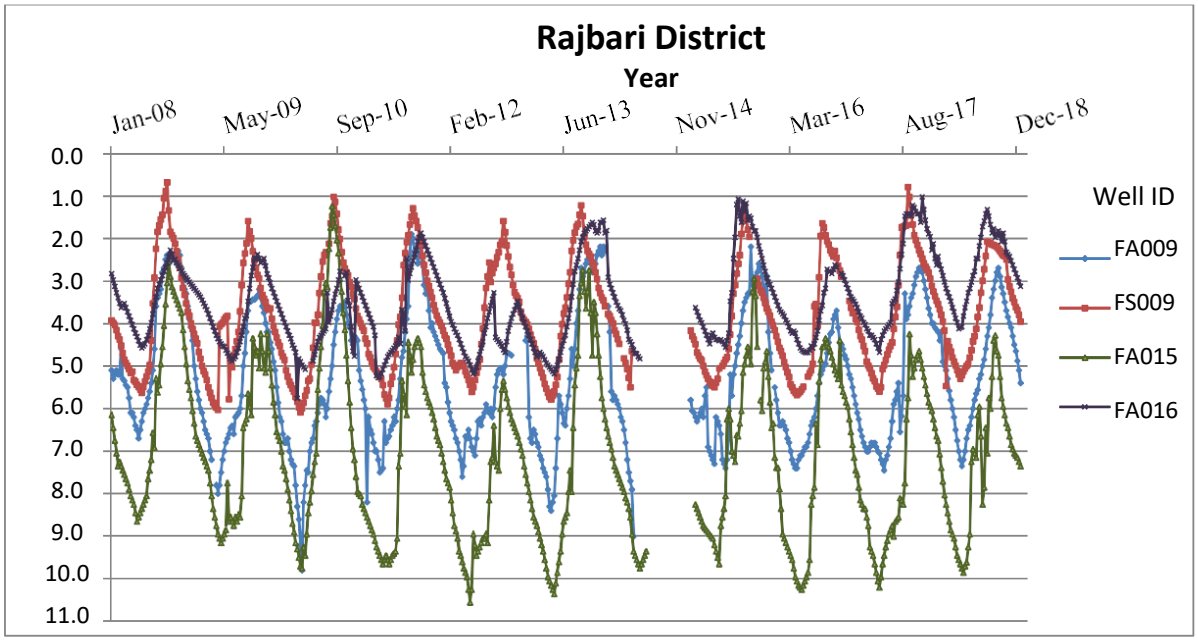


(Bangladesh Forest Department)

Figure 4.14: Protected Areas, Eco Parks and Safari Park of Bangladesh

4.10 Hydrology

Groundwater is an important segment of the hydrologic cycle and constitutes about one third of world's fresh water reserves. It has distinct advantages over surface water resources. It is the most dependable resource and is available almost everywhere on land phases. It is the only source of water supply for drinking and main source of irrigation. As other parts of the country this area also receives sufficient amount of rainfall and there is a good availability of ground water, which is being used by hand pumps for drinking and domestic purposes. The source of groundwater is either precipitation or seepage from large water bodies like reservoirs, lakes, River.



(BWDB 2020)

Figure 4.15: Hydrographs of GWT of Rajbari District

BWDB selected 32 districts of the country, among which Rajbari is the nearest one from the proposed project site. The general trends of hydrographs are normal and show almost similar seasonal fluctuations. In these district 4 wells were selected FA009, FS009, FA015 and FA016 from 4 different upazillas Baliakandi, Goalandaghat, Pangsha and Rajbari Sadar respectively. Seasonal fluctuation of GWT in this district varies from around 2m to 7.60m during this 11-year period. The nearest well from the project site is Rajbari Sadar Upazila (approx. 22 km). According to **Figure 4.15**, ground water level has shown a dramatic ups and downs in depth from 2008 to 2018. On January 2008, it was found around 2.5 – 4.5 m. The maximum depth was discovered at almost 6.0 m on September 2010 and the minimum depth was 1.0 m on November 2014 and December 2018.

4.10.1 Surface Water Quality

The primary data for surface water quality parameters near the project site was collected and the sample was analyzed in the laboratory. **Table 4.13** represents surface water quality report near the project site. Surface Water quality test report is attached as **Annexure 8 (a).** The result shows that all the parameters remain within the allowable limit of surface water value as per as Environmental Quality Standards for Bangladesh.

Sampling date: 15th April, 2023
Reporting date: 28th May, 2023

Table 4.12: Sampling locations ID and Name with Longitude-Latitude

Category	Identification of Location	GPS Co-ordinate		Specific Location
		X	Y	
Surface Water Quality	Location-01, SW1	23°56'46.51"N	89° 9'48.79"E	Padma River
	Location-02, SW2	23°57'32.71"N	89°10'54.21"E	Branch river of Padma

Table 4.13: Surface Water Quality

Name of the Parameter	Concentration present		Unit	DoE Standard according to ECR, 2023 (Schedule 2-Ka-1)	Method of analysis	Minimum Detection Limit (MDL)
	SW1	SW 2				
Temperature	26.5	27	°C	20-30	Mercury filled thermometer	-
pH	6.9	6.8	-	6.5-8.5	pH meter	-
TDS	137	113	mg/l	1000	TDS meter	-
TSS	20	<MDL	mg/l	NF	USEPA 160.1:1971, SM 2540D (23rd Edition)	5
Dissolved Oxygen (DO)	7.9	7.8	mg/l	NF	USEPA 360.1:1971, SM 4500-O (23rd Edition)	N/A
BOD5	<MDL	<MDL	mg/l	≤ 12	SM 5210B (23rd Edition), SM 5210D (23rd Edition) & USEPA 405.1:1974	8
COD	11	5	mg/l	100	SM 5220 D	0.2
Chromium	0.006	<MDL	mg/l	0.1	SM 3111 B	0.01
Cadmium	<MDL	<MDL	mg/l	-	SM 3111 B	0.001
Sulphate	<MDL	8	mg/l	-	SM 4500-SO4 E	7
Nitrate	0.4	0.6	mg/l	5.0	SM 4500-NO3-N E	0.1
Pb	0.017	0.013	mg/l	0.1	SM 3111 B	0.01
Zinc	0.18	0.06	mg/l	-	SM 3111 B	0.02
Copper	<MDL	<MDL	mg/l	-	SM 3111 B	0.014
EC	306	282	µS/cm	2250	USEPA 120.1:1982	20
Total Coliform	118	84	CFU/100 ml	NF	ISO 9308-1:2014, USEPA 9132:1986	1
Fecal Coliform	42	36	CFU/100 ml	NF	SM 9222 (23rd Edition), Membrane Filtration	1
Nickel (Ni)	<MDL	<MDL	mg/l	NF	USEPA 200.8:1994, ISO 17294-2:2016, ISO 1185:2007	0.1

Name of the Parameter	Concentration present		Unit	DoE Standard according to ECR, 2023 (Schedule 2-Ka-1)	Method of analysis	Minimum Detection Limit (MDL)
	SW1	SW 2				
Iron (Fe)	1.4	<MDL	mg/l	NF	USEPA 200.8:1994, ISO 17294-2:2016, ISO 1185:2007	0.1
Aluminum (Al)	0.7	<MDL	mg/l	NF	USEPA 200.8:1994, ISO 17294-2:2016, ISO 1185:2007	0.1
Phosphate	<MDL	<MDL	mg/l	2.0	USEPA 365.2:1978, USEPA 365.3:1978, SM 4500-P E (23rd Edition)	3

N.B.: *ECR – Environment Conservation Rules, 2023*
USEPA – U. S. Environmental Protection Agency
ISO – International Organization for Standardization
SM – Standard Methods set by National Environmental Method Index, United States
EC – Electrical Conductivity
CFU/ml – Colony Forming Unit per milliliter
MDL – Minimum Detection Limit
NF – Not Found
N/A – Not Applicable

SW-1

SW-2

Figure 4.16: Photograph of Surface Water Sampling

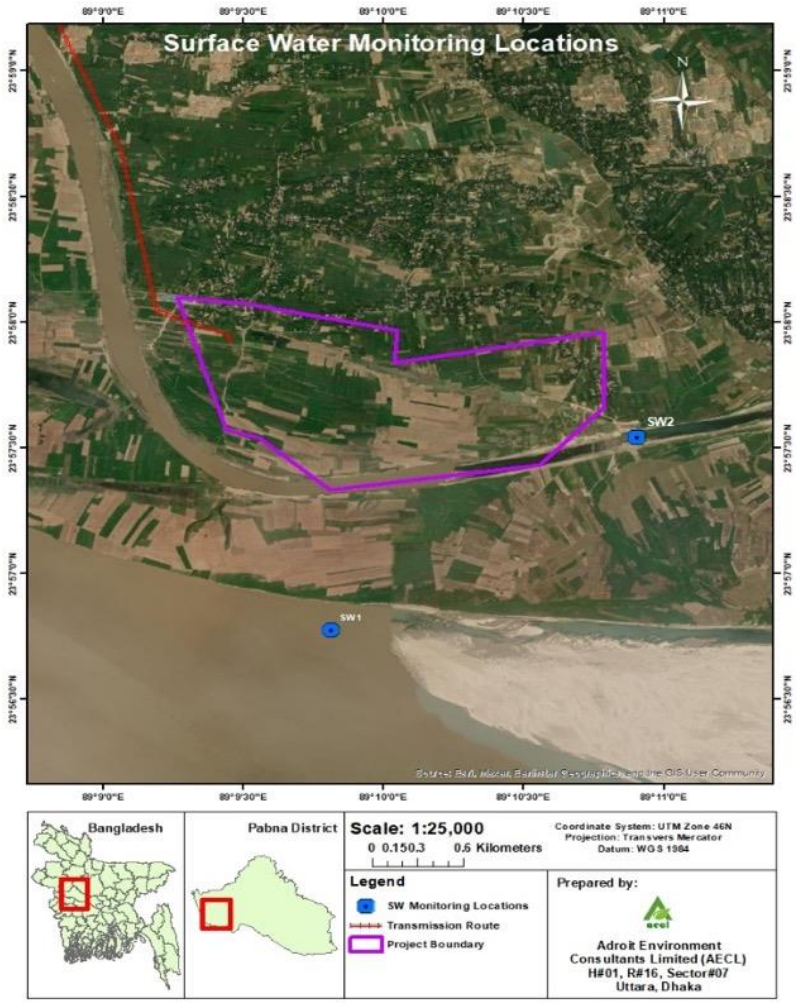


Figure 4.17: Surface Water Quality Monitoring locations

4.10.2 Ground Water Quality

To determine quality of ground water around the project site, water sample was collected from a nearby tube well and analyzed for different parameters. This water sample was not used for any kind of drinking purpose in the project associates. The result shows that all the parameters, except Lead (Pb) and Cadmium (Cd) remain within the allowable limits of drinking water value as per as Environmental Quality Standards for Bangladesh. The parameters which have been analyzed in laboratory during this study are presented below in **Table 4.15.** Ground Water quality test report is attached as **Annexure 8 (b). Figure 4.19** shows the ground zoning map of Bangladesh. According to the map, the depth of ground water level is 7.6-9.8 m.

