Bangladesh – India Friendship Power Company (Pvt.) Limited
(A joint Venture of NTPC Ltd and BPDB)

Monitoring of environment parameters and implementation of Environmental Management Plan during pre-construction and construction period along with Engineering Activities for site development of Khulna 1320 MW Coal based Thermal Power Plant




Second Quarter Monitoring Report of Third Year (2016)

Monitoring Period: May 2016 – July 2016

August 2016

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Abbreviations and Acronyms

AECL	Adroit Environment Consultants Ltd
AAS	Atomic Absorption Spectrophotometer
BIFPCL	Bangladesh-India Friendship Power Company (Pvt.) Limited
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BCSIR	Bangladesh Council of Scientific and Industrial Research
BUET-BRTC	Bangladesh University of Engineering and Technology- Bureau of Research, Testing and Consultation
CEGIS	Center for Environmental and Geographic Information Services
COD	Chemical Oxygen Demand
CPUE	Catch per Unit Effort
DO	Dissolved Oxygen
DoE	Department of Environment
DPHE	Department of Public Health Engineering
dBH	Diameter at Breast Height
EC	Electrical Conductivity
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
FGD	Focus Group Discussion
FGD	Flue Gas Desulfurization
FSR	Fisheries Species Richness
GoB	Government of Bangladesh
GIS	Geographic Information System
GPS	Global Positioning System
HS	Household Survey
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
IFC	International Finance Corporation
Kg	Kilogram
KII	Key Informants Interview
MoPEMR	Ministry of Power, Energy and Mineral Resources

MW	Mega Watt
NTPC	National Thermal Power Corporation
OHSAS	Occupational Health and Safety Management Systems
PCU	Passenger Car Unit
PGCB	Power Grid Company of Bangladesh Ltd
PMU	Project Management Unit
PRA	Participatory Rural Appraisal
PWD	Public Works Datum
QMR	Quarterly Monitoring Report
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SRDI	Soil Resources Development Institute
SRF	Sundarbans Reserve Forest
TDS	Total Dissolved Solid
TH	Total Hardness
ToR	Terms of References
TSS	Total Suspended Solid
U.S.EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

Unit

dB	Decible
ppm	parts per million
ppt	parts per thousand
hr	Hour
Kg	Kilogram
Km	Kilometer
KW	Killo Watt
m	Meter
mg	Milligram
ton/year	Ton Per Year
MW	Mega Watt
Nm	Normal Meter
s	Seconds
KV	Kilo Volt

Unit Conversion Table

General Units

1 meter = 3.2808 feet

1 kilometer = 0.621371192 mile

1 kilogram = 2.20 pound

1 metric ton = 1000 kg

1 square mile = 640 acres = 2.590 km2

1 hectare = 10-2 km2 = 2.471 acres

1 pascal = 1 N/m2= 0.01 millibar

1 liter = 0.001 cubic meter

1°C = 274.15K=33.8°F

1 mg/m3 = 1 µg /L

1 mg/L ≈1 g/m^3≈1 ppm (w/w)

Energy Unit

1 KWh = 3412 Btu

1MW=1000KW=106 W

1 KWh = 3.6 x 10 6 J

1 kWh = 859.85 kcal

1 horsepower = 746 W

1 GWyr = 8.76 x 10^9 kWh

Glossary

Aman:	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus:	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
B:	When preceding a crop means broadcast (B. Aus)
Bazar:	Market
Beel:	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Boro:	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Haat:	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Gear/Jaal:	Different types of fishing net to catch fish from the water bodies.
Kutcha:	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal:	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
Kharif:	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Perennial Khal:	Water available in the khal all the year round.
Pacca:	Well constructedbuilding using modern masonry materials.
Rabi:	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
Seasonal Khal:	Water not available in the khal all the year round.
T. *Aman*:	When preceding a crop means transplanted (T. Aman).
Upazila:	Upazila is an administrative subdivision of a District.

Executive Summary

This is the tenth Quarterly (2nd quarter of the 3rd year) Environmental and Social monitoring report covering status of different environmental and social parameters including environmental compliance related monitoring in regard to EMP of ongoing pre-construction activities. The report represents the period from May to July 2016 and accordingly CEGIS has carried out the monitoring activities in July, 2016 comprising of the monitoring of implementation of Environmental Management Plan (EMP) and Environmental Compliance with the environmental parameters such as ambient air quality, noise level, water quality and Land resource condition, fisheries resources which coves fish habitats, migration and production, Ecosystem monitoring and Sundarbans forest health monitoring.The status of environmental compliance in regard to the EMP (provided in the EIA) summarizes the assessment of the effectiveness of the recommended mitigation measures and also to identify any further need for additional mitigation measures or remedial action associated with pre-construction and construction phases of the project. In regard to the project progress it revealed that the land development for the BIFPCL's site (Block A) has been completed under pre-construction phase. Construction of the embankments and slope protection work are about to complete. Site office construction has been continuing. At present, the construction of main access road from Babur Bari to the Plant site is in progress. In general, in this quarter, the environmental due diligence covers: the Environmental Management System and Action Plan, Occupational Health and safety, workers' well being, Biodiversity and Sustainable Management of Natural Resources. The monitoring study found that BIFPCL has been complying with the EMP as suggested in the EIA report with few exceptions such as implementation of safe work procedures at project site, updating of safety equipment at project sites, employment of site specific EHS Officers etc., which are stipulated in the pre-construction (Land development) stage, and has planned to take the preparation to meet the compliance requirements to the next stages. However, as per the EMP approved by DoE and being the Environmental Monitoring Consultant of the Project, CEGIS makes a few Site Specific Measure(s) that should be complied for ensuring environmental and social safeguarding of the Project, such as, demarcation of traffic way and taking precautionary measures like using proper road signs; temporary drainage for rain fall runoff should be constructed and sediment fences/traps need to be maintained to prevent sediment wash load to Maidara river; stockpile of construction materials should be placed at a safe distance from river bank; sufficient waste disposal bins need to be placed at the labor shed, and working area.

The HR policies which are under preparation shall include: Working Conditions and Management of Worker Relationship, labor policy, Occupational Health and Safety Policies, and worker's well beings following OHSAS 18001, ISO 14001; establishment of the grievance redress mechanism ; proper documentation of any accident/incident or any health hazard risk issues needs to be recorded; preventive measures for near miss accidental events and any unforeseeable injury, illness, or damage shall be adopted; an officer responsible for enforcing and monitoring safety procedure shall be appointed; site specific ESMP shall be prepared by the EPC contractors; safety training program for the Project personnel and labor force shall be arranged.

Air quality monitoring inferred that the wind flowed from South-Southeast to North-Northwest direction. The weather condition was mostly rainy, cloudy with little storms and gust of wind. This time all the ambient air quality monitoring parameters (SO_2, NO_2, $PM_{2.5}$, PM_{10}, CO and

O_3) are found within the standard limit. Newly developed land for industrial activities along the Passur River, loading-unloading activities and cement industries are the known sources of $PM_{2.5}$, PM_{10}andSPM in this area. Other pollutants are generated from the commonly known sources like the vehicles (human hauler/ Nosimon) while working beside the roads; whereas in case of the monitoring spot in or around the waterways, the sources are engines of trawler, barges, ship etc.

The overall observation in regard to noise generation sources at the current stage in the Sundarbans, industrial areas and other locations in the vicinity of the project area are natural and anthropogenic as well. The natural domains are mainly birds' chirping, stormy wind, wave breaking on the shoreline and howling of leaves. On the other hand, traffic mobilization, industrial activities, vessels movement within the rivers and local vehicles are the salient sources of noise generation. Nevertheless, all the average day time noise level data are relatively closer or within the standard limits. In the Sundarbans, noise level has been found within the threshold at all the sampling points during this monitoring period (**2nd quarter** monitoring **of 3rd year**, i.e., July, 2016) and it warns that any additional anthropogenic noise producing activities will cross the noise level.

In continuation of the monitoring study, this time in July, 2016 water samples were collected from all the earlier locations (14 locations for surface water and 3 locations for ground water analysis) except in Hiron point due to the bad weather condition. The samples have been submitted to DPHE and BCSIR for laboratory analysis. This monitoring report contains laboratory reports of the last monitoring study (April, 2016) and in-situ monitoring results of this quarter. The analyzed results of all parameters are found within the standard limit set by ECR' 1997and are found to be minimal in concentrations comparing to the results previous season (mention what are the other season. However, similar to the earlier year, spatial and seasonal variation is still present for the analyzed parameters. For example, the values of TDS are found very high comparing to the last monitoring period. This may be due to the lack of fresh water flow from upstream and the erosion accretion process of the said river system.

It was found from the laboratory analysis report of dry season (insert time period…) of 2015-16 that the status of EC, pH, OM, N, P, K, S, Ca, Na, B, Fe, Zn, Mn and Pb concentration is higher than the previous wet season in all locations. But, EC of Baranpara observed lower than the previous dry and wet season. In contrary to that the Mg level decreases from the aforementioned period. However, Concentration of Pb in the leachate is not exceeded the GOB permissible limit. By comparing the heavy metals analysis data, Pb belongs to not polluted category.

Fisheries resources have been monitored at the same locations for seven capture and three culture sampling sites as of earlier quarter monitoring. The following are the key findings of the monitoring in 2ndquarter of 3rdyear (2015-16). Yearly Changes in habitat uses has also observed in the fourth quarter monitoring (as compared between the year of 2014-2015 and of 2015-2016) caused mainly due to having tidal effect, seasonal variability and also fisheries resource management. Moreover, through analyzing the types of habitat usage by different ages of various fish species (on the basis of the length-based community structure model), mainly two types of habitats have been found: i) Nursery ground and ii) Feeding and Breeding ground. Shannon-Weiner index has also been observed which shows variation between 2nd quarter of 2014, of 2015 and of 2016. The highest index has been found at Chalna Point (0.87). On the contrary, the lowest evenness has been found at Mongla Point (0.5). Moreover, maximum FSR was recorded at Mongla Point (n=7), while very low FSR was recorded in Maidara sampling sites (n=2). Furthermore, very rough weather especially in the downstream of the Passur River (inside the Sundarbans) is expected to be a major cause of the spatial and

yearly variation for both the evenness and richness of fish species. Fry for fin fish were more widely distributed among the middle stretches of the Passur River. Among these Bagda, Bele, Ekthuto and Paissa fishes were widely distributed. Moreover, brood female fish of Tapsi in Maidara and Chalna Point have highly observed in this quarter. Fish species like Potka and Bele attained the maximum abundance among the migratory fish species. Moreover, three species like Tapsi, Poma and Pheksa showed long range of distribution. The farms under this monitoring program at Rajnagar and Kapasdanga collected Bagda fry from both the wild (Passur) and hatchery (Namira and Sonar Gaor at Chalna) and another farm of Chunkuri-2 also collected Bagda seed directly from Passur River. Both growth and mortality rate has been observed highest at the farm in Kapashdanga. The highest productivity has been found in Sheola Khal at Chandpai and the lowest in the Mongla-Passur River Confluence because of the abundance of fries which are not considered as the production. Moreover, higher productivity was observed in this second quarter of 2016 compared to the second quarter monitoring of the year 2014 and 2015. The most frequently used gears are Ber Jal in upper reach and Charpata Jal in lower reach of the Passur River. Furthermore, the total catch is higher in this monitoring year than that found in the first monitoring year. In case of shrimp/fish firm, the highest fish production has been found in the Gher of Kapasdanga and lowest in Chunkuri-2.

Plant canopy cover, bird habitat, butterfly occurrences, dolphin occurrence and status of benthos and zooplanktons in river water have been monitored for this monitoring season. Canopy status of homestead vegetation under this monitoring programme has been increasing than last monitoring season' This change has been happened due to more foliage growth of tree in rainy season and also for growth of planted saplings in homestead platforms. Coverage of living lichen on tree barks have been observed slightly higher in Rajnagar and Chalkghona sites and major coverage occurred on *Excoecaria agallocha* bark. A total of 20 bird nests composed of Little cormorant, Little egret and Great egret have been observed in Rajnagar and Chalkghona sites. Number of nests recorded more than the same season in previous year (Aug 2015). This happened due to expand canopy and increase of height of the nesting trees and also for the damages of trees from the nearer homesteads where these local birds are usually nested in each season. Occurrence of butterfly is recorded less than previous monitoring period (insert period…) for hindrance of this flying arthropod due to heavy rainfall and high moisture. Dolphins have been sighted at Passur River and dhangmari khal and most of which are centered inside the Maidara khal and Dhangmari khal. Beside this, Ganges River Dolphin was also found at Passur River near Karamjal and Harbaria. The observed benthos and zooplankton were recorded three classes in each major group from the collected sample in January 2016. Sample of benthic community have also been collected in this monitoring tier which will be incorporated in next quarterly monitoring report.

The Sundarbans Reserve Forest health has been monitored at four permanent sample plots (under this monitoring programme. In this regard, six indicators (Seedling Density, Pneumatophores Density, Crab hole Density, Canopy Cover, Leaf Area Index and Lichen Coverage) have been observed. The observed indicators have been compared with previous findings. Mangroves are dynamic ecosystem and forest health monitoring indicators are interlinked with each other. After comparing the monitoring results, it can be predicted that the changing trend for most of the indicators of forest health in SRF is related to spatial and temporal variation ' The temporal variation is distinctive by season like from monsoon to post monsoon period, seedlings' and pneumatophores' density are high whereas at dry period they are low. The indicators even show variation among the monitoring sites (PSPs) that could be due to the different physical environment for respective locations. The continued survey will help to establish a baseline on Sundarbans forest health monitoring indicators.

1 Introduction

1.1 Background

1. This study report aims to carry out the monitoring of the recommended different environmental and social parameters, and environmental compliance monitoring of pre-construction activities for this quarter **(2nd quarter of 3rd year)** for the proposed **1320 MW Coal based Thermal Power Plant** being constructed at Rampal, Bagerhat.

2. The proposed Plant is a joint venture project of Bangladesh Power Development Board (BPDB) and National Thermal Power Corporation (NTPC) Ltd., India as per the contract signed in January, 2012 and run by Bangladesh-India Friendship Power Company Ltd. (BIFPCL).

3. The proposed coal based thermal power Plant falls under the Red category project as per ECA, 1995 and the subsequent rules ECR, 1997, and therefore, need Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from Department of Environment (DoE). To that end, BPDB engaged Center for Environmental and Geographic Information Services (CEGIS) with the responsibility of conducting Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) studies under a Contract signed on 13thJuly, 2010 between BPDB and CEGIS.

4. Accordingly, CEGIS has conducted detailed EIA study in mid 2013 encompassing a rational study area which is also ecologically very important by virtue of the existence of the world's largest single tract of Mangrove Forest, the Sundarbans with remarkable biodiversity in this area. As per the scope of EIA study, a detailed Environmental Management Plan (EMP) has been developed suggesting mitigation, enhancement, contingency, and compensation measures that shall duly be implemented during project preconstruction, construction and operation phase in order to minimize the negative impacts.

5. Successful implementation of the EMP depends on regular monitoring of the selective indicators at specified locations. Therefore, an independent environmental monitoring team has been proposed under the Department of environmental health and safety. Moreover, compliance monitoring has been suggested mandatory for this Project due to the presence of the Sundarbans. It has also been recommended that the environmental monitoring officer/agency should monitor the EMP implementation and submit a quarterly report to the concerned department.

6. Subsequently, BIFPCL has initiated a study on monitoring environmental and social parameters and implementation of EMP during pre-construction and construction phases of the proposed Thermal Power Plant to safeguard the environment of the Sundarbans Mangrove Forest and the surrounding communities. CEGIS has been engaged for carrying out the study since early 2014 and will continue till early 2017 over a span of three (3) years.

7. The location of the proposed project encompasses Sapmari Katakhali and Kaigar Daskati Mauza of Rajnagar Union under Rampal Upazila of Bagerhat district (**Map 1.1**). The Power Plant lies in between latitude 22˚37'0''N to 22 ˚34'30''N and longitude 89˚32'0''E to 89˚34'5''E and is about 23km south from the Khulna City and 14 km in the north-west direction from the Sundarbans. Location of the study area and their relative distance from various heritage sites are presented in Map1.1. The study area includes: i) area covering 10 km radius from the Plant location, ii) 10km strip from both bank of Passur and Sibsa rivers starting from the Plant site to Hiron point (**Map 1.2**).

8. The results of all the monitoring are reported quarterly to BIFPCL through monitoring reports. Eventually, BIFPCL submits these reports to DoE and Forest Department. Accordingly, CEGIS has so far submitted nine (9) monitoring reports on quarterly basis. The current document constitutes 10th monitoring report (i.e. monitoring activities of the 2nd quarter of 3rd year); the field study has been carried out in July 2016 covering Project monitoring locations, and the generated report upgrades the environmental monitoring database up to date.

1.2 Objectives

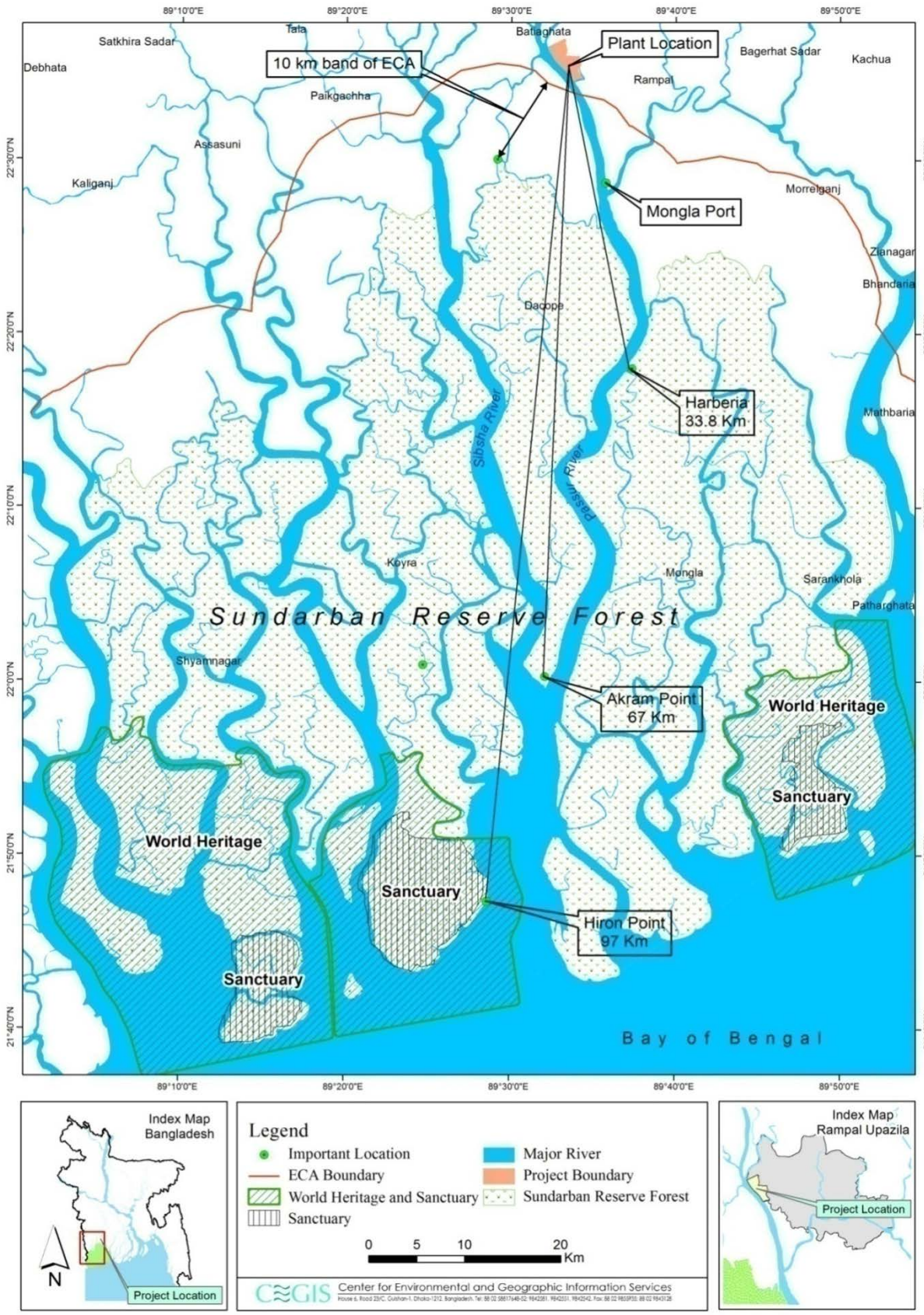
9. The overall objective is to monitor the environmental parameters and implementation of Environmental Management Plan (EMP) during pre-construction and construction phases of the installation of the Power Plant.

10. The aim of the quarter monitoring is to monitor the ambient state of environment that will be considered as the baseline and will later be compared with the environmental condition in future when the Power Plant will be in operation phase. The monitoring activities also include monitoring of environmental compliance of the power plant's pre-construction activities.

1.3 Criteria for Selection of Monitoring sites/locations

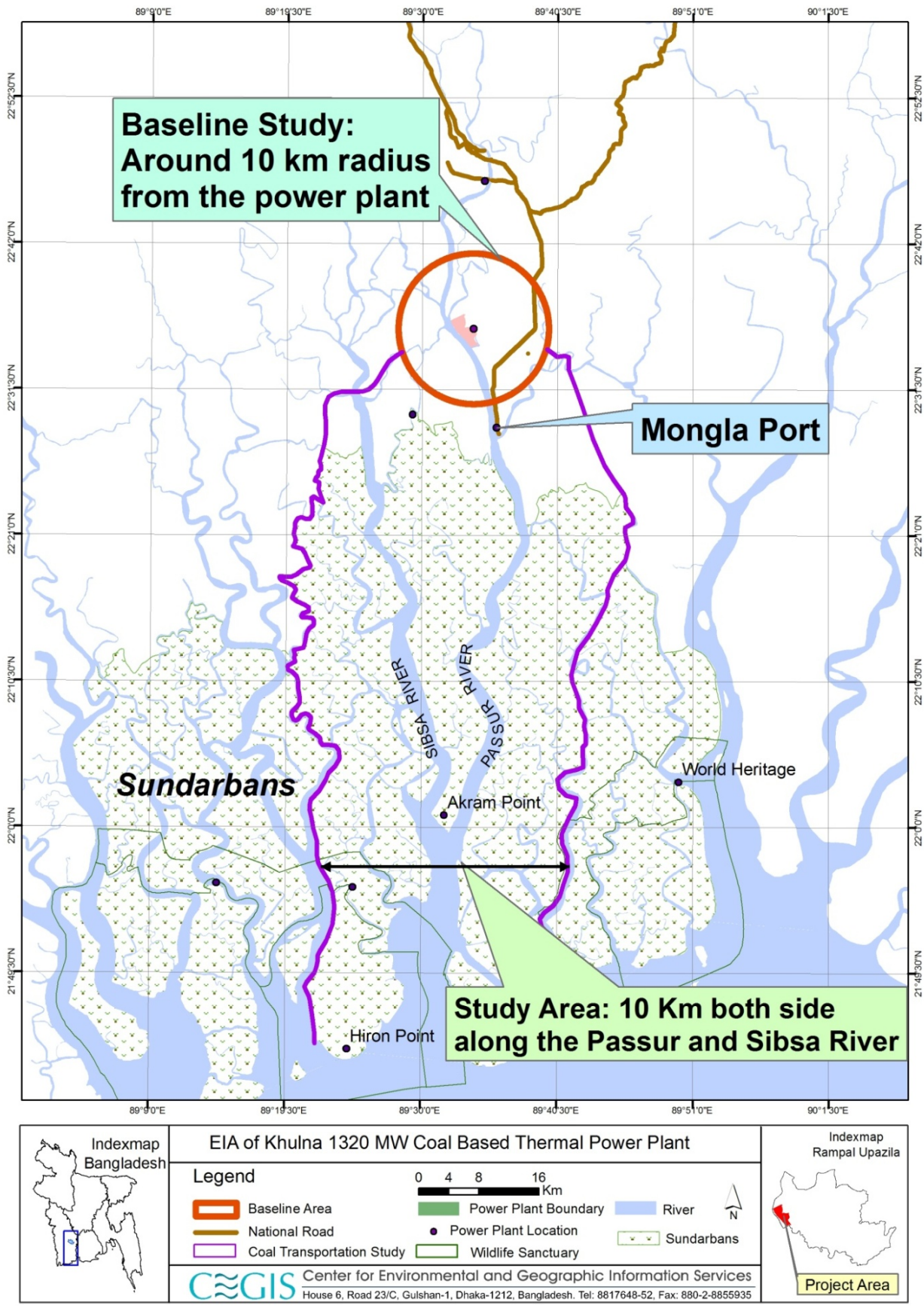
11. The monitoring sites have been selected considering the sensitive receptors and the ambience likely to be impacted from the Project related activities.

- Monitoring locations for ambient air quality are selected considering the wind direction, sensitive receptors in the vicinity of the Project etc. Site selection for monitoring of ambient noise condition also considers the same as for Air quality.
- Sites for ambient water quality are selected by considering the water sources likely to be impacted/ polluted by the project activities.
- Monitoring sites of fisheries resources covers the fish habitats, biodiversity, migration and production zones likely to be impacted.
- Monitoring locations of ecosystem and biodiversity have been selected considering the induced impacts of the Project.
- Sundarbans forest health Monitoring locations (PSPs) have been selected in view of the potential access routes for Power Plant which may have impacts on Sundarbans Reserve Forest (SRF).



Map 1.1: Location Map of the Coal Based Thermal Power Plant

CEGIS



Map 1.2: Area under the Interest of Environmental and Socio-economic Monitoring

1.4 Main stakeholders

Forest Department

12. The monitoring of the study area includes some locations in Sundarbans that needs to comply to the conditions set out by the DoE in the approval of EIA report. Hence, permission from the Forest Department is necessary to carry out monitoring activities in the Sundarbans.

13. The Forest Department has issued the permission of carrying out monitoring activities in the Sundarbans under certain conditions that include keeping close communication with Forest Department, submitting the monitoring report to Forest Department and including the following activities in the monitoring study:

- Inclusion of soil scientist and a botanist in the monitoring team,
- Monitoring of regeneration, ingrowths (seedlings), diseases and pests (if necessary carry out laboratory analysis),
- Monitoring of soil nutrients (macro, micro) and heavy metals,
- Monitoring of floral diversity, species richness and dominancy,
- Measurement of carbon at above and below ground level,
- Assessment of impact on canopy cover, leaves phenology, flowers behaviour, pneumatophore condition.

14. The monitoring team has been formed as per the requirements of the Forest Department. BIFPCL also forwarded a copy of an earlier quarterly monitoring report to the Chief Conservator of Forest, Bangladesh Forest Department, Agargaon, Dhaka and Conservator of Forest, Khulna Circle, Boyra, Khulna. Similarly, this monitoring report will also be forwarded to the Forest Department.

Department of Environment (DoE)

15. The monitoring plan, including indicators, location and schedule, has been prepared incorporating the suggestion(s) of the Department of Environment. Before initiating the monitoring study, a discussion meeting is held with experts of DoE to finalize the monitoring plan at CEGIS office.

16. The BIFPCL forwarded the monitoring reports and data to the DoE regularly. In addition, the BIFPCL officials along with the study team members of the monitoring study visited DoE office to inform them the progress of the study. The monitoring report are also being presented to the Environmental Clearance Committee of the DoE during the renewal of the EIA approval.

Bangladesh India Friendship power company (Pvt.) Limited (BIFPCL)

17. Bangladesh India Friendship Power Company (Pvt.) Limited (BIFPCL) is the project proponent. The monitoring plan has been prepared based on the conditions set by DoE which have been suggested in the EIA study. During field survey for baseline study, official(s) from BIFPCL has been assisting the study team from the beginning of the study. In addition, BIFPCL is implementing the environmental management plan (EMP) for ensuring environmental and social safeguarding of the project.

Bangladesh Power Development Board (BPDB)

18. BPDB is the main promoter of BIFPCL and is giving lateral support the BIFPCL in every phase (pre-construction, construction and operation) of the power plant. In addition, BPDB is also ensuring the environmental compliance monitoring of different stages of the power plant construction.

Local Community

19. The project affected peoples (PAPs) were included in the monitoring of social environment. The changes on important socio-economic parameters were examined based on the Focus Group Discussions (FGDs) and informal discussions with local people at different locations surrounding the project area as stated in the monitoring reports.

1.5 Study Scopes

20. In this study, the Physical, Biological aspect has been monitored on quarterly basis and the quarterly monitoring report is furnished in the subsequent chapters as such,

- Physical aspects would cover air quality, noise level, water quality and land resources
- Biological environment include fisheries resources, ecological resources, Sundarbans Reserve Forest (SRF) health conditions ;
- Environmental compliance monitoring includes Monitoring of Environmental and Social Management System Action Plan Implementation, Monitoring of labor and working conditions, Monitoring of community health, safety and security and monitoring of biodiversity and sustainable management of living natural resource.

2 Physical Environment

21. A number of physical environmental parameters including air quality, noise level, water quality, land resources and hydro morphology are monitored quarterly as per the monitoring schedule to establish a baseline.

2.1 Air Quality

22. The ambient air quality has been monitored in this 2nd quarter of 3rd year at 10(Ten) specific locations.

2.1.1 Methodology

23. Five (5) major air pollutants i.e., Particulate Matter **($PM_{2.5}$, PM_{10}, SPM), SO_X, NO_X, CO** and **O_3** are expected to occur from the proposed Power Plant in the ambient air which have been also considered for monitoring in this study. The locations for monitoring have been selected during the EIA study. In this context, eleven (11) sites have been selected based on a number of criteria e.g., the sensitivity of the receptors, project activities like coal-carrying vessel movement, transhipment point etc.; wind direction and atmospheric stability class. Moreover, the potential location of air pollution has been projected on the basis of model generated pollutant dispersion scenario. U.S. EPA approved regulatory air quality software SCREEN 3.0 has been used to select the location of potential pollutants which may be dispersed from the Power Plant. On the other hand due to the bad weather condition air quality could not be monitored in the Hiron Point of Sunderbans. However, in this part the monitored air quality of the remaining locations will be discussed comprehensively.

Method of Sampling and Laboratory Testing

24. Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550) have been used to collect the air sample. The $PM_{2.5}$, PM_{10}, and SPM have been tested by gravimetric method. The concentration of SO_x has been tested by West-Gaeke method. Likewise the NO_2 has been tested by Jacob and Hochheiser method.

Monitoring locations

25. Ambient air quality has been monitored in the same locations as monitored in the earlier quarters except at the Hiron point of Sunderbans due to the bad weather condition. The locations of the air quality monitoring points have been shown in **Map 2.1.1**. The details of the monitoring plan have been provided in the **Table 2.1.1.**

Pollution sources at Project area

26. The major pollution sources currently contributing to the ambient air pollution along the Passur River in between the Project site and Mongla Port are the existing infrastructures (i.e., cement and petroleum industries) and other pollution sources (i.e., marine vessels and residential sources) are listed in **Table A.2** of Appendix **IV.**

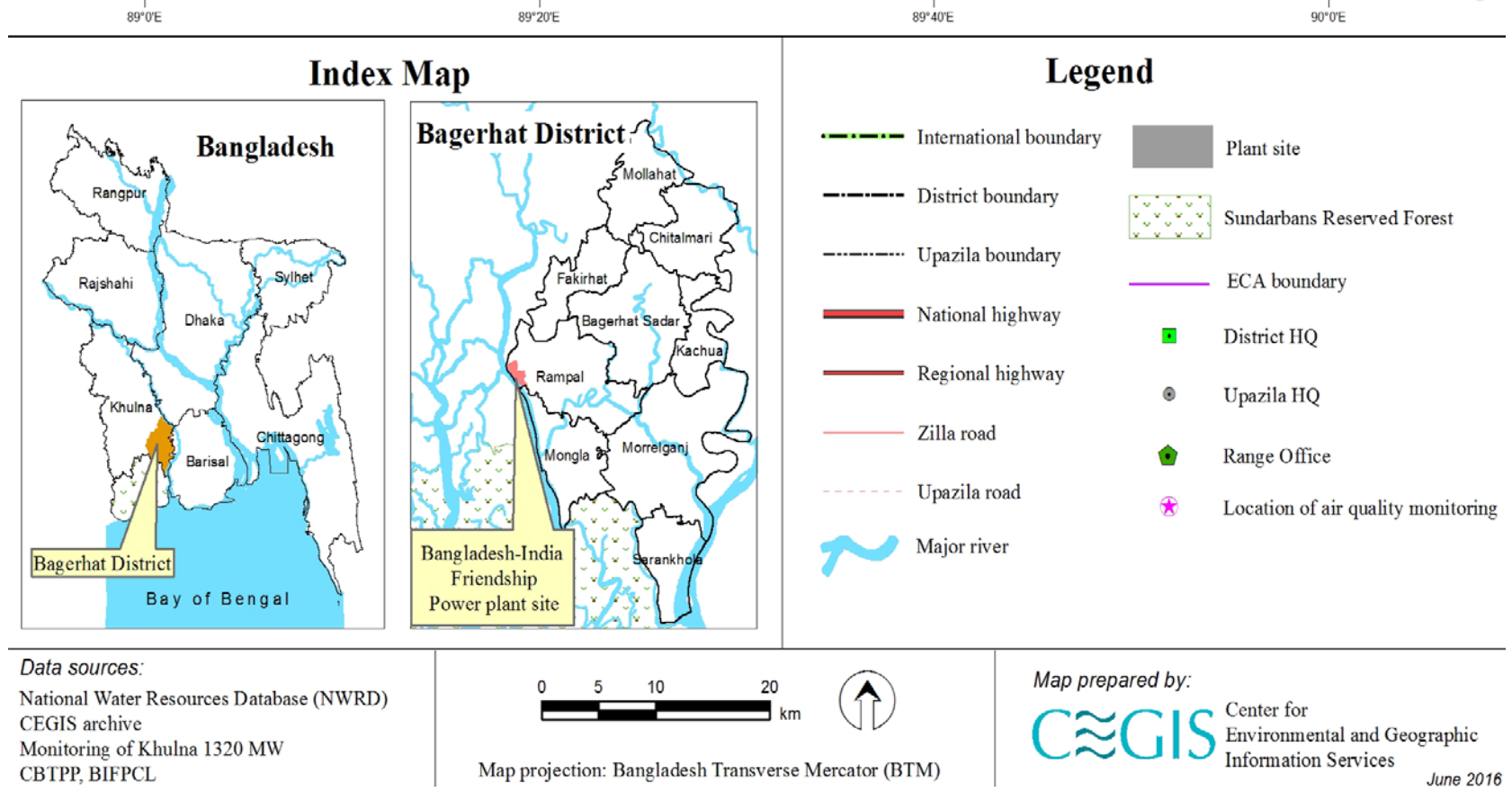
Pollution sources in the Sundarbans

27. Mostly river traffic of Mongla Port travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx) and Green House Gas (GHG).

28. An inventory of the existing emission types and sources in the study area have been provided in **Table A.2** of **Appendix IV**.

Table 2.1.1: Air Quality Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS Points	Frequency	Methods/Tools/Techniques
1	Particulate Matter ($PM_{2.5}$, PM_{10}, SPM) SO_X, NO_X, CO and O_3	South West corner of the Project boundary	89°33'34.5"E 22°34'33.8"N	Quarterly	In situ field measurement conducted with the facilities of outsourced laboratory. **Method of testing $PM_{2.5}$:** Gravimetric **Method of testing PM_{10}:** USEPA (1997) Method 201 or 201A (as appropriate) **Method of testing SO_X:** USEPA (2000) Method 6 or 6A or 6B or ISO (1998) Method 11632 (as appropriate) **Method of testing NO_X:** USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or ISO (1993) Method 10396 (as appropriate).
2		Proposed township area near Chimney location, Mauza: Sapmari Katakhali	89°32'3.8"E 22°36'32.5"N		
3		North West corner of the Project boundary (Kaigar Daskati)	89°33'51.8"E 22°36'1.06"N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89°34'37.7"E 22°38'51.8"N		
5		Chunkuri-2, Bajua Union (4km South West from the chimney location)	89°34'01.1"E 22°32'3.3"N		
6		Pankhali, Dacope, (4km North West from the Chimney location)	89°31'24.2"E 22°36'6.7"N		
7		Mongla Port Area	89°35'50.4"E 22°28'24.8"N		
8		Harbaria, Sundarbans	89°35'34.2"E 22°17'43.1"N		
9		Akram point, Sundarbans	89°30'54.1"E 22°'23.50"N		
10		Hiron Point, Sundarbans	89°27'53.2"E 21°46'27.60"N		
11		Khulna city near Khan Jahan Ali Bridge	89°35'35.5"E 22°46'36.8"N		



Map 2.1.1: Air Quality Monitoring Locations

2.1.2 Status of air quality

29. Air quality is expressed in terms of standards set forth for public health and welfare protection (against decreased visibility and damage to animals, crops, vegetation etc.). The current standards are listed below. Units of measurement for the standards are parts per million (ppm) by volume, and micrograms per cubic meter of air (µg/m^3).

Table 2.1.2: Ambient Air Quality Standards

Pollutant		Averaging Time	IFC/WB Standard	Bangladesh (DoE) Standard for ambient Air (ECR 2005)
Carbon Monoxide (CO)		1 hour	-	40 mg/m^3
		8 hours	10 mg/m^3	10 mg/m^3
Nitrogen Dioxide (NO_2)		1 hour	200 µg/m^3	-
		Annual	40 µg/m^3	100 µg/m^3
Ozone (O_3)		8 hours	100 µg/m^3	157 µg/m^3
		1 hour	-	235 µg/m^3
Particle Pollution (PM)	$PM_{2.5}$	24 hours	75 µg/m^3 (Interim Terget-1)	65 µg/m^3
	PM_{10}	24 hours	150 µg/m^3 (IT-1)	150 µg/m^3
	SPM	8 hours	-	200 µg/m^3
Sulphur Dioxide (SO_2)		24 hours	125 µg/m^3 (Interim target-1)	365 µg/m^3

Particulate Matter ($PM_{2.5}$, PM_{10} and SPM)

30. The values of $PM_{2.5}$ and PM_{10}have been found within the standard limit at each location. Among those locations, the maximum concentration of $PM_{2.5}$ (16µg/m^3) is found in the Khulna City, near Khan Jahan Ali Bridge which was the highest in this season comparing to the observed results of other location. Similarly, during this time of monitoring, PM_{10} and SPM concentration have been recorded also lower comparing to the same season of the previous years, which may be due to the prevailing rain at the sampling sites. Though a large number of two-stroke human hauler, small engine boats and the anthropogenic activities are experienced during the time of monitoring. In addition, cement industries and road traffic may also be considered as other source of the particulate matters. However, all the monitoring data are given in **Table A.1** in **Appendix IV.**

Sulphur Dioxide (SO_2)

31. Concentration of Sulphur dioxide in the ambient air is found within the Bangladesh standard limit of 365 µg/m^3. The SO_2 values in and around the Project ranged between 4 µg/$m^3$and 10µg/m^3 which are the lowest among all the monitored data. SO_2 concentration has also been measured in the Sundarbans reserve forest; the result indicates a low condition ranging from 4 to 6 µg/m^3.

Nitrogen Dioxide (NO_2)

32. NO_2 concentration in the ambient air of Sundarbans ranged between 5 µg/m^{3}and 8µg/m^3. In Project site and its adjoining areas, the values are found lower than the previous season and within the Bangladesh standard limit of 100 µg/m^3. The monitoring results are shown in **Table A.1**in **Appendix IV.**

Carbon Monoxide (CO)

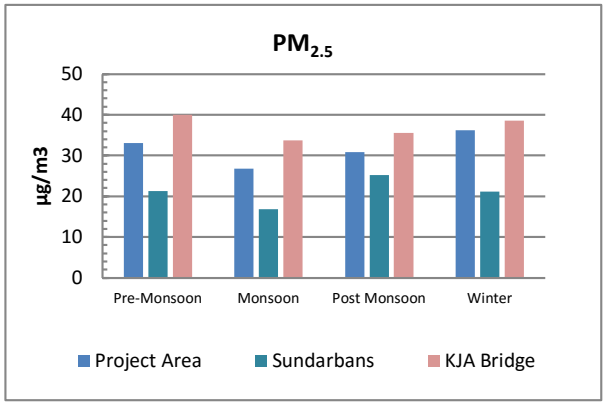
33. CO concentration is found in between 29 µg/m^{3}to41 µg/m^{3}in and around Project area. The possible causes for the CO concentration could be the movement of numerous types of vehicles in roads and boats in the river. However, most importantly the concentration in the Sundarbans ranges between 32 and 37 µg/m^3 which may be contributed by the ship's anchorage beside the sampling point and for the loading-unloading activity. The values are found very insignificant in the context of national standard (10,000 µg/m^3 for 8 hours).

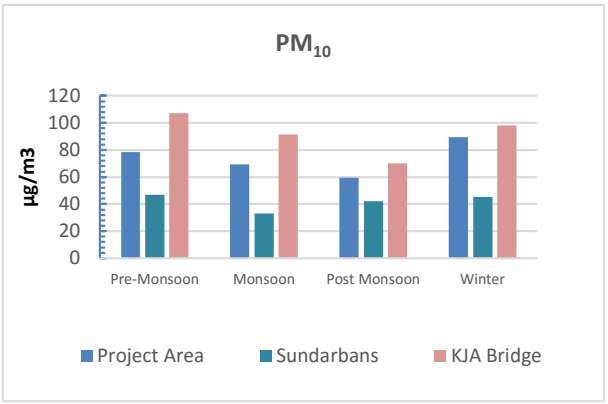
Ozone (O_3)

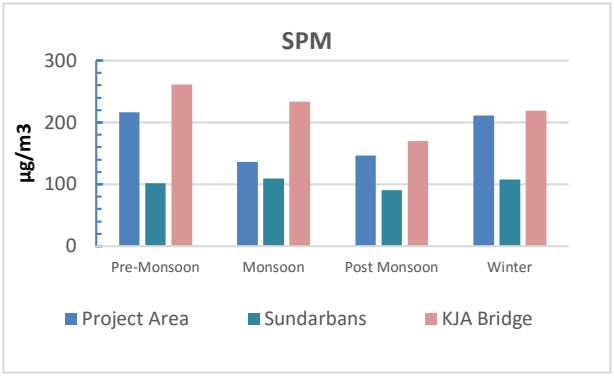
34. Similarly, results of O_3 both in the Sundarbans and Project area are lower (0 - 2 µg/m3) than the Bangladesh standards of 100µg/m3 for 8 hours. Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight.

2.1.3 Findings

35. All the air pollutant data satisfactorily comply with the national standards and showed lowest concentration in this season (monsoon). This may be due to the prevailing rain experienced in the monitoring sites and minimal movement of the traffics both in roads and river. (**Figure 2.1.1**).