Sampling date: 15th April, 2023
Reporting date: 28th May, 2023

Table 4.14: Sampling locations ID and Name with Longitude-Latitude

Category	GPS Co-ordinate	Specific Location

	Identification of Location	X	Y	
Ground Water Quality	Location-01, GW1	23°58'2.51"N	89°10'9.16"E	North side (out of site)
	Location-02, GW2	23°57'52.98"N	89° 9'23.24"E	West side of the site

Table 4.15: Ground Water Quality

Name of the Parameter	Concentration Present		ECR, 2023 (Schedule 2-Kha)	WHO Drinking Water Quality Standards	Unit	Method of analysis	Minimum Detection Limit (MDL)
	GW -01	GW -02					
Temperature	22	23	20 - 30	-	°C	Mercury filled thermometer	N/A
pH	7.0	7.1	6.5 – 8.5	6.5 – 8.5	-	pH Meter	-
TDS	372	353	1000	1000	mg/l	TDS Meter	-
Total Hardness	440	460	500	500	mg/l	SM 2320 C	0.2
Total Alkalinity	393	485	-	500	mg/l	SM 2320 B	1
Nitrate	3.2	2.6	45	50	mg/l	SM 4500-NO3-N E	0.1
Sulphate	45	<MDL	250	250		SM 4500-SO4 E	7
Phosphate	<MDL	<MDL	6	6	mg/l	USEPA 365.2:1978, USEPA 365.3:1978, SM 4500-P E (23rd Edition)	3
As	<MDL	<MDL	0.05	0.01	mg/l	SM 3113 B	0.001
Nickel (Ni)	<MDL	<MDL	0.05	0.07	mg/l	USEPA 200.8:1994, ISO 17292-2:2016, ISO 1185:2007	0.1
Iron (Fe)	<MDL	<MDL	0.3 – 1.0	0.3	mg/l	USEPA 200.8:1994, ISO 17292-2:2016, ISO 1185:2007	0.1
Aluminum (Al)	<MDL	<MDL	0.20	0.20	mg/l	USEPA 200.8:1994, ISO 17292-2:2016, ISO 1185:2007	0.1
Chromium	<MDL	<MDL	0.05	0.05	mg/l	SM 3113 B	0.001
Pb	0.027	0.027	0.01	0.01	mg/l	SM 3113 B	0.001
Cd	0.01	0.01	0.003	0.003	mg/l	SM 3113 B	0.001
Zn	0.04	0.03	5		mg/l	SM 3113 B	0.02
Cu	<MDL	<MDL	1.5	2.0	mg/l	SM 3113 B	0.014
Total Coliform	0	0	0	0	CFU/100 ml	ISO 9308-1:2014, USEPA 9132:1986	1
Fecal Coliform	0	0	0	0	CFU/100 ml	SM 9222 (23rd Edition), Membrane Filtration	1

N.B.: No standard found for ground water. Water result has been compared with drinking water standard.

GW-1

GW-2

Figure 4.18: Photograph of Ground Water Sampling

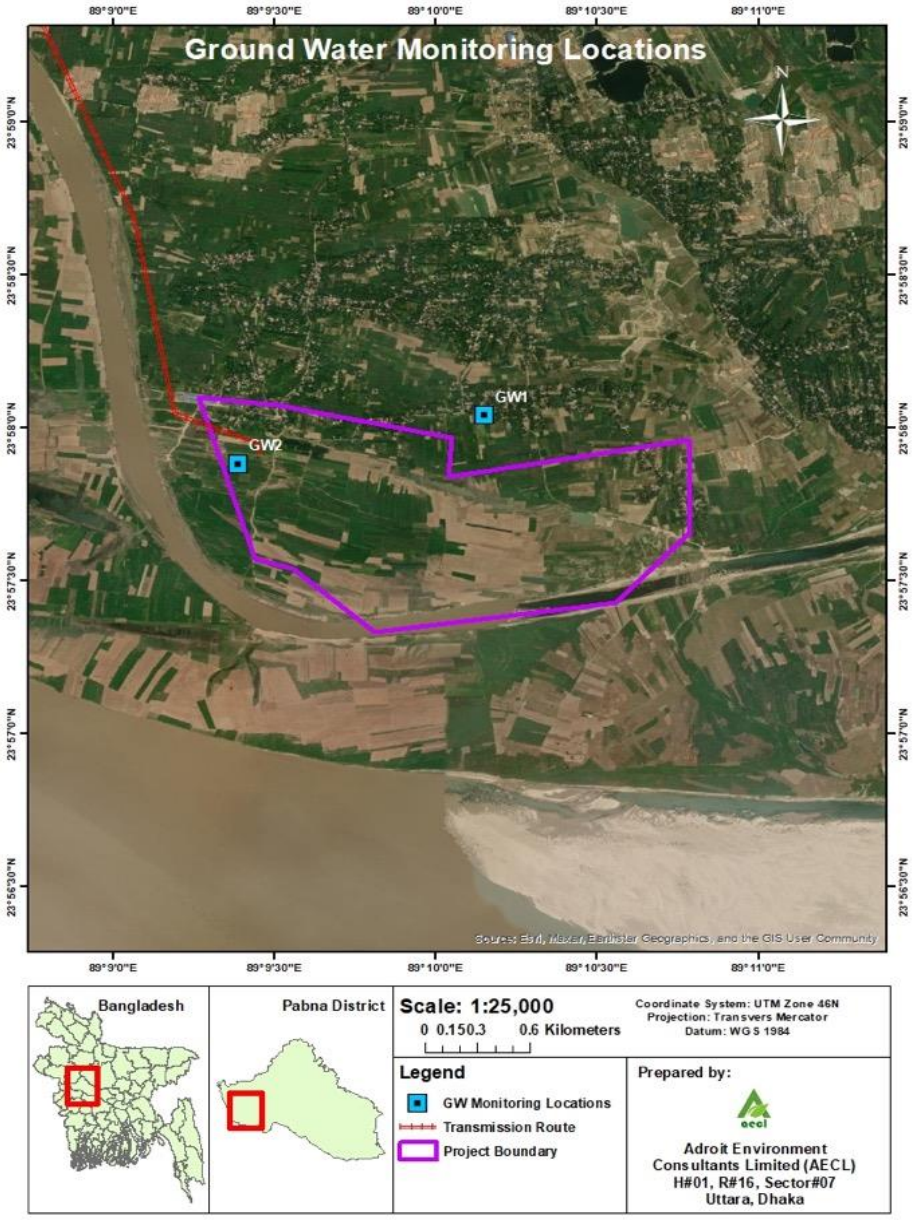
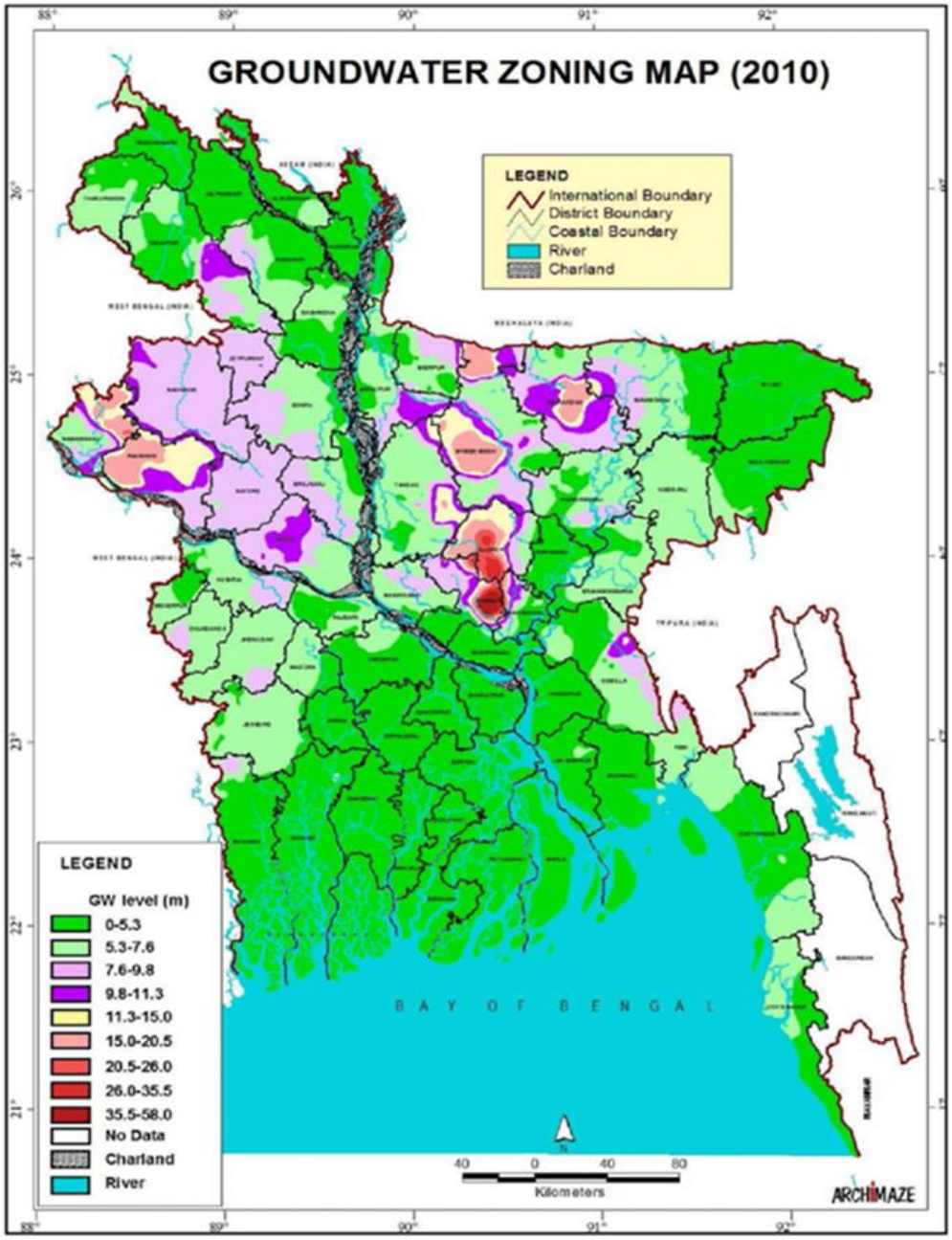


Figure 4.19: Ground Water Quality Monitoring Location



(Bangladesh Agricultural Development Corporation)

Figure 4.20: Ground Water Zoning Map of Bangladesh

4.10.3 Drinking Water Quality

DSEPL had treatment facility at site for treating ground water for drinking purpose while the depth of the tube well was 70 ft. Right now, DSEPL has set up new submersible pump at 220 ft depth along with water treatment plant (WTP) which can treat 1000 liters of drinking water per hour (24m^3/day) for the supply of drinking water for the rest of the construction period and operation phase ahead. A drinking water quality test was conducted, which showed all the parameters comply with the standards set by DoE (ECR, 2023) and WHO (Drinking Water Quality Guideline). Test result of Pb and Cd is added in Table 4.16 (b). Both drinking water quality test reports are attached in Annexure 10.

Test report Date: 09-09-23

Table 4.16 (a): Drinking water quality of Sub-mersible pump

Name of the Parameter	Concentration Present	DoE Standard according to ECR, 2023 (Schedule 2-Kha)	WHO Drinking Water Quality Standards 2004	Unit	Method of analysis	Minimum Detection Limit (MDL)
pH	6.5	6.5 – 8.5	6.5 – 8.5	-	SM 4500 H-B	0
Color	2	15	15	Pt-Co	SM 2120 C	0.01
Turbidity	0.14	5	5	NTU	SM 2130 B	0.01
Total Hardness as $CaCO_3$	14	500	200	mg/l	SM 2340 C	0.2
Chloride	5	250	250	mg/l	SM 4500-Cl-B	1
TDS	25	1000	1000	mg/l	SM 2540 C	5
Manganese (Mn)	<MDL	0.4	0.4a, 0.1b	mg/l	PAN Method	0.005
Arsenic (As)	<MDL	0.05	0.01	mg/l	SM 3113 B	0.001
Iron (Fe)	<MDL	0.3-1.0	0.3	mg/l	SM 3113 B	0.02
TC	0	0	0	CFU/100 ml	SM 9221 E	0
FC	0	0	0	CFU/100 ml	SM 9222 D	0

Test report date: 04-11-23

Table 4.16 (b): Drinking water quality of Sub-mersible pump

Name of the Parameter	Concentration Present	DoE Standard according to ECR, 2023 (Schedule 2-Kha)	WHO Drinking Water Quality Standards 2004	Unit	Method of analysis	Minimum Detection Limit (MDL)
pH	6.71	6.5 – 8.5	6.5 – 8.5	-	SM 4500 H-B	0
Color	3	15	15	Pt-Co	SM 2120 C	0.01
Turbidity	0.23	5	5	NTU	SM 2130 B	0.01
Total Hardness as $CaCO_3$	1	500	200	mg/l	SM 2340 C	0.2
Chloride	10	250	250	mg/l	SM 4500-Cl-B	1
TDS	10	1000	1000	mg/l	SM 2540 C	5
Manganese (Mn)	<MDL	0.4	0.4a, 0.1b	mg/l	PAN Method	0.005
Arsenic (As)	0.002	0.05	0.01	mg/l	SM 3113 B	0.001
Iron (Fe)	<MDL	0.3-1.0	0.3	mg/l	SM 3113 B	0.02
TC	0	0	0	CFU/100 ml	SM 9221 E	0

Name of the Parameter	Concentration Present	DoE Standard according to ECR, 2023 (Schedule 2-Kha)	WHO Drinking Water Quality Standards 2004	Unit	Method of analysis	Minimum Detection Limit (MDL)
FC	0	0	0	CFU/100 ml	SM 9222 G	0
Total Alkalinity (as $CaCO_3$)	13	-	-	mg/l	SM 2320B	1
Sulphate (SO_4)	<MDL	250	250	mg/l	SM 4500-SO4	7
Nitrate-Nitrogen (NO_3-N)	0.3	45	50	mg/l	SM 4500-NO3-N-F	0.1
Chromium (Cr)	<MDL	0.05	0.05	mg/l	SM 3113 B	0.001
Lead (Pb)	<MDL	0.01	0.01	mg/l	SM 3113 B	0.01
Cadmium (Cd)	<MDL	0.003	0.003	mg/l	SM 3113 B	0.001
Zinc (Zn)	0.11	5	3-5	mg/l	SM 3113 B	0.02
Copper (Cu)	<MDL	1.5	2	mg/l	SM 3113 B	0.014

4.11 Air Quality

Major atmospheric pollution is caused by construction works and transportation activity. Air monitoring has been conducted at six different locations (24 Hour Basis). The air quality data of the proposed site is given in **Table 4.18**. The result for ambient air quality monitoring shows the PM2.5, PM10, SPM, SO2, NOx & CO concentrations of the ambient air. Air quality test report is attached as **Annexure 8 (c).** The result shows that all the parameters remain within the allowable limit of Ambient Air as per as Environmental Quality Standards for Bangladesh.

Sampling date: 15th – 16th April, 2023
Reporting date: 25th April, 2023

Table 4.17: Sampling locations ID and Name with Longitude-Latitude

Category	Identification of Location	GPS Co-ordinate X	GPS Co-ordinate Y	Specific Location
Ambient Air Quality	Location-01, AQ1	23°57'48.2"N	89°10'39.9"E	East side of the site
	Location-02, AQ2	23°58'2.89"N	89°10'4.99"E	North side of the site
	Location-03, AQ3	23°57'34.86"N	89° 9'38.89"E	North-western side of site (near branch river of Padma)
	Location-04, AQ4	23°57'55.56"N	89° 9'22.54"E	North-western side of site
	Location-05, AQ5	24° 1'14.62"N	89° 4'43.28"E	Near Dadapur Purba Para
	Location-06, AQ6	24° 5'21.83"N	89° 5'25.96"E	Residential area near Rajshahi-Kushtia Highway

Table 4.18: Ambient Air Quality Analysis

SN	*Parameters*	Method	Test Duration (hours)	Unit	AQ1	AQ2	AQ3	AQ4	AQ5	AQ6	(DoE) Standard	IFC Standard
1	$PM_{2.5}$	Gravimetric	24	µg/m^3	31.11	33.52	32.72	28.41	27.61	25.73	65	75
2	PM_{10}	Gravimetric	24	µg/m^3	65.73	61.66	64.68	52.39	50.33	51.48	150	150
3	SPM	Gravimetric	8	µg/m^3	105.84	105.18	103.4	87.8	82.94	80.21	200	NF
4	SO_2	West-Geake	24	µg/m^3	12.44	13.83	10.20	8.73	7.12	6.36	80	125
5	NO_x	Jacob and Hochheiser	24	µg/m^3	10.83	11.49	9.15	6.53	5.35	5.09	80	200
6	CO	CO/O_3 Meter	1	ppm	1	1	2	1	1	1	20	NF

N.B.: NF – not found;
DoE – Department of Environment

AQ-1

AQ-2

AQ-3

AQ-4

AQ-5

AQ-6

Figure 4.21: Ambient Air quality monitoring locations

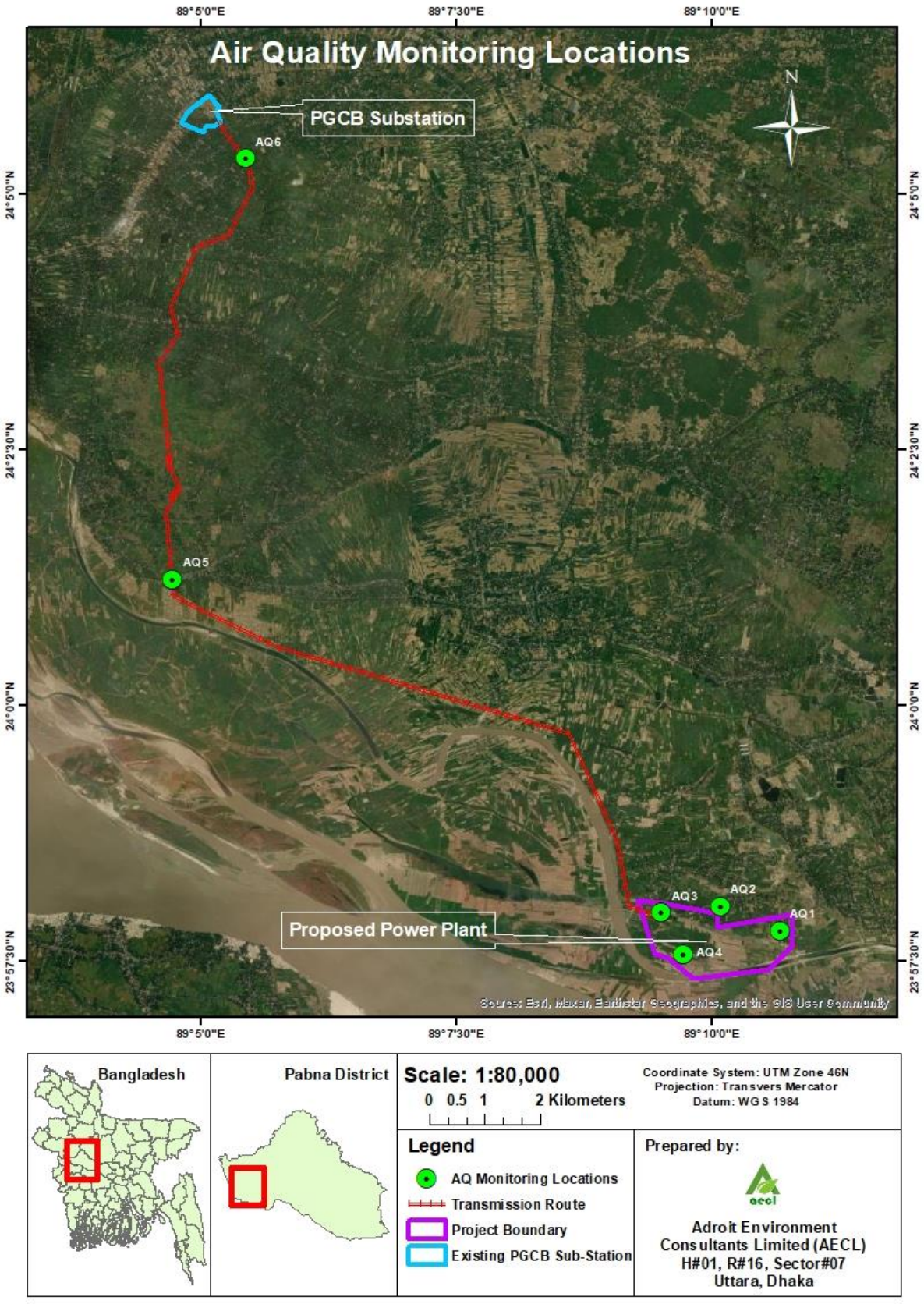


Figure 4.22: Air Quality Monitoring Location

4.12 Noise Level

The ambient noise level data were collected from different sides (six locations) of the project within 5 km radius area by noise level meter and has been given below in **Table 4.20.** All the noise level data are under the standard value set by DoE and IFC/International Standard. Noise quality test report is attached as **Annexure 8 (d).**

Sampling date: 15th – 16th April, 2023
Reporting date: 29th April, 2023

Table 4.19: Sampling locations ID and Name with Longitude-Latitude

Category	Identification of Location	GPS Co-ordinate		Specific Location
		X	Y	
Ambient Noise Level	Location-01, NQ1	23°57'44.76"N	89°10'41.40"E	East side of the site
	Location-02, NQ2	23°58'2.89"N	89°10'5.24"E	North side of the site
	Location-03, NQ3	23°57'23.06"N	89° 9'57.29"E	South side of the site
	Location-04, NQ4	23°57'55.02"N	89° 9'23.66"E	West side of the site
	Location-05, NQ5	24° 1'14.57"N	89° 4'44.41"E	Near Dadapur Purba para
	Location-06, NQ6	24° 5'21.41"N	89° 5'25.46"E	Residential area near Rajshahi-Kushtia Highway

Table 4.20: Ambient Noise Quality Analysis

SN.	Site Location with GPS Coordinates	Concentration present (LA_{eq}) dBA.			
		Day Time		Night Time	
		Minimum	Maximum	Minimum	Maximum
01	NQ-1	36.6	40.7	27.5	31.6
02	NQ-2	32.4	38.6	25.3	28.5
03	NQ-3	30.9	33.4	25.4	26.9
04	NQ-4	35.9	41.8	27.6	30.2
05	NQ-5	38.6	44.1	30.2	35.8
06	NQ-6	30.2	36.3	25.3	28.7
DoE (Bangladesh) Standard for Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)		60		50	
IFC/International Standard for Residential; institutional; educational		55		45	

NQ-1 (Day)

NQ-1 (Night)

NQ-2 (Day)

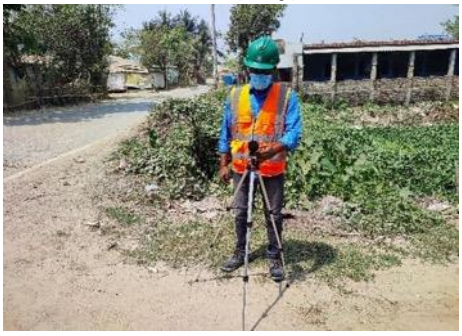
NQ-2 (Night)

NQ-3 (Day)

NQ-3 (Night)

NQ-4 (Day)

NQ-4 (Night)



NQ-5 (Day)

NQ-5 (Night)

NQ-6 (Day)

NQ-6 (Night)