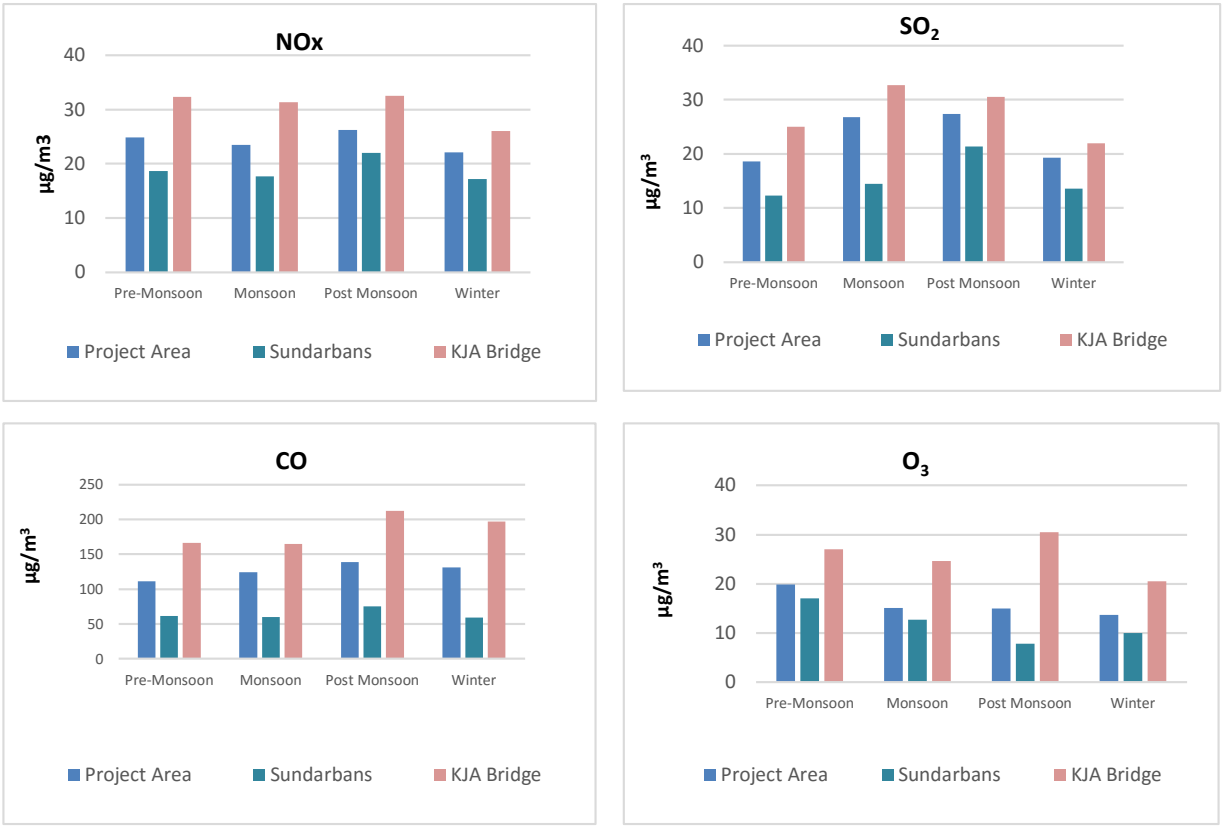


Figure 2.1.1: Seasonal variation of the Air Quality Parameters

2.2 Noise

36. Noise is sound that is not wanted by the perceiver, because it is unpleasant, loud, or interferes with hearing. By extension, in experimental sciences, "noise" refers to any random fluctuations of data that makes more difficult the perception of an expected signal. From a physics standpoint, noise is indistinguishable from sound as both are vibrations through a medium, like air or water. In general point of view, noise is the chaotic feeling of sound where many sound waves are mixed and difficult to distinguish a single signal.

37. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dBA). Noise is recorded through Noise Level (Sound Pressure Level) Meter for a certain period of time for determining the ambient noise level in the study area.

38. Noise levels have been monitored during 2014 (March, July, October), 2015 (January, April, August, October) and 2016 (January, April and July). Ambient noise levels have been monitored quarterly at ten (10) locations during this session. Hiron Point has not been monitored due to adverse weather condition. In this 2nd quarter monitoring of 3rd year, the noise level has been recorded at monsoon period.

39. The noise is generated from the common sources i.e., the rural vehicles (human hauler/ Nosimon, auto-rickshaw); whereas in case of the monitoring spot in or around the waterways, the sources are trawler, ship, sometimes waves breaking against the shore, etc. Barges, trawlers and ships are found plying over the waterway during this season.

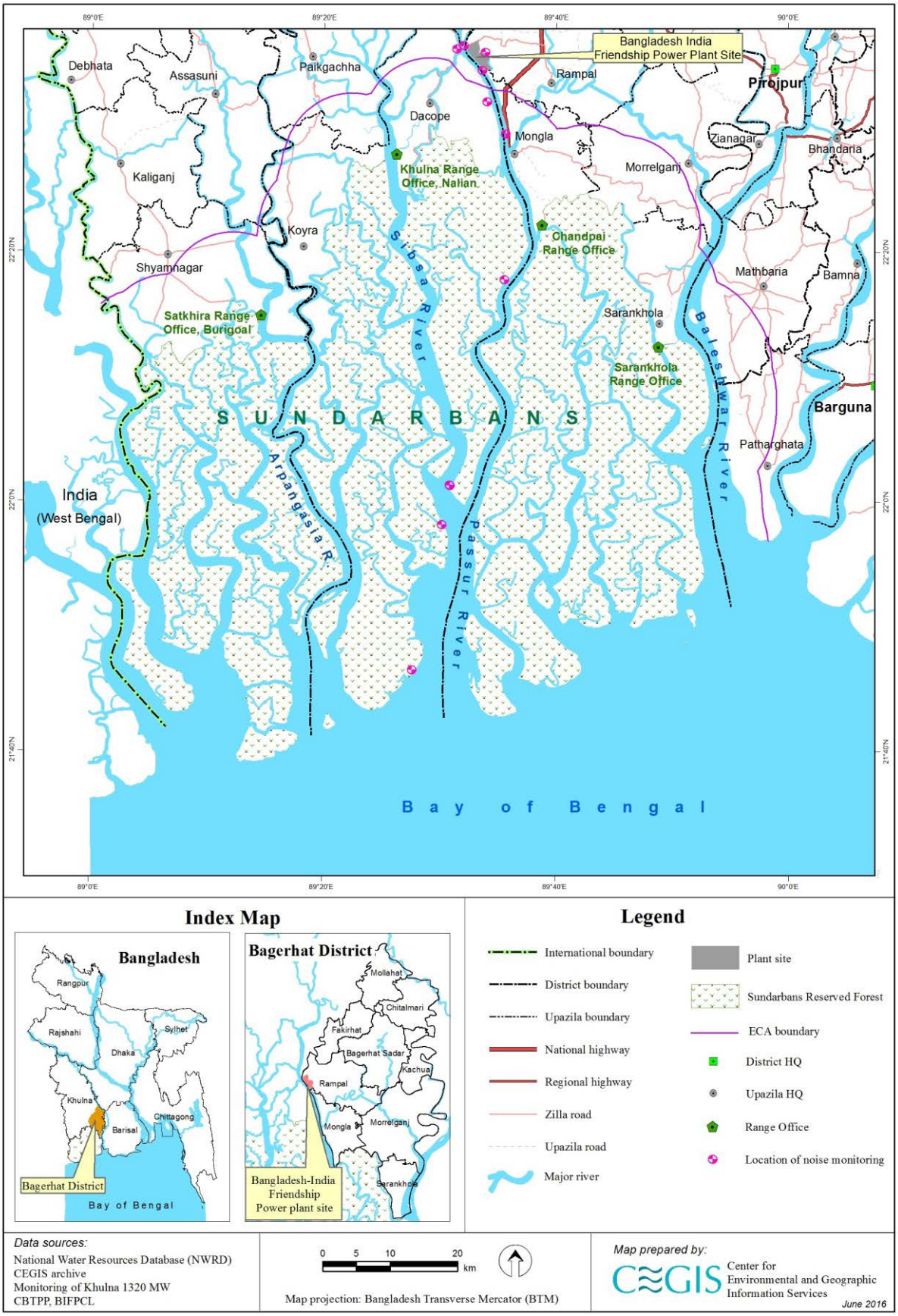
2.2.1 Methodology

40. Noise level has been measured thrice in a day (morning, afternoon and evening) at ten (10) locations. Each time noise level is recorded using portable noise level meter for a five minutes time span with a 30 seconds interval. Depending on the site condition and acoustic environment, the noise meter is set up and calibrated following the instruction manual. All the data are collected in Leq, L10 and L90 dBA values.

Locations of Noise level Monitoring

41. There are ten(10) locations for the noise level monitoring of which two locations are inside the Sundarbans, six locations are in and around the Project site, one is at Khan Jahan Ali Bridge on Rupsha River and one is at Mongla Port (**Map 2.2.1**).

Photo 2.2.1: Professional conducting an ambient noise acquisition survey



Map 2.2.1: Noise Level Monitoring Locations

2.2.2 Status of Noise

42. The brief summary of Noise level data is appended in the **Table 2.2.1**; but the detailed field Noise level data is attached to the **Table no. C1, C2** and **C3** in the **Appendix IV**. Ambient noise data have been recorded at the following places:

Dacope Upazila Parishad

43. The monitoring location is at Chalna Bazar [Pankhali, Dacope (4km North West from the Chimney location); 89.5234°E, 22.6046°N] which is a commercial area. According to the Environmental Conservation Rules (ECR) 1997, noise level standard for commercial area at day time is 70dB (A). The noise level has been recorded as 52.42 dB which is below the Bangladesh standard.

44. The significant noise sources at this place are road traffic and crowd. The road traffics are mostly from locally made engine van (locally called Nosimon), motor bike, easy bike (battery operated tri-cycle), etc.

North West Corner of the Project Area

45. The North West (NW) corner of the Project area [89.5334°E, 22.6093°N] is under Kaigar Daskati mauza of Gaurambha union. The monitoring location is nearby Gucchha gram (a cluster village built by the Government for the landless and homeless people). This area is residential and the standard is 55dB (A) at day time (ECR, 1997). This time the average day time noise level has been recorded as 52.65 dB, which is nearly similar to the day time standard value.

Chunkuri-2, Bajua

46. This area [4km South West from the chimney location, 89.5669°E, 22.5342°N] is residential and the standard is 55dB (A) at day time (ECR, 1997). Noise levels in two consecutive years are found abrupt and fluctuating around the day time. During this time (July, 2016), it is found to be 53.4 dB which is very close to the standard value. It is observed that the sound level has a fluctuation about 8.91 dB in this monitoring season than that of last monitoring season. The noise sources are rural road traffic and crowd. The road traffics are mostly locally made engine van (called as Nosimon), motorcycle, bicycle, van, etc.

South West corner of the Project area

47. The South West corner of the Project area [89.5601°E, 22.5761°N] is in Maidara Khal of Rajnagar union. This area is residential and the standard is 55dB (A) at day time (ECR, 1997). The noise level is found much higher (65.37 dB) than the standard value. Frequent movement of water vessel over the Moidara Khal is one of the main reasons for exceeding the standard value.

Proposed township area of the Project

48. The proposed township area, Sapmari [89.5644°E, 22.6005°N] of the Power Plant is located at the middle of the eastern portion of the Project area. This area is residential and the standard is 55dB (A) at day time (ECR, 1997). Compared to the previous quarterly monitoring data collected in the 1stand 2nd monitoring year, the noise level of the last couple of quarters is found considerably higher (53.77 dB, 53.37dB, 55.79 dB) in level and this is due to accelerated construction works in the area but within the day time standard.

Barni, Gaurambha

49. This area [4km North East from the chimney location; 89.5772°E, 22.6477°N] is both residential and commercial and the standard for a mixed zone is 60dB (A) at day time (ECR, 1997). The noise level is found 56.75 dB during this monitoring season(July, 2016) which is still lower than the standard value but it shows an increasing trend compared to the previous monitoring years and this changing trend may be due to the gradual increasing of different human activities like establishment of new homes, shops etc. The traffic load and crowd are higher than most of the past which has also accelerated the increase of the noise level.

Khan Jahan Ali Bridge, Khulna

50. The monitoring location is close to the toll booth of Khan Jahan Ali Bridge, Khulna [89.5935°E, 22.7779°N]. This area is considered as commercial due to activities around the bridge side and the standard for the commercial area is 70dB (A) at day time (ECR, 1997). The average noise level is found 63.77 dB which is below the standard of day time. The highway traffic is the main source of noise. The highest noise level has been recorded both in the morning and evening due to higher traffic load.

Mongla Port area

51. The monitoring location [89.5936°E, 22.4916°N] is at Khulna-Mongla highway, 200m northward from the main entrance of the Mongla Port area. The area is industrial and the standard for the industrial area is 75dB (A) at day time (ECR, 1997). The average day time noise level is found lower (52.86 dB) than the standard. The sources of noise are mostly road traffic (heavy vehicles, light vehicles, Nosimon, etc) and noise from Mongla Port activities (crane, ships, etc.).

Harbaria, Sundarbans

52. Harbaria area of the Sundarbans is very critical considering the richness of biodiversity. The area is important navigation route for Mongla Port Area. Most of the sea going vessels is used to anchor at this site for lighter age operation. The area is under silent class of noise standard and standard of ambient at day time is 50 dB (A) (ECR, 1997). The noise level is 52.90 dB measured at 100m inside the forest on the right bank of the Passur River [89.5926°E, 22.2968°N] to avoid the disturbance of noise from wave breaking against the shore and is found higher than day time standard value. This relatively higher value is for the higher wind action on this day

53. Distant ship movement, running engines of anchored ships, wind, birds, wave and wind action on tree leaves are the main sources of noise.

Akram point, Sundarbans

54. Akram Point of the Sundarbans is another biodiversity hot spot in the Sundarbans. This area has been selected for anchorage point of coal carrying mother vessel for the Power Plant. This area is also under the silent class where the ambient day time noise standard is 50 dB (A). The monitoring location [89.5152°E, 22.0219°N] is at the left bank of the Sibsa River.

55. Noise is recorded at about 100m inside the forest from the river bank to avoid noise from wave breaking. The average day time ambient noise level during this monitoring period is found to be 47.96 dB which is within the standard. Birds' chirping, stormy wind, wave and tree leaves are the main sources of noise here.

Hiron Point, Sundarbans

56. This noise sampling location [89.4614°E, 21.7755°N] falls under the demarcated area of World Heritage Site. Noise level is measured at the western bank of Passur river mouth and eastern side of the Sundarbans South Sanctuary. This location is highly important as the Mother vessels enter into the Passur river adjacent to this point. However, the river is roughly 5-6 km wide between two banks at the confluence point. But due to adverse weather condition measurement has not been done in this season

Table 2.2.1: Summary of the ambient noise recorded in consecutive 9 Quarter monitoring sessions in 2014, 2015 & 2016

Sl No.	Location	QM1 Mar-14	QM2 Jul-14	QM3 Oct-14	QM4 Jan-15	QM5 Apr-15	QM6 Jul-15	QM7 Oct-15	QM8 Jan-16	QM9 Apr-16	QM10 July-16	Std*
1	Chalna, Dacope	68.13	52.87	54.63	53.28	57.08	49.77	65.12	66.07	65.08	*52.42*	*70*
2	NW Corner of the Project area	51.89	*NM*	41.92	35.25	44.67	41.56	41.94	50.96	50.79	*52.65*	*55*
3	Chunkuri-2, Bajua	57.76	52.55	51.39	49.29	47.05	40.66	47.43	53.62	44.49	*53.4*	*55*
4	SW corner of the project area	49.2	47.6	45.95	36.03	43.58	43.75	42.7	60.44	54.50	*65.37*	*55*
5	Proposed Township area, project site	48.75	46.68	41.92	41.47	41.47	46.75	50.52	53.77	53.37	*55.79*	*55*
6	Barni, Gaurambha	58.84	49.95	49.78	43.6	54.17	46.18	55.16	59.16	53.97	*56.75*	*60*
7	Khan Jahan Ali Bridge, Khulna	71.7	60.8	66.28	61.72	73.45	52.82	64.25	68.45	65.85	*63.77*	*70*
8	Mongla Port area	61.24	53.84	60.5	38.69	48.15	39.61	47.01	52.7	49.88	*52.86*	*75*
9	Harbaria, Sundarbans	40.88	56.13	55.3	34.38	65.37	35.03	50.75	45.2	44.55	*52.9*	*50*
10	Akram Point, Sundarbans	40.94	47.9	43.98	34.32	54.86	*NM*	49.6	42.95	42.95	*47.96*	*50*
11	Hiron Point, Sundarbans	38.63	51.29	47.98	37.37	47.84	*NM*	46.06	*NM*	43.11	*NM*	*50*

*Note: All values are in decibels (dBA), QM- Quarter Monitoring, NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

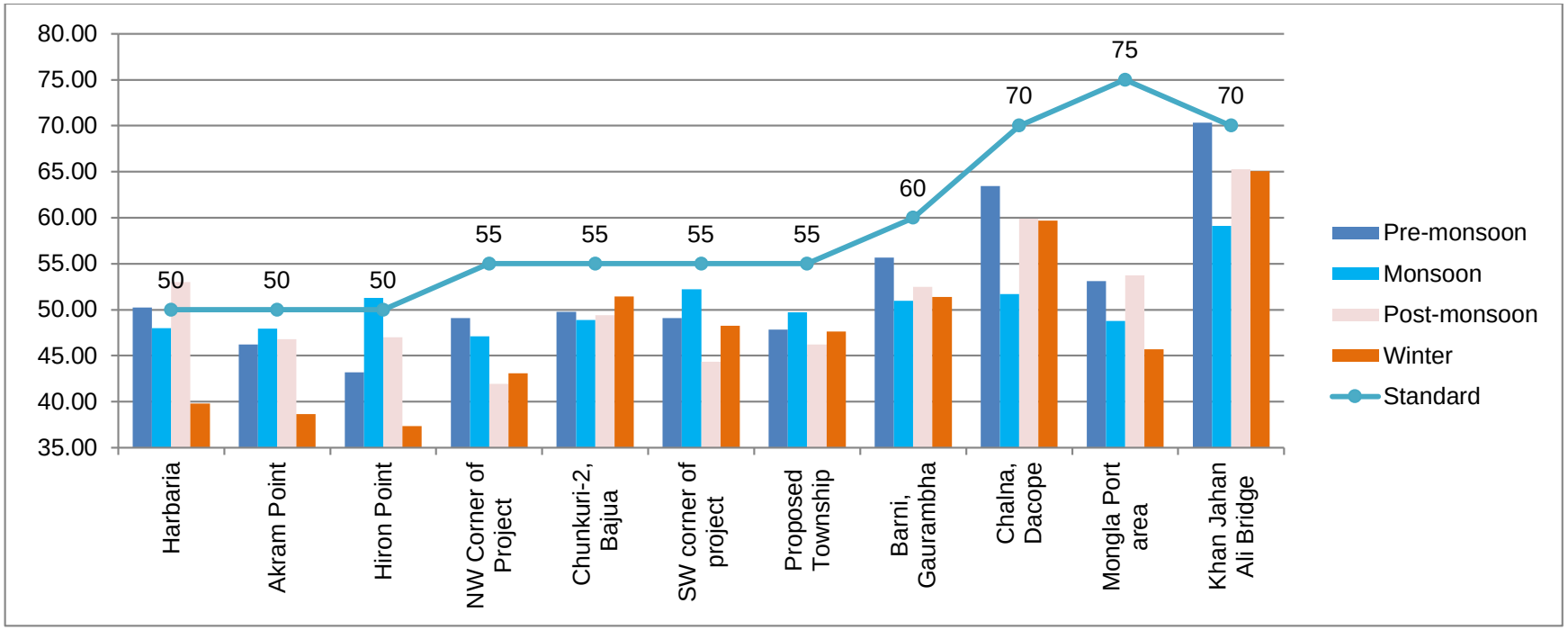


Figure 2.2.1: Seasonal variation of Noise level at different

2.2.3 Findings

57. The noise generation sources in the Sundarbans, industrial areas and other locations in the vicinity of the project area are mostly natural and anthropogenic. The natural domains are mainly birds' chirping, stormy wind, wave breaking on the shoreline and howling of leaves. On the other hand, traffic mobilization, industrial activities, vessels movement within the rivers and local vehicles are the salient sources of noise generation. Nevertheless, all the average day time noise level data are relatively closer or within the standard limits (**Figure 2.2.1**).In the Sundarbans, noise level has been found within the threshold at all the sampling points during this monitoring period (2nd quarter monitoring of 3rd year, i.e., July, 2016) and it warns that any additional natural/anthropogenic source may contribute to cross the standard noise level.

2.3 Water Quality

58. A detail description of the current water quality status of Passur-Sibsa river system has been updated in this section. The entire monitoring activities and analyzing methodologies has been adopted following both the national and international guidelines. A systematic sampling design has also been adopted in order to emphasize the multiple lines of evidence of the water quality. This report includes in-situ water quality data collected during the **2nd quarter** of **3rd year** (**10th program**) and the available laboratory data obtained up to July 2016.

59. The water quality monitoring activities include surface water and ground water at the respective locations. A number of identical parameters are chosen to understand the quality of the water for community use, aquatic life, and the Sundarbans forest ecosystem.

60. The samples collected for the 9thmonitoring program (in April, 2016) have been analyzed for the specific parameters which is included in this report and the data of the recently collected samples (July, 2016) will be discussed in the next 11thMonitoring report due to timing of laboratory analysis.

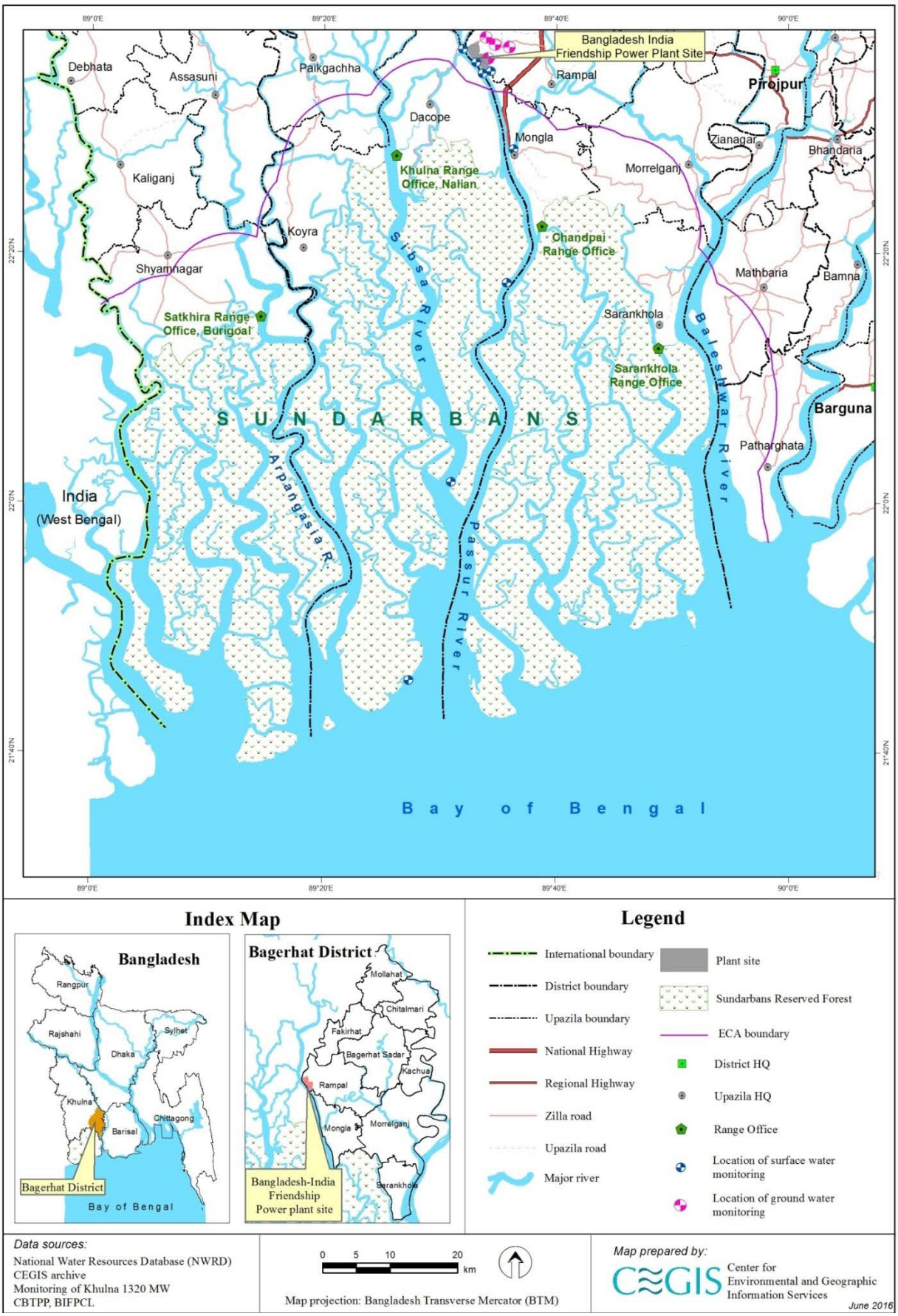
2.3.1 Methodology

61. Monitoring of water quality directly depends on selection of water quality parameters, sampling locations, sampling frequency, evaluation criteria etc. Standard practices have been followed to analyze the water quality. Both the surface and ground water quality have been assessed to examine the water quality status in and around the Power Plant and the Sundarbans. The monitoring results have not only been presented but also been compared with the national standards (ECR, 1997 and all amendments).

62. The samples have been collected from Seventeen (17) preselected sites (14 locations for surface water along Passur River, Sibsa River, Maidara River, near the plant site, and three locations for groundwater around the study area) for 10thmonitoring program as shown in the **Map 2.3.1**. Only one location is not monitored due to the adverse weather condition. However, one tube well, once used for collecting groundwater sample, has been found damaged near Kalekarber from the 3rd monitoring program; hence the site has not been monitored since then. Recently, these sampling locations are preliminarily selected at inception stage and finalized during the 1stmonitoring study. The details of the monitoring plan (selected water quality parameters, sampling locations, and frequency of sampling at each location) for surface water is shown in **Table 2.3.1** and for groundwater in **Table 2.3.2.**

Table 2.3.1: Surface Water Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, BOD_5, TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.604167˚N	89.527222˚E	Quarterly	In-situ measurement (pH, Temperature, Salinity, DO and BOD_5) and Laboratory analysis (TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease)
2		Middle of Passur River at 100m u/s of North West corner from the Project boundary	22.607222˚N	89.528889˚E		
3		Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.609361˚N	89.531417˚E		
4		Left Bank of Passur River at Project site-Jetty	22.584833˚N	89.543583˚E		
5		Middle of Passur River at Project site-Jetty	22.587667˚N	89.546472˚E		
6		Right Bank of Passur River at Project site-Jetty	22.589333˚N	89.548222˚E		
7		Left Bank of Passur River at South West corner from the Project boundary	22.572889˚N	89.552583˚E		
8		Middle of Passur River at South West corner from the Project boundary	22.574611˚N	89.557500˚E		
9		Right Bank of Passur River at South West corner from the Project boundary	22.575667˚N	89.559861˚E		
10		Maidara river at the South East corner of the project at Ichamoti-Maidara confluence	22.600639˚N	89.565611˚E		
11		Maidara river near proposed Township area	22.577472˚N	89.569250˚E		
12		Passur river at Passur – Ghasiakhali confluence	22.473861˚N	89.602361˚E		
13		Passur river at Harbaria of Sundarbans	22.295250˚N	89.593139˚E		
14		Passur river at Akram Point of Sundarbans				
15		Passur river at Hiron point of Sundarbans				



Map 2.3.1: Surface water and Groundwater Quality Monitoring Locations

Table 2.3.2: Groundwater Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, COD, As, Hg, Pb, TH, TDS, TSS, Nitrate, Sulphate, Phosphate	Near Proposed Township Area of the Project	22.594167° N	89.566139° E	Quarterly (April, July, October, January)	In-situ measurement and Laboratory analysis
2		Rajnagar	22.612528° N	89.576056° E		
3		Kalekarber	22.609306° N	89.596278° E		
4		Kapasdanga	22.622528° N	89.563000° E		

Sampling Procedure

63. The standard sampling procedure has been followed for both surface and groundwater sampling to reduce the probability of error. Each sample is tagged at the time of sampling.

Photo 2.3.1: Professional is collecting water samples

Surface Water Sampling Procedure

64. The study area is highly influenced by tidal variation. Hence, temporal and spatial variations of tides have been considered significantly in sampling procedure. Surface water samples are collected during the low tides or relative slag period after the low tide. Samples are taken 50 m away from the riverbank and at a depth of 6 cm below the river surface, whereas for oil and grease, samples are collected from the river surface. The individual sampling bottle is rinsed with respective water samples before storing. Acidified sampling bottles are used for heavy metal (As, Pb, Hg) analysis and wrinkle bottles are used for BOD_5. All the samples are preserved as per standard practices.

Groundwater Sampling Procedure

65. Groundwater availability depends on the recharge factor of aquifer, seasonal variation in water table, excessive water extraction from nearby agricultural field. Groundwater samples are collected from hand operated tube wells after 5-7 minutes of water extraction. Each sampling bottle is rinsed with respective water samples before storing. Acidified sampling bottles are used for heavy metal (As, Pb, Hg) analysis and are preserved following standard practices.

Photo 2.3.2: water samples are tagged by professionals

Parameters tested for water quality

66. Water quality parameters have been selected on the basis of tentative potential impacts generated during pre-construction, construction and operation phases of the Power Plant Project. Only five parameters namely pH, temperature, salinity, DO and BOD5 have been tested while conducting the monitoring study and the rest of the preselected parameters are analyzed in the laboratories.

Surface Water Quality Parameters

67. The selected parameters for surface water quality includes Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Suspended Solids (TSS), Total Hardness (TH), Turbidity, Temperature and Oil and Grease. The main parameters are grouped into following four categories:

- Physical and aggregate properties i.e. pH, Temperature, Salinity, Hardness, TDS, TS, Turbidity, Oil & Grease
- Inorganic non-metallic constituents i.e., DO, NO^{3-}, PO_4^{3-} and SO_4^{2-}
- Aggregate organic constituents i.e. BOD, COD
- Heavy metals i.e. As, Pb and Hg

Groundwater Quality Parameters

68. The parameters for ground water quality includes Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Hardness, Nitrate (NO3), Total Dissolve Solids (TDS), Total Hardness (TH) and Temperature.

Water quality analysis procedure

69. The collected samples of selected water quality parameters are analyzed as per the procedure of American Public Health Association (APHA) standard. The analysis procedures along with the standards have been appended in **Table 2.3.3.**

Table 2.3.3: Testing Methodology of Water Quality Parameter

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Temperature	Thermometer	$^{\circ}C$	20 - 30
pH	Microprocessor pH meter		6.5-8.5
TDS	TDS meter (Multimeter)	ppm	1000
TSS	Drying and Filtration	ppm	10
Salinity	Salinity Refractometer (Master-S/MillM Cal. No. 2493, ATAGO)	ppt	
DO	Dissolved Oxygen meter DO-5509	ppm or mg/l	6
BOD_5	5-Day BOD Test at 20^0C	ppm or mg/l	50 (SW)
COD	Closed Reflux Method	ppm or mg/l	200 (SW), 4.0 (GW)
Total Hardness (as $CaCO_3$)	Titrimetric	ppm or mg/l	200-500
Ortho-Phosphate (PO_4^{3-})	UV-VIS Spectrophotometers	ppm	6
Nitrate (NO_3^-)	UV-VIS Spectrophotometers	ppm or mg/l	10
SO_4^{2-}	UV-VIS Spectrophotometers	ppm or mg/l	400

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Oil and Grease	Liquid-liquid extraction with hexane, treatment with silica gel and gravimetric determination	ppm or mg/l	10 (SW)
Arsenic (As)	Atomic Absorption Spectrophotometers–Hydride Vapor Generating (AAS-HVG)	ppm or mg/l	0.05
Lead (Pb)	Atomic Absorption Spectrophotometers–Graphite Furnace (AAS-GF)	ppm or mg/l	0.05
Mercury (Hg)	Mercury Analyzer	ppm or mg/l	0.001

2.3.2 Status of the surface water quality

In-situ tested parameters

(a) pH

70. During this period of monitoring pH values ranged in between 7.3 to 8.2 among the sites. The highest value is found in Right Bank of Passur River at South West corner from the Project boundary while the lowest value is observed in Middle of Passur River at 100m u/s of North West corner from the Project boundary and Passur River at Passur-Mongla confluence. The results show close conformity among all the locations and to the monitoring results of the same period of previous years.

71. pH values of pre-monsoon and monsoon seasons are found to be comparatively lower than post-monsoon and winter seasons. During post monsoon and winter seasons, river water level normally goes down because of less rainfall and less from u/s flow of Passur-Sibsa RS and as a result, pH values becomes higher than pre-monsoon and monsoon seasons as reported by others (Rahman et al., 2013). Fluctuations in pH values during different season of the year can be attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction in salinity and temperature, and decomposition of organic matter (Rajasegar, 2003).

72. No significant pH differences are observed except spatial variation in the river water. Seasonal variations in pH among the selected monitoring locations during first and second year quarterly monitoring of Passur-Sibsa RS are presented in Figure-2.3.1 and all the observed dataset are attached in**Table B.1**of**Appendix- IV.**

(b) Temperature

73. Recent monitoring results of temperature show close conformity with the previously monitored values in the same season of 1st year. The latest values vary from 29.10C to 30.70C among the monitored locations. During all the monitoring period maximum temperature is found in July 2014 which seemed to be slightly higher than the standard limit set by environmental conservation rules (ECR), 1997. But all the observed values are found to be within the BD standard (20oC-30oC).

74. The surface water temperature largely depends on daily weather condition (Bartram J et al., 1996). According to the seasonal weather pattern of Bangladesh the temperature drops to a minimum level during winter which is also applicable for the water temperature and thus it differs largely than the others season's data. However, the average temperature in all the other seasons is seen to be very similar with each other. No significant spatial variation had been observed during the monitoring periods. The measured temperature values of selected

monitoring locations during quarterly monitoring of first and second year are presented in **Figure-2.3.2**and all the observed dataset are attached in **Table B.2** of **Appendix- IV**

(c) Salinity

75. The observed salinity values vary from 0 ppt to 4 ppt during this monitoring period and the maximum value is observed at Akram point in Sunderbans while salinity level has been found zero in all the observed locations.

76. During this monitoring period fresh water flow from upstream was found significant and thus the tidal inflow could not acts as a dominant factor in increasing the salinity level. However, the observed results are found similar for the same seasons in the previous years. Salinity was found to be zero in Passur River from project site to Harbaria during post monsoon of 2014 and monsoon and post-monsoon of 2015. This might be due to excessive rainfall and fresh water flow from upstream. The highest average values are found in pre-monsoon season of the both years. Water salinity data at the selected sampling stations of Passur-Sibsa RS of nine consecutive periods are presented in **Figure: 2.3.3** and all the observed dataset are attached in **Table B.3** of **Appendix- IV.**

(d) Dissolved Oxygen

77. Among all the monitored locations DO concentrations are found to be ranged between 5.2 mg/L to 6.8 mg/L. The maximum concentration found at Akram point in Sundarbans while the lowest amount is recorded at Maidara River of the South East corner of the Project at Ichamoti-Maidara confluence.

78. It may be mentioned that the Maximum concentrations are observed during monsoon and post monsoon than the other two seasons. These higher values of DO in the upstream stations could be due to DO enriched inland freshwater input through the river. Seasonal variations of DO at the monitoring sites of Passur-Sibsa RS are shown in **Figure: 2.3.4;** all the observed dataset are attached in **Table B.4** of **Appendix- IV**.

(e) Biochemical Oxygen Demand (BOD_5)

79. The BOD_5 values ranged from 2.1 to 3.4 mg/L. Maximum value of BOD_5 is found at Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence while. the lowest (2.1 mg/L) value is observed at Left Bank of Passur River at Project site-Jetty. However all the values are found to be within the standard limit as stated in the ECR' 2005 and in IFC standard.

80. It is also evident from the figure that the highest average value has been recorded in Passur-Mongla confluence during monsoon season because of the river receives huge amount of organic load and agricultural runoff from the adjacent areas. Thus, BOD_5 has been found higher during summer season than monsoon and the least during winter. The water temperature normally goes down in winter season than those of pre-monsoon, monsoon and post monsoon seasons, which in turn decreases the bacterial and microbial activities and contributes a low level of BOD_5.

81. The measured BOD_5 values at different monitoring locations during the monitoring of Passur-Sibsa RS are presented in Figure: 2.3.5 and all the observed dataset are attached in **Table B.5 of Appendix- IV.**

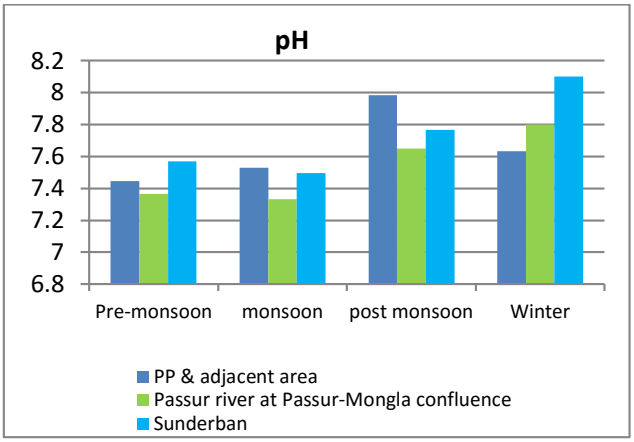


Figure 2.3.1: Variations in average pH values in sampling spots for the consecutive seasons

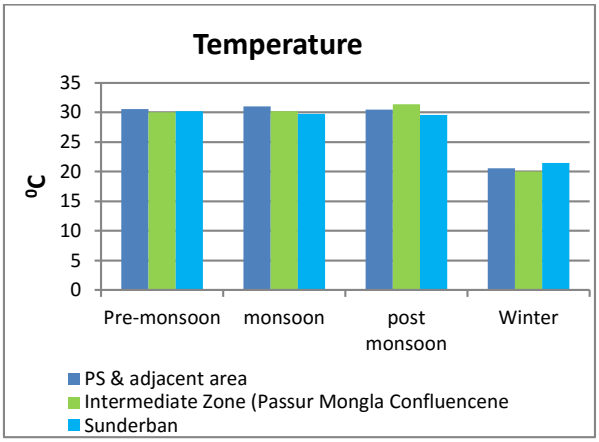


Figure 2.3.2: Variations in average temperature values in sampling spots for the consecutive seasons

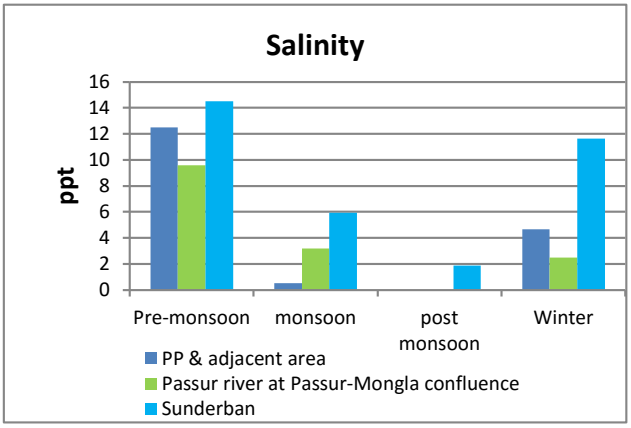


Figure 2.3.3: Variations in average salinity values in sampling spots for the consecutive seasons

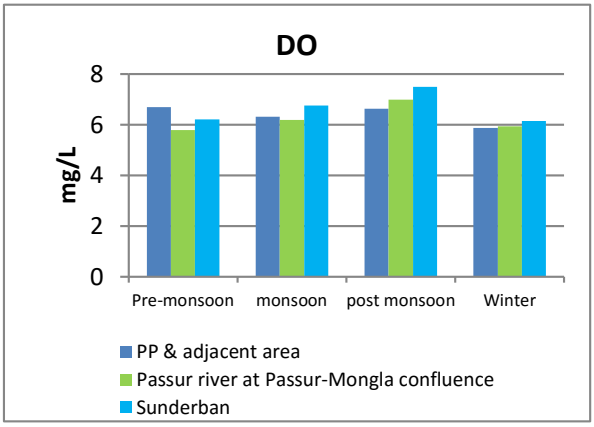


Figure 2.3.4: Variations in average DO values in sampling spots for the consecutive seasons

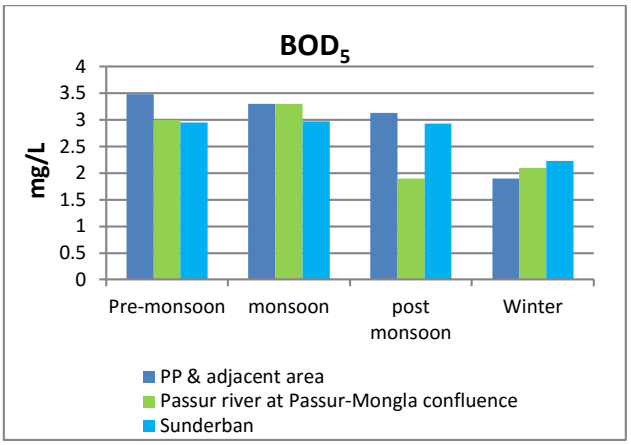


Figure 2.3.5: Variations in average BOD_5 values in sampling spots for the consecutive seasons

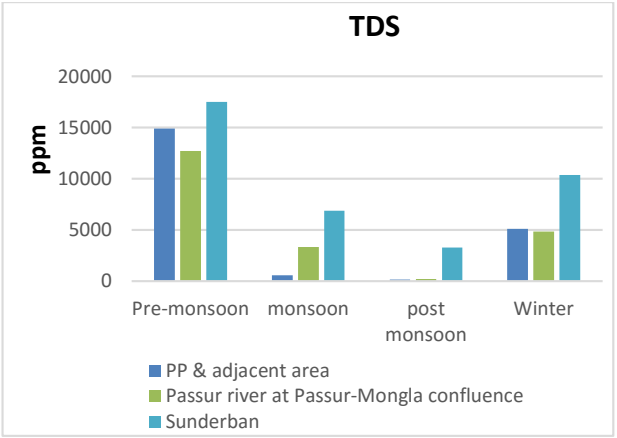


Figure: 2.3.6 Variations in average TDS values in sampling spots for the consecutive seasons

Laboratory tested parameters

(a) Total Dissolved Solids (TDS), Total Hardness (TH) and Total Suspended Solids (TSS)

82. The observed values of TDS vary from 11,330 mg/L to 25,500 mg/L which shows a little proximity to that of the previously obtained data of the same season of 2014 and in 2015.

83. In most of the observed locations, the TDS concentrations seem to be lower in monsoon and post monsoon period and higher in pre-monsoon and winter season. A Significant spatial variation is found, which could be due to the sea water and the erosion-accretion process of the river. Sediment load in Passur River is relatively higher as it is located in the south western part of Bangladesh. TDS mainly indicates the presence of various kinds of minerals like ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulphates and metallic ions etc. which comprise both colloidal and dissolved solids in water (***Tareq M S et al., 2013***).

84. The highest and lowest concentration of Total Hardness are found to be 3010 mg/L and 5050 mg/L and observed in Left Bank of Passur River at Project site-Jetty and in Passur River at Akram point respectively. During the rainy season, the hardness in all monitoring stations in Passur River are found to be lower whereas it is found remarkably higher in pre-monsoon season. Because, in general cases the hardness is found to be higher in monsoon season but in Passur River it is found higher in pre monsoon season due to the saline water intrusion to the upstream in this season (***Rahman et al., 2013***).

85. TSS includes solid materials of organic and inorganic in origins which are suspended in water. In Passur and Sibsa Rivers system the suspended matters generally contain sand, clay, silt and loam. However, during the 9th monitoring period the TSS concentrations vary from 6 mg/L to 23 mg/L among the monitoring locations. The highest value is found in Passur river at Akram point of Sunderbans while the lowest value is found in Maidara river near proposed township area.TSS values in every spots are found to be within the standard limit (150 mg/L) suggested for Bangladesh (ECR, 1997) inland fresh water and the monitored values are found to be lowest in this pre-monsoon season comparing to the other values recorded in the previous season of the monitoring year.

86. The values are found to be relatively higher in pre-monsoon season than those of monsoon. During dry season (pre-monsoon and winter season) the TSS value increases, probably due to less freshwater flow, urban runoff, industrial wastes, bank erosion, bottom feeders (such as carp), algae growth or wastewater discharges. In Mongla-Passur confluence the concentration is very high which could be due to the heavy load of marine vehicles, and Mongla Port Authority's development work, and most importantly the domestic and industrial runoff from the adjacent areas.