Figure 4.23: Ambient Noise quality monitoring locations

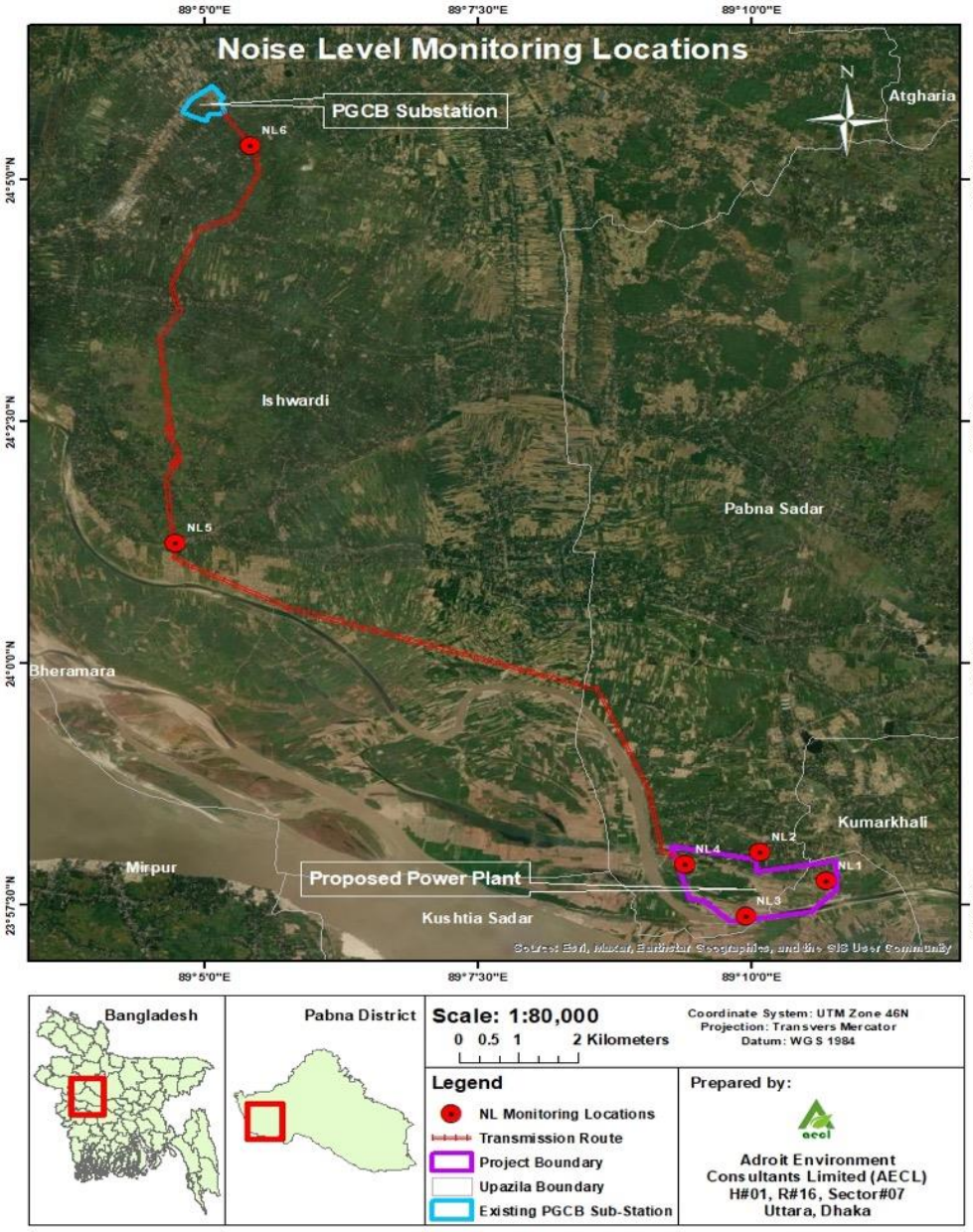


Figure 4.24: Noise Quality Monitoring Location

4.13 Traffic Volume Study

The project location is beside the existing LGED Road. For Project Access, in DSEPL's own land, only a 200m herringbone road has been constructed and developed for accessing the Project from the nearby LGED Road. No land was acquired for this purpose. Access road from Heliboard Bazar to Project Site is kacha and damaged. Though after implementing the project, DSEPL has improved the quality of road than before. The width of this roads is almost 10-12 ft. Normally, motorcycles, bi-cycles, easy-bikes, auto-rickshaws, and local vans use this road for communication. During construction phase, heavy-weight vehicle will move in these roads with materials and wastes, which may increase the load on the roads. But it will not cause any traffic jam. This is the only road from Pabna Sadar Upazila to reach the project site. So, no other option is left to carry out to reach the site.

Traffic volume around the project site has been studied on 16th May, 2023 and 16th August, 2023. The traffic volume counts have been recorded continuously for 24 hours to assess the peak hour traffic and traffic composition. Traffic Survey was done at Heliboard Bazar to Project site road and near to Project access road. Traffic study locations are shown in **Figure 4.25**. The full data of the traffic survey is listed in the **Table 4.21** & **Table 4.22** below:

Table 4.21: Traffic Volume Data (Road Traffic) at Heliboard Bazar

Hour	Direction	Truck	Car/ Jeep	Micro Bus	CNG	Rickshaw	Easy Bike	Motor cycle	Bicycle	Van	Tractor
Day											
07:00-09:00AM	North to South	4	0	0	8	4	5	7	11	3	**2**
	South to North	0	0	0	3	6	3	5	4	2	**0**
09:00-11:00AM	North to South	1	3	0	5	8	9	8	5	4	**1**
	South to North	0	0	0	6	9	6	9	3	3	**0**
11:00AM -01:00PM	North to South	0	0	1	8	5	8	10	8	5	**2**
	South to North	3	0	0	7	6	3	7	5	7	**2**
01:00-03:00PM	North to South	0	0	0	2	4	2	7	3	8	**3**
	South to North	2	0	0	5	7	1	9	2	2	**1**
03:00-05:00PM	North to South	0	0	0	7	2	3	11	5	1	**0**
	South to North	1	3	0	8	5	5	8	1	1	**1**
05:00-07:00PM	North to South	2	0	0	7	6	1	9	9	6	**3**

Hour	Direction	Truck	Car/ Jeep	Micro Bus	CNG	Rickshaw	Easy Bike	Motor cycle	Bicycle	Van	Tractor
	South to North	1	0	0	6	7	3	6	13	1	**1**
Night											
07:00-09:00PM	North to South	3	0	0	5	6	2	7	6	0	**0**
	South to North	0	0	0	6	3	2	7	8	5	**3**
09:00-11:00PM	North to South	0	1	0	5	5	0	8	3	1	**2**
	South to North	2	0	1	3	2	1	6	5	3	**0**
11:00PM-01:00AM	North to South	0	0	0	1	1	0	3	2	2	**0**
	South to North	0	0	0	0	0	0	2	2	0	**2**
01:00-03:00AM	North to South	0	0	0	0	0	0	0	0	0	**0**
	South to North	0	0	0	0	0	0	0	0	0	**0**
03:00-05:00AM	North to South	0	0	0	2	0	0	0	1	0	**1**
	South to North	0	0	0	0	0	0	1	1	0	**0**
05:00-07:00AM	North to South	2	0	0	5	2	2	4	5	3	**6**
	South to North	1	1	0	3	2	1	2	4	3	**2**
Total		**21**	**8**	**2**	**102**	**90**	**56**	**136**	**106**	**61**	**32**

Table 4.22: Traffic Volume Data (Road Traffic) near to Project Access Road

Hour	Direction	Truck	Car/ Jeep	Micro Bus	CNG	Rickshaw	Easy Bike	Motor cycle	Bicycle	Van	Tractor
Day											
07:00-09:00AM	North to South	3	3	0	2	4	4	5	10	1	**0**
	South to North	1	0	0	2	4	2	0	0	2	**0**
09:00-11:00AM	North to South	2	0	0	0	3	5	7	12	7	**3**
	South to North	0	0	0	0	3	5	4	0	5	**0**
11:00AM-	North to	3	1	1	3	0	1	6	3	4	**4**

Hour	Direction	Truck	Car/ Jeep	Micro Bus	CNG	Rickshaw	Easy Bike	Motor cycle	Bicycle	Van	Tractor
01:00PM	South										
	South to North	0	0	0	0	0	1	7	2	2	**2**
01:00-03:00PM	North to South	1	0	0	0	1	0	3	1	0	**0**
	South to North	2	1	0	3	1	0	3	1	0	**0**
03:00-05:00PM	North to South	0	0	0	2	0	2	4	3	3	**0**
	South to North	0	0	0	0	0	3	7	0	4	**2**
05:00-07:00PM	North to South	0	3	0	0	2	5	3	0	2	**3**
	South to North	1	0	1	2	2	2	5	14	3	**1**
Night											
07:00-09:00PM	North to South	1	0	0	1	3	0	7	0	4	**4**
	South to North	0	0	0	1	3	3	7	8	4	**3**
09:00-11:00PM	North to South	0	1	0	0	0	0	2	0	1	**0**
	South to North	1	1	0	0	0	0	3	3	0	**2**
11:00PM-01:00AM	North to South	0	1	0	0	0	0	0	0	0	**0**
	South to North	0	0	0	0	0	0	0	0	0	**0**
01:00-03:00AM	North to South	0	0	0	0	0	0	0	0	0	**0**
	South to North	0	0	0	0	0	0	0	0	0	**0**
03:00-05:00AM	North to South	0	0	0	0	0	0	0	0	0	**0**
	South to North	0	0	0	0	0	0	0	0	0	**0**
05:00-07:00AM	North to South	2	0	0	0	0	0	0	0	3	**2**
	South to North	0	0	0	0	0	0	0	2	1	**1**
Total		**17**	**11**	**2**	**81**	**26**	**33**	**73**	**59**	**46**	**27**

The traffic volume study shows that, the access road to the project site has very low traffic flow and the road is calm and quiet. Table 4.21 & 4.22 show that, not much heavy vehicles use this road, only local transports i.e., rickshaw, easy bike, motorcycle, bicycle, and local van uses this road. Due to the project activity of DSEPL few trucks, lorry etc. runs through this road. Traffic survey data shows that even during full-fledged construction phase the traffic flow is way less than saturation condition. After the completion of construction phase, the traffic movement will decrease even more. So, the traffic study shows that, the project has no negative impact on traffic movement.

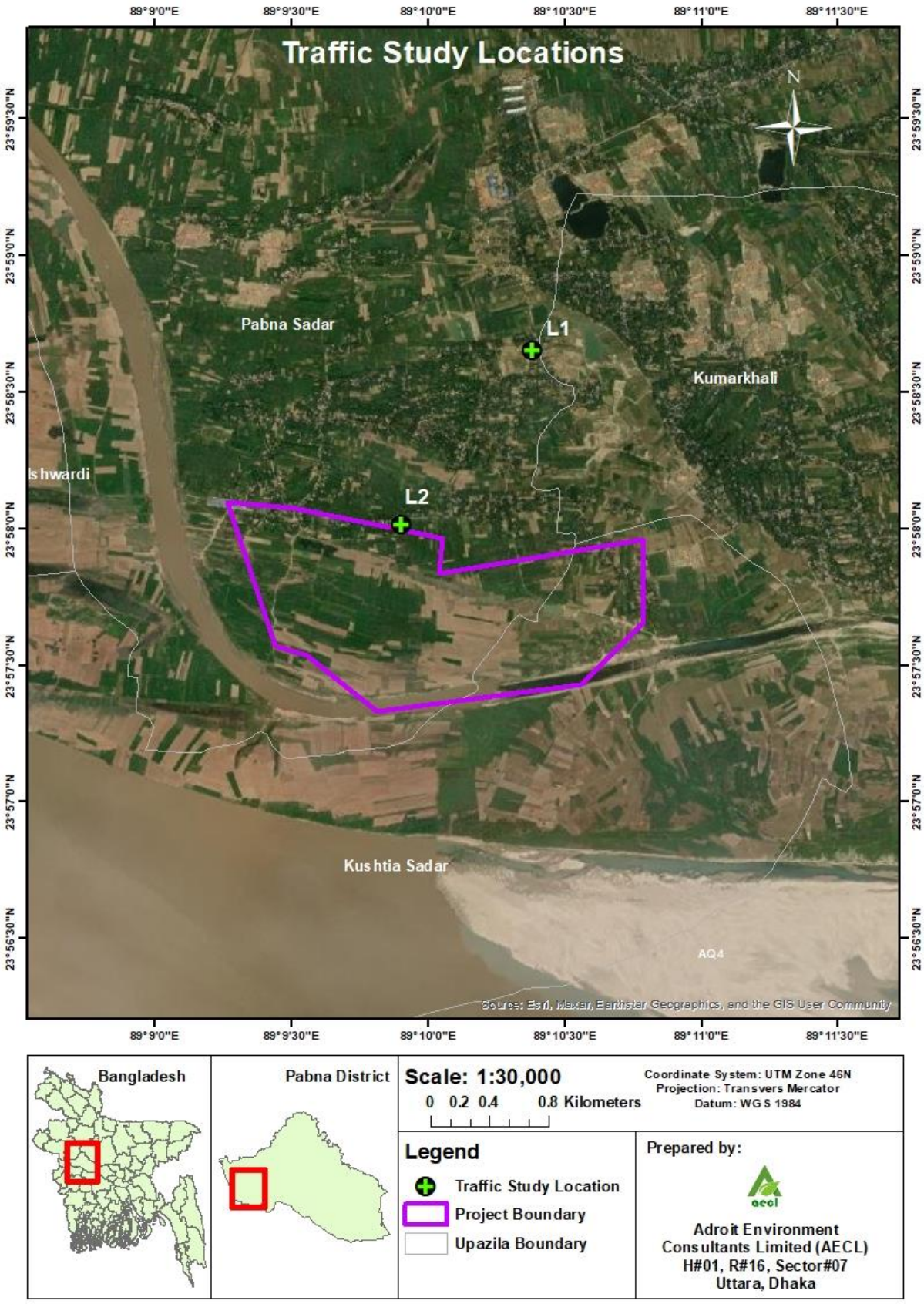


Figure 4.25: Traffic volume study locations

4.14 Geology

The geological evolution of Bangladesh is related to the uplift of the Himalayan mountains and outbuilding of deltaic landmass by major river systems having their origin in the uplifted Himalayas. This geology is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments was deposited as a mega delta built out and progressed towards the south. The delta building is continuing into the present Bay of Bengal and a broad fluvial front of the Ganges-Brahmaputra-Meghna River system gradually follows it from behind.

4.14.1 Soil

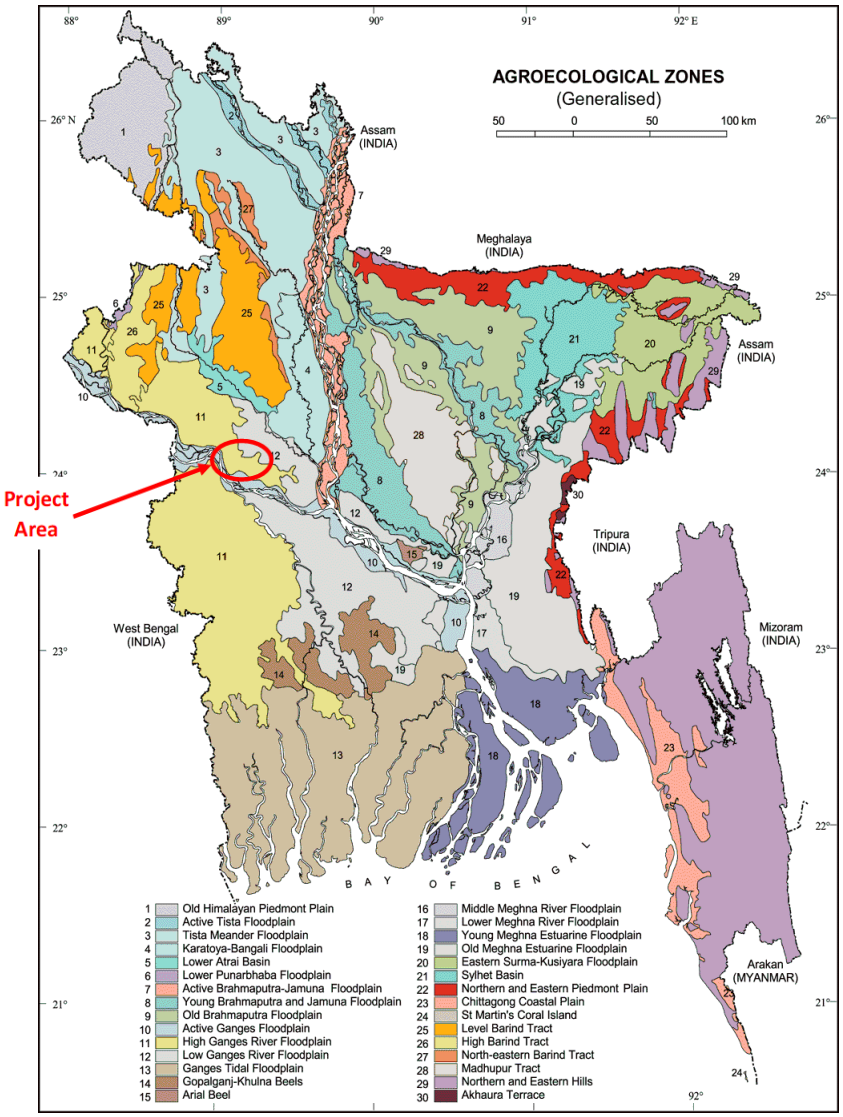
Most of the area of Bangladesh is a vast, low-lying alluvial plain, sloping gently to the south and southeast. According to Bangladesh Agricultural research council's Agro-Ecological Zoning map [**Figure 4.26 (a)]** the project area falls in High Ganges River Floodplain.

The proposed project area falls in the High Ganges River Floodplain. This region includes the western part of the Ganges River floodplain which is predominantly highland and medium highland. Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions. The upper parts of high ridges stand above normal flood level. Lower parts of ridges and basin margins are seasonally shallowly flooded. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low.

The project area falls under Mixed highland, shallowly flooded and deeply flooded phases according to **Figure 4.26 (b).** This type of zone is segregated into different elevations which makes them both shallowly and deeply flooded at wet seasons. Flood visits these phases regularly. The southwestern corner along the Padma River is characterized by calcareous alluvium that is called Calcaric Fluviosols. The rest of the southern and southwestern parts are characterized by calcareous dark grey floodplain soils which are called mainly Calcaric Gleysols with some vertisols and calcareous brown flood plain soils also called as Calcaric Cambisols with some Calcaric Gleysols which are mixed highland, shallowly flooded and deeply flooded phases.

4.14.2 Topology

Project proponent has distributed the project area into 15 Blocks. Each of the block has different elevations according to the **Figure 4.27.** According to the site elevation map the highest elevation of the power plant site is 13.162m and lowest elevation is 7.487m.



(Islam et al, 2020)

Figure 4.26 (a): Agro-ecological zones Map of Bangladesh

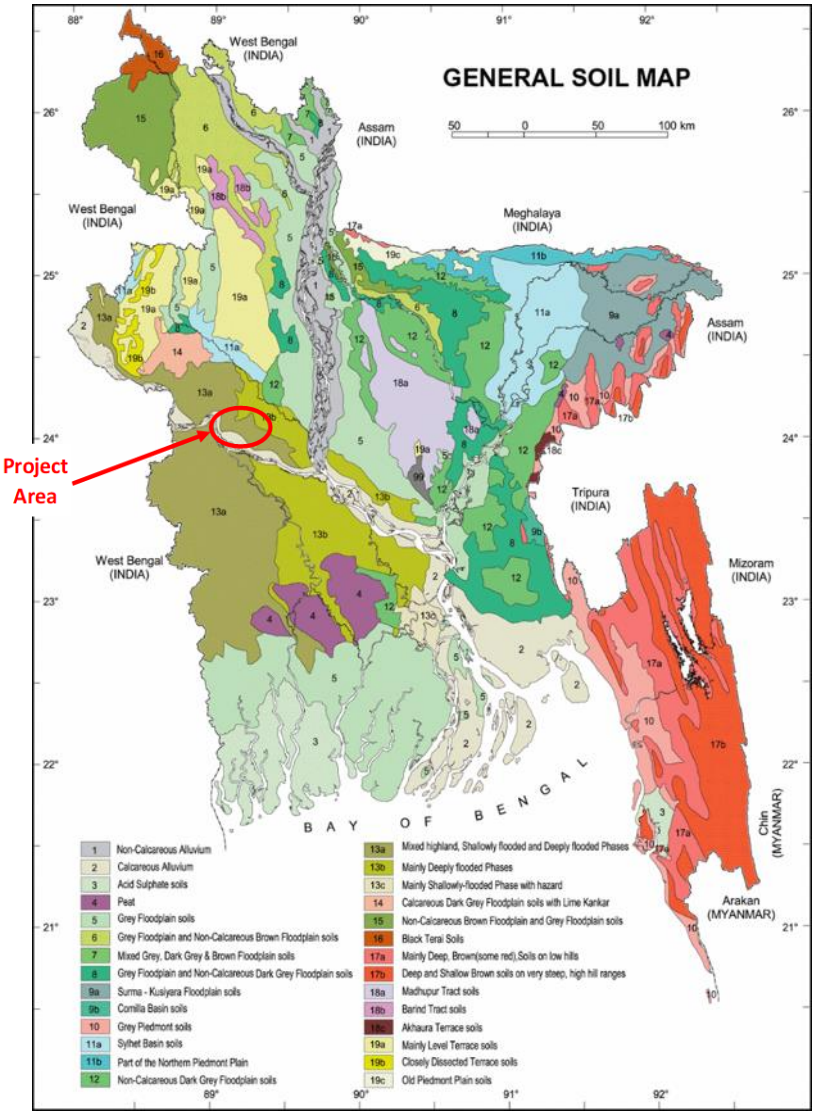


Figure 4.26 (b): Soil Map of Bangladesh

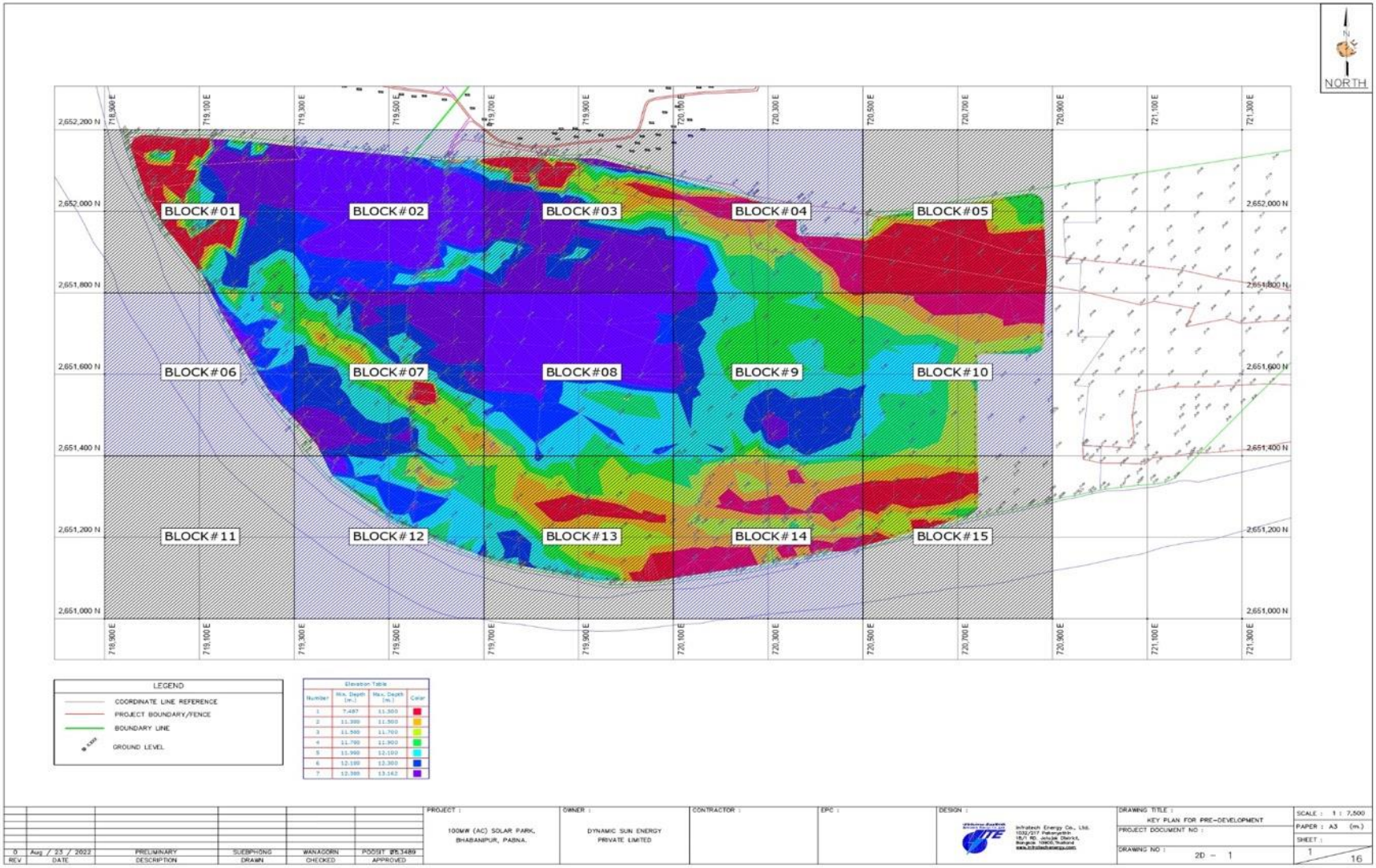


Figure 4.27: 2D site elevation map of the project site.