87. The TDS, TH and TSS of Passur River in pre-monsoon, monsoon, post-monsoon and winter seasons at different monitoring locations are presented in **Figure: 2.3.6, 2.3.7**and **2.3.8**respectively and all the observed dataset are attached in **Table B.8** of **Appendix- IV.**

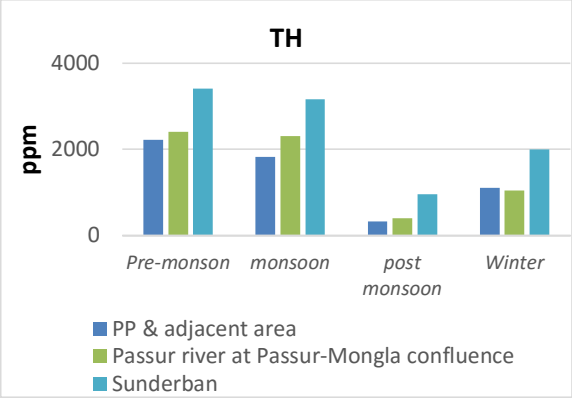


Figure 2.3.7: Variations in average TH values in sampling spots for the consecutive seasons

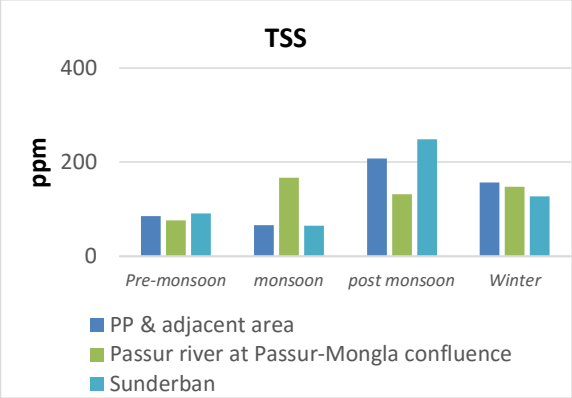


Figure: 2.3.8 Variations in average TSS values in sampling spots for the consecutive seasons

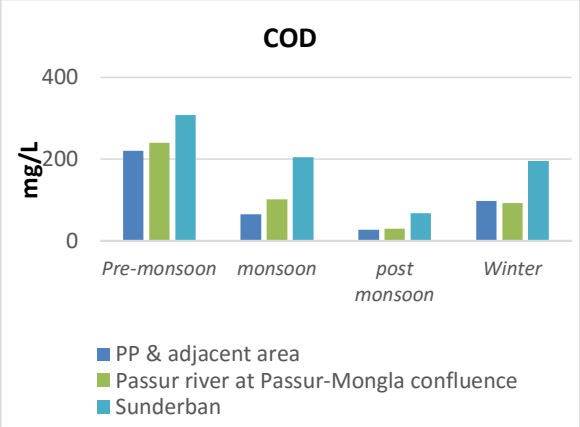


Figure 2.3.9: Variations in average COD values in sampling spots for the consecutive seasons

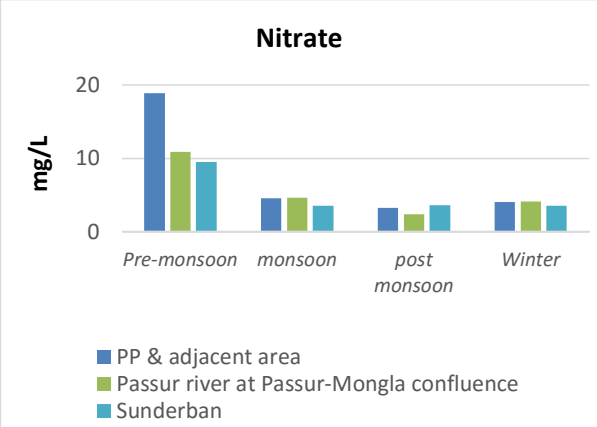


Figure 2.3.10: Variations in average Nitrate values in sampling spots for the consecutive seasons

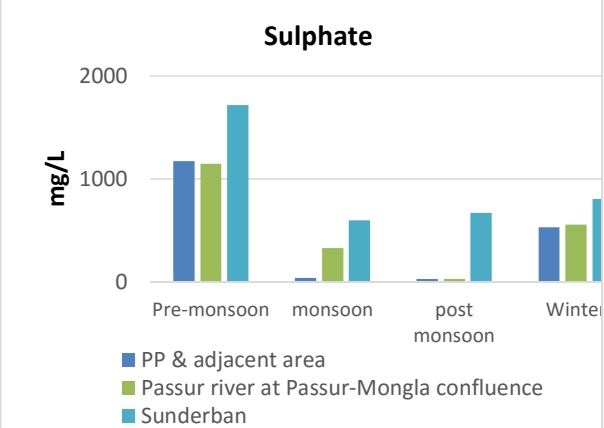


Figure 2.3.11: Variations in average Sulphate values in sampling spots for the consecutive seasons

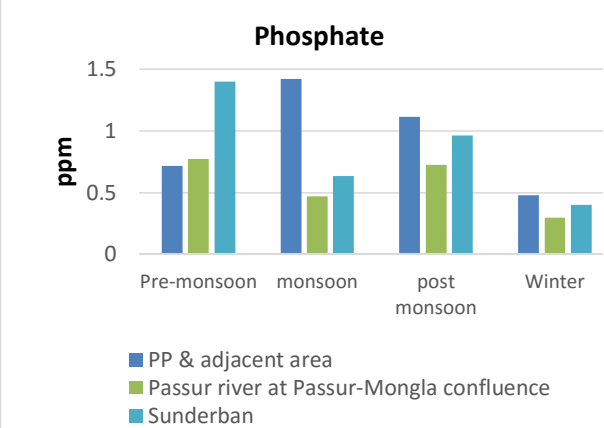


Figure 2.3.12: Variations in average Phosphate values in sampling spots for the consecutive seasons

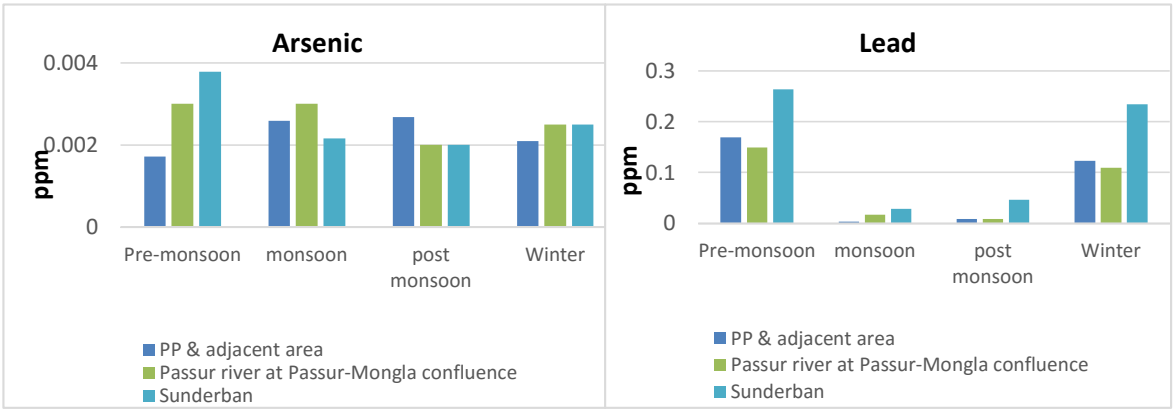


Figure 2.3.13: Variations in average Arsenic values in sampling spots for the consecutive seasons

Figure 2.3.14: Variations in average Pb values in sampling spots for the consecutive seasons

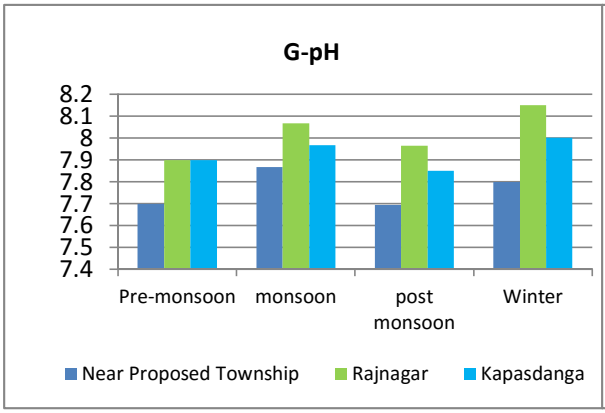


Figure 2.3.15: Variations in average G-pH values in sampling spots for the consecutive seasons

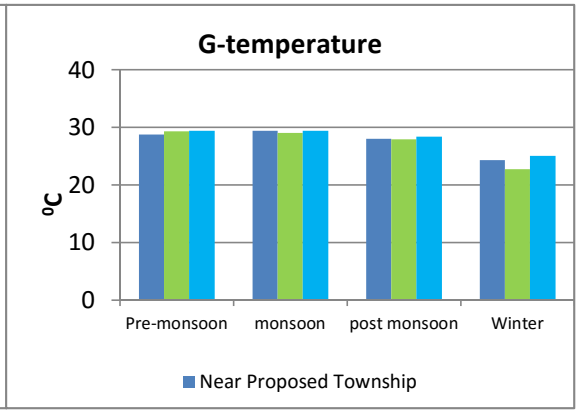


Figure 2.3.16: Variations in average G-Temperature values in sampling spots for the consecutive seasons

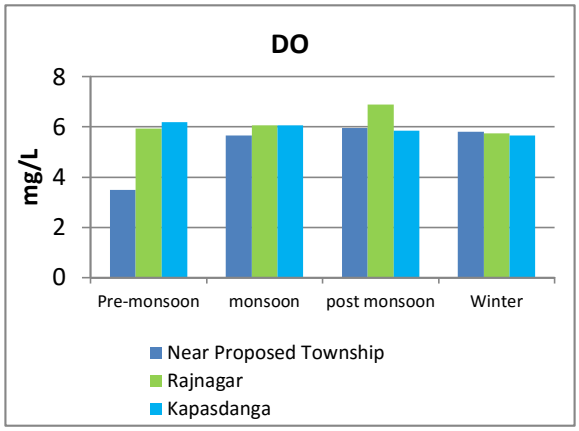


Figure 2.3.17: Variations in average G-DO values in sampling spots for the consecutive seasons

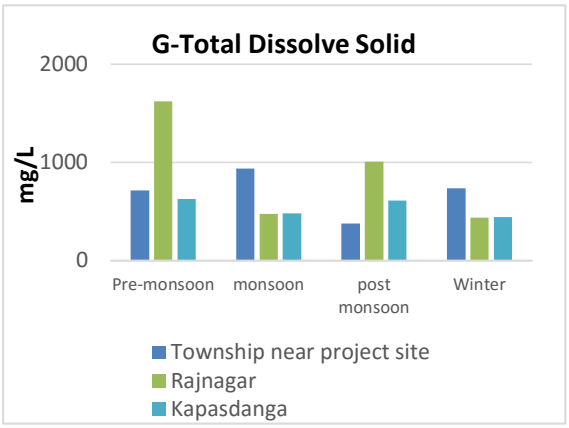


Figure 2.3.18: Variations in average G-TDS values in sampling spots for the consecutive seasons

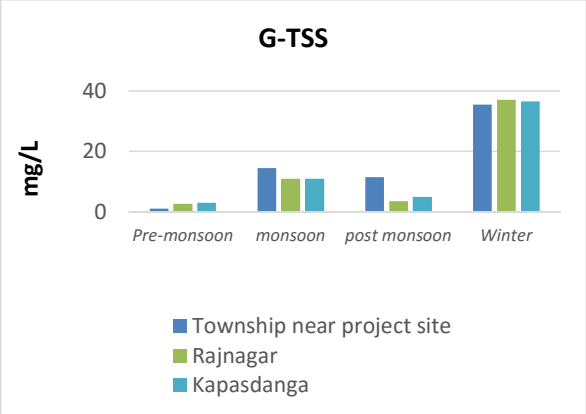


Figure 2.3.19: Variations in average GTSS values in sampling spots for the consecutive seasons

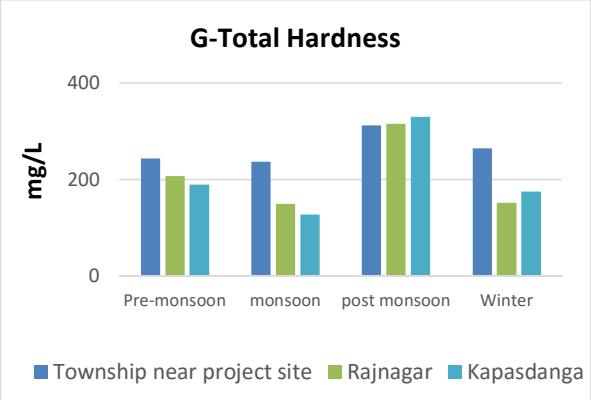


Figure 2.3.20: Variations in average TH values in sampling spots for the consecutive seasons

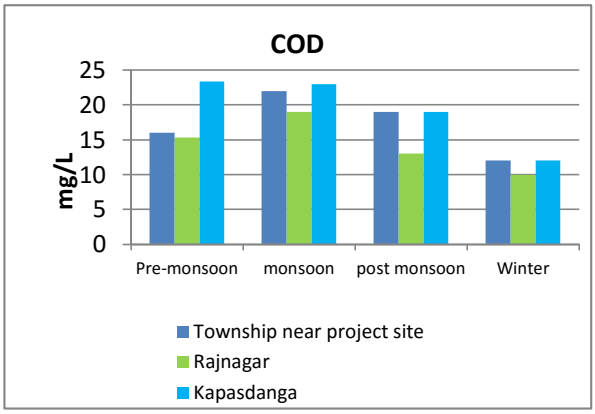


Figure 2.3.21: Variations in average COD values in sampling spots for the consecutive seasons

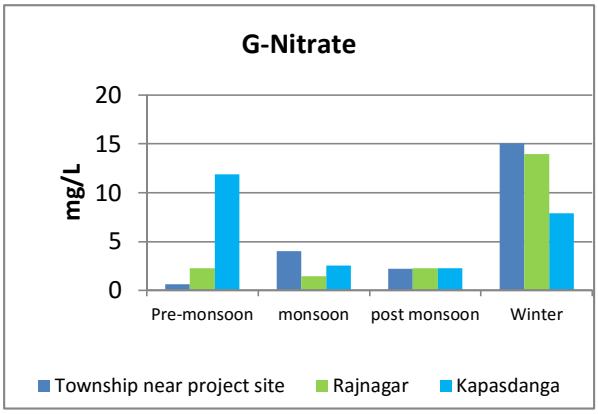


Figure 2.3.22: Variations in average G-Nitrate values in sampling spots for the consecutive seasons

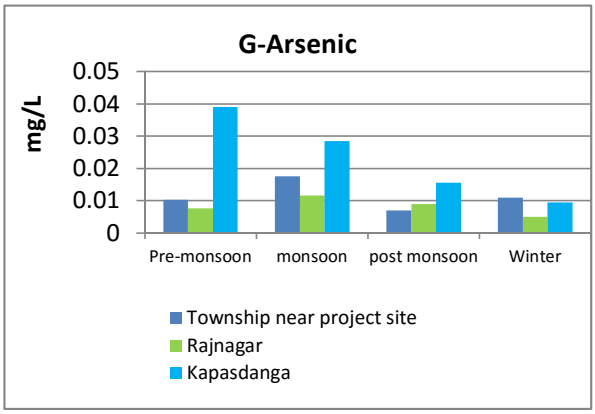


Figure 2.3.23: Variations in average G-Arsenic values in sampling spots for the consecutive seasons

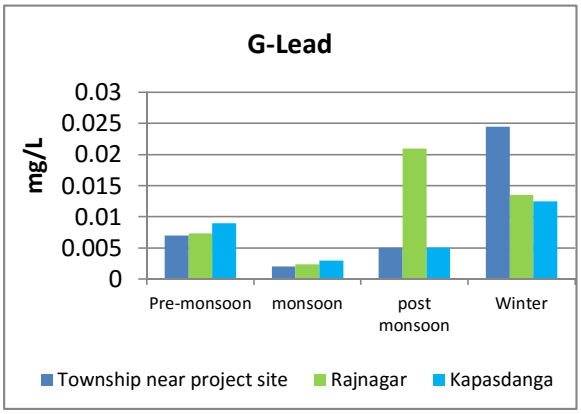


Figure 2.3.24: Variations in average G-Lead values in sampling spots for the consecutive seasons

(b) Chemical Oxygen Demand

88. COD is an indicator of organic pollution, which is caused by the inflow of domestic, livestock and industrial waste that contains elevated levels of organic pollutants (***Ayati, 2003***). Generally, COD found to be higher in Passur-Sibsa RS as it has been recorded to receive high amount of organic matter from the Sundarbans forest area and from Sundarbans adjacent community.

89. The observed values of COD vary from 140 mg/L to 280 mg/L in the last monitoring period among all the spots. The highest amount was found in Right Bank of Passur River at 100m u/s of North West corner from the Project boundary and in Left Bank of Passur River at Project site-Jetty while the lowest are recorded in Harbaria of Sunderbans. However, high values of COD indicate high levels of organic pollution in the river water (Sivasubramanium, 1999). Moreover, a large scale industrial activity is taking place along the left bank of Passur River from Chalna to Harbaria, which might also contribute to the high concentration of COD.

90. The COD concentrations of pre-monsoon and winter seasons (dry) are found to be higher than monsoon and post-monsoon seasons. In monsoon, higher discharge diluted the COD load in the river which in turn reduces COD concentration in post monsoon. The observed dataset are shown in **Figure: 2.3.9**and all the observed dataset are attached in **Table B.6 of Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

91. Among the monitoring locations, the nitrate values vary from 2 mg/L to 3.6 mg/L. The maximum value of nitrate (3.6 mg/L) is recorded in Right Bank of Passur River at Project site-Jetty. This may be due to the excessive agricultural runoff from the nearby areas.While on the other hand the lowest value (2 mg/L) is recorded at Left Bank of Passur River at Project site-Jetty. The results obtained from all the monitoring locations from 9th monitoring period are found higher than the previously analyzed data of the same season. However, the highest values are found in pre-monsoon season of 2nd year, which may be due to the higher amount of surface and groundwater runoff, dissolution of nitrogen-rich geological deposits, and biological degradation of organic matter (***Spencer, 1975; Kinne, 1984; Gleick, 1993; Wetzel, 2001; Rabalais, 2002***).

92. Naturally, SO_4^{2-} concentration is higher in sea water as well as in river in coastal region due to the tidal behavior of the respective water bodies. The monitored dataset reveals this general fact i.e., the SO_4^{2-} concentration of Passur-Sibsa RS increases in the direction of upstream to downstream. The highest value (97 mg/L) of sulphate is found in Hiron point while the lowest is found in Left bank of Passur River at 100 u/s of north west corner from the project boundary (7mg/L) and in passur river at Harbaria. However, all the observed dataset of Sulphate found to be within the standard limit (400 mg/L) specified in ECR, 1997. Comparatively lower concentration of SO_4^{2-} in monsoon and post monsoon seasons could be due to the dilution effect of upstream fresh water.

93. In the 9th monitoring phase, the values of PO_4^{2-} (0.179-0.625 mg/L) are found to be relatively similar to that of the results pre-monsoon period (0.13-0.63 mg/L) in the previous year. The highest value observed in pre-monsoon period of 2014 and could be due to the discharge of bilge water from numerous ships and fishing boats, agricultural and industrial runoff. However, all the observed values are found to be within the standard limit (6 mg/L) specified for surface water. The recorded low phosphates value during dry seasons could be attributed to the limited flow of freshwater from upstream, high salinity and utilization of phosphate by phytoplankton (***Senthilkumar et al., 2002; Rajasegar, 2003***) but agricultural fields as fertilizers and phosphates used in households as detergents can be other sources of inorganic phosphates during the season (***Tiwari and Nair, 1993***).

94. The observed NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentrations at different monitoring locations of five consecutive monitoring periods are presented in **Figure: 2.3.10, 2.3.11**and in**2.3.12** and all the observed dataset are attached in **Table B.9 of Appendix- IV**.

(d) Heavy Metals

95. The observed dataset of Arsenic (As) concentrations demonstrated conformity among all the spots which vary from 0.001 mg/L to 0.006 mg/L. The minimum value are found in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary and the highest value is observed in akram point of Sunderbans. In pre-monsoon season subsurface flow from groundwater to river might increase the concentration of as in the river water. In monsoon, lower concentration of as is recorded. It might be due the dilution effect in river water caused by surface runoff.

96. Heavy metal (Pb) dissolved in water is very harmful to aquatic organisms; due to bioaccumulation, it increases in body tissue of organisms (***Rompas, 2010***). It is also evident that organic fertilizer, which comes from lime and compost fertilizers, can contain heavy metal, e.g., NPK fertilizer (phosphate fertilizers containing Pyromorphite- $Pb_5(PO_4)^3$ (***Zhu et. al., 2004***) which may results in higher amount of Pb concentration in river water in winter season. During the last monitoring period, the lowest concentration of Pb (0.203 mg/L) was found in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary and the highest value (0.607 mg/L) was found Hiron point of Sunderbans.

97. The values of Hg (Mercury) revealed a continuous consistency among all the spots in all the seasons. The values never exceeded 0.0020 mg/L. All observed data found to be within the Bangladesh standard limit set by the environmental Conservation rule, 1997, Bangladesh.

98. The observed As, Pb concentrations at different monitoring locations of the consecutive monitoring periods are presented in **Figure: 2.3.13**and in **2.3.14**and all the observed dataset are attached in **Table B.10 and B.11 of Appendix- IV**.

(e) Oil and Grease

99. In order to measure the concentration of oil and grease in Passur River, samples have been taken from five locations during low tide from the surface layer. The analysis has been conducted through standard testing method of APHA. The concentration of oil and grease are presented in **Table-B.7**of **Appendix-IV**.

100. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease has been found negligible and all of the monitoring results are fully in conformity with the Standard of ECR 1997. Passur and Sibsa rivers have contained high concentration of oil and grease in winter period which may be due to accidental oil spill occurred on the 9th December, 2014. An amount of 350,000 liters (Philips, 2014) of furnace oil has been spilled in the river which spread over a 350 km2 area (Welle, 2014).

101. During the last monitoring period, the concentrations of oil and grease varied from 26 mg/L to 82 mg/L and are found to be exceeded the standard limits for inland surface water, 10 mg/L (ECR, 1997) in all the spots. Maximum concentration was found atHiron point and the lowest value found in Harbaria during the monitoring period. This higher concentration may be due to oil spillage and other organic residues discharges from marine vessels; oil discharge from the fishing boats and other anthropogenic activities might contribute to this higher amount of oil and grease concentration.

2.3.3 Status of the Groundwater quality

In-situ tested parameters

a) pH and Temperature

102. The values of groundwater pH and temperature at observed locations are found fully complied with the drinking water quality standards as specified in ECR, 1997. The pH values of 10thmonitoring program are found to be varied from 7.8 to 8.1 while temperature is found to be between 28.6°C and 29.4°C (**Table 5.15**). The recorded pH values are always found slightly alkaline in all the spots in all the season. No significant difference and negative health effect have been observed by the monitoring team. Similarly, no significant variation has been recorded in groundwater temperature over the monitoring period. In addition, larger seasonal variations, related to warming of or cooling at the surface are common, and ranges in the order of 5 to 10 degrees.

103. Both the results of pH and Temperature are found to be more or less consistent with all the previously obtained data. The seven consecutive monitoring results of pH and temperatures of selected locations are presented in **Figure: 2.3.15**and**2.3.16**and all the observed dataset are attached in **Table B.12**of **Appendix- IV**

b) Salinity and Dissolved Oxygen

104. Salinity is a common parameter in order to determine the ground water quality for drinking and irrigation purpose. However, groundwater is found to have 0 ppt of salinity in all the consecutive monitoring seasons.

105. The observed values of dissolved oxygen are ranged in between 5.7 mg/L and 6.1 mg/L and found in Karpashdanga and in Rajnagar respectively among all the observed data are found to be are within the BD standard (6.0 mg/L) set by ECR, 1997. Higher DO values makes water tastier but cause corrosion to the supply pipe.

106. Eight (8) consecutive monitoring results of salinity and DO of selected locations are presented in **Figure: 2.3.17**and all the observed dataset are attached in **Table B.13** of **Appendix- IV.**

Laboratory tested parameters

(a) TDS, TSS and TH

107. During the 9th monitoring period TDS values are found within the standard limit (1000 mg/L). Though the Highest value (1025 mg/L) is recorded in Township area which does not exceed significantly while the lowest value (384 mg/L) is recorded in Rajnagar. The TDS concentration is found to be within than the BD standard (ECR, 1997) found in the last monitoring period.

108. Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2µm filter (***U.S.EPA, 1998***). Among all the monitoring season the values are found to be much higher in monsoon season which could be due to the runoff from industrial, urban or agricultural areas. In all the monitoring locations the concentration found to be 3-4mg/L which presents an ideal condition and fully in conformity with the BD drinking water standards (***ECR, 1997***).

109. TH concentrations of the three monitored spots vary from 163 mg/l to 305 mg/l. The maximum value is found in Township area near project site. The monitored values are found to be within the standard limit (200-500 mg/L) set by the ECR 1997. However, no incidents of weathering of Ca2+ bearing minerals or excessive application of lime is found during the monitoring period which could cause TH. Groundwater TDS, TSS and TH value of seven (7)

consecutive monitoring periods in all the monitoring period are presented in **Figure: 2.3.18, 2.3.19** and **2.3.20** and all the observed dataset are attached in **table B.14** and **B.15** of **Appendix- IV.**

(b) Chemical Oxygen Demand

110. The Bangladesh standard for COD in drinking water is 4.0 mg/L. However, all the monitored data from the tube wells found to be within the standard limit. COD concentrations found higher than those of second year. Such high COD value is likely from anthropogenic sources such as percolation from landfill leachates and/ or industrial effluents.

111. The analyzed results are found to be lower than those of the previously monitored results. The COD concentrations of all the monitoring locations are presented in **Figure: 2.3.21**.and all the observed dataset are attached in **Table B.16 of Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

112. Nitrate values are found to be varied from 1.7 mg/L to 2.3 mg/L and remained within the standard limit (10 mg/L) as specified in ECR, 1997. However, Maximum values are observed in winter season in 4th monitoring program (i.e. 1st year 4th quarter). Again the value is found higher in pre-monsoon in Rajnagar which might be due to the excessive fertilizer use in the nearby agricultural field.

113. SO_4^{2-} and PO_4^{2-} concentrations monitoring of Passur-Sibsa RS have been included in this study since 2nd monitoring report (i.e. 1st year 2nd quarter). Sulphate concentrations are found to be zero in all the points in every monitoring season except in monsoon of first year and winter of second year. During 9th monitoring the values have varied from 1 to 8 mg/L. On the other hand, the values of PO_4^{2-} are within the standard limit (6 mg/L) and ranged between 1.08 mg/L to 3.26 mg/L. Among all the monitoring period the recorded data are found maximum in the post-monsoon period. The values have never been higher than the Bangladesh drinking water quality standard. The observed ground water NO_3^-, SO_4^{2-} and PO_4^{2-} concentrations are presented in **Figure 2.3.22** and all the observed dataset are attached in **Table B.17** of **Appendix- IV**.

(d) Arsenic (As), Lead (Pb) and Mercury (Hg)

114. As per Bangladesh Standard (ECR, 1997), the maximum acceptable concentration of Arsenic in groundwater is 0.05 mg/L. Among all the monitoring locations, the As concentration ranged between 0.007 and 0.047 mg/L which is completely within the BD permissible standard limit (ECR, 1997). However, the As values in Kapasdanga are found to have a decreasing trend in all the consecutive seasons and may be considered as suitable for the drinking purpose.

115. The Pb and Hg concentrations are detected and the values remained much lower than the acceptable limit specified in ECR 1997. The concentration of Pb is found higher in pre-monsoon and post-monsoon in Rajnagar and Kapasdanga respectively. In the 9th monitoring period the values of Pb concentration have ranged between 0.007 mg/L and 0.019 mg/L, while Hg concentration for that period is very much negligible (<0.00015 mg/L). Therefore, it reveals that the monitored tube well is found suitable for drinking purposes.

116. The observed values of As, Pb and Hg in all the monitored locations are presented in **Figure: 2.3.23**and**2.3.24**and all the observed dataset are attached in **Table B.18** of **Appendix-IV.**

2.4 Land Resources

2.4.1 Methodology

Monitoring Indicators

117. Monitoring of the selected indicators is very crucial for land resources in the study area. Land use, soil fertility/nutrient status, soil contamination with heavy metals, soil salinity and physical quality of soil are the major monitoring indicators for land resources. It is assumed that during the operation phase of the power plant ash may be deposited on the surrounding land.

Sampling Frequency

118. Dry season, soil samples have been collected in April, 2016 and wet season, soil samples will be collected in October 2016.

Location

119. Five mauzas within the 10 Km radius of the power plant were selected for monitoring of plot use, soil fertility/nutrient status, soil contamination with heavy metals. The selected mauzas are Baranpara (E: 89°30′59.1″, N: 22°37′57.0″) of Batiagahata upazila, Chunkuri-2 (E: 89°32′20.0″, N: 22°34′51.0″) of Dacope Upazila, Kapalirmet (E: 89°36′8.8″, N: 22°32′18.9″) of Mongla upazila, Chakgona (E: 89°34′25.3″, N: 22°34′18.3″) and Basherhula (E: 89°34′25.0″, N: 22°36′14.0″) of Rampal upazila under Khulna and Bagerhat district. Locations of collected soil samples are presented in the **Table E.1** of**Annex-IV** and **Map 2.4.1.**

Process of soil samples collection

Plot selection

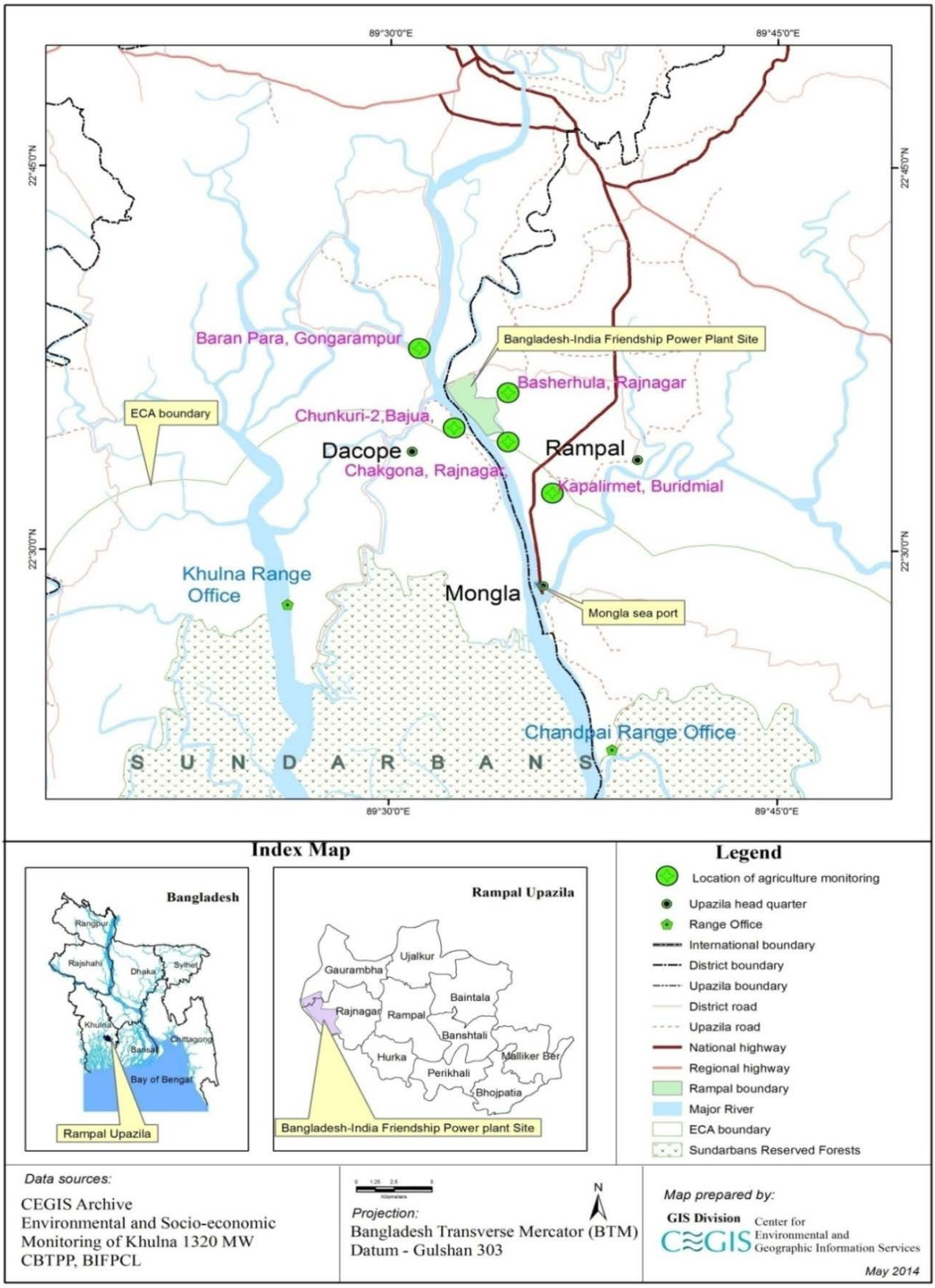
120. Monitoring plot has been selected before initiation of monitoring through group discussion, especially with the plot owners and specific experts such as Upazila Agriculture Officer Batiaghata, Dacope, Rampal and Mongla of Khulna and Bagerhat districts and Senior Scientific Officer of Soil Resource Development Institute (SRDI), Khulna Office. All the selected areas are medium high (F1) land, which is normally flooded to the depth of 30-90 cm continuously for more than two weeks to few months during the flood season. Main emphasis is given to potential locations of dry/wet deposition of ash, SOx and NOx to be emitted from the Plant.

Soil samples collection

121. Soil l sample were collected from five locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the monitoring area in the month of April, 2016. Some basic indicators are selected to evaluate the base condition of adjacent area of Rampal power plant. Besides, continuous monitoring of that area gives an opportunity to observe the seasonal change of the indicators of that specific locality. The indicators are soil reaction (pH), salinity (EC), Organic matter (OM), base cations-Ca, Mg, K and Na, macro nutrient status (N, P and S), status of micro nutrients (B, Fe, Mn and Zn) and presence of heavy metals (Pb and Cd).

Laboratory analysis

122. Collected soil samples have been handed over to the SRDI, Dhaka for laboratory analysis. Results will be presented in the next monitoring report (3rdquarterly monitoring report of 3rdyear) after obtaining it from SRDI.



Map 2.4.1: Land Resource Monitoring Locations

2.4.2 Status of Land Resources

123. The analyzed results are compared in this 9th monitoring report. Seasonal variation of these indicators is described below according to their location. The parameter considered for earlier monitoring will be same in this quarter as well. The result of the 2013-14, 2014-15 and dry season of 2016 year has been provided in the **Figure 2.4.1-2.4.16 and in Table E.2 of Appendix IV)**

124. Soil quality/fertility is an important factor for crop production. In general, organic matter content of the soil is pretty low in the coastal regions of Bangladesh (***Haque, 2006***). Thus in addition to salinity, plant nutrients in soils affect plant growth.

125. In general monitoring study area comprises under the Agro-Ecological Zone, Ganges Tidal Flood Plain (AEZ13) (***BARC, 2012***). So, the analysis report of soils of monitoring land is compared to the physico-chemical properties of soils of AEZ 13 to understand the variation of the soil fertility status. Generally, organic matter content of the soil is low in the coastal regions of Bangladesh. Some basic characteristics of AEZ 13 are pH: (4.5-8.4), OM(%): (1.0-3.4%), N(%): (0.091-0.18%), P: (<5.25-10.5) (µg/gm), K: (0.181-0.36 (meq/100g), S: (15.1-30.0) (µg/gm), Ca: (4.51-7.5) (meq/100g), Mg: (0.751-1.5) (meq/100g), Zn: (0.451-1.35) (µg/gm), B: (0.31-0.6) (µg/gm) , Mo: (0.226-0.30) (µg/gm).

126. Though the sampling area is medium high land, all are situated within a polder area. Another special characteristic of the area is frequent tidal waves, which makes some significant changes in pH and EC of the area.

Monitoring plot-1 (Baranpara)

127. It has been observed that salinity has increased in both seasons (wet and dry) of 2014-15 10.1 (ds/m)-dry and 5.56 (ds/m)-wet than that of 2013-14 9.6 (ds/m)-dry and wet 5.8 (ds/m)-wet among the three layers. This may be due to lack of water source connectivity of Baranpara. As a polder area, most of the openings of this locality are confined, so natural flow of water is disrupted. Natural precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity of a vast area. The present study also found the similar pattern. Soil salinity tremendously reduced 2.23-4.32(ds/m) in dry season of 2015-16 at all layer over both dry and wet season of 2013-14 and 2014-15 due to repeated flushing of land by rain water and there was no scope to inundation by saline water. It is also noted that amount of base cations (except Mg) has increased Ca: 31.50 (meq/100g)-dry and 14.75 (meq/100g)-wet season gives highest value among the three layers in 2014-15. Amount of Mg might be suppressed by Ca intrusion as both of them are divalent cations. On the other hand, amount of base cations has increased Ca: 15.12(meq/100g), K: 0.69(meq/100g), Mg: 2.58(meq/100g) and S: 212.18(µg/gm in dry season of 2015-16 over wet season of 2014-15.

128. Due to top soil erosion, organic matter content drops in wet season (1.27%) than dry season (3.1%) of 2013-14. In 2014-15, owner of the land introduced fish and crab culture. To prepare the land for aquaculture he cut off the top soil, which drastically lowers the organic matter. After the wet season a portion of organic matter is replenished by sedimentation. But, organic matter content has increased (1.35%) in dry this dry season over wet season of 2014-15. Basic nutrients (N: 0.06%, P: 4.60 (meq/100g), K: 0.57 (meq/100g) and S: 210.0 (µg/gm) also follow the similar trend of organic matter in wet season of 2014-15 than wet season of 2013-14. In the dry season of 2015-16, the basic nutrients (N: 0.08%, P: 5.33 (meq/100g), K: 0.69 (meq/100g) and S: 212.18 (µg/gm) also follow the similar trend of organic matter.

129. Micro nutrients (Fe, Mn, B, Na and Zn) in soil are also analyzed for baseline data. It has been noted that all these elements Fe: 78.25 (µg/gm), Mn: 6.89 (µg/gm), B: 2.11 (µg/gm) and Na: 4.76 (meq/100g) and Zn: 2.47 (µg/gm) show an increasing pattern in wet season of 2014-15. It might be due to increased salinity, which cannot be removed properly by rainwater.

It has also been found that all the micronutrients decreased in wet season than that of dry season, which may be an after effect of leaching and percolation in wet season. Na has also decreased by this process. Micro nutrient such as B: 2.05 (µg/gm) and Na: 4.43(meq/100g) and Zn: 1.82 (µg/gm) show a decreasing pattern in dry season of 2015-16 over wet season of 2014-15 whereas Fe: 42.96(µg/gm), Mn: 11.90 (µg/gm) shows increasing trend.

130. There is a trace of heavy metal in dry season, where Pb and Cd are within the critical limit. But in wet season Cd has washed out by water, Pb concentration shows a decreasing trend. The concentration of Pb was observed in the soils of monitoring land in the dry season of 2015-16. The concentration level of Pb was decreased in dry season than that of wet season of 2014-15. The analytical results of soil were verified with India/Austria/Australia Guidelines for agricultural soil [mgkg-1/(µg/gm)/ppm-dry weights] to know the Maximum Acceptable Concentrations (MAC) level of collected soil samples. This is due to there was no huge research conducted on heavy metals in Bangladesh. Limited research work had been conducted on heavy metals. So, there was no sufficient information available related to permissible limit/maximum acceptable concentration of heavy metals in our country. So, there was no standard setting for heavy metal by our scientist for our country context. Concentration of Pb in the leachate is not exceeded the permissible limit of Indian/Austria/Australia Guidelines for agricultural soil standard. By comparing the heavy metals analysis data, Pb belongs to not polluted category (Awashthi, 2000) and (Kabata-Pendias, A. and H.Pendias, 1992) presented in **Table E.3** of **Appendix IV**.