4.14.3 Soil Quality

Soil sample has been collected during field survey. Test result on soil sample has been presented in **Table 4.23.** Soil quality test report is attached as **Annexure 8 (e).**

Sampling date: 15th April, 2023
Reporting date: 14th June, 2023

Table 4.23: Soil quality test result

Name of the Parameter	Concentration present	Unit	WHO permissible limit for heavy metal in soil (1996)
Location: SQ -01 (22°14'17.86"N, 91°8'34.37"E)			
pH	7.5	-	-
Zinc (Zn)	0.40	ppm	50
Copper (Cu)	2.04	ppm	36
Lead (Pb)	17.14	ppm	85
Chromium (Cr)	4.26	ppm	100
Cadmium (Cd)	0.12	ppm	0.8
Nickel (Ni)	1.59	ppm	35

Figure 4.28: Soil Sample Collection

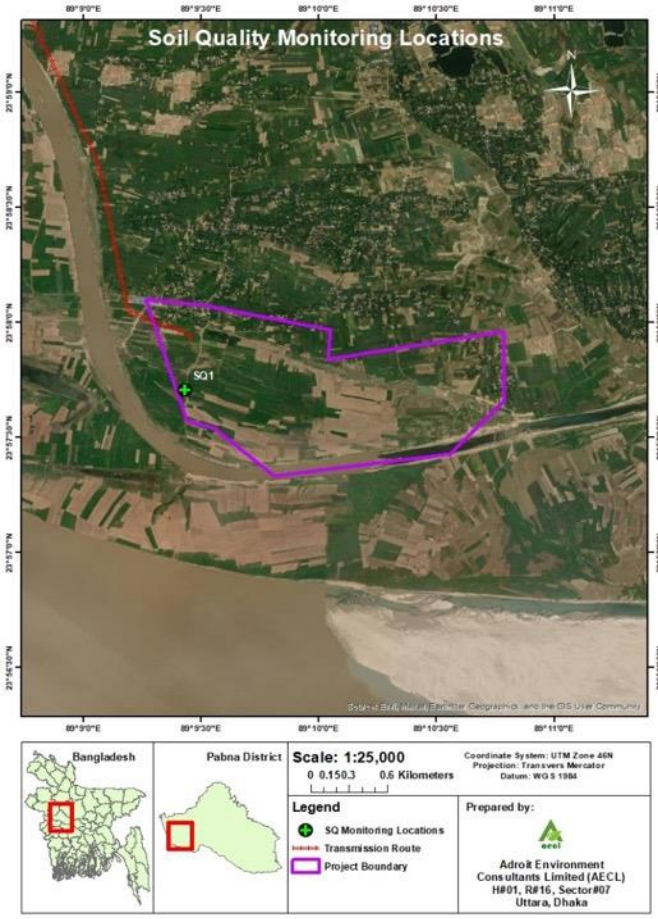


Figure 4.29: Soil Quality Monitoring Location

4.15 Climate Change and Natural Disaster

Bangladesh is one of the most vulnerable countries, who is facing problems on climate change due to global warming. Low-lying coastal regions like Bangladesh are vulnerable to sea level rise and increased occurrence of intense, extreme weather conditions such as the cyclones from 2007 and 2009. It is necessary to identify all present vulnerabilities and future opportunities, adjusting priorities, at times even changing commodity and trade policies in the agricultural sector while promoting training and education throughout the masses in all possible spheres.

4.15.1 Seismicity

Earthquakes are closely related to plate tectonics. Bangladesh is in a tectonically active region close to the plate boundaries of the Indian plate and the Eurasian plate. The plate boundaries lie to the north and east of Bangladesh. The collision of the north-east moving (around 4 cm or more annually) Indian Plate with the Eurasian plate **(Figure 4.30)** is the cause of frequent earthquakes in the region comprising North East India, Nepal, Bhutan, Bangladesh, and Myanmar.

Tectonically Bangladesh is divided broadly into three divisions: (i) Stable Shelf (in the northwest) (ii) Bengal Foredeep (in the Central) and (iii) Chittagong-Tripura Folded Belt (in the east). In addition, there is a SW-NE trending 25 km wide hinge zone separating the Bengal Foredeep from the Stable Shelf.

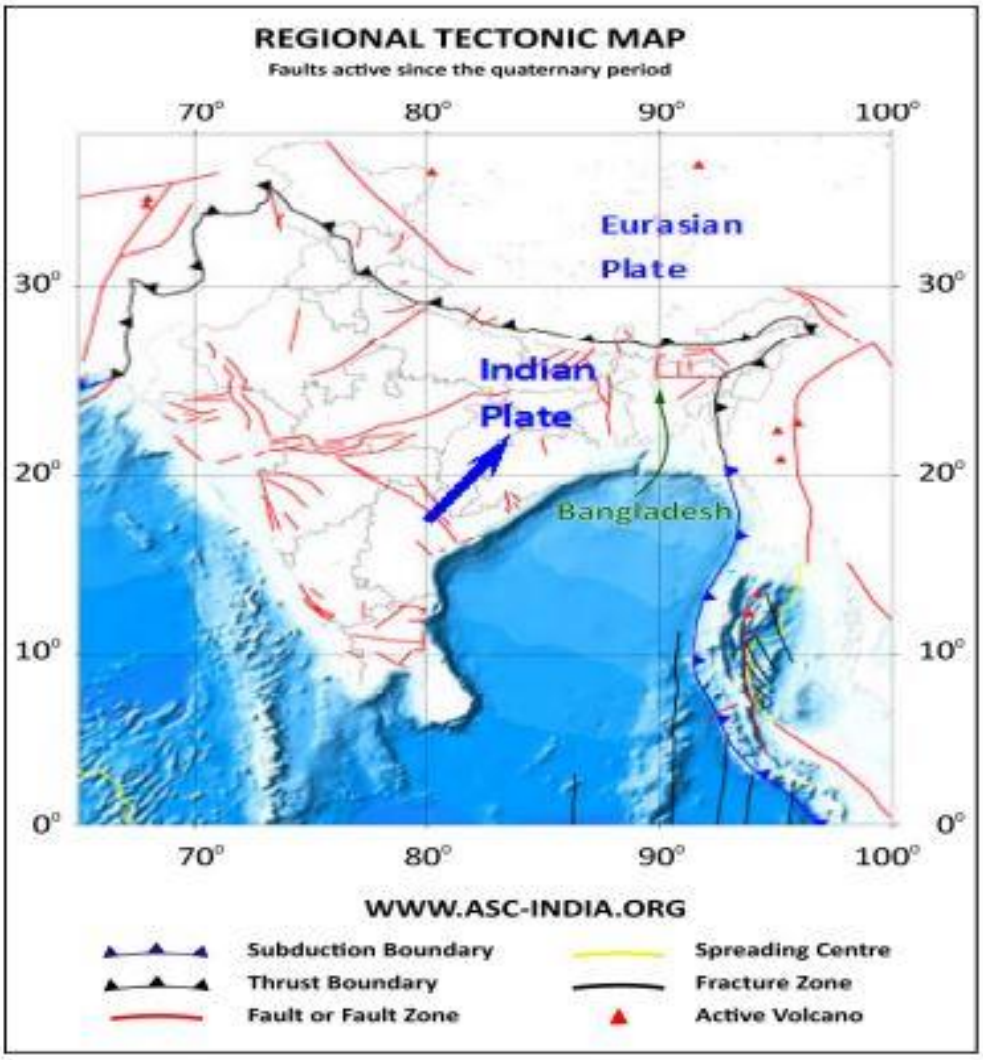
- The Stable Pre-Cambrian Shelf in the northwest consists of relatively thin sedimentary strata over bedrock. In Madhyapara area of Dinajpur the basement is only 130 m deep from the ground surface. The basement plunges gently from Madhyapara towards the southeast up to the Hinge Zone. Seismic contours on top of limestone in Bogra show regional dip of 2-3^{o} besides revealing several NE-SW trending faults.

- In the hinge zone, the depth of the limestone increases from 4000m to 9000m within a narrow zone of 25-km. Hinge Zone relates to Bengal Foredeep by deep basement faults that probably started with the breakup of Gondwanaland. The SW-NE trending Hinge Zone turns to the east near Indian border in Jamalpur and seems to relate to the Dauki Fault, probably by a series of east-west trending faults. Bengal Foredeep occupies the vast area between Hinge Line and Arakan Yoma Folded System in the east. The Bengal Foredeep consists of some Troughs and some relatively high lands.

- Eastern part of the country is represented by the Chittagong-Tripura Folded Belt. The folded belt in the east consists of narrow, elongated N-S trending folds in Sylhet and Chittagong Divisions of Bangladesh, Tripura, southern Assam, and Mizoram states in India and also Myanmar territory. The elevation of these elongated anticlinal folds in Bangladesh ranges from 100-1,000m. Some of the structures are faulted and thrusted and the intensity of folding increases gradually from west to east.

The project area falls in seismic zone II according to the [**Figure 4.31**] Revised Seismic Zonation of Bangladesh (2017) and BNBC 2020. According to Revised Seismic Zonation of Bangladesh (2017) and BNBC 2020, the country is divided into four seismic zones with different expected levels of intensity of ground motion. Each zone has a seismic zone coefficient (Z) which represents the maximum

considered peak ground acceleration (PGA) on very stiff soil/rock (site class SA) in units of g (acceleration due to gravity). The zone II consists of Lower Central and Northwestern part including Noakhali, Dhaka, Pabna, Dinajpur, as well as Southwestern corner including Sundarbans in where seismic intensity is ***Moderate*** and seismic zone coefficient (Z) is 0.2 [**Table 4.24**].