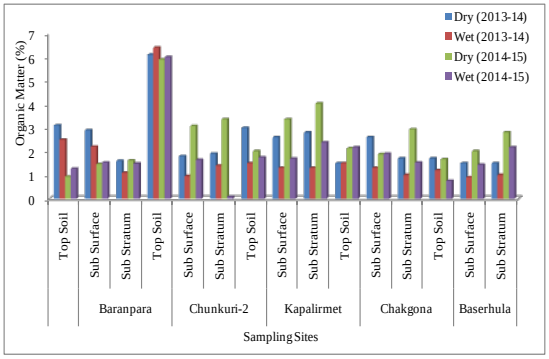


Figure 2.4.1: Organic matter concentration of the sampling sites around Project (cumulative year-2)

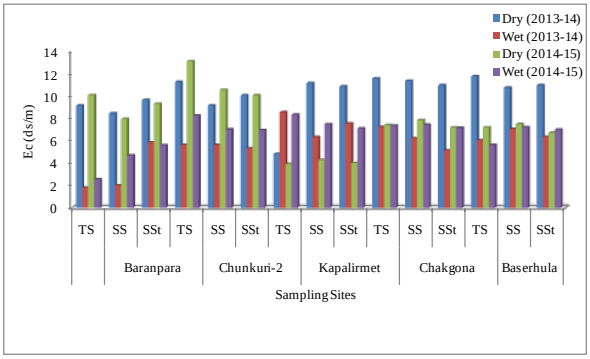


Figure 2.4.2: Ec concentration of the sampling sites around Project (cumulative year-2)

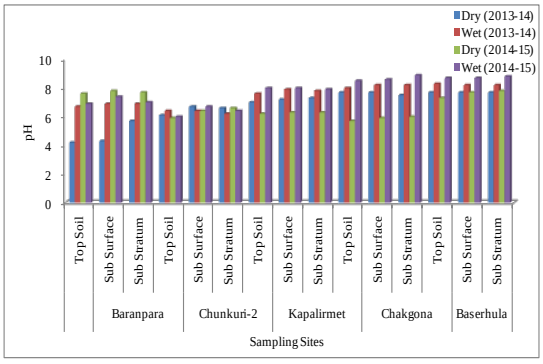


Figure 2.4.3: pH of the sampling sites around Project (cumulative year-2)

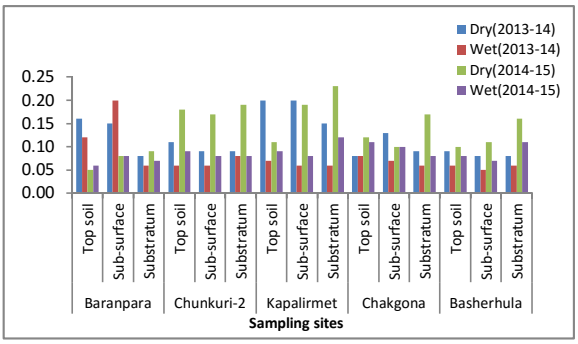


Figure 2.4.4: Nitrogen concentration of the sampling sites around Project (cumulative year-2)

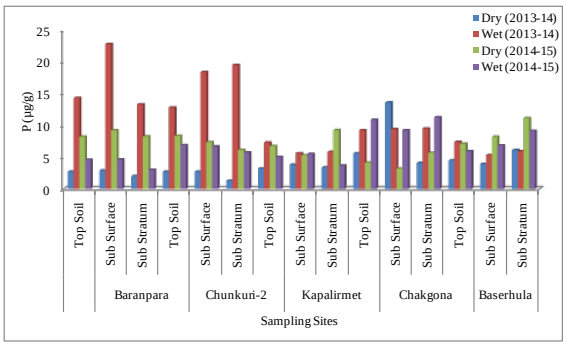


Figure 2.4.5: Phosphorus concentration of the sampling sites around Project (cumulative year-2)

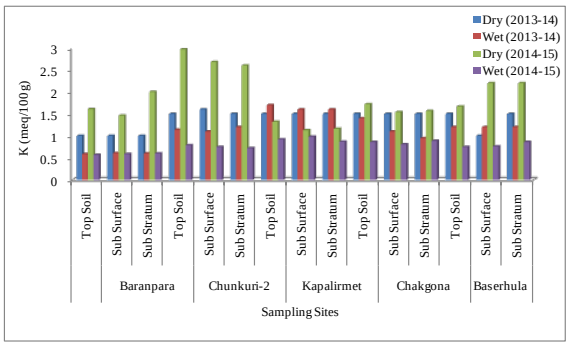


Figure 2.4.6: Potassium concentration of the sampling sites around Project (cumulative year-2)

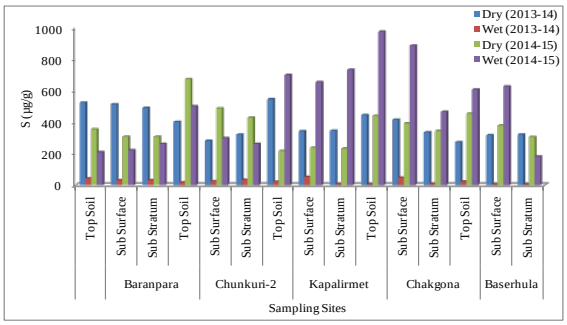


Figure 2.4.7: Sulphur concentration of the sampling sites around Project (cumulative year-2)

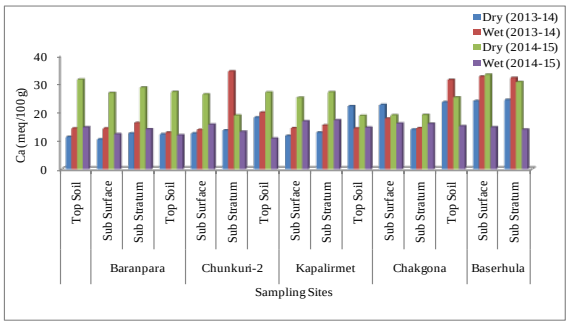


Figure 2.4.8: Calcium concentration of the sampling sites around Project (cumulative year-2)

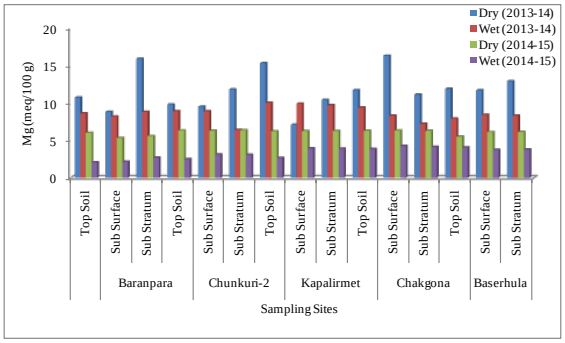


Figure 2.4.9: Magnesium concentration of the sampling sites around Project (cumulative year-2)

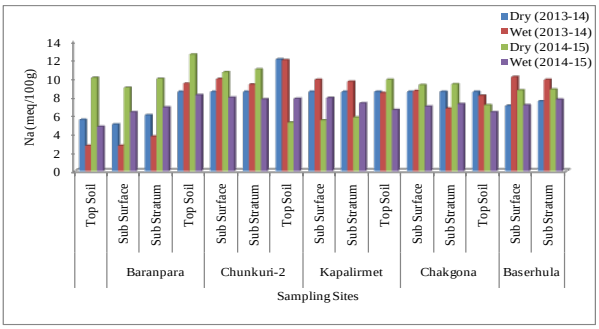


Figure 2.4.10: Sodium concentration of the sampling sites Project (cumulative year-2)

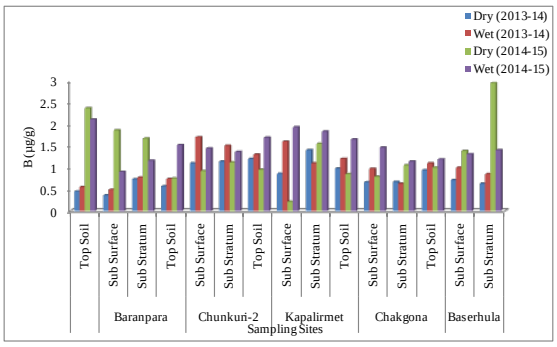


Figure 2.4.11: Boron concentration of the sampling sites around Project (cumulative year-2)

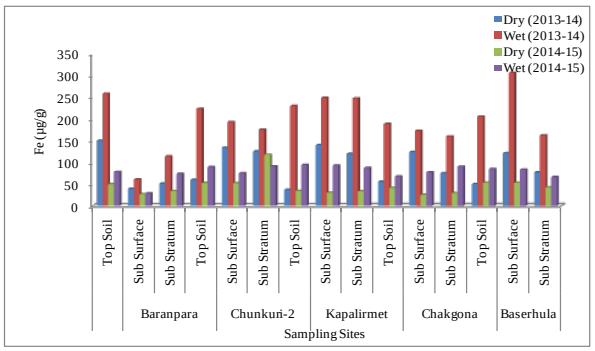


Figure 2.4.12: Iron concentration of the sampling sites around Project (cumulative year-2)

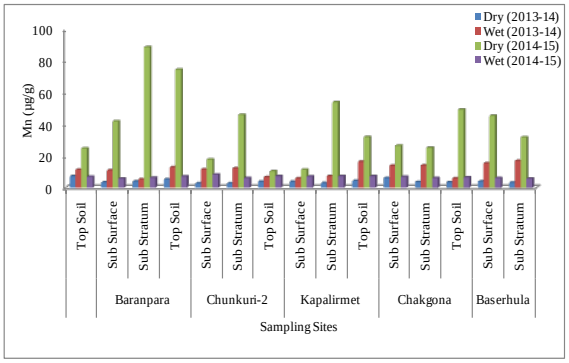


Figure 2.4.13: Manganese concentration of the sampling sites around Project (cumulative year-2)

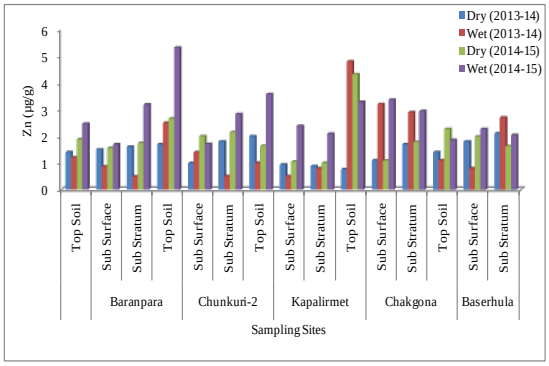


Figure 2.4.14: Zinc concentration of the sampling sites around Project (cumulative year-2)

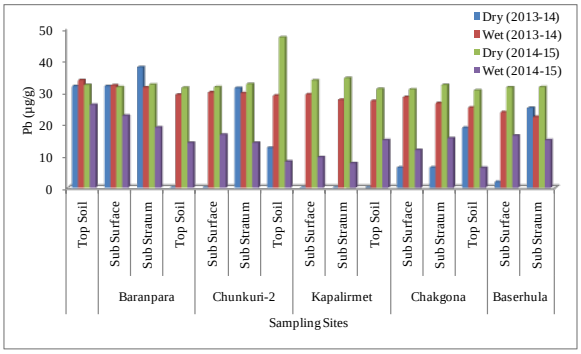


Figure 2.4.15: Lead concentration of the sampling sites around Project (cumulative year-2)

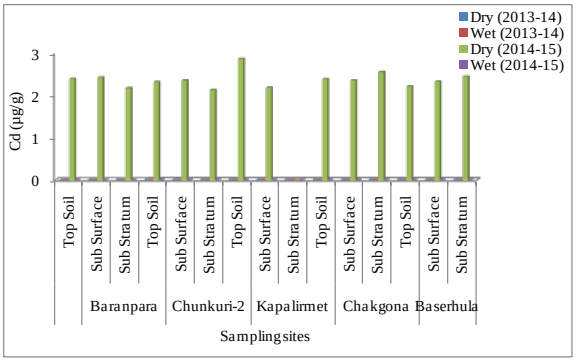


Figure 2.4.16: Cadmium concentration of the sampling sites around Project (cumulative year-2)

Monitoring plot-2 (Chunkuri-2)

131. Salinity level has slightly increased 13.05 (ds/m)-dry and 8.20 (ds/m)-wet in both seasons of 2014-15 than 2013-14 {11.2 (ds/m)--dry and 5.6 (ds/m)—wet}. Polder areas are generally confined area with very limited water source connectivity. As a result natural flow of water is disrupted. Precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity. This was due to there was no saline water intrusion in the monitoring land. On the other hand, amount of base cations (except Mg) are also increases in similar pattern. Amount of Mg 6.34 (meq/100g)–dry and 3.13 (meq/100g)-wet might be

suppressed by Ca intrusion as both of them are divalent cations. Salinity level has decreased 5.74-6.92(ds/m) in the dry season of 2015-16 in all layers over both dry and wet season of 2013-14 and 2014-15. Amount of base cations (except Mg) are also increases in the dry season of 2015-16 over wet season of 2014-15.

132. Organic matter content has increased (1.75% -wet; 2014-15) than wet season of (1.4%: 2013-14) in Chunkuri-2. Beyond Aman season, the sampling area is mostly used as a grazing land. Crop residue and animal wastes helped to improve the organic matter content in soil. New sedimentation also contributed in this process. Amount of organic matter content has increased (1.66-1.98%) in the dry season of 2015-16 over wet season of 2014-15. Basic nutrients (N: 0.09%, P: 6.89 (µg/gm), K: 0.79 (meq/100g) and S: 500.0 (µg/gm)) also follow the similar trend of organic matter in wet season of 2014-15 over 2013-14. The amount of basic nutrients (N: 0.11%, P: 8.05 (µg/gm), K: 0.86 (meq/100g) and S: 511.0 (µg/gm)) also follow the similar trend of organic matter in dry season of 2015-16 over wet season of 2014-15.

133. Micro nutrients Fe: 91.20 (µg/gm), Mn: 8.29 (µg/gm), B: 1.52 (µg/gm), Na: 8.16 (meq/100g), Zn: 5.32 (µg/gm) show an increasing pattern in wet season of 2014-15 over wet season of 2013-14. It might be due to increasing salinity, which cannot be removed properly by rainwater. It has been found that all the micronutrients decreased in wet season than that of dry season, which could be an after-effect of leaching and percolation in wet season in 2014-15. Na+ has also decreased this process. Fe: 71.73 (µg/gm), Mn: 11.21 (µg/gm), B: 1.88 (µg/gm), show an increasing pattern in dry season of 2015-16 over wet season of 2014-15. However, Na: 7.11 (meq/100g) and Zn: 2.09 (µg/gm) shows a decreasing trend over wet season of 2014-15.

134. There is a trace of heavy metal in dry season, where Pb and Cd have been within the critical limit. But in wet season, Cd is totally washed out. On the other hand, amount of Pb decreases but it is not totally removed. The concentration level of Pb was observed in the dry season of 2015-16. It was decreased in sub-surface and sub-stratum layer but increased in top soil over wet season of 2014-15. Pb Level was under not pollute category **Table E.3of Appendix IV.**

Monitoring plot-3 (Kapalirmet)

135. As regards, soil salinity in coastal belt, the general trend is that it increases in dry season. But in Kapalirmet this scenario is quite opposite. Soil salinity in wet season, 8.29 (ds/m), is almost double than that of dry season 4.26 (ds/m) of 2014-15. Golbunia Khal and Gona River flooded the area including our sampling site. Besides, pH (8.0) is also found higher in wet season than those of dry season (7.3). It could be an impact of shrimp culture in this zone. Aman is the only crop of Kapalirmet but its practice is very limited. People used to store saline water for shrimp cultivation and as a consequence base cation presence did not change significantly. The Ca2+, Mg2+ and K+ level are found almost similar in both seasons of first year (2013-2014) but in second year (2014-15) the concentrations decreases in wet season Ca:17.20 (meq/100g), Mg: 3.94 (meq/100), K: 0.98 (meq/100g) than that of dry season Ca:27.13 (meq/100g, Mg:6.25 (meq/100g), K:1.32 (meq/100g) in 2014-15. It has also been observed that concentration of S2+ has decreased in wet season of 2013-14, but has increased again in wet season of 2014-15. So, this might be due to replacement of base cations by S2+ at that time. Na is also decreased by this process.

136. The salinity level has decreased in all layer but increases in sub-surface layer 8.60(ds/m) in the dry season of 2015-16. On the other hand, pH level has increased in top and sub-surface layer than that wet season of 2014-15. Consequently the base cations Ca: 16.88 (meq/100g, Mg: 4.12(meq/100g), K: 0.89 (meq/100g) has decreased in 2015-16 over wet season of 2014-15.

137. Soil erosion is a common feature of coastal area. As a result, organic matter could also be eroded due to erosion. It has been observed that the overall organic matter content is increased (2.38%) in wet season 2014-15 than that of 2013-14(1.5%). Basic nutrients (N:0.12%, P:5.01 (µg/gm) and S: 655.0 (µg/gm) also follow the similar trend of organic matter .The overall organic matter content (1.95-2.42%) has increased in 2015-16 over the wet season of 2014-15. N: 0.13%, P: 6.21 (µg/gm) and S: 764.07 (µg/gm) also follow the similar trend of organic matter in the dry season of 2015-16.

138. As regards micro nutrients, most of the elements show an increasing trend in wet season than those of dry seasons, which might be after effect of salinity. However, concentration of Pb did not show similar pattern in last two years. Its concentration in 2013-14 increases in wet season but it decreased to almost one-fourth in dry season of 2014-15. Cd could be totally washed-out by rain water in wet season. Pb and Cd were within the critical limit. Pb concentration observed in all layers of the monitoring land in the dry season of 2015-16 and the highest was observed in sub-surface layer 10.03 (µg/gm). Pb concentration belongs to not polluted category **Table E.3 of Appendix IV.**

Monitoring plot-4 (Chakgona)

139. Salinity and pH plays a vital role for the distribution of elements in Chakgona. In 2013-14, EC 7.38 (ds/m) dropped in wet season than dry season 7.81 (ds/m) but pH has been almost same. As a result, most of the cations show a decreasing trend in wet season. But EC content has been almost similar in both seasons of 2014-15 and pH (8.9) is found to be higher in wet season of 2014-15, which helped to move up the cation concentrations. Maidara River flooded the sampling area and as a result salinity has not changed that much in wet season. The most significant rise is found in case of sulphur 975 µg/gm, which is found 440 µg/gm in dry season. Other elements are found to be in a decreasing trend. This scenario indicates that sulphur replaced other cation from the exchange sites of clay.

140. The salinity level has increased 7.02-7.67(ds/m) in the dry season of 2015-16 over dry and wet season of 2014-15 and the pH level was almost same. The highest sulphur level was 990.48 µg/gm in the dry season of 2015-16 which was higher than both dry and wet season of 2014-15.

141. Organic matter shows an increasing trend (2.17%) in wet season of 2014-15 at Chakgona over wet season (1.5%) of 2013-14., which might be due to stagnant water, limited crop production and grazing practice. Basic nutrients N: 0.11%, P: 11.26 (µg/gm)and K:0.89(meq/100g) also followed the similar trend of organic matter. As organic matter and pH increases there is a possibility of formation of chelates. As a result, most of the micro nutrients show a decreasing pattern in second year. Organic matter shows a decreasing trend (2.15%) in the dry season of 2015-16 over the wet season of 2014-15. N: 0.09%, P: 8.27 (µg/gm) and K: 0.84(meq/100g) also followed the similar trend of organic matter.

142. In wet season of 2013-14, presence of Pb concentration is found in soil. In 2014-15 trace of Pb was found in both seasons. Moreover, as most of the Pb has possibly washed out in rainy season, concentration is found much lower in wet season than dry season. On the other hand, Cd might be completely washed out in wet season. Pb and Cd have been within the critical limit. In dry season of 2015-16, the concentration of Pb has been found in the monitoring land in all layers. It was also observed that comparing the Pb level in the wet season of 2015-16, it was decreased in dry season over wet season of 2014-15. Comparing the heavy metals data, Pb concentration belongs to not polluted category **Table E.3 of Appendix IV.**

Monitoring plot-5 (Basherhula)

143. Level of EC dropped in dry season 6.3 (ds/m) from that of wet season 7.16 (ds/m) in 2014-15 over 2013-14. On the other hand, pH shows the opposite trend. Although EC indicates that overall salinity is decreased in wet season but Na and Ca concentration increased at that time. But there is a possibility of increase in base cation due to high pH (8.3-8.7). But most of the elements show a decreasing trend at that time, except S and Fe. The overall situation indicates that there is a possibility of replacing other elements by S and Fe from exchange sites of clay. This area is flooded by Passur River and Basherhula Khal in rainy season.

144. Overall organic matter content (2.17%) increased in wet season of 2014-15 year than that of 2013-14. Every year's sedimentation could have contributed to this. But dry season content of organic matter is generally higher than wet season due to top soil erosion. Basic nutrients N: 0.11%, P: 9.12 (µg/gm) and K: 0.86 (meq/100g) also followed the similar trend of organic matter.

145. Micro nutrients Fe: 85.08 (µg/gm), Mn: 6.50 (µg/gm), B: 1.40 (µg/gm), Na: 7.68 (meq/100g, Zn: 2.27 (µg/gm) show an increasing pattern in 2014-15. It could be due to new sedimentation, which is not removed properly by rainwater. It has also been found that all the micronutrients decreased in wet season than that of dry season, which could be an after effect of leaching and percolation in wet season.

146. Concentration of Pb did not show similar pattern in last two years. In 2014-15 its concentration increased in wet season but in 2014-15, it decreased to almost one-forth than that of dry season. Cd might be totally washed out by rain water in wet season. Pb and Cd are within the critical limit. It was observed in dry season of 2015-16, Pb level **Table E.3 of Appendix IV.**

3 Biological Environment

147. Biological resources include all living organism within an ecosystem which interact with one another as well as with the physical environment. The biological resources around the project site were categorized into three major groups and monitored quarterly with the aim to establish baseline conditions to compare with the probable impact of proposed project in place. These groups include fisheries resources, ecological resources and Sundarbans Reserve Forest (SRF).

3.1 Fisheries Resources

148. Fisheries resources have been monitored quarterly in a year. Monitoring of all four quarters of 2014-15 and of 2015-16 and first quarter of 2016-17 have been completed and reported earlier. This chapter contains the outcome of this 2ndquarter monitoring of 2016-17 along with the comparisons with the earlier nine quarters.

Location of Monitoring Sites

149. The monitoring activities are being carried out at ten pre-selected locations of which seven (7) are capture fish habitat and three (3) are shrimp/fish farm. The capture sampling sites have been selected based on the fishing availability of upstream, middle stream and downstream of Passur River system. Shrimp/fish farms have been selected based on the direct impacted area of Plant site. The sampling sites are detailed in **Table 3.1.1.**

Table 3.1.1: The Sampling Locations for monitoring of Fisheries Resources

Site	Capture Habitat Location	Culture Habitat Location
A	Akram Point	Bhekatkhali Khal, Rajnagar
B	Haldikhali	Kapasdanga-Muralia
C	Harbaria	Chunkuri-2
D	Chandpai	
E	Mongla Port	
F	Maidara	
G	Chalna Point, Batiaghata	

Selection of Parameters

150. In the fisheries monitoring, five major components had been selected according to TOR, such as, fish habitat status, fish migration, fish diversity, shrimp/fish farm practices and fish production. Fish habitat status has been monitored through investigating habitat suitability index in view of habitat classification based on length frequencies of different fish species and sensitivity of fish diversity and survival success of different life stages of fish to abiotic factors (water quality, bed material, hydrological condition, morphological aspects and biotic factors (food cover).Fish migration status has been monitored through assessing migratory fish species diversity, migration pattern, migration purpose, period and extent of migration etc. Species evenness, species richness and community structure have been investigated for

monitoring fish diversity. Shrimp/fish farm practice has been monitored by viewing stocking pattern, growth rate and mortality rate. Fish production monitoring has been divided into capture and shrimp/fish farm production.

3.1.1 Methodology

Fish Habitat Status

151. Fish habitat status has been monitored through determination of Habitat Suitability Index (HSI) based on the habitat classification and sensitivity of fish diversity and survival success of different life stages of fish to abiotic and biotic factors. Fish habitat classification has been analyzed by calculating Ecludean Distance among sampling sties. Moreover, the similarities in species composition among the sites were analyzed using the Jaccard index (JI) for estimating the extent of similarity between pairs of data sets. Basic life requirements for fish community are given in **Table D.1 of Appendix IV.**

Fish Migration

152. Migratory species have been identified by analyzing the common species found in the catch assessment survey from the sampling sites based on IUCN list.

Fish Diversity

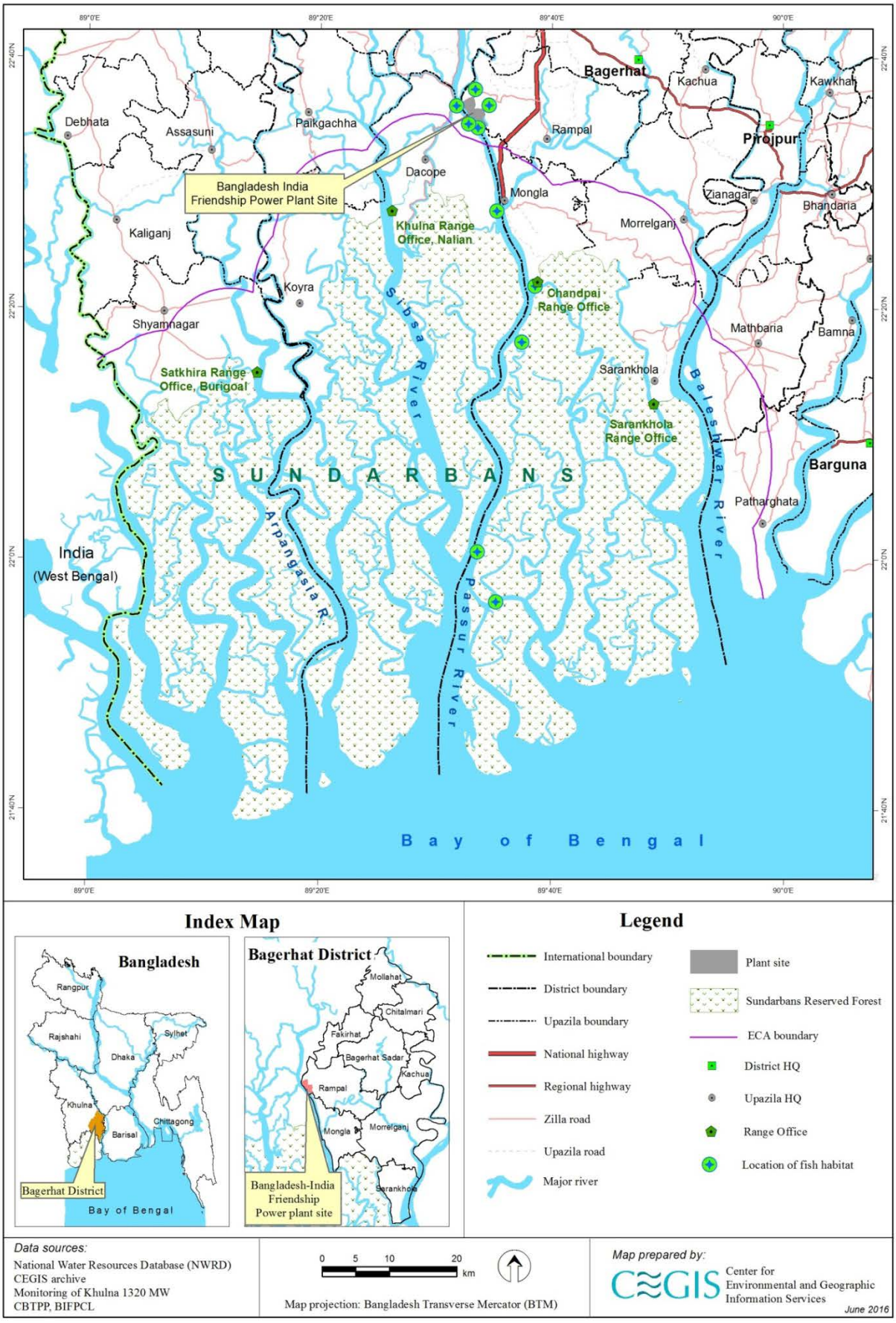
153. Fish diversity has been surveyed by Catch Per Unit Effort (CPUE) method. The fish individuals were counted according to the length of each species from the samples. Diversity has been estimated by analyzing Shannon-Weiner Index ranges from 0 to 1. Fish species richness (FSR) has been analyzed using the Simpson's Index that generates two types of values. The first one includes values from 0 to 1 expressing normalization scores for species richness status and the second one includes values from one (01) to values equal to the total number of species found in the sample which means that how many species are dominant in this fish community. Fish community structure has also been analyzed through counting the length-wise fish individuals.

Fish-Shrimp Culture Practice

154. For monitoring shrimp/fish farm, three farms within the direct impact zone of the proposed Power Plant have been surveyed. Stocking pattern of the shrimp/fish farm is the major issue for successful production, because of having natural genetic resources from the wild source of the Passur River System. Moreover, mortality rate should be minimized for getting more economical output from the farms. So, stocking pattern and mortality rate and its causes have been surveyed intensively.

Fish Production

155. Fish production for riverine fish has been surveyed through CPUE. The information on the species-wise production of shrimp/fish farm has been collected from the selected farms for the last catch.



Map 3.1.1: Fisheries Resources Monitoring Locations

3.1.2 Status of monitoring

156. Followed by the first quarter monitoring of the third year, second quarter monitoring has been conducted during the period of 14 to 23 July, 2016.

Fish Habitat Status

157. Fish habitat status has also varied in the view of habitat classification and habitat use pattern of different life stages of different fish species.

(a) Habitat Classification

158. Habitat classification is analyzed by using the length-wise distribution of different fish species in the sampling sites. The length of different life stages of fish species were identified and collected from literature. Linkage distance is then calculated with the similarity in distribution. The entire stretch of the Passur River System consists of three major behavioral habitats. The sampling sites have been classified (shown in the **Figure 3.1.1**) on the basis of abundance of different life stages of fish species in those habitats.

159. During 1st monitoring (April, 2014) fish habitat had been classified as the grazing ground (Akram Point and Harbaria), grazing and breeding ground (Haldikhali and confluence of the Passur river at Chalna Point) as well as spawning and nursery ground (Sheola khal at Chandpai, Passur River at Mongla Point and Maidara River). In the second quarter monitoring (June – July 2014) two habitats – i) grazing ground, ii) spawning and nursery ground have been identified. However, during third quarter monitoring in the month of October 2014 the similarity of size group distribution of fish species among the habitats has been found to be shifted to some extent. In fourth monitoring phase in the month of January 2015 three habitats – i) grazing ground, ii) grazing and breeding ground; and iii) spawning, nursery and grazing ground have been identified. During the 1st quarter (April, 2015) of the second year three habitats – i) grazing ground, ii) nursery ground; and iii) spawning and nursery have been identified. During the 2ndquarter monitoring of 2nd year (October, 2015) two habitats have been identified as: i) grazing and breeding ground and ii) spawning and nursery ground. During the 3rd quarter monitoring of 2nd year (October, 2015) such three habitats as i) grazing ground, ii) nursery ground and iii) growing and feeding have been identified. During the 4th quarter monitoring of 2nd year (January, 2015) two major habitats – i) nursery and feeding ground and ii) feeding and growing ground have been identified. During the 1st quarter monitoring of 3rd year (April, 2016) two major habitats – i) spawning and nursery ground and ii) feeding and growing ground have been identified.

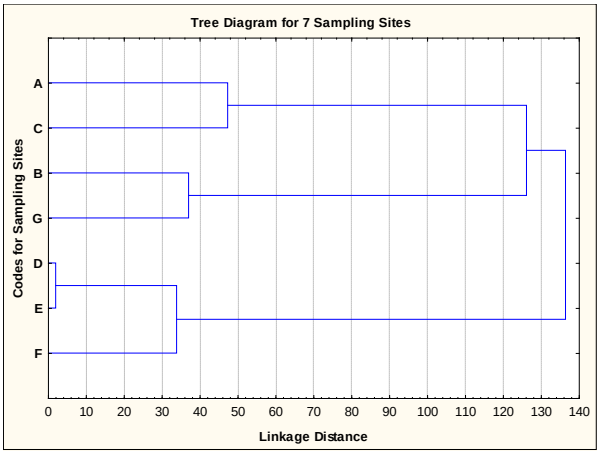
160. During the 2nd quarter monitoring of 3rd year (April, 2016) two major habitats – i) nursery ground and ii) feeding and breeding ground have been identified as shown in the **Figure-3.1.1.**

Nursery Ground:

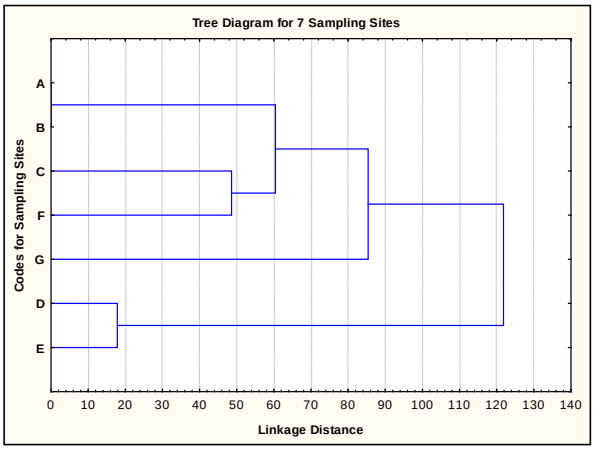
161. Among the sampling sites, Mongla Point (E) of Passur River was identified as the nursery ground for abundance of fry to age-1 juvenile fishes.

Feeding and Growing Ground:

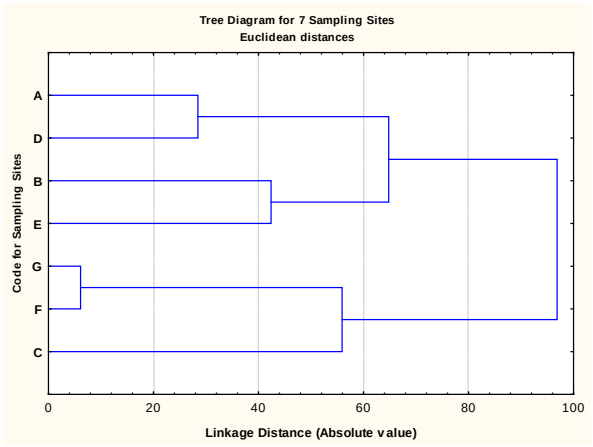
162. Among the sampling sites, the Chalna Point (G) and Maidara-Passur confluence (F) were similar in the distribution of life stages from first aged juvenile to adult fish. Moreover, brood fishes of Tapsi fish have been found in these sites. These habitats were classified as the feeding and breeding ground.



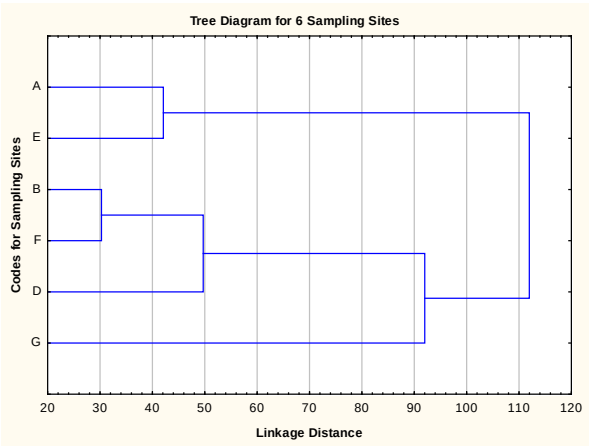
1st Monitoring, April, 2014



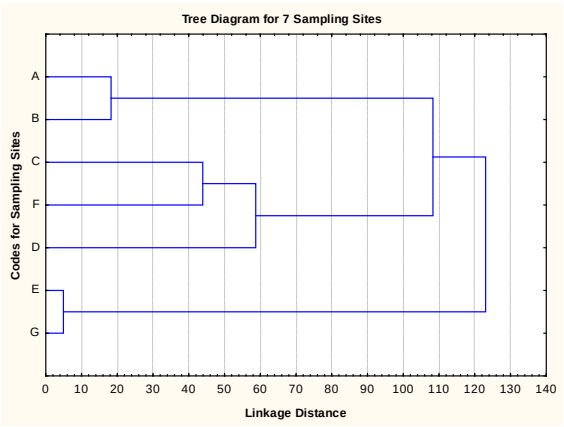
2nd Monitoring, July 2014



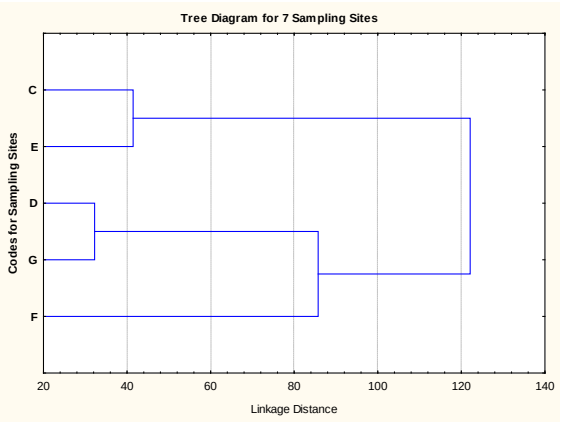
3rd Monitoring, October, 2014



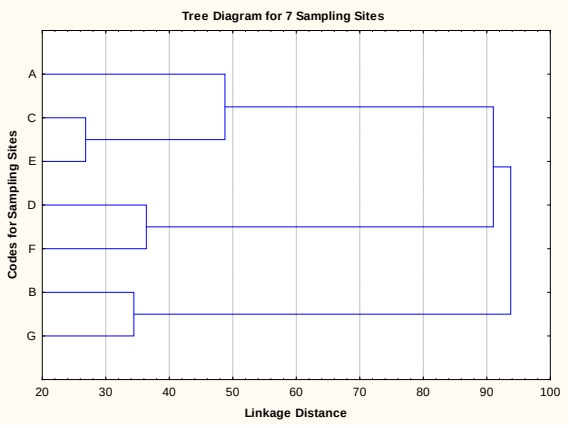
4th Monitoring, January 2015



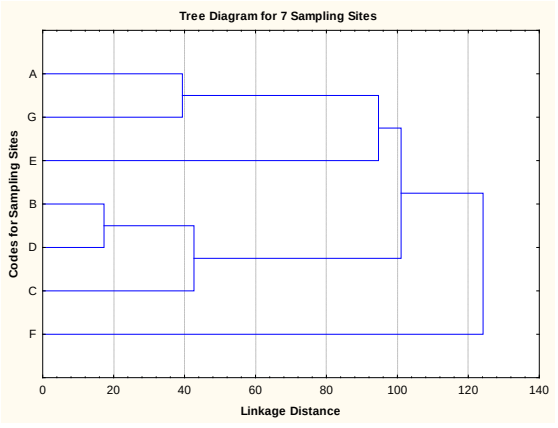
5th Monitoring, April, 2015



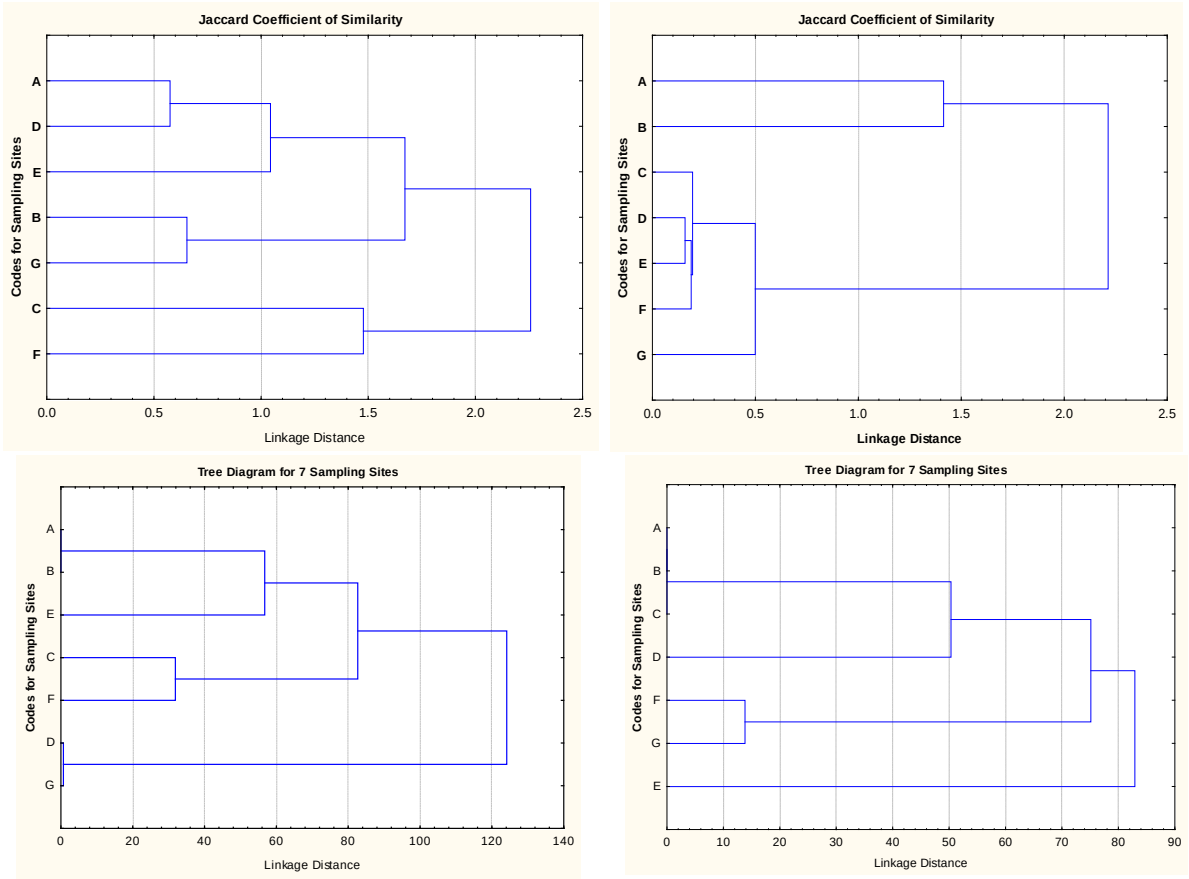
6th Monitoring, August, 2015



7th Monitoring, October, 2015



8th Monitoring, January, 2016

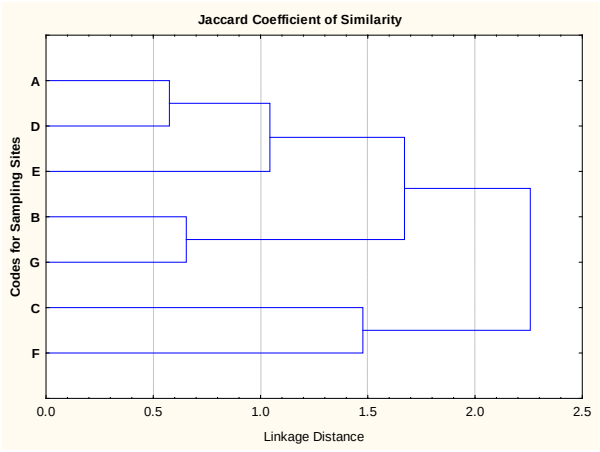


9th Monitoring, April, 2016 **10th Monitoring, July, 2016**

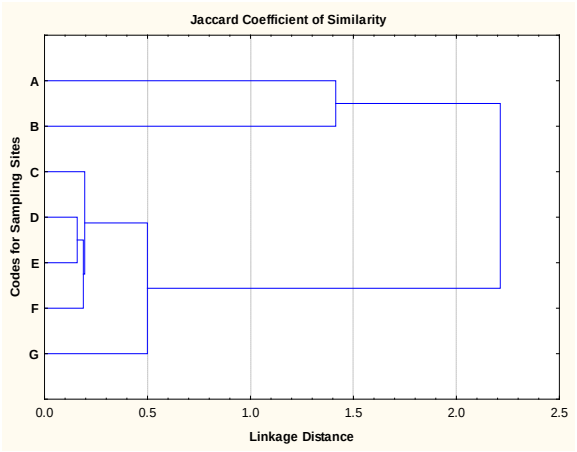
(Note: Life stage is identified through length measurement of the fish individuals)

Figure 3.1.1: Habitat Classification on the basis of Different Life Stages of Fish Species

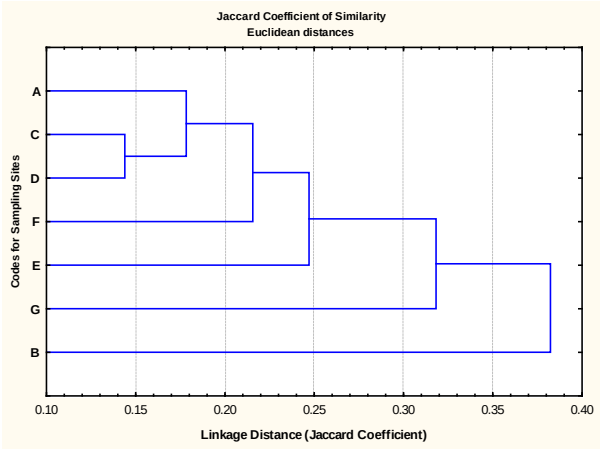
163. The dendogram analyses the distances among the JI (Jaccard Coefficient Index) indices which are opposite to the JI values. It has been found that the length-wise distribution relationship varies not only with four quarter but also with year to year. In the first quarter of the third monitoring year, the JI value between C and E sampling sites is the highest (**Figure 3.1.2**) which indicates the maximum similarity in species occurrence between these two sites out of seven (7) sampling sites.