(BNBC, 2020)

Figure 4.30: Movement of Indian plate relative to Eurasian plate

Table 4.24: Seismic Zonation of Bangladesh, 2017

Seismic Zone	Location	Seismic Intensity	Seismic Zone Coefficient, Z
1	Southwestern part including Barisal, Khulna, Jessore, Rajshahi	Low	0.12
2	Lower Central and Northwestern part including Noakhali, Dhaka, Pabna, Dinajpur, as well as Southwestern corner including Sundarbans	Moderate	0.20
3	Upper Central and Northwestern part including Brahmanbaria, Sirajganj, Rangpur	Severe	0.28

Seismic Zone	Location	Seismic Intensity	Seismic Zone Coefficient, Z
4	Northeastern part including Sylhet, Mymensingh, Kurigram	Very Severe	0.36

(BNBC, 2020)

(BNBC, 2020)

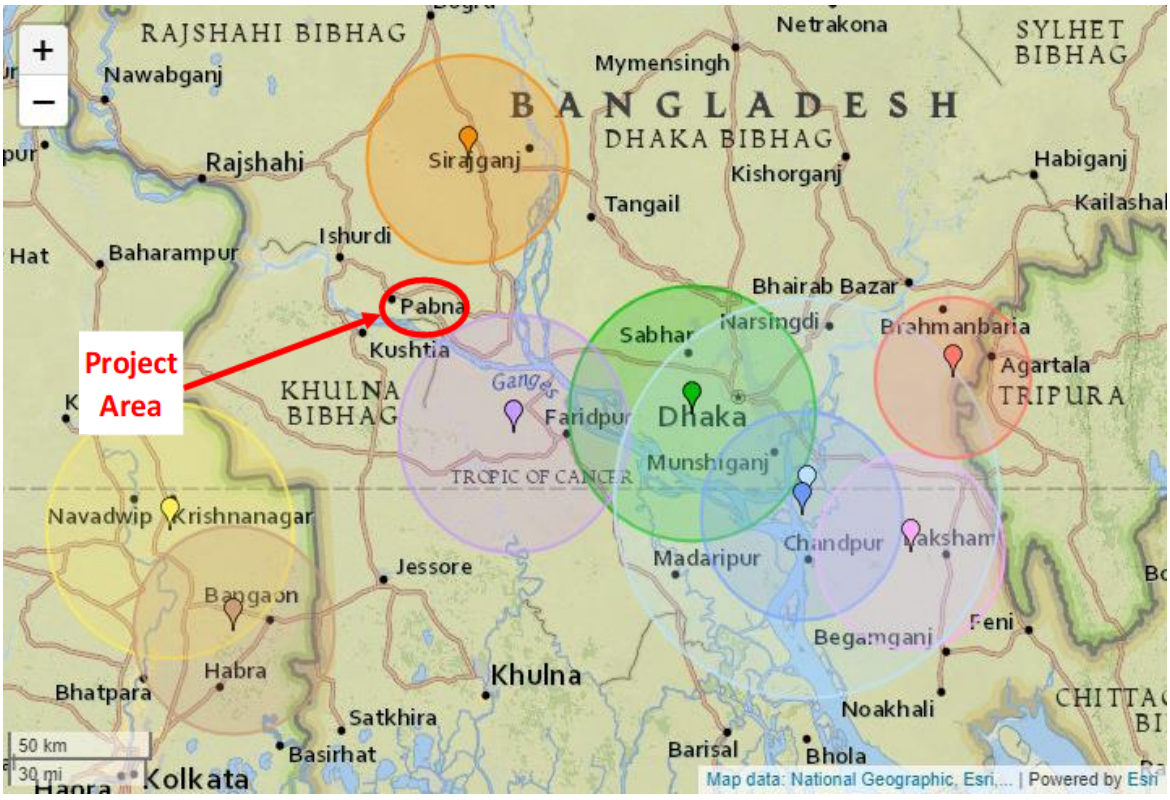
Figure 4.31: Earthquake Zoning Map of Bangladesh

Since 1900, Pabna district felt 56 quakes in total till last year. Among them, only one earthquake was 7.8 on richter scale, which was started from Kathmandu, Nepal on April 2015. Maximum of them are ranging from magnitude level 4-5. Details are given on **Table 4.25**.

Table 4.25: Earthquakes in or near Pabna since 1900

Magnitude Range	7+	6 - 7	5 - 6	4 - 5	3 - 4	2 - 3
No. of Quakes occurred	1	1	3	31	17	3

Recent earthquakes which were near to Pabna Sadar Upazila and the project site are shown on the map given **Figure 4.32**. Details of the quakes are provided on **Table 4.26**.



(National Geographic and Environmental Systems Research Institute)

Figure 4.32: Recent nearest earthquakes of Pabna

Table 4.26: Recent nearest earthquakes of Pabna

Year	Magnitude	Location	Depth (km)
2008	3.8	Agartala, Tripura, India	35
2009	4.2	Bangaon, West Bengal, India	35
2010	5.1	Narayanganj, Dhaka, Bangladesh	10
2010	4.1	Laksham, Chattogram, Bangladesh	10
2011	4.4	Faridpur, Dhaka, Bangladesh	35
2011	4.2	Hajiganj, Chittagong, Bangladesh	10
2012	4.5	Dohar, Dhaka, Bangladesh	44

Year	Magnitude	Location	Depth (km)
2013	4.1	Joypurhat, Rajshahi, Bangladesh	11
2013	4.5	Shantipur, West Bengal, India	35
2014	4.2	Sirajganj, Rajshahi, Bangladesh	14
2014	4.1	Mankachar, Meghalaya, India	15

4.15.2 Floods

Bangladesh is a land of rivers. It is prone to flooding due to being situated on the Padma River Delta (also known as the Ganges Delta) and the many distributaries flowing into the Bay of Bengal. The project area falls in moderate to low river flooding area shown in **Figure 4.33**. Recent floods occurred in Pabna are listed here below:

Table 4.27: Recent floods occurred in Pabna

Year	Description
2022	The catastrophic floods occurred throughout July and August in the country. Bhabanipur, Hemayetpur, Pabna Sadar Upazila was under the water for several days.
2021	Heavy rainfall and continuous rise of water level of Padma caused flood on August. Sadar Upazila and Ishwardi was under water for a few days that time.
2020	Over 20 thousand families have been marooned as swelling Padma, Jamuna and Boral rivers have flooded around a hundred villages of five upazilas in Pabna. That time it was, the Jamuna river which caused massive flood.

4.15.2.1 Danger Level of Padma River at Talbaria Point (SW 91)

Padma River is on the south side of the project site which is around 1.5km from the project site. According to the local people, the project area does not get flooded as the project area is 1.5km away from the Padma River. Observing the maximum and minimum water level data from the year 1950 to 2019, it is found that the maximum highest level was 14.53m, minimum highest level was 13.09 and the danger level is considered as 14.53m. The proponent has already undertaken a flood study and has designed the project accordingly so that during flood the project does not get hampered due to water level rise. Details of flood study report and consideration of flooding in project design has been discussed in Section 3.8.1. The details of water level of Ganges-Padma River at Talbari point (1950-2019) are given on **Table 4.28**.

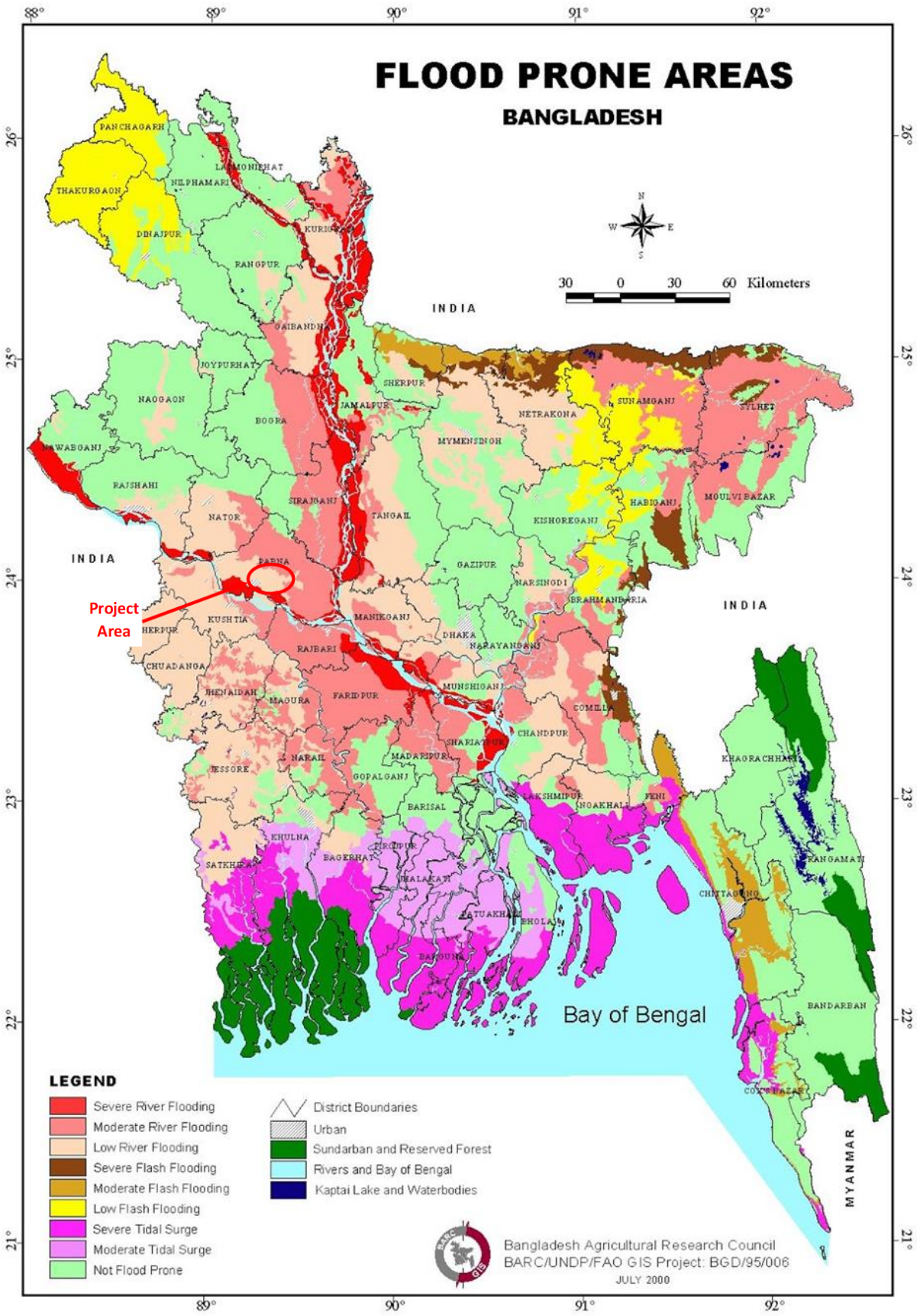
Table 4.28: Maximum and Minimum water level of Ganges-Padma River at Talbari point (1950-2019)

River	Station ID	Station Name	Year	Maximum WL(m)	Minimum WL(m)
Ganges-Padma	SW91	Talbaria	1950	13.84	5.51
Ganges-Padma	SW91	Talbaria	1951	13.14	6.61
Ganges-Padma	SW91	Talbaria	1952	13.32	6.56
Ganges-Padma	SW91	Talbaria	1953	13.56	6.12
Ganges-Padma	SW91	Talbaria	1954	13.41	5.95