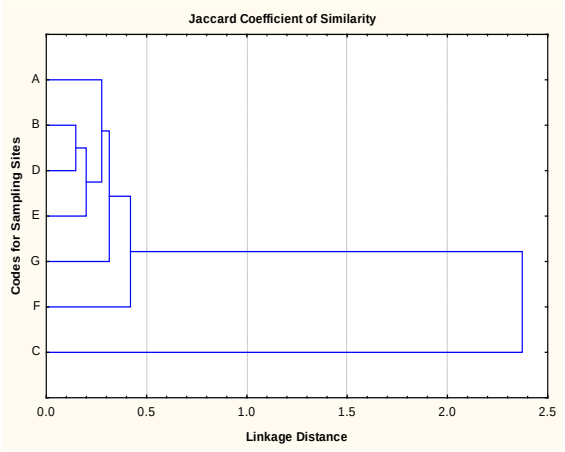
1st Monitoring, April, 2014



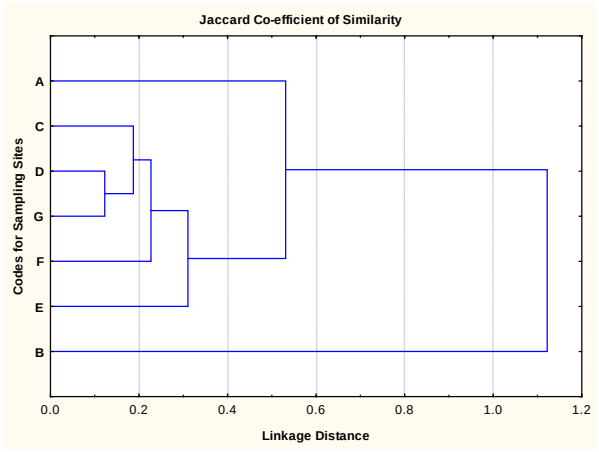
2nd Monitoring, July 2014



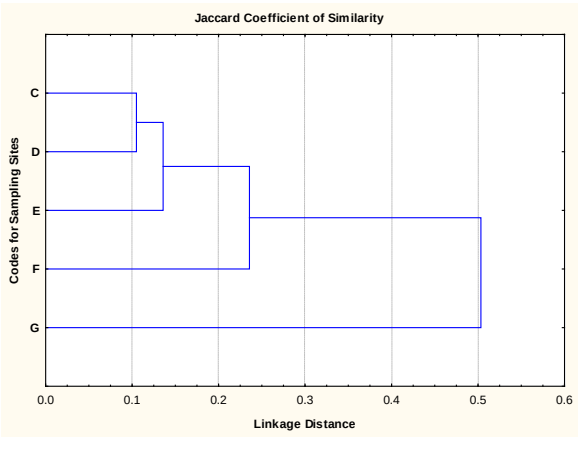
3rd Monitoring, October, 2014



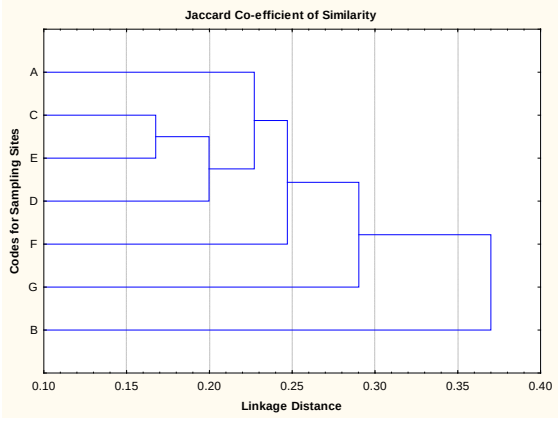
4th Monitoring, January 2015

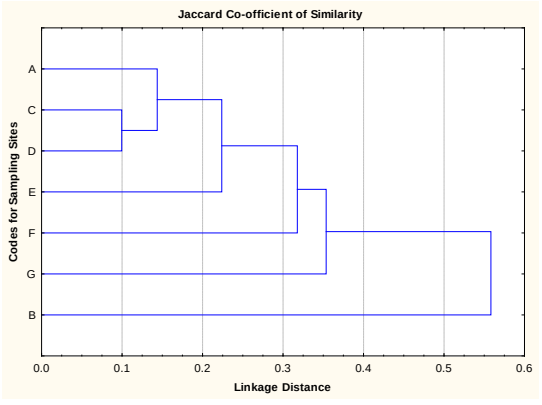


5th Monitoring, April, 2015

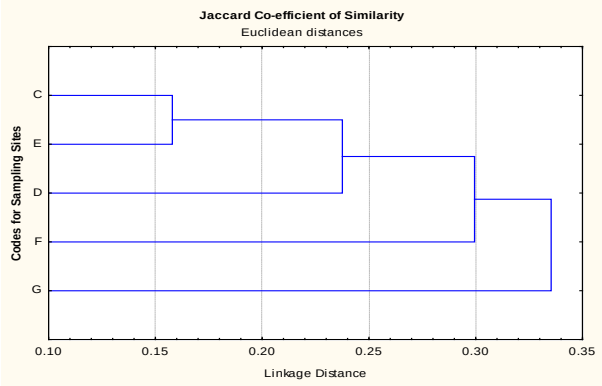


6th Monitoring, August, 2015

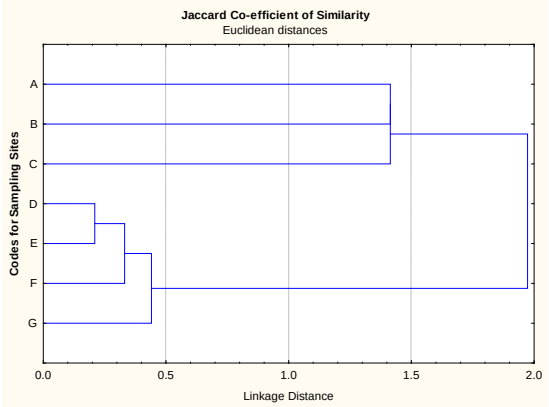




7th Monitoring, October, 2015



8th Monitoring, January, 2016



9th Monitoring, April, 2016

10th Monitoring, July, 2016

Figure 3.1.2: Dendogram Showing Similarity in Binary Species Composition in seven sampling sites

(b) Habitat Suitability Index (HSI)

164. Habitat Suitability Index (HSI) has been determined for the year of 2014 considering the exposure to water quality and the production performance of different fish species. Production performance has been measured through considering length-structured production assessment model (E. L. Cadima, 2003) Suitability analysis has been conducted by applying Iyengar and Sudarshan (1982) developed model. All data has been normalized through using UNDP developed normalization equation (***UNDP, 2006***).

165. In the first year of monitoring, Sheola khal at Chandpai has been found as the most suitable habitat for fish species among Passur River System. Sheola khal has also been identified as the most suitable which is followed by Harbaria, Akram Point, Haldikhali, Mongla Point, Maidara and Chalna Point (**Table 3.1.2).**

Table 3.1.2: Habitat Suitability Index (HSI) for selected spot in the study area

Sampling Sites	Location	HSI* (2014-2015)	HSI (2015-2016)	HSI (2016-2017)
A	Akram Point	0.334	0.56	
B	Haldikhali	0.408	0.54	
C	Harbaria	0.226	0.64	
D	Chandpai	0.520	0.72	
E	Mongla Port	0.321	0.43	
F	Maidara	0.224	0.25	
G	Botiaghata, Chalna Point	0.218	0.32	

**HSI value is calculated on the basis of life requirement and length-age structured population dynamics model*

Note: The HSI will be calculated on the basis of one year monitoring data

Fish Diversity

a) Shannon-Weiner Index

166. In the second quarter monitoring of third year (2016-17), species evenness strongly varied with the sampling sites. Similar variation has also been found in previous quarters. However, highest Shannon-Weiner index has been found at Chalna Point (0.87) indicating most evenly distributed fish species. On the contrary, lowest evenness was found at Mongla Point (0.55) shown in the following table **(Table 3.1.3**).

Table 3.1.3: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct 2014)	4th QM(Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
A	3 3	0	1 3	7	3	-	10	15	0	0			0.49	0	0.73	0.57	0.96	-	0.55	0.44	0	0		
B	1 2	0	2 4	1 4	0	-	11	3	0	0			0.85	0	0.57	0.39	0.00	-	0.56	0.58	0	0		
C	2	1 2	9	0	11	26	18	24	17	0			0.29	0.77	0.40	0.00	0.78	0.59	0.54	0.67	0.57	0		
D	1 2	2 2	1 5	2 6	27	24	20	25	8	19			0.31	0.78	0.73	0.51	0.65	0.72	0.51	0.71	0.61	0.55		
E	7	1 3	1 0	1 1	6	16	9	9	15	12			0.38	0.60	0.76	0.77	0.15	0.73	0.85	0.41	0.66	0.50		
F	3	1 3	6	4	10	8	14	6	7	5			0.82	0.77	0.54	0.60	0.67	0.39	0.77	0.65	0.75	0.68		
G	6	3	5	7	18	3	8	6	6	4			0.68	0.82	0.72	0.66	0.18	0.95	0.72	0.81	0.58	0.87		

**According to Shannon-Weiner Index, 0-0.30: Low diversity/equally distribution (VH); 0.31-0.50: Moderate Diversity (M); 0.51-0.80: High Diversity (HD) and 0.80-1.0: Very High Diversity (VHD)*

b) Fish Species Richness (FSR)

167. Fish species richness has been identified through Simpson's Index1. Considerable difference is noticed in the fish species richness (FSR) in different habitat classes (**Table 3.1.4** and **Figure-3.1.3**).

168. In this monitoring phase, the sampling sites have more or less same species richness. However, maximum FSR is obtained in Mongla Point (n=7), while very low FSR is recordedat Maidara Passure confluence (n=2). Moreover, the richness in this quarter is more or less the same in both the monitoring years. Among habitats in upstream portions of the Passur river, Mongla Port has been home to a rich assemblage of Bagda, Paissa and Tit Punti; Maidara River at Baro Durgapurwas of Tapsi and Poma; and Chalna Point has been of Tapsi, Poma, Banspata and Khorsula. Among the habitats in down stream portions, Chandpai has been rich in Bele, Chata Bele, Chaka Chingri, Gusha Chingri, Potka and Katali Chingri.

[1]Simpson's index is a method to calculate the community characteristics of fish in a particular habitat. It is mainly used to know about the species richness of a particular habitat to tell how many species are rich in their abundance. The value of this index ranges from 0 to 1. There is other kind of value which is described in the methodology section. The second value is mainly used tomeasure the species richness in the sampling sites.

Table 3.1.4: Site wise Rich Species Number

Site	Location	No. of Rich Species											
		2014-2015				2015-2016				2016-2017			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
A	Akram Point	4	0	4	3	3	-	3	2	0	0		
B	Haldikhali	7	0	4	2	0	-	3	2	0	0		
C	Harbaria	1	5	2	0	4	4	3	6	4	0		
D	Chandpai	2	2	5	4	5	8	3	7	4	6		
E	Mongla Point	1	10	4	5	3	6	4	2	4	7		
F	Maidara at Baro Durgapur	3	6	2	2	4	2	4	2	3	2		
G	Botiaghata, Chalna	3	3	2	3	1	3	3	4	2	4		

Rupchanda in 1stQuarter of 1st Year

Chela in 2nd Quarter of 1st Year

Phesa, Chela, Hilsa, Gagla Tengra

Harina Chingri

Fish Species at 3rd Quarter Monitoring of 1st Year 2014-15

Amadi Chela

Banspata

Fish Species in Upstream of Passur River at 4th Quarter Monitoring of 1st Year 2014-15

Adult Poma in Chalna Point

Fry of Bagda at Chalna Point

Meth and Gagra Tengra

Gagra Tengra

Fish species found in 1st quarter of the second monitoring year (2015-16)

Mutkure and Paissa

Khorsula

Menu

Vetki

Fish species found in 2nd quarter of the second monitoring year (2015-16)

Gulsha Tengra, Bele, Aswine Bele and Paissa

Gangania

Telcupa

Golda

Kain Magur

A Mix of Culture and Capture Fishes

Fish species found in 3rd quarter of the second monitoring year (2015-16)

Tau Paissa

Bele

Horina Chingri

Gulsha and Gagra Tengra

Jaba

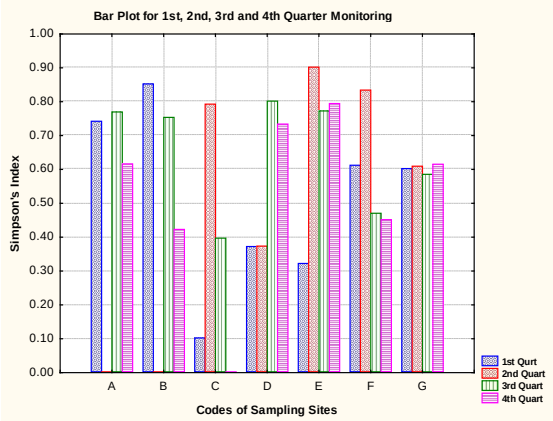
Female Gulsha Tengra

Fry Fishes

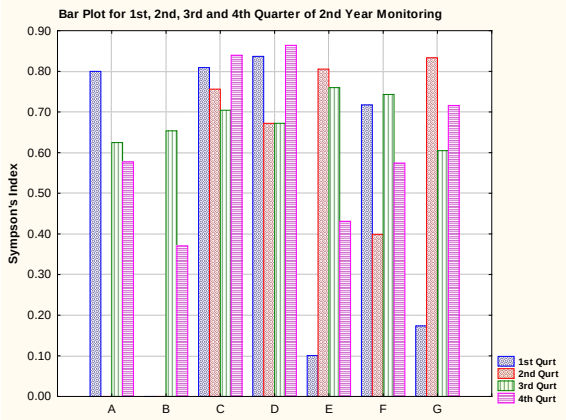
Chata Bele

Fish species found in 4th quarter of the second monitoring year (2015-16)

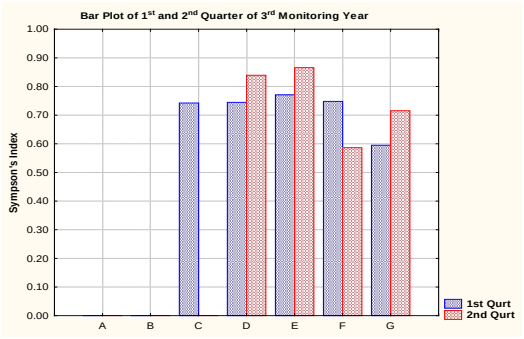
Photo 3.1.2: Length-wise distribution of fish species



2014-2015



2015-2016



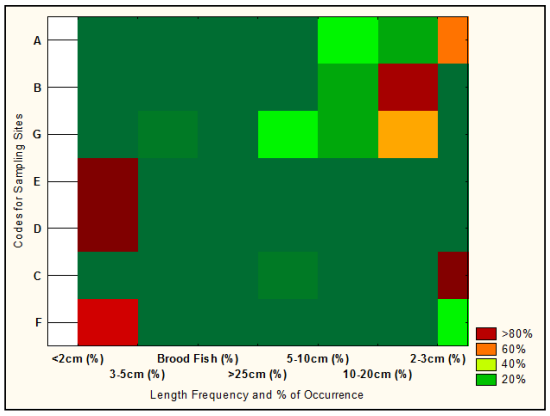
2016-2017

(FSR is identified though Simpson's Index)

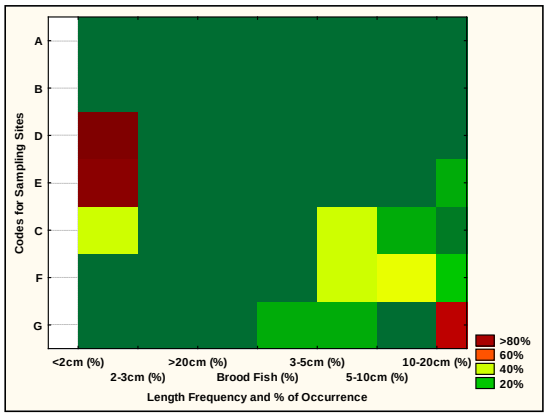
Figure 3.1.3: Site-wise fish species richness (FSR) in the Passur River System.

c) Fish Community Structure

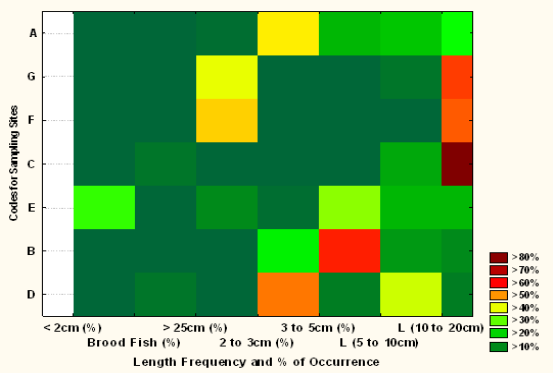
169. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 3.1.2**). The following **TableD.2** and **D.3** of **Appendix IV** and **Figure 3.1.4** for second quarter of third monitoring year shows that fry for fin fish were more widely distributed among the middle stretches of the Passur River. Among these Bagda, Bele, Ekthuto and Paissa fishes were widely distributed. Moreover, brood female fish of Tapsi in Maidara and Chalna Point have highly observed in this quarter



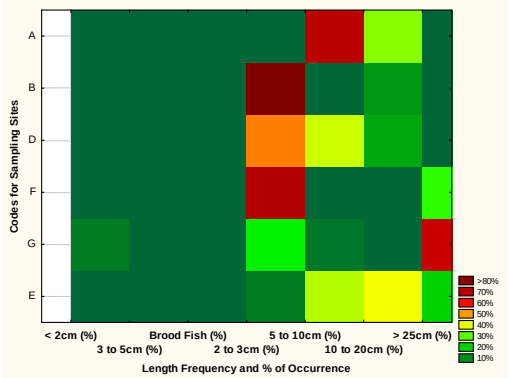
1st Monitoring, April, 2014



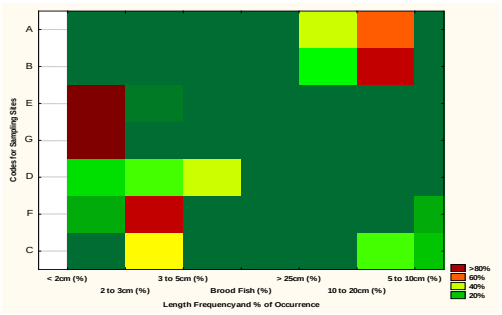
2nd Monitoring, July 2014



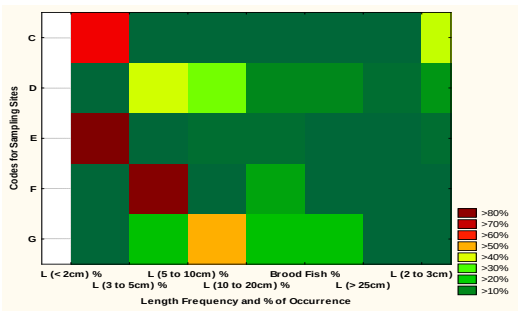
3rd Monitoring, October, 2014



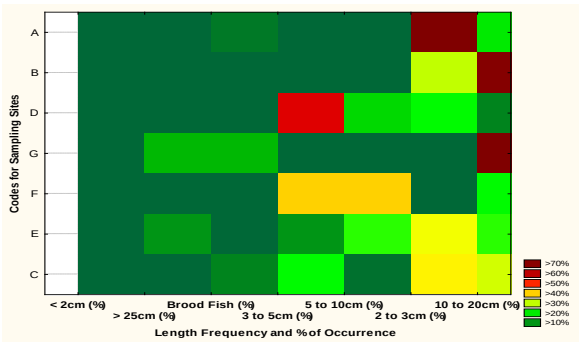
4th Monitoring, January 2015



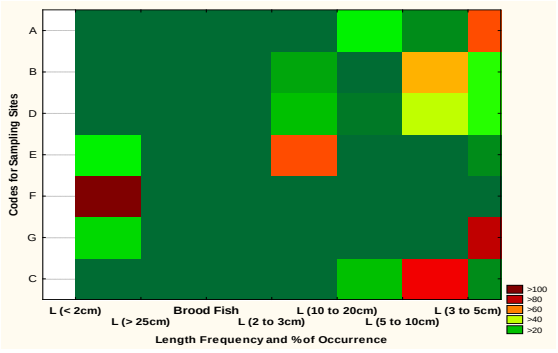
5th Monitoring, April, 2015



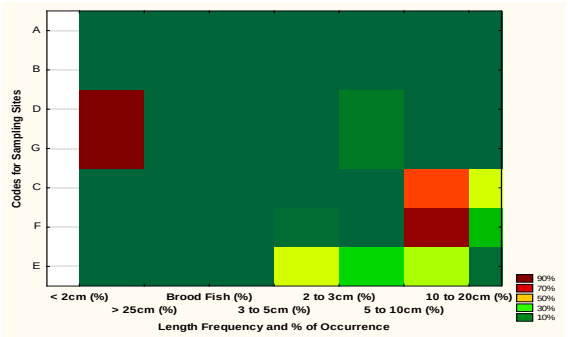
6th Monitoring, August, 2015



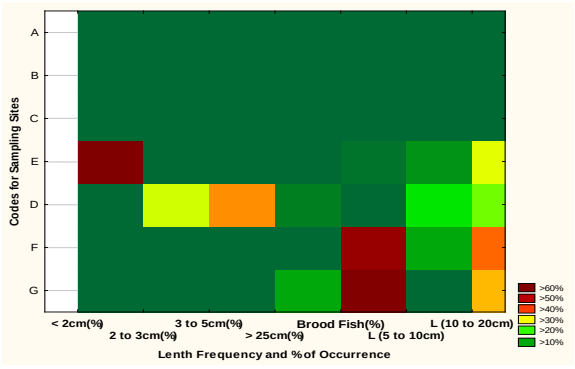
7th Monitoring, October, 2015



8th Monitoring, January, 2016



9th Monitoring, April, 2016



10th Monitoring, July, 2016

Figure 3.1.4: Habitat Distribution of Different Life Stages of Fish Species

Note: N.B.: Colour ranges from deepest green to deepest red. 0-4.99% Occurrence signifies Deepest Green; 5-9.99%-Shaded Green; 11-14.99%-Normal Green; 15-19.99%-Light Green; 20-24.99%; 25-29.99%-Lightest Green; 30-34.99%; 35-39.99%; 40-44.99; 45-49.99; 50-54.99-Light Magenta; 55-59.99-Deep Magenta; 60-64.99%; 65-69.99%; 70-74.99%; 75-79.99%-Light Red; 80-84.99%-Deep Red; 85-89.99%; 90-94.99%; 95-100%-Deepest Red

Fish Migration

(a) Migratory Species Diversity

170. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Potka and Bele attains the maximum abundance among the migratory fish species observed in second quarter of third monitoring year. The relative abundance of the migratory species is give below in the **Figure 3.1.5.**

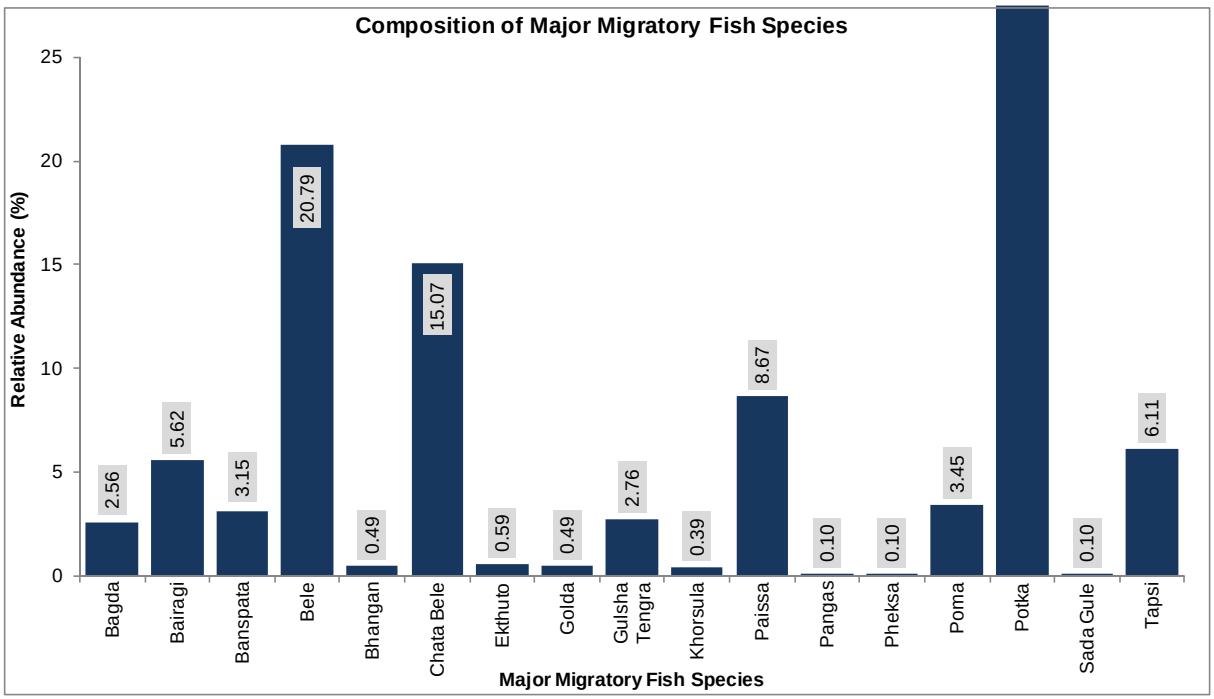


Figure 3.1.5: Relative abundance of major migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

171. Major fish species showed interesting pattern in distribution for exploiting different purposes mentioned in the following table all along the sampling sites. Three (3) fish species were found common in most of the sites. Only three species, Tapsi, Poma and Pheksa, have been observed indicating long range of distribution **(Table D.4 of Appendix IV).**

172. It is interpreted from the findings that in the month of April fish species migrate to the middle rift is interpreted from the findings that in the month of July that some fish species migrate to the middle and upper reaches of the Passur River mainly for breeding and spawning purpose. However, some species use these reaches for their nursing as in case of Bagda and Golda in Mongla Point

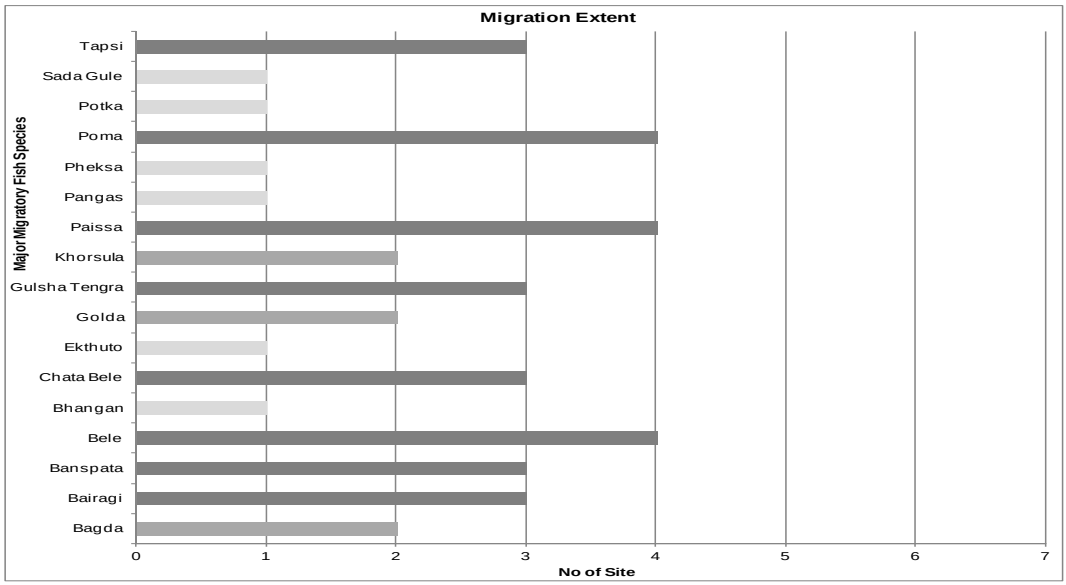


Figure 3.1.6: Migration extent of major migratory fish species in sampling sites

Shrimp/Fish Farm

173. Three farms situated in the direct impact zone of Power Plant have been surveyed for monitoring shrimp/fish farm. Stocking pattern of the shrimp/fish farm is one of the major issues for successful production because of having natural genetic resources from the wild source of the Passur River System. Moreover, maximization of growth rate and minimization of mortality rate should be ensured for getting more economical output from the farms. So, stocking pattern, growth rate and mortality rate and its causes have been surveyed intensively.

Stocking Pattern

174. It was reported by the farmers of the shrimp farms that availability of wild seed (PL) has been declining over the years. For this reason, the farm at Rajnagar and Kapasdanga collect Bagda fry from both the wild (Passur) and hatchery (Namira and Sonar Gaor at Chalna) and another farm of Chunkuri-2 collected Bagda seed directly from Passur river.

Shrimp/Fish Growth Rate and Mortality

175. During the second quarter of third monitoring year, both the highest growth and mortality rate has been observed at farm in Kapashdanga (**Table 3.1.5)**.

Table 3.1.5: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QM (Apr 2014)		2nd QM (Jul 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug2015)		7th QM (Oct 2015)		8th QM (Jan 2016)		9th QM		10th QM		11th QM		12th QM	
	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)
1	0.3	15-20	0.2	40	0.25	50	-	-	-	30	0.18	25	0.20	60	-	-	-	-	0.2	20				
2	0.3	30-35	0.3	94	0.25	10	-	-	-	-	0.14	20	0.15	100	-	-	0.21	15	0.3	40				
3	0.2	25-30	0.2	25	0.20	65	-	-	-	10	0.15	50	0.25	20	-	-	0.17	30	0.15	30				

Source: CEGIS Field Survey, 2014 & 2015

Fish Production

(a) Capture Fish Production

176. In second quarter monitoring of the third year, the highest productivity has been found in Sheola Khal at Chandpai(Table 3.1.6). The lowest productivity has been found in the Chalna Point. However, in case of Mongla Point lower productivity has been observed mainly because all the fry fishes (not considered as catch) have been found in these sites.

177. The present study observed that Charpata andBer Jal are frequently used to catch fish. The highest catch susceptibility has been found in case of Charpata Jal (11.8 kg/haul) (Table 3.1.6). The following table also expresses that Ber Jal is very commonly used in upper reach and Charpata Jal in lower reach of the Passur River. Moreover, the highest total catch is observed in Sheola Khal at Chandpai and lowest in the Maidara-Passure confluence in this monitoring phase (**Table-3.1.7**).

Table 3.1.6: Total Catch in Different Gears in the Sampling Sites

Sl. No	Site	Habitat	Gear Name/Type	Haul Duration (hr)	No of Haul	Total Catch (kg)	kg/haul
A	Akram Point	Passur River	0	0	0	0	0
B	Haldikhali	Passur River	0	0	0	0	0
C	Harbaria	Harbaria Khal	0	0	0	0	0
D	Chandpai	Sheola Khal	Charpata Jal	14	1	11.8	11.80
E	Mongla Point	Passur River	Ber Jal	2	1	7.5	7.50
			Net	2	1	0	0.00
F	Maidara	Maidara River	Ber Jal	1.5	14	0.77	0.05
G	Chalna Point	Passur River	Ber Jal	1.75	10.5	0.28	0.03
			Khepla Jal	2	2	0.5	0.25

Source: Catch assessment survey, CEGIS (2015)

Table 3.1.7: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM(Oct 2014)	4th QM(Jan 2015)	5th QM(Apr 2015)	6th QM(Aug 2015)	7th QM(Oct 2015)	8th QM(Jan 2016)	9th QM	10th QM	11th QM	12th QM
A	28*	0	3	28.7	6	-	20	276.2	0	0		
B	65	0	1	3.3	0	-	10	12.8	0	0		
C	1,559	0.5	8	8.7	1.05	0.33	19.5	173.6	2.75	0		
D	**	12	3	30.0	10.5	5.08	10.75	189	0.00	11.8		
E	**	0.6	5	0	0.5	0.40	0.6	7.8	5.00	7.5		
F	**	1.2	13	3.7	1.5	0.70	0.8	0	1.50	0.77		
G	**	1.6	4	0.7	2.9	0.83	0.825	70	1.00	0.78		

**Average Weight 0.15kg/mud crab and average weight 0.6 kg/mud eel*

*** Weight of Fry is not considered for catch assessment*

(b) Culture Fish Production

178. The present study on shrimp/fish farm in the second quarter monitoring of 3rdyear phase showed that the highest fish production has been found in the Gher of Kapasdanga and lowest in Chunkuri-2 (**Table D.5 in Appendix IV**).

Photo 3.1.3: Fishing gears and crafts use in fishing at sampling sites

3.2 Ecosystem Monitoring

3.2.1 Monitoring of Ecosystem and Biodiversity

Indicator selection

179. Indicators for terrestrial and aquatic ecosystems have been selected by prior anticipation of probable impacts on ecological resources in different phases of the proposed project.

180. Plant composition and diversity is important for vegetation study which indicates vegetation structure of an area. Plant health is directly related with biomass productivity. Plant health of an area may change for changing of different environmental parameters like temperature, composition of gaseous components, soil salinity, humidity and nutrients, air particulate dust etc. Plant diseases and proportion of healthy/ unhealthy plant is needed to observe the plant health condition.

181. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be change for change of plant growth rate due to soil properties change, plant physiological disorders due to change of climatic parameters or even for different human interventions. To monitor vegetation canopy status of the study area, canopy cover has been followed in different time intervals.

182. Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Because lichens are very sensitive to air pollution, particularly to sulfur dioxide, fluoride, and ammonia, their presence or absence is an indicator of homestead forest health. The acidity of a tree's bark can also affect lichen abundance. Presence of lichen coverage on homestead trees would be a bio indicator for monitoring air quality standard of the study area.

183. Bird is important class in terrestrial faunal community that is sensitive to their habitat condition. Changes of environmental parameters, land use and vegetation composition directly impact on bird's habitat of a locality. Broadly, two types of bird are found in an area; local and migratory. To observe local bird habitat suitability, number of bird nest and nesting bird species can be a good indicator. Numbers of wetlands where migratory birds come yearly have also been considered to observing migratory bird habitat suitability.

184. Monitoring butterfly is an important means of measuring change in the environment as well as state habitats for biodiversity. Insects are by far the most species rich group of animals, representing major portions of terrestrial biodiversity. Contrary to most other groups of insects, butterflies are well visible and mostly sensitive to changes of environmental parameters.

185. Dolphin is an ecological indicator which indicates water quality as well as aquatic habitat suitability of an aquatic system. This aquatic mammal is still present all the river systems of the study area. Any changes of water quality and river bed siltation may change dolphin occurrence in a river system. So, dolphin occurrence is needed to monitor.

Rationales for selection of indicators

186. 4 homesteads have been selected for monitoring terrestrial ecosystem's indicators of the study area. Locations of the homesteads have been selected considering wind direction and spatial distribution from the project boundary. All the selected locations for terrestrial ecosystem monitoring is at northern sites as maximum time of the wind rose south to north direction and anticipated impacts will be take part according to this area. Beside this, Sundarbans Reserve Forest is located sum of 14 km south from the project and various

indicators of different locations of this forest is also observing for forest health monitoring. So, no site has been selected at south site of the proposed project.

Terrestrial ecosystem

187. Terrestrial ecosystem supports most of the floral and faunal communities which are directly related to the environmental parameters like temperatures, air quality, sunlight, soil nutrients etc. In the study area, homesteads occupy maximum portions of terrestrial ecosystems. As such, observation on different indicators of selected homestead vegetation and dweller wildlife will be helpful to know the ecological impacts for the proposed project.

a. Vegetation canopy status

188. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be changed for the change in plant growth rate due to soil properties change, plant physiological disorders due to change of climatic parameters or even for different human interventions. To monitor vegetation canopy status of the study area, canopy cover is monitoring in different time intervals.

189. **Species representation in different canopy layers of homestead vegetation**

190. Cocos nucifera occupied top canopy of all the studied homestead vegetation. Phoenix sylvestris is prevalent as second top layer followed by Excoecharia agallocha. Most of the fruit yielding trees like Manilkara zapota, Mangifera indica possess upper bole of canopy layer. Lower bole are occupied by small fruit yielding trees like Psidium guajava, Musa sp. Very few grass species and undergrowth vegetation were followed at studied homesteads.

191. **Estimated Canopy cover in homestead vegetation of sampling sites**

192. Vegetation Canopy status is followed slightly increase from the last monitoring period (Jan 2016) in all the monitoring locations. This have been caused for more foliage growth of tree in rainy season and also for growth of planted saplings in homestead platforms. Comparing with same monitoring time in June 2014, it has also appeared in upward trend in 3 locations out of 4. In the case of Borni site, canopy cover remains unchanged compare to the same timeframe in the year 2014. However this change is not significant. Canopy coverage of the studied homesteads has been represented in following **Table 3.2.1**

Table 3.2.1: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage								
	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	10th QM (Jul 2016)
Rajnagar	NS	19	19	17	20	20	20	20	21
Borni	NS	26	18	18	12	14	20	20	25
Kalekarber	NS	20	24	25	23	24	24	22	24
Chalkghona	NS	13	24	22	17	21	21	20	21

Note: NS = Not Surveyed

b. Lichen cover

193. In Rajnagar and Chalkghona sites, alive lichen cover on tree barks have been observed higher than previous monitoring in Jan, 2016. A substantial part of this increment have been added for the more coverage of lichen on Excoecaria agallocha barks at Chalkghona site and Cocos nucifera barks at Rajnagar site. Lichen coverage at the other two sites have recorded less than previous monitoring tier. However, overall trend shows that the coverage in decreasing. Lichen coverage recorded highest in Chalkghona site. Following table refers average percentage of lichen coverage of the studied locations. The data of observed Lichen Coverage on different tree barks at different homestead vegetation are presented in the following table (**Table 3.2.2)-**

Table 3.2.2: Lichen Coverage on different tree barks at studied homestead vegetation

Location	% of Lichen Coverage						
	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	5th QM (Apr 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	10th QM (Jul 2016)
Raj Nagar	NS	5.1	2.5	1.4	2.6	1.5	2.1
Borni	NS	7.8	3.1	2.4	4.8	3.1	2.1
Kalekarber	NS	4.3	3.2	1.0	2.1	1.6	0.7
Chalkghona	NS	2.1	2.6	1.6	3.1	2.5	3.7

Note: NS = Not Surveyed

Photo 3.2.1: Alive Lichens on Areca catechu (Left) and Manilkara zapota (Right) barks at Borni site

c. Bird Habitat

194. **Local birds and their nesting behavior**

195. The study area supports numerous local bird species. Most of which, dwell in homestead vegetation. Existence of vast shrimp farms as well as canals and rivers also favor good number of water dependent bird species in this area. Most of the birds are nesting on tall trees of homesteads. Coconut (Cocos nucifera) and Gewa (Excoecaria agallocha) followed top priority for nesting. Small bird like Tailor bird, prefer small bushy shrubs. Although, birds do not follow any local boundaries, a clear conception on available bird species have been gathered through discussions with studied homestead owners as well as physical observation.

Bird species and number of Bird nests in sampling sites

196. A total of 20 bird nests have been observed in two monitoring sites out of four. Of which, 12 nests of little cormorant and 4 number of little egret have been found at Rajnagar site and all the bird nest took place on Excoecaria agallocha tree. In the site of Chalkghona, there observed 2 nests of Little Cormorant and Little egret and these nests also took place on the same tree species like Rajnagar. Like the same nearer time in previous year, Bird nest have been recorded more. There is no definite cause found against this incretion, but may be have for cut tree at nearer homesteads where some of the mentioned bird species take place their nest in previous year. Increasing tree height and canopy favor nesting of these birds which is the another cause behind this issue. Table below (**Table 3.2.3**) show the bird nest monitoring data for the studied homesteads.

Photo 3.2.2: Bird nets at Rajnagar site

Table 3.2.3: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																																	
	1st QM (Apr 2014)				2nd QM (Jun 2014)				3rd QM (Oct 2014)				4th QM (Jan 2015)				5th QM (Apr 2015)				6th QM (Aug 2015)				7th QM (Oct 2015)				8th QM (Jan 2016)				10th QM (Jul 2016)			
	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Little Cormorant	NS	-	NS	-	12	-	-		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	NS	NS	NS	NS	10	-	-	1
Little Egret	NS	-	NS	1	4	-	-		-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	NS	NS	NS	NS	5	-	-	1
Asian Pied Starling	NS	1	NS	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-
Tailor Bird	NS	-	NS	1		-	-		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-
Spotted Dove	NS	-	NS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-
Great Egret	NS		NS																										NS	NS	NS	NS	3	-	-	-

Source: CEGIS Monitoring (2014-2016)

Note: R = Rajnagar, B = Barni, K = Kalekarber C= Chakgona, NS = Not Surveyed, '-'= Not Found

d. Butterfly occurrence

197. Population and abundance of butterfly was poor in this monitoring tier due to having heavy rainfall and moist weather during monitoring. However 7 different species have been recorded from all the monitoring sites. Small Grass Yellow (Eurema smilax) is the most common species from all the locations. Altogether, 32 species of butterfly have been recorded from studied sites during last different monitoring tiers. Of which Common crow, Common Emigrant, Common Rose, Small Grass yellow, Peacock Pansy etc. are followed most of the homesteads in most of the monitoring season. Abundance of butterfly is fluctuates according to seasonal variations. All the observed dataset have been appended in the following table (**Table 3.2.4**)-

Table 3.2.4: Occurrences of Butterflies in the study area

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																													
		Apr 2014				Jun 2014				Oct 2014				Jan 2015				Apr 2015				Aug 2015				Oct 2015				Jan 2015			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Common Albatross	*Appias albina*																									*	*	**	**				
Blue Tiger	*Tirumala hamata*										**	*																*					
Lime Butterfly	*Papilio demoleus*								*				*		*		*												*		**		
Chocolate Argus	*Junonia hedonia*					*		*						*																			
Common albatross	*Appias albina*																			*													
Common Cerulean	*Jamides celeno*											*																					
Common Crow	*Euploea core*					*		*	*	*	*		*				*		*							*	*	*	*				
Common Emigrant	*Catopsilia pomona*									*	*	**	*		*	*																	
Common Gull	*Cepora nerissa*										*																						
Common Leopard	*Papilo phalantha*										*	*																					
Common palmfly	*Elymnias hypermnestra*	NS	NS	NS	NS						*	*			*		*		*									*	*		*		
Common Pierrot	*Castalius rosimon*										*		*			*														*		
Common Rose	*Pachliopta aristolochiae*												*					*				*						*	*		*		
Common Sailor	*Neptis hylas*																	*															
Dainty Grass-blue	*Zizula hylax*										*	*												*	*		*	**				*	
Danaid Eggfly	*Hypolimnas misippus*															*																	
Evening Brown	*Melanitis leda*								*						*		*			** *													*
Foscus Swallowtail	*Papilio fuscus*																																
Grey Pansy	*Junonia atlites*										*											*										

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																													
		Apr 2014				**Jun 2014**				**Oct 2014**				**Jan 2015**				**Apr 2015**				**Aug 2015**				**Oct 2015**				**Jan 2015**			
		R	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**
Indian sunbeam	*Curetis thetis*												*						*														
Lemon Pansy	*Junonia lemonius*										*					*																	
Mangrove Jewel	*Hypochrysops epicurus*						*		**																								
Stripped Tiger	*Danaus genutia*									*		*															**		*				
Orchard Swallowtail	*Papilio aegeus*					*	**													*													
Pale Grass Blue	*Pseudozizeeria maha*																		**	**													
Three spot Grass Yellow	*Eurema blanda*									*	**		*																				
Peacock pansy	*Junonia almana*										**								*								** *		*		*		
Rice Swift	*Borbo cinnara*										**	*	**				*																
Small Grass-yellow	*Eurema smilax*						**									*			*	**		**		**	*					*	**	*	*
Spotted Pea-blue	*Euchrysops cnejus*																																
Swamp Tiger	*Danaus affinis*																*			*													
Common Red Eye	*Matapa aria*																											*				*	

Source: CEGIS Monitoring (2014-2016)

Note: R = Rajnagar, B = Barni, K = Kalekarber C= Chakgona, NS = Not Surveyed, '-'= Not Found

*Butterfly occurrence: *= Low, **=Moderate, ***=High*

Aquatic Ecosystem Monitoring

198. Rivers, canals, ponds and saline water shrimp farms are main wetland forms in the study area. Of which, river bear the flowing/ lotic and ponds bear the stagnant/lentic water systems. Canals of this area have merged with shrimp farms. Shrimp farms extend a large proportion of total watershed of the study area those are intervene by human. Therefore, canals are not a actual flowing or stagnant water system.

a. Monitoring Locations

199. Passur is the only external river beside the project area which maintains connectivity with all flowing water systems of the study area. On the other hand, Maidara River including two branches (Maidara Sailtakhali and Ichamoti) exists as internal river system. Hence, status of benthos, planktons and aquatic mammals (Dolphin) in different locations of the study area has been monitored. In the case of stagnant (lentic) water system, indicator specimen has been collected from two big ponds inside the study area. Village pond is the only type of stagnant water body in the study area as maximum ditches, canals and beels have merged with saline water shrimp farms. All types of these wetlands are directly or indirectly connected with flowing river system.

b. Dolphin Occurrence

Dolphin migration route in study area

200. Two dolphin species (Ganges River Dolphin and Irrawaddi Dolphin) travel throughout the Passur riverfor whole of the year. The Ganges river dolphin migrates from estuary regions to upstream connected rivers like Rupsha and Madhumoti. Though Irrawardi Dolphin is mostly habituated in estuary regions of Bangladesh, but this aquatic mammal is also sighted in Passur River. Ganges Dolphins also roam through Maidara rivermainly during high tide. Siltation and narrowing of upstream branches is limiting the length of migration area of this river day by day.

Dolphin occurrence in Passur River

201. Occurrence of dolphin have been monitored by 29 km boat transect Passur and Maidara River surround the project area from the confluence point of Passur-Chunkuri River at Chalna Bazar to Mungla river at Mongla. A total of 11 Ganges River Dolphins were recorded at different locations of the surveyed transect. Of which, 6 dolphins have been recorded only within 1 km River area of Maidara River. All of which are followed in diving Position. High wavy condition in Passur River during the transect survey was a barrier to monitor the dolphins in this season.

Detail survey result is presented in following figure (Figure 3.2.1).

202. Another survey have been conducted in the Dhangmari Khal Dolphin sanctuary. Most of the dolphins were centered at confluence point of Mrigamari-Dhangmari Khal. A total of 28 dolphin individuals have been recorded with an average encounter rate of 3.16/km/hr. Dolphins also sighted at Harbaria and Akram Point.

Table 3.2.5: Dolphin observation Datasheet

Location of River systems	Occurrence Status																	
	1st QM (Apr 2014)		2nd QM (Jun 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug 2015)		7th QM (Oct 2015)		7th QM (Oct 2015)		10th QM (Jul 2016)	
	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T
Passur River Near Project Site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	Y	Y	Y
Karamjal	NS	NS	NS	N	NS	Y	Y	Y	N	N	NS	Y	NS	Y	Y	N	Y	-
Harbaria	NS	NS	NS	N	NS	Y	Y	N	N	N	N	N	Y	NS	Y	N	Y	Y
Akram Point	NS	NS	NS	N	NS	N	NS	Y	Y	Y	NS	NS	N	Y	Y	NS	NS	NS
Moidara River	Y	N	N	N	Y	Y	Y	N	Y	N	Y	N	NS	Y	N	Y	Y	NS

Note: FT=Flood Tide, NT=Neap Tide, NS=Not Surveyed, Occurrence Status: Y = Occurred, N = Not occurred

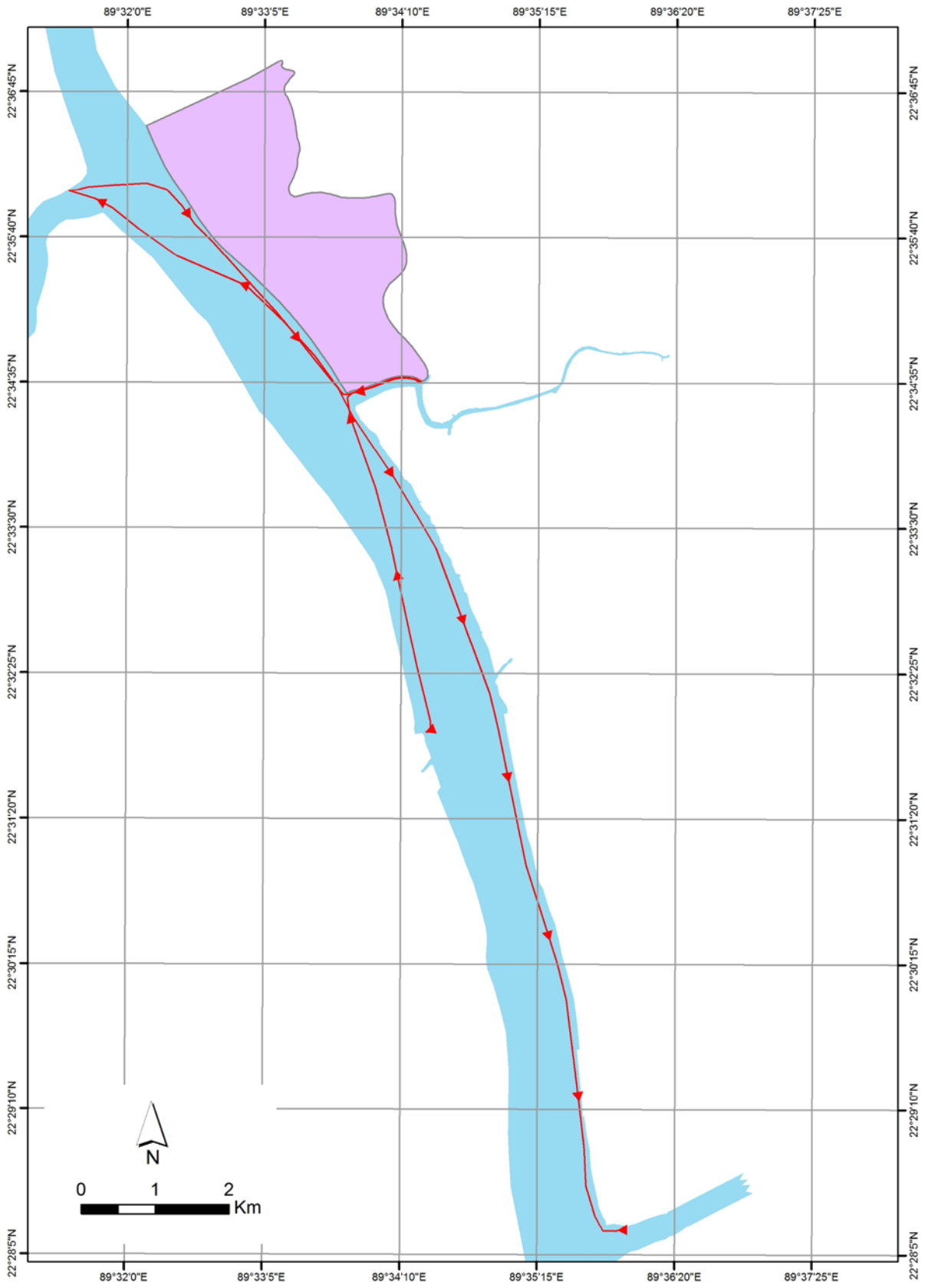

89°32'0"E
89°33'5"E
89°34'10"E
89°35'15"E
89°36'20"E
89°37'25"E
22°36'45"N
22°35'40"N
22°34'35"N
22°33'30"N
22°32'25"N
22°31'20"N
22°30'15"N
22°29'10"N
22°28'5"N
N
0
1
2
Km

Photo 3.2.3: One of surveyed Ganges River dolphin found at Dhangmari khal

c. Status of benthos and planktons in river systems

203. Benthos and plankton sample have been collected from 7 different locations of Passur, Shibsa and Sutarkhali rivers during different tidal conditions in July 2016. Detail current status of benthos and planktons will be incorporated with next monitoring report after getting the laboratory analysis result. In this tier, status of benthos and zooplankton have been represented according to collected samples in January, 2016.

Species Composition of Benthos

204. Benthos samples were collected from 5 different locations of the Passur and Shibsa river in January 2016. However, 3 species have been found of which 1 is unidentified. Benthos species composition is represented in following **Table:3.2.6**

Table 3.2.6: Benthos Species Composition

Sl. No.	Sampling Location	Observed Benthic Species	Observe Number in 1 sq ft
1	Passur River Near Chalna Bazar	Not found	-
2	Passur River at Mongla Port Jett Site	Polycaetis	1
		Annelid	1
3	Passur River near Banisanta Bazar	Not found	-
4	Passur River near Harbaria	Unknown Mollusca Parts	2
		Gastropod	1
5	Shibsa River near Akram Point	Not found	-

Source: CEGIS Field Survey, Jan 2016 (Sample analyzed from Department of Zoology, University of Dhaka)

Species Composition of Zooplankton

205. 3 major classes of zooplankton have been identified from different locations of river systems in earlier monitoring season (January 2016). At the river system in Sutarkhali, recorded high density of Zooplankton population. Detail Zooplankton species association is presented in **Table 3.2.7** below:

Table 3.2.7: Zooplankton species composition and abundance of the study area (January 2016)

Sl. No.	Sampling Location	Population (No./M^3)			Total
		Protozoans	Lerval Crusteceans	Micro Crustecean	
1	Passur River near Project Jetty	0	249	191	440
2	Passur River near Banisanta Bazar	400	0	270	670
3	Passur River near Harbaria	169	128	74	371
4	Sibsa River near Akram Point	65	90	195	350
5	Sutarkhali	219	238	380	837
6	Passur River near Chalna Bazar	36	108	312	456

Source: CEGIS Field Survey, Jan 2016 (Sample analyzed from Department of Zoology, University of Dhaka)

3.3 Sundarbans Forest Health

206. CEGIS team is periodically monitoring Sundarbans forest health to oversee the probable impacts of Rampal Thermal Coal Power Plant Project under implementation. This monitoring program will also support in determining the status, trend and changes in the indicators of the forest condition. The Sundarbans forest health is being monitored quarterly as per monitoring schedule and so far, ten (10) surveys have been conducted at five locations, namely Sutarkhali, Karamjal, Harbaria, Akram point and Hiron point. The overall monitoring indicators observed in ten monitoring schedules broadly include plant growth, tree regeneration, tree crown condition, tree damage, lichen communities, plant diversity, soil chemistry, and plant physiology.

3.3.1 Methodology

Indicators Selected for Second Year Fourth Quarter

207. Monitoring frequency for different indicators has been determined considering efficiency in time, cost and applicability. In this quarter, Sundarbans Reserve Forest (SRF) heath has been monitored at four locations, namely Sutarkhali, Karamjal, Harbaria, and Akram point. Due to adverse weather condition, the monitoring team could not reach to the Hiron Point. The indicators observed in this tier are as follows:

- Seedling Regeneration
- Pneumatophores
- Crab hole density
- Canopy cover
- Leaf Area Index
- Lichen Coverage

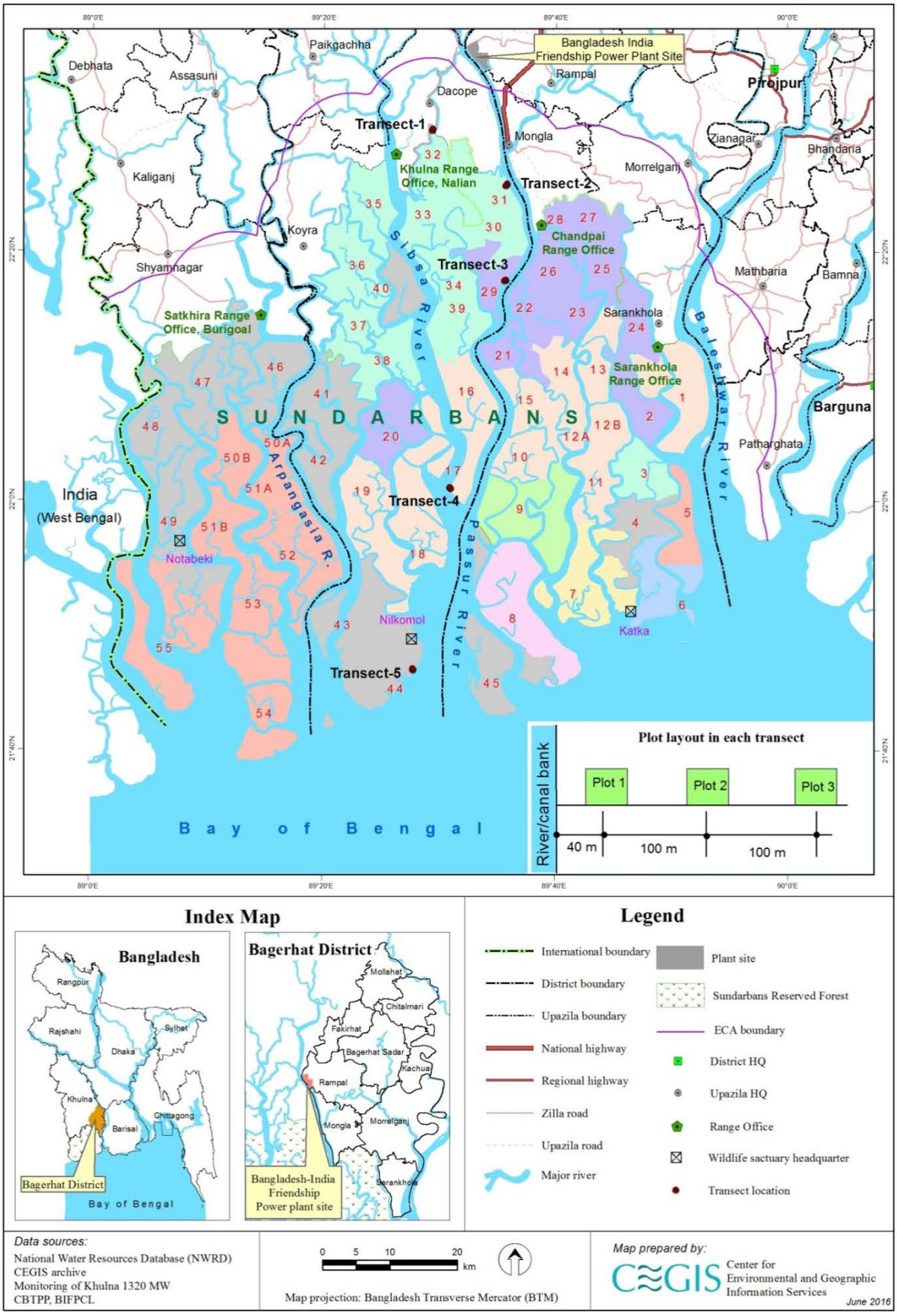
Forest Health Monitoring Location

208. To set up permanent sample plots five sites have been selected on the basis of the survey conducted from April 3 to April 6, 2014 (**Map 3.3.1**). Among those, four sites are along the Passur River at Karamjal, Harbaria, Akram point and Hiron point, and the fifth one is near Sutarkhali forest office. The sites have been selected considering the distance from the

proposed Project site, coal transportation route, protection of the permanent sample plots, and vegetation types.

Sampling Design of Permanent Sample Plots (PSPs)

209. In each site, a transect line has been laid out perpendicular to river or canal bank. Along the transect line three circular nested subplots of 12.62 m radius have been laid out at 100 m intervals in order to capture the maximum tree species (**Figure 3.3.1**). Because of the variation in species composition in SRF, observation plots have been laid out from the coast, river or canal side to landward zone (forest proper side). The location of the first subplot is 40 m away from ecotone (riverside) to inner ward of forest in order to save the subplot from river bank erosion. Each subplot is again subdivided into four quadrates for the ease of data detection and recording (**Figure 3.3.2**).



Map 3.3.1: Location Map of Sundarbans Forest Health Monitoring Plots (PSPs)

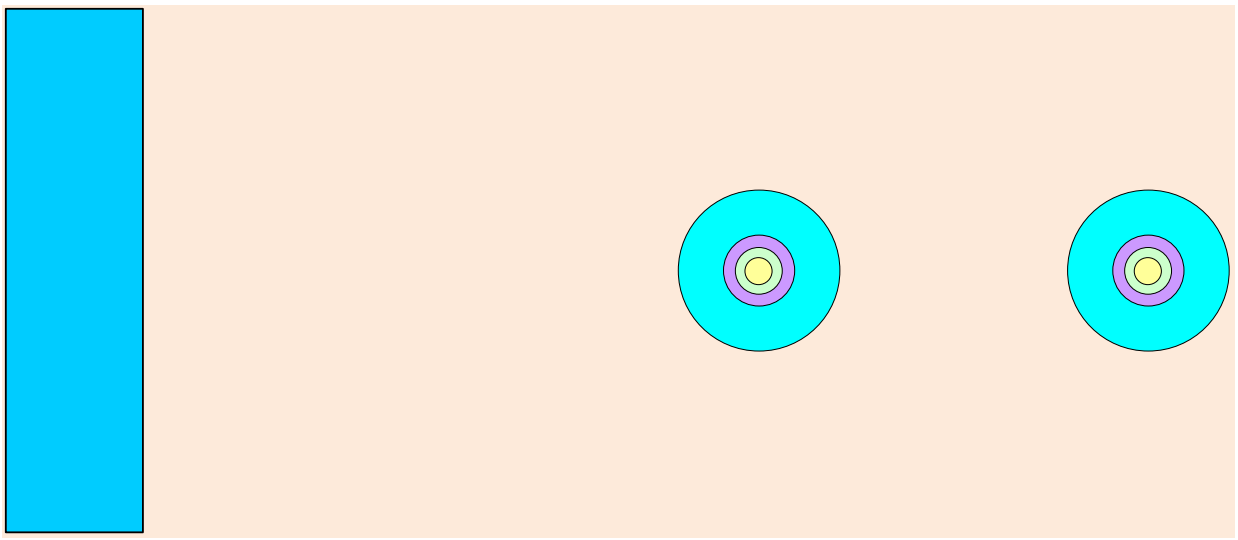
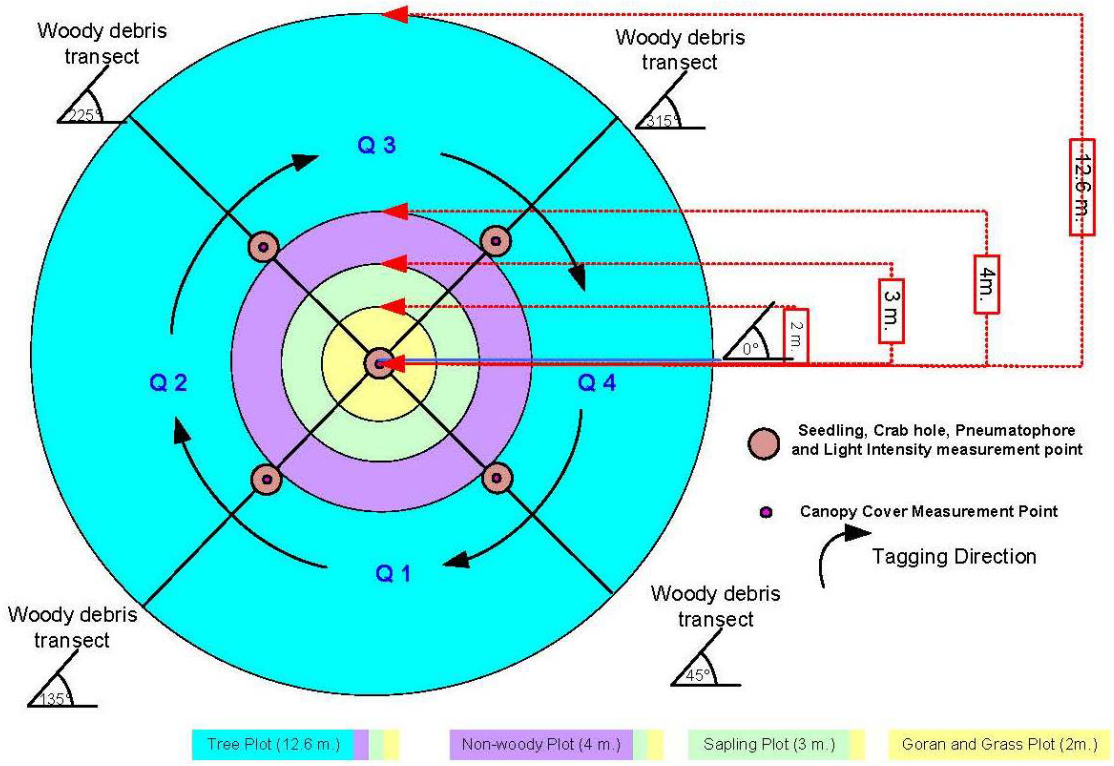


Figure 3.3.1: Layout of the subplots and transect line perpendicular from ecotone (river or canal bank)



B

Figure 3.3.2: Layout of the survey activities in each subplot

Forest Health Survey

(a) Trees

210. The tag number of trees (DBH ≥ 5cm and lean angle greater than 45º) is monitored and rewritten if any new tree is found within 12.62 m radius circle of the Permanent Sample Plot (PSP). In the same monitoring period a map showing the location of all trees (tag number) is developed to ease the next data collection.

(b) Sapling and seedling

211. Saplings (DBH < 5 cm and height 1.37 m) and seedlings (height < 1.37 m) have been assessed within 3m and 2m radius circle, respectively in each PSP. Seedlings have been counted species wise, and their status of living have also been recorded (**Photo 3.3.1**). For saplings, species name and DBH have been recorded along with the living status (**Photo 3.3.2).**

Photo 3.3.1: Team member counting the seedlings in the subplot

Photo 3.3.2: Surveyor measuring the DBH of saplings in the subplot

(c) Pneumatophores

212. The total number of living pneumatophores has been recorded within a circular area of 1 m radius centering each of the five points of all the subplots. The first point has been laid out in the center of each subplot and other four have been in the midpoint of the four woody debris transects that are facing at 45°, 135°, 225° and 315° (**Photo 3.3.3**).

(d) Crab hole

213. Crab plays an important role in mangrove ecosystems such as decomposing litter fall thereby increasing fertility. In order to work out the crab density, usually crab hole abundance is monitored. For this purpose, the crab holes have been counted within an area of 1 m radius circle in each subplot's center and in the midpoint of four woody debris transect (**Photo 3.3.4**).

Photo 3.3.3: Team member counting pnuematophore on forest floor

Photo 3.3.4: Counting of crab holes on forest floor

(e) Canopy Cover

214. Percentage (%) of canopy cover has been estimated by a spherical densiometer, a gridded convex mirror that provides a simple and inexpensive approach of measuring canopy cover. The densiometer has been held at a distance of 30–40 cm from the body and at an elbow height so that head is not visible in the mirror (**Photo 3.3.5).** After levelling the instrument using the level bubble, the dots, which are not occupied by canopy, are systematically counted. In each subplot, the meter readings have been taken at five points facing north, south, east, and west direction including the centre point of the subplot. The canopy cover has been calculated by taking the average of these five readings.

(f) Leaf Area Index

215. Leaf Area Index (LAI) is a key structural characteristic of forest ecosystems because of the role of green leaves in controlling many biological and physical processes in plant canopies. It influences net canopy photosynthesis. Light absorption by the forest canopy can be used to estimate leaf area index (**Photo 3.3.6**). In this monitoring report, LAI is calculated as follows:

Leaf Area Index (LAI) = $\log_e (I/I_o)/-K$ m^2leaf area /m^2area of ground

(Where, I = Under Canopy Light Intensity, I_o = Open Canopy Light Intensity and K is Canopy light extension coefficient i.e., 0.5)

Photo 3.3.5: Team member taking canopy cover using Densiometer

Photo 3.3.6: Team member taking light intensity using Lux Meter

(g) Lichen Coverage

216. Lichens are unique organisms composed of either algae or cyanobacteria living in a symbiotic relationship with fungus. Lichens can be used to assess atmospheric levels of sulfur dioxide, SO_2. When they are exposed to some kinds of air pollutants, especially to SO_2, lichens are injured and die. As coal based power plant is considered to be one of the potential sources of additional SO_2 in the atmosphere, lichen coverage is considered as monitoring indicators for baseline establishment. The Lichen cover percentage (%) on tree trunk has been measured visually at breast height (**Photo 3.3.8**). The plot average percentage has been calculated and the status has evaluated following the Pathfinder Science standard (2006).

Photo 3.3.7: Team Member recording and cross checking data in the field sheet

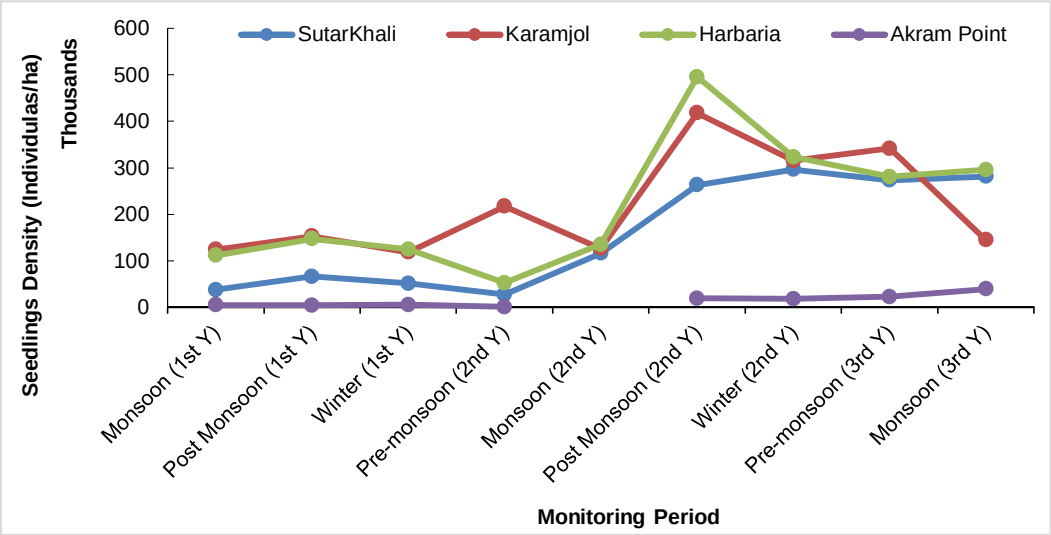
Photo 3.3.8: Team Member recording Lichen cover percentage (%) on tree trunk

3.3.2 Status of monitoring of SRF Health

Seedling

217. The seedlings density (number of seedlings per ha) has been monitored in four PSPs in the third year second monitoring period. The last ten monitoring period graph predicts that the seedlings survival rate is increasing in almost all monitoring locations. The graph has also shown that higher number of seedlings is being found during monsoon to post-monsoon period

whereas the number decreases during winter to pre-monsoon period. Among all monitoring locations, the seedlings status is comparatively lower in Akram point (**Figure 3.3.3**). Seedlings usually die at an early stage in natural forest due to competition for nutrients as well as light intensity. Other than the silvicultural competition, the seedlings at Akram point also face natural stresses due to their location being very much closer to the sea. In the Sundarbans, most of the mangroves' seeds disperse during the rainy season and go up to forest floor. In this relation, seedlings are usually found more after the rainy season (monsoon to post monsoon) than in other seasons. However, the monitoring result of this period has shown lower number of seedlings at Karamjal than pre-monsoon. This may be due to improper counting of seedlings as of submerging into tidal water.

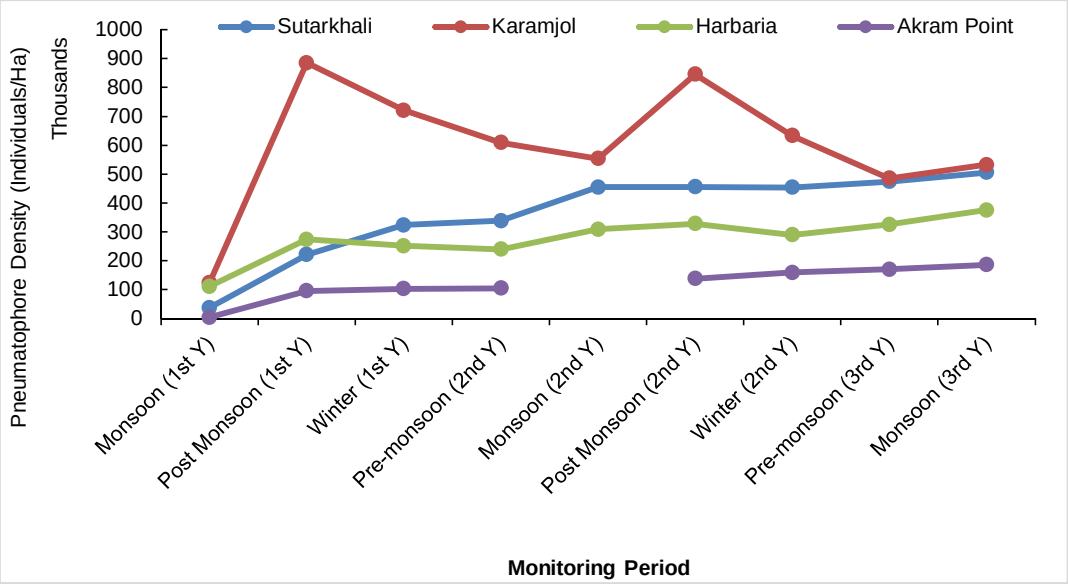


(Seedlings density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.3: Mean (±95%CI) seedlings density among the quarterly surveys in five PSPs

Pneumatophores

218. Like seedlings, pneumatophores density also changes due to seasonal variability (**Figure 3.3.4**). Pneumatophores usually dry up and die during dry season. Hence, the number of pneumatophores per hectare is found comparatively higher in post-monsoon period. However, among four monitoring sites, the mean pneumatophores density is found lower in Akram point due to floristic composition. From the species composition inventory, it is found that this monitoring site is mainly dominated by Gewa (Exoecariaagallocha) species. On the contrary, Karamjal is mainly dominated by Baen (Avicenniaofficinalis) tree and it has numerous tender pneumatophores considering to others. The number of pneumatophores may also vary due to the elevation of the forest floor from the mean sea level (MSL). The major function of pneumatophores is to exchange gas into the atmosphere during tidal inundation. Hence, the highly elevated plot with less effect of inundation may have lesser number of pneumatophores.

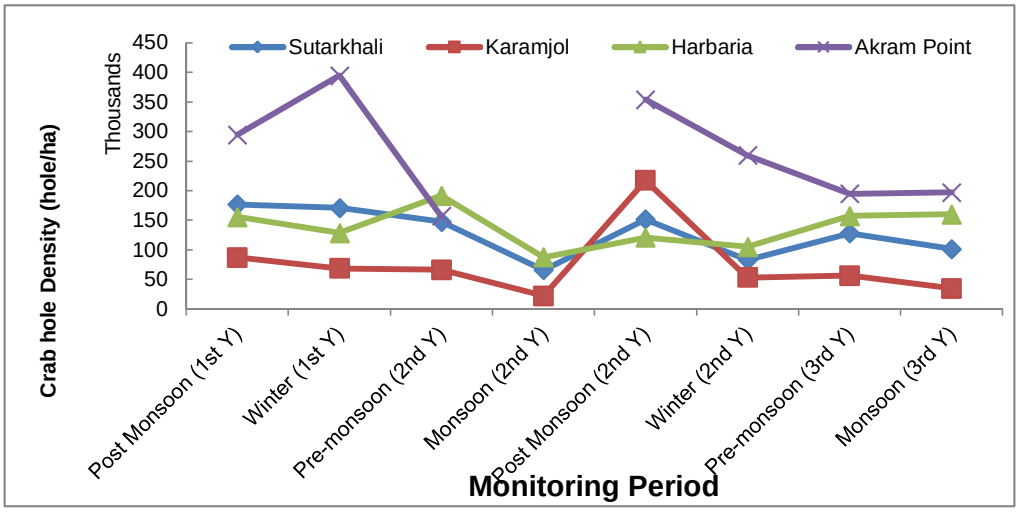


(Pneumatophores density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.4: Mean Pneumatophores Density among the quarterly surveys in four PSPs

Crab hole

219. The crab hole density, the indicator of availability of crab in a site, has been found the highest at Akram point among the four monitoring sites (**Figure 3.3.5**). From figure, it is difficult to predict the relationship of crab hole with seasonal variability. This may be due to the nature of mangrove (evergreen forest) forest floor. Although mangroves are marshy land, there are differences in terms of area in dry period (winter) and wet period (monsoon) which shows some influences on crab hole abundance.



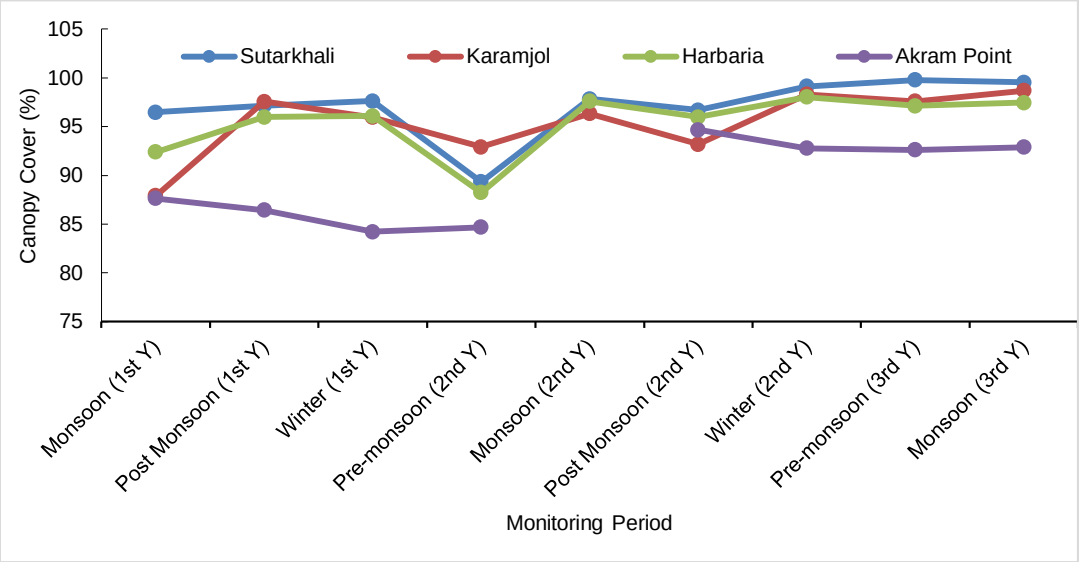
(Crab hole density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.5: Mean crab hole density among the quarterly surveys in five PSPs

Canopy cover

220. In the monitoring plots, the canopy cover percentages have not varied significantly. From the first year to second year pre-monsoon, the highest canopy cover percentages are observed during monsoon to post monsoon which started decreasing during winter and is

found the lowest in pre-monsoon period. However, from monsoon second year to monsoon third year, it is found that the canopy cover percentages are similar among the monitoring sites (**Figure 3.3.6**). Since greater than 60% of the canopy coverage in a site is treated as healthy, all the locations of the monitoring sites are in good shape.

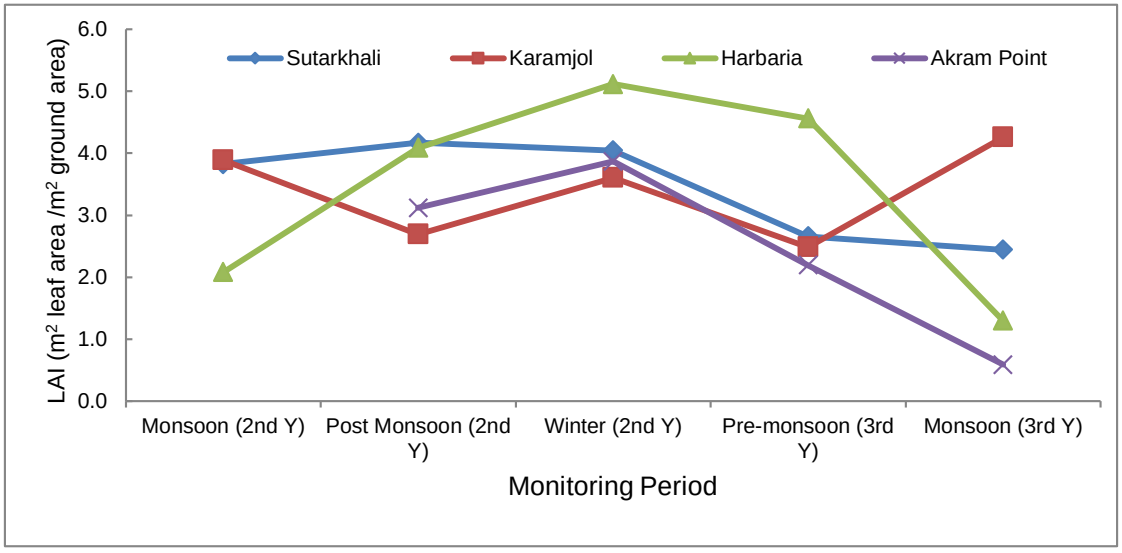


(Canopy cover was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.6: Mean canopy cover (%) among the quarterly surveys in five PSPs

Leaf Area Index (LAI)

221. The Leaf Area Index of the four monitoring sites are shown in **Figure 3.3.7**. The LAI influences daily rate of net canopy photosynthesis which results in exchange of atmospheric CO2. The minimum the under canopy light intensity the maximum the LAI. Hence, the maximum the net canopy photosynthesis. From **Figure 3.3.7**, it is difficult to predict the effect of seasonal variability on LAI. This may be due to the dynamic nature of mangrove forest as well as the monitoring time. However, in most of the cases it is found that the LAI value increase from monsoon to winter while it starts decreasing from winter to monsoon.

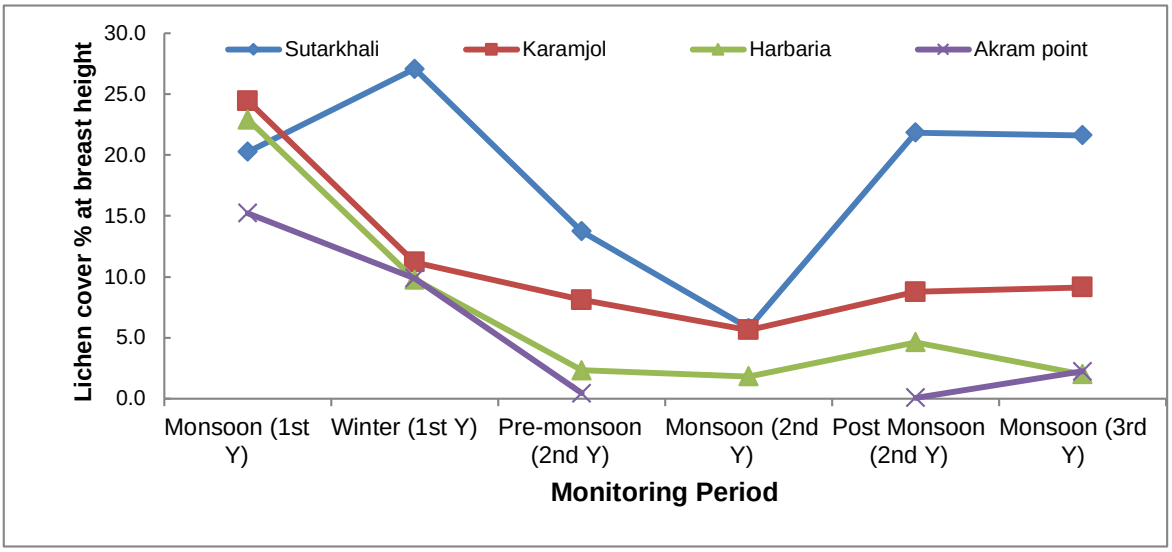


(LAI was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.7: Leaf Area Index (m² leaf area /m² ground area)among the quarterly surveys in four PSPs

Lichen Coverage

222. The lichen coverage (percentage at breast height) on tree has gradually been reducing in all of the monitoring sites from July 2014 to July 2015. In SRF, environmental conditions (Temperature, humidity, salinity etc.) usually get worse in April and May (**Figure 3.3.7**). This could be a reason behind changes in lichen availability among the quarters in the monitoring sites of SRF.



(Lichen cover was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.3.7: Mean Lichen cover % at breast height among the quarterly surveys in four PSPs

3.3.3 Findings

223. The first and second year monitoring results predicted that there might have some relation of the indicators with seasonal changes. However, after analyzing the ten monitoring survey indicators, it has become difficult to predict that the changing trend for majority of the indicators of forest health in SRF is related to seasonal variation. Therefore, the monitoring should be continued to know the dynamism of mangrove attributes which are very much interlinked with each other as well as with the environment.

4 Environmental Compliance

4.1 Introduction

224. The Project is now at the end of site development stage. The land development activities of the Project area for the first phase are completed. The first phase Project site is encircled by boundary wall, pre-fabricated office building, slope protection works are nearly completed where the roads and other infrastructure, tree plantation activities etc. have been moving ahead. Construction and development of connecting (approach) road between the Project site and Khulna-Mongla road is progressing fast and about to complete. However, there are some environmental compliance measures in environmental management plan that should be at place during this pre-construction stage.

225. The environmental compliance monitoring that includes monitoring of EMP implementation is based on physical observation and assessment. A comprehensive diligence checklist has been developed to monitor the environmental compliance to different components e.g., Environmental and Social Management System and Action Plan; Labor and Working Condition; Community Health, Safety and Security; Biodiversity and Sustainable Management of Living Natural Resources.