River	Station ID	Station Name	Year	Maximum WL(m)	Minimum WL(m)
Ganges-Padma	SW91	Talbaria	1955	13.48	5.18
Ganges-Padma	SW91	Talbaria	1956	13.69	6.29
Ganges-Padma	SW91	Talbaria	1957	12.88	7.20
Ganges-Padma	SW91	Talbaria	1958	13.44	6.59
Ganges-Padma	SW91	Talbaria	1959	12.99	7.12
Ganges-Padma	SW91	Talbaria	1960	13.58	6.58
Ganges-Padma	SW91	Talbaria	1961	13.70	7.20
Ganges-Padma	SW91	Talbaria	1962	13.53	6.99
Ganges-Padma	SW91	Talbaria	1963	13.53	6.11
Ganges-Padma	SW91	Talbaria	1964	13.50	6.43
Ganges-Padma	SW91	Talbaria	1965	12.74	6.40
Ganges-Padma	SW91	Talbaria	1966	13.11	5.39
Ganges-Padma	SW91	Talbaria	1967	13.38	5.51
Ganges-Padma	SW91	Talbaria	1968	12.34	5.12
Ganges-Padma	SW91	Talbaria	1969	13.58	5.51
Ganges-Padma	SW91	Talbaria	1970	12.41	4.76
Ganges-Padma	SW91	Talbaria	1971	12.34	5.12
Ganges-Padma	SW91	Talbaria	1972	12.41	5.76
Ganges-Padma	SW91	Talbaria	1973	13.29	5.64
Ganges-Padma	SW91	Talbaria	1974	13.57	5.53
Ganges-Padma	SW91	Talbaria	1975	13.10	5.15
Ganges-Padma	SW91	Talbaria	1976	13.58	4.11
Ganges-Padma	SW91	Talbaria	1977	13.08	4.80
Ganges-Padma	SW91	Talbaria	1978	13.55	5.12
Ganges-Padma	SW91	Talbaria	1979	12.33	5.23
Ganges-Padma	SW91	Talbaria	1980	13.73	4.54
Ganges-Padma	SW91	Talbaria	1981	12.44	4.25
Ganges-Padma	SW91	Talbaria	1982	5.17	4.24
Ganges-Padma	SW91	Talbaria	1983	13.88	4.16
Ganges-Padma	SW91	Talbaria	1984	13.64	5.16
Ganges-Padma	SW91	Talbaria	1985	13.16	5.18
Ganges-Padma	SW91	Talbaria	1986	13.15	5.36
Ganges-Padma	SW91	Talbaria	1987	13.69	5.07
Ganges-Padma	SW91	Talbaria	1988	14.09	5.43
Ganges-Padma	SW91	Talbaria	1989	12.36	5.00
Ganges-Padma	SW91	Talbaria	1990	12.89	4.51
Ganges-Padma	SW91	Talbaria	1991	12.33	4.16
Ganges-Padma	SW91	Talbaria	1992	12.45	4.15
Ganges-Padma	SW91	Talbaria	1993	12.50	3.56
Ganges-Padma	SW91	Talbaria	1994	13.39	0.00
Ganges-Padma	SW91	Talbaria	1995	12.58	3.97
Ganges-Padma	SW91	Talbaria	1996	13.77	4.39
Ganges-Padma	SW91	Talbaria	1997	12.42	3.83

River	Station ID	Station Name	Year	Maximum WL(m)	Minimum WL(m)
Ganges-Padma	SW91	Talbaria	1998	14.53	3.98
Ganges-Padma	SW91	Talbaria	1999	13.37	4.45
Ganges-Padma	SW91	Talbaria	2000	13.53	4.02
Ganges-Padma	SW91	Talbaria	2001	12.66	4.02
Ganges-Padma	SW91	Talbaria	2002	12.61	4.87
Ganges-Padma	SW91	Talbaria	2003	13.46	4.89
Ganges-Padma	SW91	Talbaria	2004	12.56	5.17
Ganges-Padma	SW91	Talbaria	2005	12.41	4.40
Ganges-Padma	SW91	Talbaria	2006	12.54	4.53
Ganges-Padma	SW91	Talbaria	2007	12.35	4.85
Ganges-Padma	SW91	Talbaria	2008	12.67	4.65
Ganges-Padma	SW91	Talbaria	2009	11.96	4.85
Ganges-Padma	SW91	Talbaria	2010	11.94	4.44
Ganges-Padma	SW91	Talbaria	2011	12.74	4.65
Ganges-Padma	SW91	Talbaria	2012	12.45	4.65
Ganges-Padma	SW91	Talbaria	2013	12.66	4.38
Ganges-Padma	SW91	Talbaria	2014	12.94	4.50
Ganges-Padma	SW91	Talbaria	2015	12.84	4.33
Ganges-Padma	SW91	Talbaria	2016	13.35	3.77
Ganges-Padma	SW91	Talbaria	2017	12.90	4.33
Ganges-Padma	SW91	Talbaria	2018	12.66	4.14
Ganges-Padma	SW91	Talbaria	2019	6.26	4.08

(BWDB 2020)

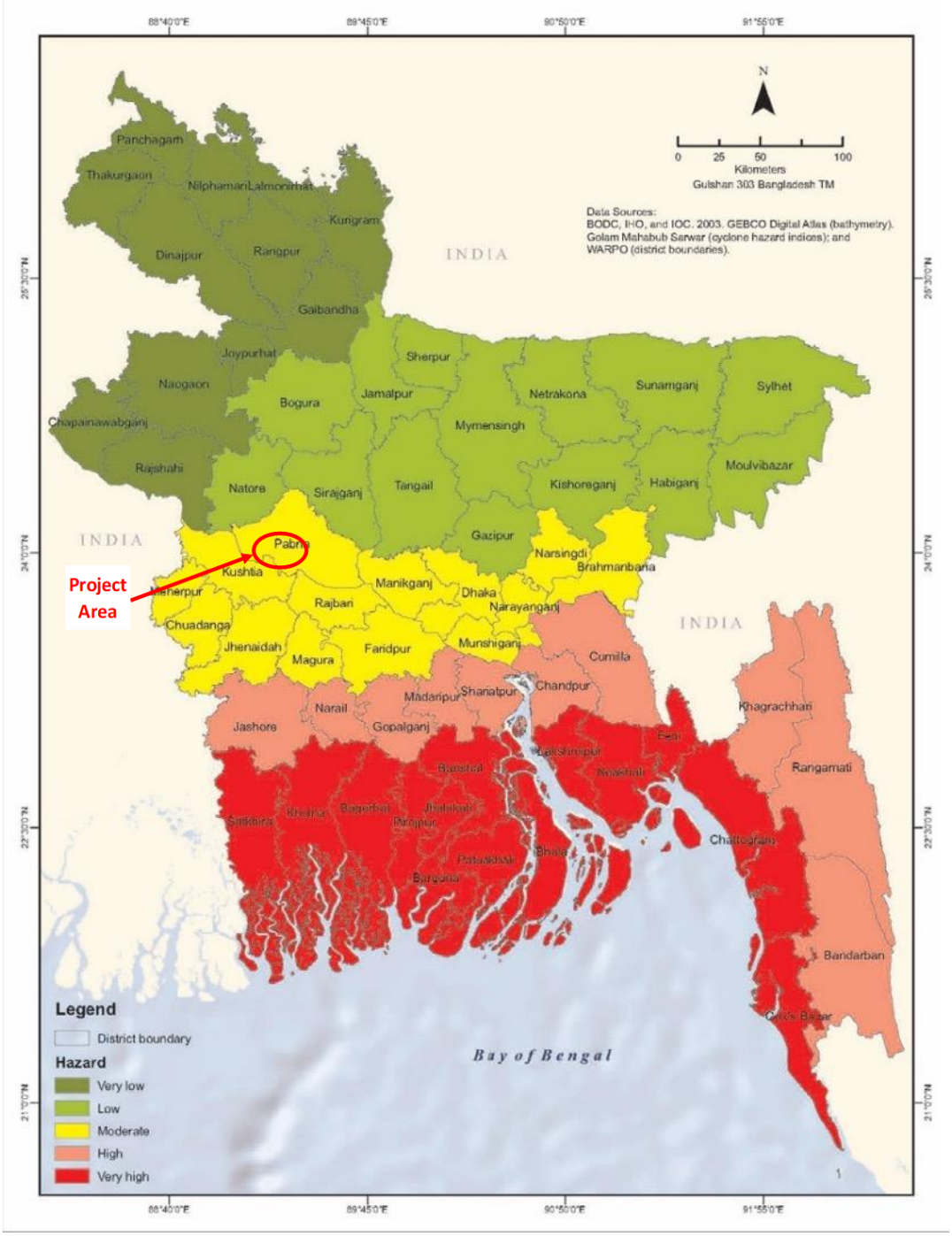


Bangladesh Agricultural Research Council (BARC)

Figure 4.33: Flood Prone Areas of Bangladesh

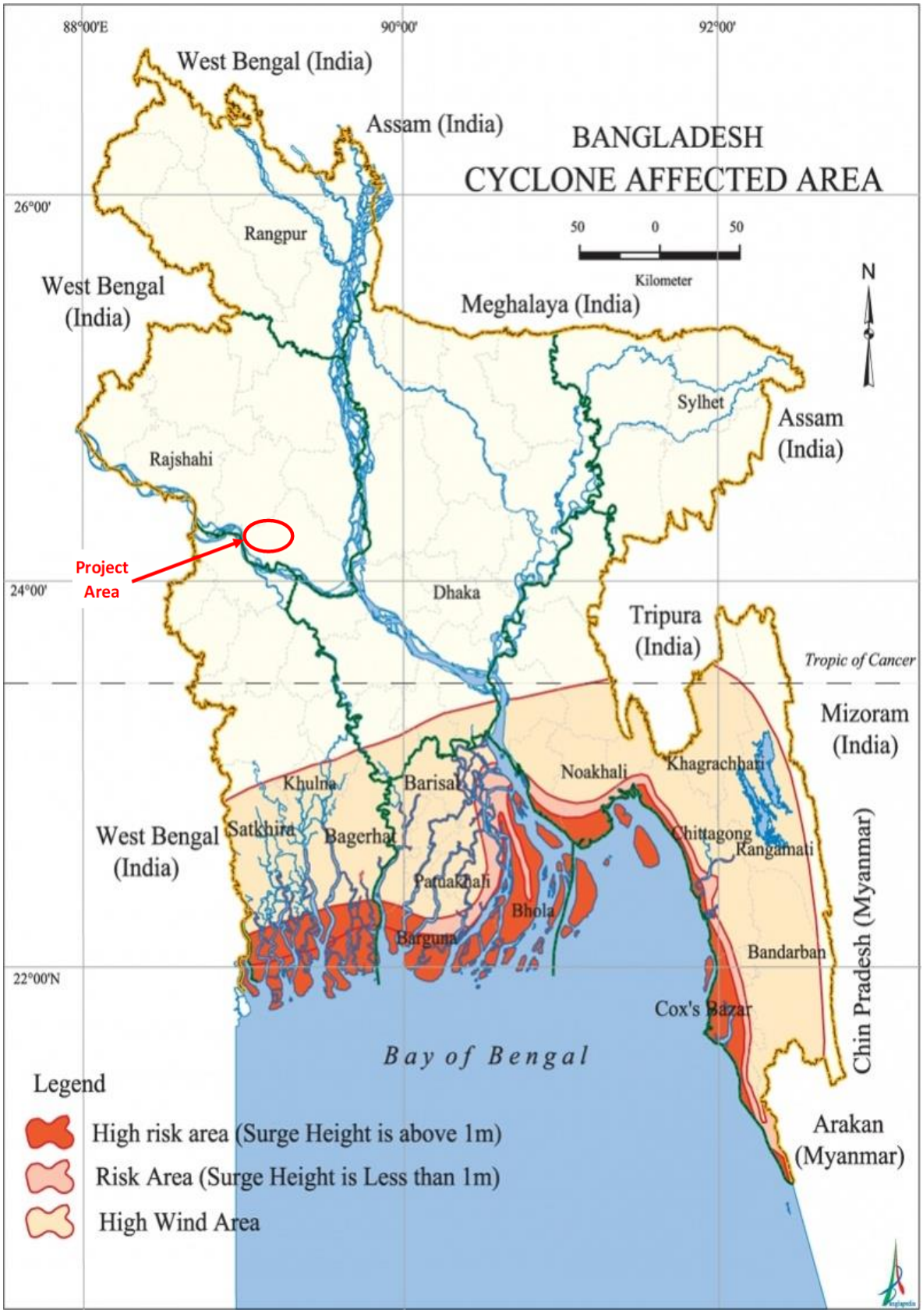
4.15.3 Cyclones

Bangladesh is one of the most cyclone prone areas on the earth. Devastating cyclones hit the coastal zones almost every year and are usually accompanied by high-speed winds, sometimes reaching 250 km/hr. or more and with 3 m to 10m high waves, causing extensive damage to life, property, and livestock. These cyclones usually occur in two seasons, April-May and October November – i.e., before and after the monsoon season. As per Cyclone Affected Area Map of Bangladesh shown in **Figure 4.34**, the project site is risk-free cyclone prone area.



(Bangladesh Climate and Disaster Risk Atlas, Volume 1, December 2021)

Figure 4.34: Cyclonic Storm Tracks in Bangladesh



(SPARRSO)

Figure 4.35: Cyclone Affected Area Map of Bangladesh