226. The aim of the checklists is to check the diligence of measures and effectiveness of the measures. The checklists are produced as Compliance Data Sheet that contains both quantitative and qualitative data. The details of the compliance checklist are attached in **Appendix I**. The **Table 4.1, 4.2, 4.3** and **4.4** present summary of the findings of the environmental compliance monitoring:

Table 4.1: Monitoring of Environmental and Social Management System Action Plan Implementation

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and also occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green plantation around the Project boundary • Switching off/ throttling down of machines/equipment/ generators which are not in use	• CEGIS is carrying out noise survey in ambient environment under environmental monitoring study. • BFD has initiated green plantation as a depository work of BIFPCL • Switching off/throttling down of machines/equipment/ generators which are passing idle period	• Create awareness among the labour for using noise muffler at construction site • Stop working of the heavy noise generating equipment operators (e.g. stone/brick crusher) during 6:00 pm-8:00 am • Supply sufficient ear plugs for the labours at the construction site	Being Complied
2	Dust Generation from land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly? • Construction of boundary wall	• CEGIS is quarterly monitoring the dust generated from land development activities and other construction works. • Construction of boundary wall for the main Plant is completed. • Preparing for construction of paved road	• The project authority should include vehicular sprinkler for using during the winter onward. • Demarcate traffic way and enforce that all the vehicles are using the demarcated way only. • Spray water along the road and road side to suppress dust generation	Being Complied
3	Water Quality	• Fencing the construction site • Arrangement of runoff drainage for reducing any water logging • Location of backfilling stockpile in safe area and protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and waste water to river or canal.	• Construction of boundary wall for the main Plant • Rainfall runoff discharge to nearby river through unmanaged/unplanned drainage network at some places • Onsite sanitation facilities has been developed at the labour sheds as well as the working places	• Stockpile of construction material should be placed at a safe distance from drainage network; •	Being Complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
4	Waste Management System	• Provision of onsite waste management system	• Conventional way of waste collection and disposal system at Plant office and kitchen	• Sufficient waste disposal bin/s with labelling should be installed at labor shed, and working area before the main construction works	Being complied
5	Compensation and Resettlement	• Prepare Proper resettlement action plan and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • Cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for movable structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance • grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Human provide/ take extra care/caution for the disadvantaged/ vulnerable group/s (i.e. women, children, ethnic minorities, indigenous people etc.) • Provision of monitoring the compensation and resettlement process	• Compensation has been given to the rightful owners of the land as per the laws of Bangladesh e.g., Acquisition and Requisition of Immovable Property Ordinance, 1982 • Compensation made by local DC office • Local DC office facilitates unauthorized occupants of the acquired land to get home in the Government's shelter homes or cluster villages • BIFPCL gives priority to affected people in Project related employment • List of 136 people indirectly affected was given by the DC office, Bagerhat. • RP is under preparation.	• Initiatives should be taken for resettlement of the people who do not own the land but have been dependent on it for their livelihoods; • To meet the international standard and guideline of the funding agencies, necessary measures have to be undertaken. • The proponent should take initiatives to engage the PAPs during construction stages according to their skills and capabilities.	In the process of Compliance
6	Livelihood and living condition	• Does the Project pose any threat to the livelihood/living standards of the local people? If yes, are adequate steps taken to reduce the impacts?	• Recruited asocial officer who is responsible for maintaining social liaison; • Engagement of Human Resources consultant for preparing HR policies, Labour	• Monitoring the status regularly • Awareness program and grievance redress mechanism should be adopted in formal way	In the process of Compliance

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		• Has the company developed any policy which prioritizes the local labourers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers? • If yes, are there any mitigation steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?	recruitment Policies, Manpower set up etc.; • Construction of toilets for labour near labour shed; • Provision of first aid; • Setting up medical unit capable of dealing emergency situation like injury, accident, etc.	• Accidental log sheet or injury log book should be put into display	
7	Green House Gas Controlling Measures	• Use of efficient generator in the construction activities; • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications; • Use of approved pollution control devices fitted in the equipment and machineries; • Switching off and throttling down the machines/equipment/generators which are not in use.	• Informing the bidders for EPC of main Plants about measures to be followed; • Making IFC guidelines, EIA approval of DoE, and EMP of the EIA, etc. as a part of the bid document.	• Prepare checklist on equipment and their condition owned by the contractors; • GHG inventory checklist might be mandatory for the EPC contractors. • Use low GHG emission machineries and CDM during main Plant construction.	To be complied during construction and operation stage

Table 4.2: Monitoring of Labor and Working Condition

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers; • Defined Working condition and Terms of Employment for direct worker; • Sustainably equivalent terms and condition for migrant workers; • Compliance to national law of forming workers' organization; • No discrimination and equal opportunity for all; • Measures for diminishing past discrimination; • Grievance Redress Mechanism.	• Engaged HR consultant to prepare relevant policies; • Preparing to recruit Environment, Occupation and Health Safety Expert; • No discrimination has been recorded. • ERP and ESMS are in Dhaka office.	• The proposed EMP measures should be addressed in the HR policies; • Follow the nation labour law 2006 and guideline of ILO • Local workers would be given priority for non-technical jobs. • Formal mechanism of grievance Redress should be established.	Compliance action initiated
2	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child health or physical, mental, spiritual, moral, or social development. • No Forced Labour	• Ensured no child labour employment • Ensured no forced labour • First Aid support to the labours during any accident (Immediate first aid medical treatment has given to about 48 numbers of labour accidents.)	• The HR policy should cover child labour policy and Labour Law 2006 and all other amendments; • Proper documentation of contract with the worker is required, which includes working hour, wage, and benefit. • BIFPCL should pay the bill for any accidental event of the workers	Compliance action initiated

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
3	Safety at site	• Installation/Construction of Safety Fence around the Project area; • Use of Personnel Protective Equipment's (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.); • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.); • Practice of Tool box meeting, safety talks • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.); • Maintaining Material Safety Data Sheet (MSDS); • Provision of Health care facilities such as doctor, hospital etc. available at/nearby the plant construction site; • Availability of First Aid at work place; • Preparation and Follow of Emergency Response Plan; • Adequate fire precautions in place (e. g., fire extinguishers, escape routes etc.); • Documentation and reporting of occupational accidents, diseases, and incidents; • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS.	• Construction of boundary wall; • Encouraged labour and Project personnel to use appropriate PPEs; • Safety Policy of DoE and IFC, Safety measures proposed in EIA report have been incorporated in the bid document of main Plant to aware the potential bidders; • Included the EHS plan in the tender documents for the EPC contractor. • Preparation of emergency response plan in association with the EPC contractor. • Safety manual has been prepared. • EPC contractor submitted the site specific SHE plan. • At present the project site is in pre-construction stage. In this monsoon period only some finishing works are going on	• Appointment of site specific EHS Officer of proponent and also contractors/sub-contractors is urgently required • Signboard must be kept into proper places. • Use of local language and picture so that the worker could aware. • 5 minute awareness speech would be deliberated to the workers at every morning • All electric distribution lines at project site required to be fixed as safe and tidy	Being complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
4	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/Organogram • Preparation of Safety Policy to be adopted during Plant operation	• Engagement of HR consultant to develop HR policy and Organogram; • Medical aid, fire extinguisher, PPE are provided; • Worker's shed and sanitation facilities have been developed at construction site; • Onsite medical facilities have been continuing. • EPC contractor already prepared the site specific Environmental Health & Safety plan which is under finalization.	• Develop a complete EHS division in the HR Management; • Regular training, awareness, motivational and mock drill should be arranged at this pre-construction phase; • OHS procedure should also be followed by all workers including the labor from sub-contractors. Appointment of EHS Officer is recommended to expedite the EHS and OHS plan/procedure at project site	EHS & OHS policy in line with World Bank standard formulated and Health and Safety manual prepared.
5	Workers Well Being	• Provision of Welfare facilities for Worker/Labor such as, timely bonuses, salaries, sick leaves, vacations etc.; • Routine medical check-up and emergency medical care for the sick and injured; • Appointment of a leader amongst the labor group, who will look into workers' well-being.	• Engagement of HR consultant to develop HR policy and Organogram; • Health care & information, canteen, restrooms, accommodation are facilitated by the proponents.	• The workers well-being should be protected in the HR policy • Freedom of Association, Rights & scope of bargaining and tripartite consultation should be open for the workers.	Being Complied

Table 4.3: Monitoring of Community Health, Safety and Security

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project area; • Installation of water spraying system to control dusts; • Conducting dust monitoring and visual inspection around the site boundary; • Adoption of Noise management plan.	• Construction of boundary wall around the Project area already completed; • Water spray for dust suppression being carried out around the Plant office. • Grievance redressal mechanism is under finalization.	• Regular communication with the local community • Prepare a register for receiving any grievance from the community	Being complied
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism; • Maintaining open communication channel with the local community.	• A Social officer has been recruited to maintain close relation with nearby community; • Regular monitoring has been conducted to identify the grievance of the nearby communities ; • National level stakeholder consultation has been conducted.	• Grievance Redress Mechanism is to be finalized early; • Establish a system to receive the grievance, and to take appropriate measures to redress it; • Regular local level consultation is necessary in presence of the officers from BIFPCL.	Being complied
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area; • Practicing Risk Assessment and Evaluation Process; • Practicing safe management for hazardous materials which may pose threat to the community; • Availability and operation of Emergency Response Plan; • Maintaining open communication channel with the local community;	• Construction of boundary wall around the Project area; • Incorporating safety policies to be followed in the bid documents for the appointment of EPC contractors; • Preparing a safety checklist to be followed during selection of construction contractors; • Maintaining a good communication with local community;	• Assign responsibility of enforcing and monitoring safety procedure to an officer • Aware labours and all employees about the safety procedure; • The EPC contractors should prepare site specific ESMPs;	BIFPCL agrees to comply all the measures during construction stage

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		• Training and instruction to the security personnel about their behaviour and communication with the local people; • Aware the security personnel about the right of the community people.	• Negotiation with local DC office and Bangladesh Ansar and VDP (who are responsible for security).	• Arrange a safety training program for Project personnel and labours; • Training and instruction to the security personnel about their behaviour and communication with the local people; • Aware the security personnel about safeguarding environment and community.	
4	Community Health Risk	• Provision of providing health service facilities to community if the Project poses any health risk like sexually transmitted disease, contract disease, vector-borne diseases; • Implement all pollution mitigation measures to ensure safeguarding to community.	• Established a medical unit (consisting medical officer, medical assistant, office assistant) at Plant site; • Arranging weekly health service program (medical consultation and free medicine) for the local community; • Provided health services to around 1136 people from April 2016to July, 2016.	• The proponent should train the migrated labour regarding the local culture and customs • The proponent may arrange consultation meeting with the local communities	Being Complied
5	Youth Employment (Local)	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities	• Informal sitting with the community	• Initiate awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities; • Appropriate hands on and hands-off training sessions, building them up for employment;	Will be complied during construction stage

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
				• Assign job responsibilities based on skills and previous experience.	
6	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting; • Sharing of Project information with local people; • Organizing environmental and social awareness programs/meetings.	• Informal sitting with the community; • Display Project related information on a display board at Project site; • Recruitment of a Public Relation Officer at head office; • Preparing a video documentation on Project related information; • Publishing Project related discussion/article in different print media.	• Arrange dissemination workshop in Dhaka and Khulna to aware the community, civil society, environmentalists about the environmental safeguarding measures considered in basic design.	Being Complied

Table 4.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel would cause deterioration of aquatic ecosystem.	• Installation of proper runoff drains; • Use of sediment fences, traps and basins for trapping the sediment, if required.	• Temporary installation of runoff drains; • Construction of sediment traps is mentioned in the Bid documents to instruct the bidders; • Develop temporary drainage network inside the Project boundary.	• Open the connectivity of the Maidara river as early as possible • The proponent has to ensure a good drainage system in before commencing the construction works by the EPC contractor.	Will be complied during the construction stage
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank; • Implementation of onsite waste and air quality management plan; • Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Safety fence around the construction site; • Limiting the use of night light; • Using shade (directed downwards) around the outdoor lights; • Provision of cut-off time to switch off unnecessary lights at night; • Initiate Green plantation; • No plantation of non-native species; • Retaining top soil for future habitat restoration; • No degradation of critical habitat?	• No cutting/ felling of trees occurred along the river bank; • Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Construction of Boundary wall; • Installation of few numbers of night light; • Provision of cut-off time to switch off unnecessary lights at night; • Selection of local plant species for green plantation; • No degradation of critical habitat.	• Using of light shade (directed downwards) around the outdoor lights; • Regular monitoring of the trees planted around the Project site. • Bird sheds can be developed at the green belt areas or on the bank slope.	Being Complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
3	Disturbance to river, inter-tidal areas and wet lands	• No encroachment of inter-tidal flood plain area; • No disturbance to Dolphin community; • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health; • If required, embankment should be constructed considering a setback distance from river/canal bank; • Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come, and; • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal dynamics	• Monitoring of forest health and ecosystem health in Sundarbans and around the Project site are being carried out by CEGIS; • Maintaining significant setback distance from Passur river to the Project site; • Completion of slope protection work; • Revising the drawing of embankment/slope protection works along the Maidara River keeping necessary setback distance from Maidara River. • The stream flow of Maidara River near access road has been blocked by a temporary cross dam of LGED and BWDB requested to keep it for the time being for widening and channel improvement of Maidara River.	• BIFPCL may take initiatives to excavate the silted reach of Maidara River near proposed township area to facilitate proper functioning of the River for maintaining tidal dynamics. • For removal of blockade, BIFPCL has taken up this matter with BWDB through LGED to keep the natural stream flow of Maidara River as it is and ensure the water connectivity like before.	Being Complied

4.2 Compliance to Conditions of DoE

Sl no	Condition of DoE	Compliance	Remarks
1	This EIA Report is approved only for 1320 MW Khulna Coal Based Power Plant. Any expansion or extension of this Power Plant will require obtaining further Environmental Clearance with additional EIA Study.	Not applicable now	***BPDB will comply with the condition prior to initiation of any expansion or extension***
2	The Coal Specification and Power Plant technology should be maintained as per EIA report. In case any change in design the proponent must obtain consent from DoE.	The Coal Specification and Power Plant technology will be maintained as per EIA report. In case of any change in Plant design and coal specification the proponent is to obtain consent from DoE.	***To be Complied if required***
3	Project Proponent may undertake activities for land development and infrastructural development of the Project.	BIFPCL has started land and infrastructure development activities.	***Complied***
4	Project Proponent may open L/C (Letter of Credit) for importing machineries for the Project which shall also include machineries relating to waste treatment plant and other pollution control devices.	BIFPCL will open L/C after finalizing the EPC contractor.	***To be Complied***
5	The activity under Proposed Khulna 1320 MW Coal based Thermal Power Plant Construction and operation shall not release any pollutant that affect human health or will have damaging impact on the environment or natural resources.	At present the Plant is in preliminary stage. BIFPCL engaged CEGIS for monitoring pre-construction and construction activities for examining environmental impacts. No damaging impact on the environment or natural resources impact has been reported yet. All necessary measures have already been incorporated in the technical specification of main plant EPC package as per DoE stipulations. Pollution control measures have widely been covered in technical specification like effluent treatment plant, ESP, FGD etc.	***Complied at present and will be complied at Construction and Operation phase***
6	Proper and adequate mitigation measures shall be ensured throughout preparation, construction and operation period of the proposed Khulna 1320 MW Coal based Thermal Power Plant Project activities.	BIFPCL is also monitoring the mitigation measures adopted through an environmental consultant CEGIS. At present preliminary site preparation (pre-construction) activities are going on. Mitigation measures appropriate at this stage have been taken. Proper and adequate mitigation measures have widely	***Complied at present and will be complied at Construction and***

Sl no	Condition of DoE	Compliance	Remarks
		been covered in Technical Specification. MP prepared & monitoring is being done for pre-construction period.	***Operation phase***
7	Any heritage sight, ecologically critical area, and other environmentally, religious and archaeologically sensitive places shall be kept protected during Project construction phase.	There is no religious, archaeological place in and around the site. The pre-construction activities has been carried out ensuring safeguarding to Sundarbans and ECA	***Complied at present and will be complied at Construction phase***
8	Environment friendly construction and development practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.	The pre-construction activity is being carried out keeping all the mitigation measures in order.	***Being Complied***
9	Construction works shall be restricted to daytime hours so as to avoid/mitigate the disturbance of local lives as well as implementation schedules of the works shall be notified in advance to nearby residents.	The Project site and the present activities are limited to day time only. BIFPCL is keeping close communication with local people to receive the grievance.	***Being Complied***
10	Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed Project period.	At present the Plant is in preliminary site preparation (pre-construction) phase. Adequate sanitation facilities have been provided for this stage. Provisions in line with this condition have been included in Clause no 2.5 of Special Condition of Contract (SCC) and in Health & safety manual. BIFPCL will ensure the same when work for Main Plant construction work starts.	***Being Complied***
11	In order to control noise pollution, vehicles & equipment shall undergo regular maintenance; working during sensitive hours and locating machinery close to sensitive receptor shall be avoided.	All vehicle & equipment used at site are under regular maintenance. Working during sensitive hours and locating machinery close to sensitive receptor are being avoided. Provisions in line with this condition have been included Clause no 14.11 of SCC and in Health & Safety Manual.	***Being Complied***
12	No solid waste can be burnt in the Project area. An environment friendly solid waste management should be in place during the whole period of the Project in the field.	At present the Plant is in preliminary site preparation (pre-construction) phase. No solid waste is burnt. Provisions in line with this condition have been included in Clause No 14.9 of SCC. Solid Waste Management system has been prepared (Section-V, B12, Part 9 of Technical Specification)	***Being Complied***
13	Proper and adequate on-site precautionary measures and safety	Pre-construction activities are being taken up with adequate on-site precautionary	***Being Complied***

Sl no	Condition of DoE	Compliance	Remarks
	measures shall be ensured so that no habitat of any flora and fauna would be endangered or destructed.	measures and safety measures to safeguard flora and fauna. Safety manual prepared and it is part of EPC contract document.	
14	All the required mitigation measures suggested in the EIA report along with the emergency response plan are to be strictly implemented and kept operative / functioning on a continuous basis.	At present the Plant is in preliminary site preparation (pre-construction) phase. BIFPCL has appointed a paramedical staff and visiting Doctor is also made available for regular health checkup of the workers. Villagers of surrounding areas also availing the health facilities. Emergency response plan shall be strictly implemented and kept operative/ functioning on a continuous basis.	***Being Complied***
15	To control dust, spraying of water over the earthen materials should be carried out from time to time.	Water is sprayed in the area around the premises of site office to control dust. A boundary wall around the Plant has been constructed to control dustwithin the project boundary.	***Being Complied***
16	Storage area for soils and other construction materials shall be carefully selected to avoid disturbance of the natural drainage.	Construction materials have been stocked and piled far away from river bank and other natural water bodies.	***Being Complied***
17	Adequate considerations should be given to facilitate drainage system for runoff water from rain/tidal surge.	Run off drainage are being constructedas required at this stage. Adequate drainage shall be ensured during construction and operation phase of the Plant.	***Being Complied***
18	Adequate facilities should be ensured for silt trap to avoid clogging of drain/canal/water bodies	Run off/ storm water drainage system shall have silt trap.	***Being Complied***
19	The entire coal handling system should be designed as an enclosed (and not only covered) conveyor system. There should be integrated dust control system with dust extraction and bag filters at unloading areas and at each transfer points on the conveyor system.	Entire coal handling system have been designed as an enclosed conveyor system as per DoE requirement. Integrated dust control system with dust extraction system / bag filter and dust suppression system at crusher house, unloading points, transfer points has been specified in the technical specification of Main Plant EPC contract package.Refer Section V, B4 of Technical Specification.	***Complied***
20	Coal Plant should have high-efficiency bag filter for arresting dust emissions.	Integrated dust control system with dust extraction system / bag filter and dust suppression system at crusher house, unloading points, transfer points has been specified in the technical specification of EPC contract package and will be implemented accordingly. Refer Section V,	***Compliance action initiated***

Sl no	Condition of DoE	Compliance	Remarks
		B4 of Technical Specification (Clause no B4.3.1.4).	
21	Col should be stored in a covered storage yard.	All these stipulations have been included in the technical specification of Main Plant EPC contract package, Section V, B4 of Technical Specification (Clause No B4.3.1.6).	***Compliance action initiated***
22	The entire coal stockyard should be covered with water sprinkler provided with automated moisture sensor to control self-combustion.	All these stipulations have been included in the technical specification of Main Plant EPC contract package, Section V, B4 of Technical Specification.	***Compliance action initiated***
23	100% utilization of fly ash and bottom ash should be planned and implemented throughout the operation of the Plant. There should only be a provision of small ash dyke that will not exceed 25 (twenty five) acres of land to store residual ash.	100% utilization of fly ash has been planned and shall be implemented throughout the operation of the plant.Only 25 acres area has been allocated to store residual ash. EOI has been received in this regards from nearby Cement Plants.	***Complied at present and Will be Complied throughout Operation phase***
24	Integrated dry ash handling, loading, unloading and transportation system should be established.	Integrated dry ash handling, loading, unloading and transportation system will be established.Provisions in line with this has been included in Technical Specification of main plant EPC contract package (Section V, Chapter B4).	***Compliance action initiated***
25	There should be adequate and properly sized and designed dry ash silo with appropriate conveyor system.	Adequate and properly sized dry ash silo with appropriate conveying system have been specified in technical specification of main plant EPC contract package (Section V, Chapter B4).	***Compliance action initiated***
26	Bottom ash should be extracted, crashed and stored in silos for utilization with proper collection and conveyor system.	Bottom ash shall be extracted, crushed and stored in silos for utilization with proper collection and conveying system. The procedures have been included in the technical Specification of EPC contract package.(Section V, Chapter B4).	***Compliance action initiated***
27	Resettlement and rehabilitation of the displaced population (including those who do not own land) should be done properly.	Land has been acquired by GoB. Resettlement and rehabilitation action was taken as per the law of the Bangladesh. However, BPDB has already written to Ministry for suitable resettlement and rehabilitation as per DoE requirement.	***Compliance action initiated***
28	Resettlement plan should be properly implemented and people should be adequately compensated.	-do-	***Compliance action initiated***
29	Construction material should be properly disposed off after construction work is over.	At present the Plant is in preliminary site preparation (pre-construction) phase. Construction wastes are being reused at this stage.Solid Waste Management	***Complied at present and Will be Complied***

Sl no	Condition of DoE	Compliance	Remarks
		system has been prepared keeping the provisions in line with this (Section-V, B12, Part 9 of Technical Specification).	***during and after Construction Phase***
30	As described in the report environmental monitoring should be strictly followed and monitoring report should be shared with DoE to ensure the environmental management properly.	BIFPCL has engaged CEGIS for environmental monitoring in February 2014. From then on, each quarterly monitoring report has been submitted regularly, based on study conducted for that period, to be shared with DoE, which are available at BIFPCL web page also.	***Being Complied***
31	All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP clearly listed in the EIA report.	BIFPCL has adopted all of the EMP applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is monitoring implementation of EMP. BIFPCL is taking all possible actions based on EMP monitoring report.	***Being Complied***
32	A third party/independent monitoring bodies excluding JVC/BPDB should be engaged immediately for monitoring of all activities during pre-construction, construction and operation phases as per monitoring plan of EIA report and monitoring report must be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	CEGIS, as an independent monitoring body has been engaged by BIFPCL as environmental consultant since February 2014. From then on, CEGIS has been conducting the monitoring programs quarterly and producing monitoring reports on regular basis which are submitted by CEGIS to BIFPCL for onward submission to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment as directed by DoE.	***Being Complied***
33	Regular monitoring of the susceptible places of Sundarbans for protecting ecosystem, biodiversity and forest coverage should be made using latest high resolution image for keeping ambient environment.	The Monitoring activities of CEGIS included this part. The monitoring report contains analysis of biodiversity and forest coverage. However, in addition to this, Forest Department has also suggested some survey & analysis which have also been monitored and reported by CEGIS through the quarterly compliance monitoring report.	***Being Complied***
34	Air, water, soil, biological and social data should be monitored regularly with a network monitoring system with a view to assess the natural quality of the Sundarbans and other fragile ecosystem and report of monitoring results should be submitted to Bagerhat District Office, Khulna Divisional Office and	The network monitoring system will be installed as a part of the project construction for online monitoring when the Plant will be in operation. All these stipulations have been included in the technical specification of Main Plant EPC contract package.(Section-V, Clause No B0 6.19.13.2 and Clause No. B0 6.19.13.5).	***Compliance action initiated***

Sl no	Condition of DoE	Compliance	Remarks
	Headquarters of the Department of Environment simultaneously.		
35	There should be regularly disclosure of the report through workshops and websites and responses should be taken care accordingly.	All the reports are available on website of BIFPCL (www.bifpcl.com). CEGIS is regularly carrying out public consultation. The progress of the monitoring is regularly discussed in monthly Project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the Project Steering Committee, Chaired by the Secretary, Power Division, MoPEMR, and Government of Bangladesh.	***Being Complied***
36	Online air and water quality monitoring system should be made functional throughout the life of the Plant.	The online monitoring system will be installed when the Plant will be in operation phase and will continue throughout the life time of the Plant. All these stipulations have been included in the technical specification of Main Plant EPC contract package.(Section-V, Clause No B0 6.19.13.2 and Clause No. B0 6.19.13.5).	***Compliance action initiated***
37	Management Information System (MIS) are to be developed for this coal based Power Plant. The scope of MIS services will obviously include representing the real time monitored data especially environmental parameters displaying at Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment, BPDB and other concern agencies/Ministries. The MIS should be web based for accessing every individual to show the real time monitored records.	The MIS will be prepared before commissioning of the Plant. The consultant for developing MIS will be engaged at least one year earlier. Specification for elaborate MIS system is already included in EPC contract document.Technical Specification like DDCMIS, DDCS, PADO System, HART system, Plant MMS, Information management security system etc. have been included.	***Compliance action initiated***
38	JVC should provide all sort of logistics support to DoE and other relevant agencies for monitoring environment related items/events.	BIFPCL is ready to provide all sort of logistic support as and when required by DoE and other relevant agencies for monitoring of Plant construction activities and environmental items/events.	***Ready to comply***
39	No ground water should be allowed to use for plant purposes.	No ground water has been used so far for Plant purposes. The Plant has been designed considering use of surface water only.	***Complied at this stage and will be complied during***

Sl no	Condition of DoE	Compliance	Remarks
			operation phase
40	Conduct stakeholder meetings on regular basis for better performance of the Project as a whole.	At present the Plant is in pre-construction phase. BIFPCL has appointed a social worker who regularly visits nearby community to consult with the local people. Besides, CEGIS, appointed by the Project authority as environmental monitoring consultant, is carrying out consultation with local people.The progress / review of the project is regularly discussed in monthly project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the project steering committee, chaired by the Secretary, Power Division.	***Being Complied***
41	Additional Environmental baseline data to be collected as suggested in the EIA report and conveyed to DoE and other concern authorities.	In February 2014, CEGIS has been engaged for preparing Detail Environmental Baseline. CEGIS has submitted annual monitoring report along with reports of quarterly monitoring containing latest baseline data to BIFPCL for further dissemination to DoE and other concerned authorities.	***Being Complied***
42	The Environmental Management Plan under the EIA study shall strictly be implemented and kept functioning on a continuous basis.	BIFPCL has been implementing all the EMP measures phase by phase as suggested in EIA report and by DoE which is regularly monitored by CEGIS.	***Being Complied***
43	The Project authority shall submit a detail work plan with time schedule of development activities at least 7 (seven) days ahead of the work commences in the field to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	At present the Plant is in preliminary site preparation (pre-construction) phase.BIFPCL shall submit detail work plan seven (7) days before the start of Main Plant Works.	***Agreed to Comply***
44	Environmental Monitoring Reports according to specific format specified in the EIA Report shall be made available simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	Environmental Monitoring Reports as per specific format provided in the EIA Report shall be made available by BIFPCL simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	***being complied***

Sl no	Condition of DoE	Compliance	Remarks
45	The following records must be kept in respect if any samples required to be collected for the purpose of environmental monitoring activities: (a) the date(s) on which the sample was taken; (b) the time(s) at which the sample was collected; (c) the point at which the sample was taken; and (d) the name of the person who collected the sample.	The Monitoring report of CEGIS keeps all the records as suggested.	***Being Complied***
46	The results of any monitoring required to be conducted under this EIA report must be recorded.	CEGIS is recording all the monitoring data and submitting to BIFPCL through proper documentation. The report is being shared with DoE on regular basis.	***Being Complied***
47	In case of any emergency, the following information shall be immediately be reported to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) simultaneously a) Nature of incident (oil spill, fire, accident. Collision, land slide, etc.) b) Personnel affected (injured, missing, fatalities, etc.) c) Emergency support available and its location (standby transport, medical facilities, etc.) d) Weather conditions e) Current operations (abandoning the site, fire fighting, etc.)	So far no such emergency has occurred. Emergency Reporting/ Emergency response plan have been prepared. Health and safety management manual have been prepared and it is a part of technical specification.BIFPCL would establish a proper mechanism for recording such incident as suggested, when main plant construction activities start.	***Compliance action initiated and Will be complied as and when required***
48	The Project authority or its employees must notify the department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.	So far no such incident has occurred. BIFPCL would establish a proper mechanism for recording such incident as suggestedand notify the department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident. Health and safety management manual has been prepared and CEGIS is monitoring EMP.	***Will be complied as and when required***
49	All pollution incidents shall be reported immediately and	So far no such incident has been happened. BIFPCL would establish a	***Will be complied as***

Sl no	Condition of DoE	Compliance	Remarks
	simultaneously to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) in Dhaka.	proper mechanism for recording such incident as suggested. CEGIS has been engaged to record such incident during pre-construction and construction period	***and when required***
50	Appropriate permission would require to be obtained from the Forest Department in favour of cutting/felling on any plant/tree/sapling forested by any individual or government before doing such type of activity.	There will be no need of cutting/felling down of any trees. However, in future, if any such case would arise, BIFPCL would seek for appropriate permission as suggested	***Will be Complied as and when necessary***
51	Re-vegetation and re-plantation under green belt activities shall be undertaken in consultation with the Forest Department according to those mentioned in the EIA report.	An MoU signed with Forest Dept., Bangladesh on 24.02.2015 for implementation of Afforestation Programme. Initial target is planting of 2 lac saplings in 3 years. By this time, they have already planted about 7500 nos. of saplings of different species. In this quarter they have again planted 1057 numbers local verities plant.	***Being Complied***
52	Climate Change impacts and maximum storm surge height shall have to consider at the design and construction phase.	The level (elevation) of the land and earthen embankment has been fixed considering the climate change impact and maximum storm surge height.	***Being Complied***
53	A separate EIA/morphological study shall have to be conducted for coal transportation and river dredging to develop sound environmental management plan towards conservation of ecosystem and biodiversity.	Mongla Port Authority (MPA) is the Implementing Agency for dredging. Coal transportation will be done through the existing maritime route, which is Mongla port controlled waterways. M/s IWM has already completed the EIA study for the dredging activity and submitted the report to MPA. A separate EIA study for coal transportation is being conducted by M/s CEGIS as per approved ToR of DoE. Inception Report for the said study has been submitted to BIFPCL.	***Being Complied***
54	A full-fledged institutional setup for EHS and CSR must be put in place before operation of the Power Plant.	A full-fledged institutional setup for EHS activities shall be in place before operation of the Plant (Project). Meanwhile, a number of CSR activities are ongoing at Project site, like free medical facilities and medicines, free potable water supply to the local people. BIFPCL has appointed a social worker to collect relevant social data. Health and Safety manual has been prepared.	***Being complied***
55	The Project authority shall extend active cooperation to DoE officials to	BIFPCL is extending its all cooperation to DoE	***Being Complied***

Sl no	Condition of DoE	Compliance	Remarks
	facilitate their visit to the site as and when necessary.		
56	Violation of any of the above conditions shall render this approval void.	Noted by BIFPCL	-
57	Any injunction on this Project from the Honourable Supreme Court/High Court Division shall render this approval void.	Noted by BIFPCL	-
58	Without installation of 275 Meter Height Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Settling Pond, Desalinization Plant, API Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring system and other pollution control equipment and obtaining Environmental Clearance Certificate, the proponent shall not start operation of the Project.	At present the Plant is in pre-construction phase. The functional technical specification of the main Plant includes 275 Meter high Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Setting Pond, Desalinization Plant, API, Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring systematic for preventing pollution. All these stipulations have been included in the technical specification of Main Plant EPC contract package.	***Compliance action initiated and will be complied before starting operation of the Project***
59	This EIA Approval has been issued with the approval of the appropriate authority.	BPDB and BIFPCL are thankful to DoE.	-

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Appendix I: Checklist of Monitoring Environmental Compliances

Table A: Checklist of Monitoring for ESMP Implementation (During Pre-Construction and Land Development)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green Plantation around the Project boundary • Switching off/ throttling down of machines/equipment's/generators which are not in use			
2	Dust Generation from Land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly?			
3	Water Quality	• Fencing the construction site by drum sheet or Tarjja of any other fencing • Arrangement of runoff drainage for reducing any water logging • Location of backfilling stockpile in safe area and protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and waste water to river or canal.			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
4	Waste Management System	• Provision of onsite waste management system			
5	Compensation and Resettlement	• Prepare Proper resettlement action plant and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for shift able structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance • grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Provide/take extra care/caution for the disadvantaged/vulnerable group(s) (i.e. women, children, ethnic minorities, indigenous people etc.) • Provision of monitoring the compensation and resettlement process			
6	Livelihood and living	• Does the Project pose any threat to the livelihood/living standards of the local people? • If yes, are adequate steps taken to reduce the impacts? • Has the company developed any policy which prioritizes the local laborers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers?			***(continued)***

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• If yes, are there any mitigative steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?			
7	Green House Gas Controlling Measures	• Use of efficient generator in the construction activities • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications • Use of approved pollution control devices fitted in the equipment's and machineries • Switching off and throttling down the machines/equipment's/generators which are not in use			

Table B: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Labor and Working Condition)

Basic Data

Sl No	Description	Values
1	Direct Workers	
2	Contracted Workers	
3	Supply Chain Workers	
	Child labor	
	0 - 12	
	13 - 14	
	14 - 18	

Checklist for Labor and Working Condition

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers • Defined Working condition and Terms of Employment for direct worker • Sustainably equivalent terms and condition for migrant workers • Compliance to national law of forming workers' organization • No discrimination and equal opportunity for all • Measures for diminishing past discrimination • Grievance Mechanism			
	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child education, or to be harmful to the child's			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		health or physical, mental, spiritual, moral, or social development. • No Force Labor			
	Safety at site	• Installation/Construction of Safety Fence around the Project area • Use of Personnel Protective Equipment (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.) • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.) • Practice of Tool box meeting, safety talks, • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.) • Maintaining Material Safety Data Sheet (MSDS) • Provision of Health care facilities such as doctor, hospital etc available at/nearby the plant construction site • Availability of First Aid at work place • Preparation and Follow of Emergency Response Plan • Adequate fire precautions in place (for example, fire extinguishers, escape routes etc.) • Documentation and reporting of occupational accidents, diseases, and incidents • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/Organogram • Preparation of Safety Policy to be adopted during plant operation			
	Worker's Well Being	• Establishment Grievance Mechanisms • Ensuring fair treatment, non-discrimination and equal opportunity • Compliance of Project's labor policy with the national labor law • No Child Labor • No incident of forced labor • Provision of Welfare facilities for Worker/Labor			

Table C: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Community Health, Safety and Security)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project are • Installation of water spraying system to control dusts • Conducting dust monitoring and visual inspection around the site boundary • Adoption of Noise management plan			
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism • Maintaining open communication channel with the local community			
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area • Practicing Risk Assessment and Evaluation Process • Practicing safe management for hazardous materials which may pose threat to the community • Availability and operation of Emergency Response Plan • Maintaining open communication channel with the local community • Training and instruction to the security personnel about their behaviour and communication with the local people • Aware the security personnel about the right of the community people			
	Community Health Risk	• Provision of providing health service facilities to community if the Project possess any health risk like			***(Continued)***

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		sexually transmitted disease, communicable disease, vector-borne diseases • Implement all pollution mitigation measures to ensure safeguarding to community			
	Youth Employment	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities			
	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting • Sharing of Project information with local people • Organizing environmental and social awareness programs/meetings			

Table D: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Biodiversity and Sustainable Management of Living Natural Resources)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel.	• Installation of proper run on/runoff drains • Use of sediment fences, traps and basins for trapping the sediment, if required			
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank • Implementation of on-site waste and air quality management plan • Limiting soil extraction activities limited within the defined area • Limiting the vegetation clearance and base stripping process within the Project boundary • Safety fence around the construction site • Limiting the use of night light • Using shade (directed downwards) around the outdoor lights • Provision of cut-off time to switch off unnecessary lights at night • Initiate Green plantation • No plantation of non-native species • Retaining top soil for future habitat restoration • No degradation of critical habitat?			
3	Occupation of river, inter-tidal areas and wetlands	• No encroachment of inter-tidal flood plain area • No disturbance to Dolphin community • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• If required, embankment should be constructed considering a setback distance from river/canal bank • Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal dynamics			

Appendix II: Photo Album

Environmental Monitoring of Khulna 2×660 MW Power Plant for 2nd Quarter of 3rd Year *(July, 2016)*

The Monitoring Team

Estimating Light Intensity by Lux Meter at Karamjal

Observe Tree Canopy cover with Densiometer

Taking Tree DBH at Koromjal

Taking Sapling Diameter at Harbaria

Temporary cross-dam over Maidara River restricting natural flow

Environmental Experts visiting the Plant site for EMP status monitoring

Fisheries catch assessment at Passur River near project site

Consultation with pant proponents

Visiting RO Water Treatment Plant by the CEGIS officials

Appendix III: Terms of References (ToR)

As per ECA 1995 and ECR 1997, the proposed Project "1320MW coal based thermal Power Plant at Rampal, Khulna" falls under red category; needs proper monitoring and documenting of environmental and socio-economic parameters.

Accordingly, the EIA study of the proposed plant has already been conducted. The EIA of the proposed Power Plant briefly describes the monitoring plan. The ToR has been prepared for engaging Engineering, environmental and social Contractor for monitoring the environmental and socio-economic parameters during pre-construction and construction phases along with the engineering consideration of the site development and construction of the Project so that the monitoring plan suggested in the EIA is properly followed and satisfies the requirement of ECR 1997 and ECR 2005.

The monitoring works has been divided in to two major components:

Work A: Monitoring of Engineering activities of site development and others.

Work B: Monitoring of Social and Environmental parameters for updating the baseline and Implementation of the Project.

Work A: The main objective of this component is to monitoring the engineering activities of site development and others during pre-construction and construction phase for installation of the Power Plant.

The specific objectives of the monitoring program are:

- To establish baseline environmental conditions;
- To detect adverse environmental impacts for river dredging and land filling activities for site development;
- To demonstrate whether the environmental control measures are operating as per designed;
- To provide data for emission inventories;
- To provide data at regular intervals for dissemination to the stakeholders
- To provide data for improvement and updating of the monitoring program;
- To assist in investigating the event of a trigger level or emission limit value being crossed.

Landfill monitoring is an interactive process of incorporating the findings of the site investigation, the environmental impact assessment, environmental monitoring results, risk assessment and the conclusions reached in the investigations.

Work B: The main objective of this component is to monitor the environmental parameters and implementation of environmental management plan during pre-construction and construction phase for installation of the Power Plant. The specific objectives of the monitoring program are:

- Update baseline data as per monitoring schedule and location.
- Monitor and provide the environmental parameters during pre construction activities.
- Provide technical assistance to the client for implementation of the EMP at different sector of construction activities.
- Monitor the environmental aspects during construction of the Project.

- Review the EIA document to evaluate the EMP measures incorporated in the contract to mitigate different social and environmental hazards and risks during construction of the Project
- Submit progress reports to the client.
- Render any other related services as and when requested.

The scope of the services can be specified as bellows:

Monitoring Parameter	Indicators
Socio-economy	Livelihood and Occupation
	Income and expenditure
	Displacement and Migration
	Cultural and heritage
	Health and sanitation
	Risks and accidental assessment
	Transportation and communication
	Public and private Infrastructure development
Ecology and Biodiversity	Bio-indicator Assessment
	Movement of indigenous/ native species
	Envision of exotic species and regime dominance
	Species composition (Flora and Fauna)
	Assessment the services of dependent ecosystem
Agriculture	Land use and canopy coverage
	Soil quality (Salinity, pH, OM,)
	Cropping pattern and crop intensities
	Irrigation and crop production
	Farmers survey result
Fisheries	Fish diversity and specification
	Fish production and availability
	Fisher survey result
Noise level	Sound level at the sensitive zone
Water resources	DO, BOD, COD, Salinity , TDS, TS, pH, Hg, Pb
	Total Hardness, Hg, NO_3 and PO_4
	River Morphology,
	Tidal inundation
	Drainage Network
	Erosion and Accretion
	Ground water quality
Air quality	SOx

Monitoring Parameter	Indicators
	NOx
	SPM (PM_{10} and $PM_{2.5}$)
	CO

Reporting Requirements

As it is proposed to carry out the monitoring program for three (3) years, the schedule of deliverables has to be re-scheduled. The proposed deliverables are scheduled below

- An Inception Report shall be submitted within 30 (thirty) days from the commencement of the assignment
- Submission of 1st quarterly monitoring report at the end of three (3) months from the date of signing contract;
- Submission of 2nd quarterly monitoring report at the end of six (6) months from the date of signing contract;
- Submission of 3rd quarterly monitoring report at the end of nine (9) months from the date of signing contract;
- Submission of Annual (1st) monitoring report at the end of one (1) year from the date of signing contract;
- Submission of 5th quarterly monitoring report at the end of fifteen (15) months from the date of signing contract;
- Submission of 6th quarterly monitoring report at the end of eighteen (18) months from the date of signing contract;
- Submission of 7th quarterly monitoring report at the end of twenty one (21) months from the date of signing contract;
- Submission of Annual (2nd) monitoring report at the end of twenty four (24) months from the date of signing contract;
- Submission of 9th quarterly monitoring report at the end of twenty seven (27) months from the date of signing contract;
- ***Submission of 10th quarterly monitoring report at the end of thirty (30) months from the date of signing contract;***
- Submission of 11th quarterly monitoring report at the end of thirty three (33) months from the date of signing contract;
- Submission of Annual (3rd) monitoring report at the end of thirty three months from the date of signing contract;
- All report shall be submitted to BIFPCL in (five) hard copies and soft copy on CD.

Appendix IV: Monitoring Data

(A) Air Quality Data

Table A.1: Ambient Air Quality Monitoring Results

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy				
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE				
		Concentrations are in µg/m^3													
SW Corner of the PP area	$PM_{2.5}$	33	37	25	33	47	25	22	34	19	5			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	78	77	53	79	83	35	52	135	117	32			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	207	239	190	200	177	42	91	175	332	51			*(200)*	*NF*
	SO_2	21	24	19	23	15	52	35	14	18	9			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	26	29	27	31	29	35	29	18	18	12			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	120	188	140	190	144	146	88	74	57	35			*(10000)*	*NF*
	O_3	27	26	19	22	26	12	5	4	1	1			*(157)*	*(100)*
	$PM_{2.5}$	39	48	48	39	34	18	17	35	25	3			*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Proposed Township area of the PP	PM_{10}	89	90	74	102	97	31	48	116	44	11			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	217	263	217	274	266	47	79	192	187	27			*(200)*	*NF*
	SO_2	19	28	22	21	22	58	27	13	11	4			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	29	39	27	26	24	46	25	16	22	6			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	165	210	230	164	136	127	102	77	22	31			*(10000)*	*NF*
	O_3	33	26	26	23	21	16	1	1	1	0			*(157)*	*(100)*
NW Corner of the PP area	$PM_{2.5}$	37	44	19	42	59	28	19	24	11	3			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	67	78	56	98	91	96	29	125	29	24			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	234	217	157	310	244	321	66	187	115	31			*(200)*	*NF*
	SO_2	19	22	18	27	21	56	32	13	17	4			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	23	28	22	32	39	43	21	18	16	5			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	110	178	110	210	140	133	87	77	38	47			*(10000)*	*NF*
	O_3	25	19	17	36	44	11	8	2	0	1			*(157)*	*(100)*
Barni, Gaurambha	$PM_{2.5}$	39	47	57	39	41	34	11	29	23	9			*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	103	122	67	97	82	65	26	97	82	45			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	233	244	183	277	236	79	112	176	268	69			*(200)*	*NF*
	SO_2	21	23	17	22	25	41	31	16	20	10			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	25	28	22	26	27	44	32	21	16	12			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	175	210	190	150	196	96	96	81	73	41			*(10000)*	*NF*
	O_3	26	29	22	19	15	9	6	4	0	0			*(157)*	*(100)*
Chunkuri-2, Dacope	$PM_{2.5}$	35	39	46	37	33	35	28	31	25	7			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	77	86	69	68	61	109	49	98	60	23			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	117	113	162	183	188	175	94	167	167	31			*(200)*	*NF*
	SO_2	19	24	21	18	11	55	33	21	13	7			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	23	26	27	24	18	49	23	16	25	10			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	190	205	170	170	33	133	75	70	33	38			*(10000)*	*NF*
	O_3	27	24	18	22	41	21	2	1	1	0			*(157)*	*(100)*
Pankhali, Dacope	$PM_{2.5}$	47	49	57	41	39	-	25	47	15	8			*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	119	127	139	101	105	144	62	128	46	42			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	297	266	254	208	299	339	183	198	114	78			*(200)*	*NF*
	SO_2	28	31	31	24	30	58	36	18	9	8			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	41	39	36	26	27	47	23	15	19	9			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	230	217	250	188	177	125	105	101	55	29			*(10000)*	*NF*
	O_3	49	38	36	27	11	13	5	2	2	0			*(157)*	*(100)*
Mongla Port area	$PM_{2.5}$	47	55	39	41	26	33	19	34	21	9			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	139	174	77	82	35	52	33	132	45	29			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	288	303	197	217	214	118	65	189	144	50			*(200)*	*NF*
	SO_2	27	28	26	24	14	45	36	16	10	8			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	44	39	33	27	17	40	20	13	14 .	10			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	230	320	220	211	24	110	84	71	29	31			*(10000)*	*NF*
	O_3	57	52	37	26	09	15	8	3	1	2			*(157)*	*(100)*
Harbaria, Sundarbans	$PM_{2.5}$	19	22	33	27	24	27	24	26	13	6			*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	41	39	59	56	49	42	50	82	42	20			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	111	117	129	139	109	70	73	159	91	43			*(200)*	*NF*
	SO_2	9	10	14	12	16	51	34	15	11	6			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	19	22	27	18	22	34	22	14	16	8			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	65	58	70	64	56	112	81	62	47	32			*(10000)*	*NF*
	O_3	13	12	13	11	14	12	4	2	2	0			*(157)*	*(100)*
Akram Point, Sundarbans	$PM_{2.5}$	17	19	23	18	49	-	25	18	9	4			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	39	44	32	39	77	-	32	77	31	15			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	114	133	97	88	102	-	51	128	46	23			*(200)*	*NF*
	SO_2	7	9	12	13	21	-	27	14	9	4			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	17	19	22	17	27	-	19	15	10	5			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	49	60	50	46	163	-	92	64	21	37			*(10000)*	*NF*
	O_3	11	14	9	10	27	-	8	1	0	0			*(157)*	*(100)*
Hiron Point,	$PM_{2.5}$	15	23	19	17	28	-	27	-	17	-			*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Sundarbans	PM_{10}	44	38	34	41	60	-	45	-	40	-			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	101	119	107	97	110	-	88	-	132	-			*(200)*	*NF*
	SO_2	8	7	13	14	15	-	28	-	15	-			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	18	18	19	22	20	-	23	-	19	-			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	52	62	65	60	60	-	93	-	40	-			*(10000)*	*NF*
	O_3	14	13	11	9	23	-	2	-	0	-			*(157)*	*(100)*
Khulna City, near Khan Jahan Ali Bridge	$PM_{2.5}$	54	39	52	42	55	46	19	35	11	16			*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	139	117	91	84	75	89	49	112	69	68			*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	301	287	239	219	222	181	101	181	112	107			*(200)*	*NF*
	SO_2	33	29	33	28	31	59	28	16	11	10			*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	49	41	39	36	33	38	26	16	15	15			*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	330	370	330	296	101	89	94	98	68	36			*(10000)*	*NF*
	O_3	59	67	57	39	21	7	4	2	1	0			*(157)*	*(100)*

Note(s):

- *Concentrations are in $\mu g/m^3$;*
- *DoE- Department of Environment, NF – Not found;*
- *Fine Particulate Matter ($PM_{2.5}$), Respirable Dust Content (PM_{10}), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_X). Sulfur dioxide (SO_2), Carbone Monoxide (CO) & Ozone (O_3);*
- *Standards for 1hr, 24hr or Annual are indicated using superscript;*
- *This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).*
- *All data presented here are 8 hrs. Monitoring data.*
- *Standards presented in parenthesis are 8 hourly standard converted using standard formula.*

Table A.2: Baseline conditions of emission of different infrastructures and sources

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
SW Corner of the PP area	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Proposed Township area of the PP	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
NW Corner of the PP area	PM	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Barni, Gaurambha	PM	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
	SOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Chunkuri-2, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Pankhali, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Mongla Port area	PM	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	SOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓
	NOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	GHGs	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	PM	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
Harbaria, Sundarbans	SOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Akram Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Hiron Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Khulna City, near Khan Jahan Ali Bridge	PM	✓	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

(B) Water Quality Data

➢ Surface Water Quality Monitoring Data

Table B.1: pH Values of Passur River Water

Sl	Sampling Locations	pH Values										
		1st year				2nd Year				3rd year		BD Standard
		Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	
		1Q M	2Q M	3Q M	4Q M	1Q M	2Q M	3Q M	4Q M	1Q M	2Q M	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.1	7.9	7.6	7.8	7.6	7.1	7.5	7.27	6.5 – 8.5
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.2	8.0	7.7	7.9	7.58	7.3	7.8	7.3	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	6.9	8.0	8.1	7.8	7.8	7.64	7.3	7.2	7.93	
4	Left Bank of Passur River at Project site-Jetty	7.9	7.1	8.1	7.9	7.5	7.9	7.6	7.1	7.4	7.56	
5	Middle Passur River at Project site-Jetty	7.1	6.9	8.1	7.9	7.6	8	7.58	7.5	7.8	7.6	
6	Right Bank of Passur River at Project site-Jetty	7.1	6.9	8.2	7.9	7.7	8	7.62	7.6	7.4	7.9	
7	Left Bank of Passur River at South West corner from the Project boundary	7.4	7.0	8.1	7.6	7.5	8.1	7.78	8.1	7.6	7.94	
8	Middle of Passur River at South West corner from the Project boundary	7.4	6.9	8.0	7.5	7.2	8	7.6	8	7.1	8.04	
9	Right Bank of Passur River at South West corner from the Project boundary	7.3	6.8	8.0	7.8	7.3	8.1	7.64	7.9	7.2	8.2	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	7.4	6.9	8.1	7.7	7.5	8.1	7.3	7.3	7.1	8.1	
11	Maidara river near proposed township area	7.4	6.8	8.1	7.3	7.6	6.9	7.56	7.1	7.4	7.8	
12	Passur river at Passur-Ghasiakhali confluence	7.3	6.8	7.4	8.2	7.5	7.9	7.1	7.4	7.3	7.3	
13	Passur river at Harbaria of Sundarbans	7.9	6.9	8.0	8.1	7.7	7.9	7.8	8.2	7.3	7.63	
14	Passur river at Akram point of Sundarbans	7.2	6.9	7.9	8.1	7.7	NS	7.63	8	7.9	7.67	
15	Passur river at Hiron po.000int of Sundarbans	7.2	7.0	7.0	8.1	7.7	NS	7.39	NS	7.8		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.2: Surface Water Temperature in Passur River

Sl	Sampling Locations	Temperature (°C)										
		1st Year				2nd Year				3rd year		BD Standard
		Apr	Jul	Apr	Jan	Apr	Jul	Oct	Jan	Apr	Jul	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	19	30	31.8	31.2	22.0	31.2	29.6	20° C – 30° C
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	20	30	30.5	31.8	21.0	31.1	29.1	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	30	20	30	30.5	30.9	21.0	30.8	29.4	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	30.8	31.3	22.0	31.4	30.1	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	30.6	31.6	22.0	30.9	30.5	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	30.4	31.1	21.0	31.0	30.5	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	20	31	30.5	30.3	23.0	30.7	30.7	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	19	30	30.8	30.5	22.0	30.4	29.8	
9	Right Bank of Passur River at South West corner from the Project boundary	31	31	29	19	31	30.6	30.8	21.0	30.1	29.8	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	19	30	30.8	31.8	22.0	31.2	30.4	
11	Maidara river near proposed township area	30	32	27	20	30	31.6	31.2	23.0	30.6	30.7	
12	Passur river at Passur-Ghasiakhali confluence	29	30	32	19	30	29.8	30.7	21	31.3	30.7	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	29.0	30.8	22.0	31.5	30.9	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	NS	30.2	21.0	30.8	30.4	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	NS	30.4	NS	31.4		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015,January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.3: Salinity (ppt) in Passur River

Sl	Sampling Locations	Salinity (ppt)									
		1st Year				2nd Year				3rd year	
		Apr	Jul	Apr	Jan	Apr	Jul	Oct	Jan	Apr	Jul
		1st QM	2nd QM	1QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1QM	2nd QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0	4.5	13	0	0	4.1	8	0
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.3	0.0	4.1	15	0	0	4.3	7.4	0
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.2	0.0	4.5	16	0	0	4.3	7	0
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9	0	0	4.4	6	0
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13	0	0	5.1	6.2	0
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14	0	0	5	9	0
7	Left Bank of Passur River at South West corner from the Project boundary	9.5	4.0	0.0	5.2	14	0	0	5.2	8	0
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0	5.2	13	0	0	4.9	7	0
9	Right Bank of Passur River at South West corner from the Project boundary	10.0	2.5	0.0	5.1	12	0	0	5.5	6.8	0
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	10.0	0.5	0.0	5.2	10	0	0	3.8	7.1	0
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9	0	0	2.5	6.3	0
12	Passur river at Passur-Ghasiakhali confluence	10.0	9.5	0.0	5.0	14	0	0	4.8	6	0
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15	0	0	5.3	8.9	0
14	Passur river at Akram point of Sundarbans	19.0	15.0	1.0	16.0	20	NS	5	11.3	9.4	4
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25	NS	6.2	NS	14	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.4: Dissolve Oxygen in Passur River

SL	Sampling Locations	Dissolve Oxygen (mg/L)										
		1st Year				2nd Year				3rd year		BD Standard
		Apr	Jul	Apr	Jan	Apr	July	Oct	Jan	Apr	Jul	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.9	6.1	5.6	5.5	6.2	5.3	6.8	5.1	7.1	6.2	5 or more (standard for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	6.8	7.7	6.6	6.4	5	6.4	5.1	6.4	5.7	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.2	6.7	7.7	6.7	6.2	5	7.1	6.2	6.9	5.6	
4	Left Bank of Passur River at Project site-Jetty	5.7	6.8	7.6	5.8	6.2	6.7	6.8	5.9	5.8	6.1	
5	Middle of Passur River at Project site-Jetty	5.9	6.9	7.2	5.9	6.6	6.6	7.2	5.3	6.1	6.3	
6	Right Bank of Passur River at Project site-Jetty	5.8	6.6	8.0	6.8	6.4	6	7.6	5.4	6.6	5.8	
7	Left Bank of Passur River at South West corner from the Project boundary	6.6	7.3	5.6	6.1	6.3	7.5	6.4	6	6.9	6.3	
8	Middle of Passur River at South West corner from the Project boundary	6.5	7.1	5.6	6.9	6.5	7.4	6.1	6.1	7.1	6.4	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	7.2	5.8	6.6	6.4	7.3	6.3	5.8	6.8	5.6	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	6.0	6.5	8.0	6.0	6.2	6	7.1	4.1	6.4	5.2	
11	Maidara river near proposed township area	6.7	6.8	8.0	6.2	6.5	6.4	7.1	5.2	5.9	5.4	
12	Passur river at Passur-Ghasiakhali confluence	5.3	6.2	7.0	6.5	6.3	7	6.6	5.4	5.8	5.4	
13	Passur river at Harbaria of Sundarbans	5.4	5.9	7.0	6.6	5.8	7.5	7.1	5.2	6.4	**5.4**	
14	Passur river at Akram point of Sundarbans	7.9	6.4	7.7	6.7	6	NS	7.3	6.2	6.1	6.2	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	6.5	5.8	NS	7	NS	7.1	6.8	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014), 3QM = Third Quarterly Monitoring (October, 2014), 4QM = Fourth Quarterly Monitoring (January 2015)

Table B.5: BOD_5 of Passur River Water

SL	Sampling Location	Biochemical Oxygen Demand (mg/L)										
		1st Year				2nd Year				3rd year		BD Standard
		Apr	Jul	Apr	Jan	Apr	July	Oct	Jan	Apr	Jul	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	3.4	2.2	1.9	1.6	3.1	3	2.1	2.1	2.8	2.4	6 or less (for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	3.3	4.1	2.3	3.2	2.4	1.9	2.2	3.2	2.8	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	2.2	2.8	3.4	2.7	3.1	2.9	3.4	1.9	3	2.5	
4	Left Bank of Passur River at Project site-Jetty	3.2	3.1	4.0	0.8	3	4.4	3.2	1.1	3.6	2.1	
5	Middle Passur River at Project site-Jetty	3.0	2.5	3.5	1.4	3.5	4.3	3.7	2.4	3.3	2.2	
6	Right Left Bank of Passur River at Project site-Jetty	5.8	3.5	3.6	2.0	3.4	3.7	2.9	1.7	3.1	3.1	
7	Left Bank of Passur River at South West corner from the Project boundary	3.9	2.8	2.6	1.0	3.1	5.3	2.2	1.2	3.1	2.9	
8	Middle of Passur River at South West corner from the Project boundary	3.8	3.3	2.8	2.6	3.2	5.2	2.3	2.3	2.6	2.7	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	3.8	2.9	2.1	3.4	5	3.1	2.4	3	3.1	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	3.2	3.3	5.5	1.5	3.2	3.9	4.2	2.7	3.3	3.4	
11	Maidara river near proposed township area	4.1	3.7	4.0	2.0	3.4	4.2	1.6	1.8	3.5	3.2	
12	Passur river at Passur-Ghasiakhali confluence	2.3	2.2	1.7	2.0	3.3	4.9	2.1	2.2	3.4	2.8	
13	Passur river at Harbaria of Sundarbans	2.2	2.5	2.6	1.9	2.4	3.9	2.7	2.1	3.2	**2.8**	
14	Passur river at Akram point of Sundarbans	5.0	2.9	3.7	2.2	3	NS	2.2	2.4	3.3	2.5	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	2.3	2.7	NS	2.5	NS	2.4	2.1	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.6: COD of Passur River System

Sl	Sampling Locations	COD (mg/L)								
		1st Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1 QM	2QM	3QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	288	24	6	128	87	42	32	124	220
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	284	20	30	68	58	43	36	100	240
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	328	56	14	92	132	18	28	96	280
4	Left Bank of Passur River at Project site-Jetty	376	28	18	84	102	26	36	100	280
5	Middle Passur River at Project site-Jetty	400	60	14	116	110	21	36	108	240
6	Right Bank of Passur River at Project site-Jetty	364	496	18	108	88	24	40	80	260
7	Left Bank of Passur River at South West corner from the Project boundary	364	108	10	104	96	32	42	100	240
8	Middle of Passur River at South West corner from the Project boundary	400	40	22	16	18	25	28	100	180
9	Right Bank of Passur River at South West corner from the Project boundary	408	120	10	100	106	25	48	124	200
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	276	32	10	116	88	51	40	100	160
11	Maidara river near proposed township area	284	96	26	84	94	36	42	108	210
12	Passur river at Passur - Ghasiakhali confluence	408	172	14	96	92	30	46	88	220
13	Passur river at Harbaria of Sundarbans	372	216	14	96	102	26	36	100	140
14	Passur river at Akram point of Sundarbans	536	520	54	316	302	NS	84	96	156
15	Passur river at Hiron point of Sundarbans	540	416	122	472	470	NS	96		160

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.7: Oil and grease concentration of Passur River System

Sl	Sampling Locations	Oil and Grease (mg/L)									ECR, 1997 (mg/L)*	IFC, 2007 (mg/L)
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	April		
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	<5	>15	16.9	9	<5	39	61	10	10
2	Passur-Ghasiakhali Confluence	<5	<5	<5	>15	13	7.63	9.87	21	30.3		
3	Passur river at Harbaria of Sundarbans	<5	6.3	<5	>20	39.1	10.1	<5	14	26		
4	Passur river at Hiron point of Sundarbans	<5	<5	<5	>20	<5	NS	10.8	ND	31		
5	Akram Point of Sundarbans	<5	<5	<5	>20	<5	NS	9.73	36	82		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.8: TDS, TH and TSS of Passur River System

SL	Sampling Locations	TDS (mg/L)									TH (mg/L)									TSS (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr	April	Jul	Oct	Jan	April	July	Oct	Jan	Apr	Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	13060	251	176	4360	14400	937	158	5570	13400	2900	250	216	930	3000	245	250	1270	3130	59	126	234	180	160	26	76	14	8
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	12630	246	162	3950	14700	941	169	5910	13280	2500	180	218	870	3050	110	330	1380	3090	45	92	193	210	167	25	80	12	7
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	12900	383	153	4330	14900	127	152	5490	13560	2650	170	335	870	3250	105	360	1240	3140	53	112	174	230	170	127	65	14	10
4	Left Bank of Passur River at Project site-Jetty	13190	445	169	4750	14600	175	172	5720	12830	2550	175	390	940	3450	118	365	1220	3010	54	99	227	450	160	30	92	17	10
5	Middle Passur River at Project site-Jetty	13330	353	156	4920	14500	132	162	5850	13100	2600	275	340	990	3250	103	355	1300	3070	60	100	232	250	165	27	85	18	8
6	Right Bank of Passur River at Project site-Jetty	13380	402	152	4870	14200	156	160	5480	13460	2625	350	355	970	3200	105	350	1260	3100	55	105	186	200	155	40	97	22	7
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	162	5040	14500	336	192	5650	12820	2550	325	330	1045	3600	153	345	1370	3060	24	116	185	300	150	32	104	20	13

SL	Sampling Locations	TDS (mg/L)									TH (mg/L)									TSS (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr	April	Jul	Oct	Jan	April	July	Oct	Jan	Apr	Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
8	Middle of Passur River at South West corner from the Project boundary	13390	587	153	5050	14600	158	164	5740	12960	2800	350	345	1125	3670	105	390	1340	3130	27	112	536	530	147	40	90	7	10
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	154	5130	14250	160	164	5650	13590	2500	475	325	975	3540	165	445	1270	3110	67	37	459	450	155	44	82	18	11
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	12400	455	214	5050	14000	2320	183	5450	13340	2500	450	350	980	3260	470	183	950	3180	7	65	798	280	148	36	96	11	7
11	Maidara river near proposed township area	10970	2510	257	4390	13900	355	176	4420	11700	2400	725	330	970	3190	130	340	1075	3080	9	24	389	206	160	28	92	10	6
12	Passur river at Passur - Ghasiakhali confluence	12800	6410	209	5130	14050	298	227	4540	11330	3150	1400	377	1000	3210	135	410	1090	3060	50	310	203	280	165	24	60	15	13
13	Passur river at Harbaria of Sundarbans	12280	9360	285	4780	13900	683	205	4940	13580	2625	2150	345	970	3080	200	430	1100	3050	65	90	869	400	160	42	74	22	18
14	Passur river at Akram point of Sundarbans	21500	15960	3400	12350	13600	NS	4220	13330	20720	4500	3625	980	2380	3420	NS	1090	2850	4520	115	99	280	103	150	NS	110	16	23

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SL	Sampling Locations	TDS (mg/L)									TH (mg/L)									TSS (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr	April	Jul	Oct	Jan	April	July	Oct	Jan	Apr	Apr	Jul	Oct	Jan	April	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
15	Passur river at Hiron point of Sundarbans	21500	14050	5720	17900	25300	NS	5830	-	25500	4850	3050	1440	2690	3640	NS	1460	-	5050	91	72	267	200	180	NS	144	-	15

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.9: NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentration of Passur River System

SL	Sampling Locations	NO_3^{2-}(mg/L)									SO_4^{2-} (mg/L)									PO_4^{2-} (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.90	2.89	0.32	3	-	9.1	4	6.3	3	1840	20	26	580	1360	67	7	570	1080	0.52	2.23	0.67	0.32	0.86	.10	1.27	0.269	0.22
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	0.70	2.40	1.57	1.5	-	7.5	7.1	4.3	2.9	1320	23	28	450	1260	11	8	590	1040	0.50	1.99	1.12	0.61	0.53	0.23	1.97	0.269	0.36
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.10	3.20	1.84	4.3	-	6.2	5	3.9	2.5	1280	36	34	480	1240	9	11	560	1020	1.10	2.55	0.95	0.7	0.72	0.67	1.94	0.179	0.27
4	Left Bank of Passur River at Project site-Jetty	1.30	0.76	1.64	3.1	-	6.6	5.7	3.1	2	1360	45	33	550	1240	26	10	550	1060	2.10	0.45	0.92	0.43	0.49	0.27	2.53	0.357	0.31

SL	Sampling Locations	NO_3^{2-}(mg/L)									SO_4^{2-} (mg/L)									PO_4^{2-} (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
5	Middle Passur River at Project site-Jetty	1.40	2.69	1.42	2.2	-	6.1	3.3	5.2	3.1	1040	32	30	520	1120	6	8	580	980	2.20	2.13	1.11	0.41	0.68	0.59	1.3	0.536	0.3
6	Right Bank of Passur River at Project site-Jetty	1.10	2.98	1.33	8.5	-	6.6	4.7	4.1	3.6	1320	20	27	540	820	8	9	565	1100	2.00	2.42	0.99	0.55	0.61	0.13	1.32	0.269	0.43
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1.85	2.7	-	14.9	4.4	4.9	2.6	1640	60	40	630	880	9	12	640	1060	0.57	1.25	1.18	0.76	0.65	0.1	0.99	0.536	0.63
8	Middle of Passur River at South West corner from the Project boundary	1.10	2.43	2.09	1.8	-	4	6.2	3.7	2.9	1520	40	35	560	1180	19	8	560	1020	1.20	1.51	1.25	0.85	0.53	0.18	1.02	0.625	0.21
9	Right Bank of Passur River at South West corner from the Project boundary	1.20	2.05	2.21	1.9	-	4.9	4.4	4.4	2.6	1280	80	64	620	900	12	6	550	1080	1.50	1.10	1	0.53	0.6	0.1	1.39	0.536	0.33

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SL	Sampling Locations	NO_3^{2-}(mg/L)									SO_4^{2-} (mg/L)									PO_4^{2-} (mg/L)								
		1St Year				2nd year				3rd year	1St Year				2nd year				3rd year	1St Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.3	2.18	2.26	6	-	7	4.9	5.6	2.7	1120	20	63	570	1220	72	11	96	1040	0.55	2.1	1.27	0.59	0.7	0.5	1.27	0.351	0.19
11	Maidara river near proposed township area	0.5	0.88	1.98	4	-	3.1	2.9	3.9	3.1	1320	210	63	460	840	27	9	480	1020	1.1	0.53	1.04	0.64	0.55	0.29	1.28	0.269	0.13
12	Passur river at Passur - Ghasiakhali confluence	0.6	1.52	1.64	4.5	-	7.8	3.1	3.7	3	1360	620	44	630	980	39	13	482	1100	1.3	0.35	0.86	0.42	0.71	0.59	0.95	0.179	**0.31**
13	Passur river at Harbaria of Sundarbans	1.4	1.75	1.67	2.7	-	4.4	4.4	5.1	3.4	1560	860	69	590	900	51	7	500	1080	1.1	0.56	1.22	0.61	0.59	0.89	0.35	0.269	0.42
14	Passur river at Akram point of Sundarbans	2.7	3.32	0.59	1.5	-	NS	3.2	4.9	2.9	2600	1400	1390	850	1540	NS	84	760	1650	1.3	0.29	0.8	0.42	0.61	NS	0.43	0.357	0.26
15	Passur river at Hiron point of Sundarbans	0.8	2.84	0.4	2	-	NS	11.5	-	3.5	2080	1160	2360	1500	1920	NS	97	-	2100	7.51	0.29	1.09	0.44	0.47	NS	0.45	-	0.36

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

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Table B.10: As, Pb concentration of Passur River System

Sl	Sampling Locations	As (mg/L)									Pb (mg/L)								
		1st Year				2nd year				3rd year	1st Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.053	0.004	0.002	0.104	0.098	0.0059	0.007	0.168	0.203
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.003	0.055	0.002	0.003	0.104	0.102	0.0038	0.006	0.092	0.302
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.001	0.003	0.004	0.003	0.003	0.002	0.001	0.001	0.003	0.055	0.005	0.002	0.111	0.138	0.0058	0.008	0.176	0.347
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.004	0.004	0.002	0.002	0.001	0.002	0.002	0.057	0.002	0.003	0.154	0.142	0.011	0.01	0.115	0.336
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.002	0.001	0.001	0.002	0.002	0.060	0.002	0.002	0.139	0.135	0.002	0.009	0.148	0.317
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.003	0.003	0.002	0.002	0.001	0.001	0.002	0.058	0.002	0.002	0.138	0.156	0.0021	0.007	0.112	0.298
7	Left Bank of Passur River at South West corner from the Project boundary	<0.001	0.003	0.006	0.003	0.002	0.002	0.001	0.002	0.001	0.053	0.002	0.003	0.16	0.142	0.0076	0.01	0.134	0.396
8	Middle of Passur River at South West corner from the Project boundary	<0.002	0.004	0.004	0.003	0.002	0.002	0.001	0.001	0.002	0.054	0.003	0.004	0.153	0.148	0.002	0.011	0.099	0.323
9	Right Bank of Passur River at South West corner from the Project boundary	0.002	0.003	0.006	0.003	0.002	0.003	0.001	0.001	0.002	0.056	0.005	0.004	0.139	0.163	0.002	0.009	0.093	0.331

Sl	Sampling Locations	As (mg/L)									Pb (mg/L)								
		1st Year				2nd year				3rd year	1st Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.001	0.003	0.006	0.004	0.003	0.002	0.001	0.002	0.002	0.053	0.004	0.004	0.143	0.135	0.002	0.07	0.023	0.35
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.003	0.002	0.001	0.001	0.002	0.048	0.004	<0.002	0.133	0.14	0.002	0.008	0.067	0.275
12	Passur river at Passur - Ghasiakhali confluence	0.002	0.001	0.003	0.002	0.001	0.002	0.001	0.002	0.003	0.05	0.03	<0.002	0.14	0.14	0.002	0.009	0.078	**0.258**
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.004	0.002	0.001	0.002	0.005	0.043	0.044	0.004	0.137	0.13	0.002	0.012	0.135	0.228
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.002	NS	0.001	0.002	0.006	0.194	0.071	0.032	0.309	0.297	NS	0.084	0.302	0.359
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.002	NS	0.001	NS	0.004	0.224	0.050	0.07	0.309	0.291	NS	0.073	NS	0.607

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.11: Hg concentration of Passur River System

Sl	Sampling Locations	Hg (mg/L)								
		1st Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
4	Left Bank of Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
5	Middle Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
6	Right Bank of Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
7	Left Bank of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
8	Middle of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
9	Right Bank of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
11	Maidara river near proposed township area	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
12	Passur river at Passur - Ghasiakhali confluence	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
13	Passur river at Harbaria of Sundarbans	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015	0,00015
14	Passur river at Akram point of Sundarbans	0.0020	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015	0,00015	0,00015
15	Passur river at Hiron point of Sundarbans	0.0023	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed

➢ Parameters for ground water quality monitoring

Table B.12: pH and Temperature of Ground Water

SI	Locations	Tube Well Type	pH value*											Temperature (°C)*											
			1st Year				2nd Year				3rd year		BD Standard*	1st year				2nd Year				3rd year		BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	8.0	TC	8.1	7.49	7.6	7.8	7.8	6.5 -8.5	27.3	28.5	26	24.5	TC	31	30	24	29.8	28.6	20 – 30 °C
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8.0	8.2	7.8	8.3	7.93	8.1	8.3	8.1		29.6	29.9	28	22.5	28.6	28	27.8	23	29.6	29.4	
3	Kalekarber	Shallow (<250 ft)	6.3	6.5	NF	NF	NF	NF	NF	NF	NF	7.9		27.5	28.7	NF	NF	NF	NF	NF	NF	NF		
4	Kapasdanga	Deep (>600 ft)	7.6	7.7	8.0	8.1	7.9	8.3	7.7	7.9	8.2	NF		29.2	28.9	28	25.1	28.8	30	28.7	25	30.1		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed: NF=Non functional *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.13: Salinity and DO in Groundwater

SI	Locations	Tube Well Type	Salinity (ppt)											DO (mg/L)*										
			1st Year				2nd Year				3rd year		BD Standard*	1st Year				2nd Year				3rd year		BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Apr	Jan	Apr	Jul		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	1st QM	4th QM	1st QM	2nd		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	
1	Near Proposed Township	Deep (>600 ft)	0	0	0	1	TC	0	0	0	0	0	N/A	4.4	5.2	6.5	6.7	TC	6	5.4	4.9	6.1	5.8	6 mg/l
2	Rajnagar	Deep (>600 ft)	0	0	0	0	0	0	0	0	0	0		6.0	6.2	7.7	6.3	6.0	5.9	6.1	5.2	5.8	6.1	
3	Kalekarber	Shallow (<250 ft)	0	0	NF	NF	NF	NF	NF	NF	NF	NF		4.4	6.0	NF	NF	NF	NF	NF	NF	NF		
4	Kapasdanga	Deep (>600 ft)	0	0	0	0	0	0	0	0	0	0		6.4	6.5	6.1	6.5	6.6	6	5.6	4.8	5.6	5.7	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.14: TDS and TSS concentrations in Groundwater

Sl	Locations	Type of tube wells	TDS (mg/L)*										TSS (mg/L)*									
			1st Year				2nd year						1st Year				2nd year					
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	BD Standard*	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	BD Standard*
			1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4QM	1 QM		1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4QM	1 QM	
1	Township near project site	Deep (>600 ft)	1113	999	-	1021	NF	881	377	447	1025	1000 mg/L	-	6	19	40	NO	23	4	5	3	10 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371	-	378	390	574	1007	491	384		-	6	2	28	4	16	5	4	4	
3	Kalekarber	Shallow (<250 ft)	1055	970	-	NF	NF	NF	NF	NF			-	48	NF	NF	NF	NF	NF	NF		
4	Kapasdanga	Deep (>600 ft)	643	635	-	600	600	328	611	284	649		-	8	6	32	6	14	4	4	3	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016
Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

Table B.15: TH concentrations in Groundwater

Sl No	Locations	Type of tubewell	TH (mg/L)*									
			1st Year				2nd year					BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	
1	Township near project site	Deep (>600 ft)	425	250	300	235	NO	225	325	295	305	200-500 mg/L
2	Rajnagar	Deep (>600 ft)	220	175	180	110	138	125	450	195	263	
3	Kalekarber	Shallow (<250 ft)	780	450	NF	NF	NF	NF	NF	NF		
4	Kapasdanga	Deep (>600 ft)	190	140	180	125	216	115	480	225	163	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.16: COD concentrations of monitored ground water locations

Sl	Locations	Tubewell Type	COD (mg/L)									
			1st Year				2nd year				3rd year	BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	
1	Township near project site	Deep (>600 ft)	32	32	34	20	NO	12	4	4	4	4.0 mg/L
2	Rajnagar	Deep (>600 ft)	28	28	18	16	14	10	8	4	4	
3	Kalekarber	Shallow (<250 ft)	32	36	NF	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	48	32	34	20	18	14	4	4	4	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.17: NO_3, SO_4 and PO_4 Concentrations in Ground Water

Sl	Locations	Type of tube well	NO_3^{2-} (mg/L) *BD Standard (10 mg/L)									SO_4^{2-} (mg/L) *BD Standard (400 mg/L)									PO_4^{2-} (mg/L) *BD Standard (6.0 mg/L)								
			1st Year				2nd year				3rd year	1st Year				2nd year				3rd year	1st Year				2nd year				3rd year
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Township near project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	7.6	4.3	2.1	1.7	-	3	-	-	-	-	1	5	1	-	2.2	-	0.74	NO	1.4	0.31	0.267	1.08
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2.2	4.2	1.9	2.3	-	2	-	-	-	-	2	6	2	-	2.5	-	0.44	1.98	1.6	0.27	0.179	1.53
3	Kalekarber	Shallow (<250 ft)	0.40	0.56	NF	NF	-		NF	NF		-	3	NF	-	-	-	-	NF		-	1.2	NF	NF	NF		NF	NF	
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	4.7	3.8	2.8	1.9	-	10	-	-	-	-	2	2	8	-	6.2	-	0.48	4.54	4.1	0.48	0.17	3.26

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.18: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

Sl	Locations	As (mg/L) *BD Standard (0.05 mg/L)									Pb (mg/L) *BD Standard (0.05 mg/L)									Hg (mg/L) *BD Standard (0.001 mg/L)								
		1st Year				2nd year				3rd year	1st Year				2nd year				3rd year	1st Year				2nd year				3rd year
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Apr	Jul	Oct	Jan	APR	Jul	Oct	Jan	Apr
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM
1	Township near project site	0.013	0.020	0.012	0.014	NO	0.015	0.002	0.008	0.018	0.002	<0.002	0.004	0.023	NO	0.002	0.006	0.026	0.019	<0.00015	<0.00015	<0.0005	<0.0005	NO	0.00015	<0.00015	<0.00015	<0.00015
2	Rajnagar	0.006	0.009	0.006	0.008	0.01	0.014	0.012	0.002	0.007	<0.002	<0.002	<0.002	0.016	0.013	0.0027	0.021	0.011	0.007	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015	<0.00015	<0.00015
3	Kalekarber	0.376	0.407	NF	NF	D	D	NF	NF		0.002	0.008	NF	NF	D	D	NF	NF		<0.00015	<0.00015	NF	NF	NF	NF	NF	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	0.034	0.024	0.011	0.002	0.047	<0.002	0.004	<0.002	0.013	0.017	0.002	0.005	0.012	0.008	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015	<0.00015	<0.00015

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; TC=temporarily closed, D=Damaged

**Drinking water quality standards, The Environment Conservation Rules, 1997*

CEGIS

(C) Noise Level monitoring data

Table C.1: Summary of the ambient noise monitoring in First Year (2014-15)

Sl No	Location	QM1 (Noise Level in dB (A)) Mar-14				QM2 (Noise Level in dB (A)) Jul-14				QM3 (Noise Level in dB (A)) Oct-14				QM4 (Noise Level in dB (A)) Jan-15				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	80.32	60.86	63.22	68.13	52.71	55.62	50.27	52.87	53.37	53.52	57	54.63	51.92	53.7	54.21	53.28	70
2	NW Corner of the Project area	55.23	53	47.43	51.89	NM	NM	NM	NM	42.67	41.73	41.37	41.92	33.87	36.42	35.46	35.25	50
3	Chunkuri-2, Bajua	62.69	57.19	53.39	57.76	54.61	51.14	51.9	52.55	52.26	51.14	50.76	51.39	55.08	46.29	46.49	49.29	50
4	SW corner of the Project area	49.2	NM	NM	49.2	44.55	48.94	49.33	47.6	45.56	45.1	47.18	45.95	36.57	34.24	37.27	36.03	50
5	Proposed Township area, Project site	47.8	49.7	NM	48.75	46.15	47.21	NM	46.68	42.67	41.73	41.37	41.92	41.49	39.55	43.37	41.47	50
6	Barni, Gaurambha	64.95	50.93	60.65	58.84	48.73	50.37	50.75	49.95	50.18	50.89	48.27	49.78	43.36	38.56	48.86	43.6	50
7	Khan Jahan Ali Bridge, Khulna	76.12	66.72	72.25	71.7	55.97	64.68	61.75	60.8	72.24	58.3	68.3	66.28	61.34	63.4	60.41	61.72	70
8	Mongla Port area	69.38	54.55	59.79	61.24	54.75	54.2	52.58	53.84	66.8	55.2	59.5	60.5	40.26	35.04	40.76	38.69	75
9	Harbaria, Sundarbans	39.24	NM	42.51	40.88	59.25	60.52	48.62	56.13	54.08	56.51	NM	55.3	36.36	32.4	NM	34.38	45
10	Akram Point, Sundarbans	40.95	41.98	39.9	40.94	48.95	46.86	NM	47.9	45.27	42.69	NM	43.98	37.9	30.75	NM	34.32	45
11	Hiron Point, Sundarbans	35.99	40.75	39.16	38.63	51.29	NM	NM	51.29	47.98	39.42	NM	47.98	42.82	31.93	NM	37.37	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

Table C.2: Summary of the ambient noise monitoring in Second Year (2015-16)

Sl No	Location	QM1 (Noise Level in dB (A)) Apr-15				QM2 (Noise Level in dB (A)) Jul-15				QM3 (Noise Level in dB (A)) Oct-15				QM4 (Noise Level in dB (A)) Jan-16				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	57.27	54.31	59.65	57.08	43.52	54.23	51.56	49.77	68.32	66.09	60.96	65.12	67.84	61.25	66.31	66.07	70
2	NW Corner of the Project area	45.05	42.15	46.8	44.67	37.58	40.91	46.18	41.56	41.51	39.58	44.74	41.94	53.91	49.02	49.95	50.96	50
3	Chunkuri-2, Bajua	45.9	48.19	NM	47.05	40.57	42.23	39.17	40.66	47.53	45.48	49.28	47.43	56.84	48.12	55.90	53.62	50
4	SW corner of the Project area	40.6	43.25	46.89	43.58	44.57	44.30	42.36	43.75	36.15	48.26	43.68	42.70	60.32	55.30	63.70	60.44	50
5	Proposed Township area, Project site	41.49	39.55	43.37	41.47	43.41	50.86	45.99	46.75	46.89	49.47	55.20	50.52	54.79	52.22	54.29	53.77	50
6	Barni, Gaurambha	58.23	50.11	NM	54.17	46.76	44.83	46.95	46.18	56.40	54.19	54.88	55.16	60.62	60.00	56.86	59.16	50
7	Khan Jahan Ali Bridge, Khulna	75.2	72.75	72.42	73.45	52.95	52.18	53.34	52.82	64.43	61.65	66.65	64.25	69.96	64.81	70.56	68.45	70
8	Mongla Port area	46.02	49.29	49.15	48.15	36.72	38.56	43.54	39.61	45.39	NM	48.63	47.01	54.15	51.82	52.14	52.70	75
9	Harbaria, Sundarbans	67.06	64.05	64.99	65.37	39.33	30.74	NM	35.03	54.97	46.54	NM	50.75	45.72	44.69	*NM*	45.20	45
10	Akram Point, Sundarbans	53.35	56.37	NM	54.86	NM	NM	NM	-	45.28	53.92	NM	49.60	45.60	40.29	*NM*	42.95	45
11	Hiron Point, Sundarbans	47.48	48.2	NM	47.84	NM	NM	NM	-	54.44	37.69	NM	46.06	-	-	-	-	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

Table C.3: Summary of the ambient noise monitoring in Third Year (2016-17)

Sl No	Location	QM1 (Noise Level in dB (A)) Apr-16				QM2 (Noise Level in dB (A)) Jul-16				QM3 (Noise Level in dB (A)) Oct-16				QM4 (Noise Level in dB (A)) Jan-17				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	67.71	61.23	66.31	65.08	50.92	50.04	52.3	51.42	-	-	-	-	-	-	-	-	70
2	NW Corner of the Project area	53.81	48.66	49.90	50.79	54.40	53.19	50.36	52.65	-	-	-	-	-	-	-	-	50
3	Chunkuri-2, Bajua	43.30	43.35	46.84	44.49	56.29	49.4	54.51	53.4	-	-	-	-	-	-	-	-	50
4	SW corner of the Project area	56.81	54.73	51.97	54.50	67.38	74.12	54.61	65.37	-	-	-	-	-	-	-	-	50
5	Proposed Township area, Project site	55.02	52.41	52.69	53.37	62.71	52.98	51.67	55.79	-	-	-	-	-	-	-	-	50
6	Barni, Gaurambha	50.63	54.19	57.09	53.97	51.2	59.54	59.53	56.75	-	-	-	-	-	-	-	-	50
7	Khan Jahan Ali Bridge, Khulna	66.40	64.82	66.34	65.85	63.52	62.15	65.73	63.80	-	-	-	-	-	-	-	-	70
8	Mongla Port area	49.89	48.67	51.07	49.88	53.87	52.04	52.7	52.87	-	-	-	-	-	-	-	-	75
9	Harbaria, Sundarbans	44.40	44.69	*NM*	44.55	53.87	53.04	52.79	52.9	-	-	-	-	-	-	-	-	45
10	Akram Point, Sundarbans	45.60	40.29	*NM*	42.95	47.16	46.48	50.24	47.96	-	-	-	-	-	-	-	-	45
11	Hiron Point, Sundarbans	48.53	37.69	*NM*	43.11	-	-	-	-	-	-	-	-	-	-	-	-	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

(D) Fisheries resources monitoring data

Table D.1: Data for Basic life Requirements for a Good Fish Community

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
2014-2015									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
2015-2016									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
2016-2017									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							

Table D.2: Occurrence of Species

Local Name	Scientific Name	Local Status*	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
			'-' = No; '+' = Occurrence											
Amadi Chela	*Chela sp.*	DD	-	-	+	+	+	-	+	+	-	+		
Hilsa	*Tenualosa ilisha*	NO	-	-	+	-	-	+	+	-	-	-		
Sagor Baim	*Anguilla bengalensis*		+	-	-	-	-	-	-	-	-	-		
Baim	*Pisodonophis cancrivorus*	NT	-	-	-	-	-	+	-	-	-	-		
Bacha	*Eutropiichthys vacha*	CR	+	-	-	-	-	-	-	-	-	-		
Bagda Chingri	*Penaeus monodon*	DD	+	+	+	+	+	+	+	+	+	+		
Banspata	*Brachypleura novae-zeelandiae*	NO	+	+	+	+	-	+	+	+	+	+		
Kukurjib	*Cynoglossus lingua*	NO	+	-	-	-	-	-	-	+	+	-		
Bele	*Glossogobius giuris*	NO	+	+	+	+	+	+	+	+	+	+		
Aswine Bele		NO	-	-	-	-	-	-	+	+	+	-		
Bairagi	*Coilia dussumieri*	NO	+	+	+	+	+	+	-	+	-	+		
Boishakhi Chingri		NO	-	+	-	-	+	+	+	+	+	-		
Chammu Chingri	*Metapenaeus brevicornis*	DD	+	+	+	-	+	+	+	+	+	-		
Chaka Chingri	*Penaeus indicus*	DD	+	+	-	+	+	+	+	+	+	+		
Ghora Chela	*Securicula gora*	-	+	-	-	-	-	-	-	-	-	-		
Chanda Chela			-	+	+	-	-	-	-	-	+	-		
Chitra			+	-	-	+	+	+	-	+	+	+		
Khayra Chela			-	+	-	-	-	-	+	-	+	-		
Sada Chewa	*Trepauchen vagina*	NO	+	-	+	-	-	+	-	-	-	-		
Lal Chewa	*Odontamblyopus rubicundus*	NO	+	+	+	+	+	+	+	+	+	+		
Chhuri	*Trichiurus muticus*	NO	+	-	+	-	-	-	-	-	-	-		

Local Name	Scientific Name	Local Status*	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
			'-' = No; '+' = Occurrence											
Sagor Chela	*Megalops cyprinoids*	NO	+	-	-	-	-	-	-	-	-	-		
Purabi Chela	*Thryssa purava*	NO	+	-	-	-	-	-	-	-	-	-		
Kabashi Tengra	*Mystus cavasius*	DD	+	-	-	-	-	-	-	-	-	-		
Gagra Tengra		DD	-	+	+	-	+	-	+	-	+	-		
Gulsha Tengra	*Mystus bleekery*	DD	+	+	-	+	-	+	+	+	+	+		
Harina Chingri	*Metapenaeus ensis*	DD	+	+	+	+	+	+	+	+	+	+		
Ekthuto	*Hyporhampus limbatus*	NO	+	-	+	+	-	-	-	+	+	-		
Kakila	*Xenentodon cancila*	NO	+	-	-	-	-	-	-	-	-	-		
Chapila	*Gudusia chapra*	NO	+	+	-	-	-	-	-	-	-	-		
Kuchia	*Monopterus cuchia*	DD	+	+	-	+	+	+	+	+	+	+		
Kain Magur		EN	-	+	+	+	+	+	+	+	+	+		
Loitta	*Harpodon nehereus*	NO	+	+	+	-	+	-	-	-	+	-		
Motka Chingri	*Macrobrachium villosimanusless*	DD	+	+	+	+	+	+	+	+	+	+		
Mud Crab	*Scylla serrata*	NO	+	-	+	+	+	+	+	+	+	+		
Tular Dandi	*Sillaginopsis panijus*	NO	+	-	+	-	+	-	+	-	-	-		
Paira Chanda	*Scatophagus argus*	DD	+	-	-	-	-	-	-	-	-	-		
Paissa	*Liza parsia*	NO	+	+	+	+	+	+	+	+	+	+		
Pangas	*Pangasius pangasius*	CR	+	-	+	-	-	-	-	+	-	+		
Tak Chanda	*Leiognathus equulus*	NO	+	-	-	-	-	-	+	-	-	-		
Phessa	*Setipinna phasa*	NO	+	+	+	+	+	+	+	+	+	+		
Teli Phessa	-	-	-	-	+	-	-	-	-	-	-	-		
Poma	*Poma poma*	NO	+	+	+	+	+	+	+	+	+	+		
Potka	*Chelonodon patoca*	NO	+	+	-	+	+	+	-	+	+	+		
Shilong	*Silonia silondia*	EN	+	-	+	-	-	-	-	-	-	-		
Tailla	*Eleutheronema tetradactylum*	-	+	-	-	-	-	-	-	-	-	-		
Tapse	*Polynemus paradiseus*	-	+	+	+	-	-	+	+	+	-	+		
Datina			-	-	-	+	-	-	-	+	+	-		
Jaba			-	-	-	+	-	-	+	+	-	-		
Shole	*Channa striatus*		-	-	-	+	-	-	-	+	-	-		
Magur	*Clarias batrachus*		-	-	-	+	-	-	-	+	-	-		
Koi	*Anabas testudineus*		-	-	-	+	-	-	-	+	-	-		
Vetki			-	-	-	+	+	+	+	+	+	+		
Gangania			-	-	-	+	+	-	+	-	-	-		

**Local Status Source: IUCN Red List*

Table D.3: Length-wise species distribution (%) in sampling sites

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Bagda	Chandpai	0	0	0	0	100	0	0
	Mongla Point	100	0	0	0	0	0	0
Bairagi	Chandpai	0	0	0	100	0	0	0
	Maidara	0	0	0	0	100	0	0
	Mongla Point	0	0	0	0	100	0	0
Banspata	Chalna Point	0	0	0	0	0	100	0
	Chandpai	0	0	0	0	11	89	0
	Maidara	0	0	0	100	0	0	0
Bele	Chandpai	0	0	0	50	50	0	0
	Mongla Point	9	0	0	0	91	0	0
Bhangan	Mongla Point	100	0	0	0	0	0	0
Chaka Chingri	Chandpai	0	38	63	0	0	0	0
Chata Bele	Chandpai	0	0	0	0	100	0	0
Chitra	Chandpai	0	14	86	0	0	0	0
Ekthuto	Chandpai	0	0	0	0	100	0	0
Golda	Chandpai	0	0	0	0	100	0	0
	Mongla Point	100	0	0	0	0	0	0
Gulsha Tengra	Chandpai	0	0	0	100	0	0	0
	Mongla Point	46	0	0	23	31	0	0
Gusha Chingri	Chandpai	0	100	0	0	0	0	0
Katali Chingri	Chandpai	0	0	100	0	0	0	0
Khorsula	Chalna Point	0	0	0	0	0	100	0
	Mongla Point	100	0	0	0	0	0	0
Kuchia	Chandpai	0	0	0	0	0	100	0
Moukatali	Chandpai	0	0	100	0	0	0	0
Paissa	Chandpai	0	0	0	69	31	0	0
	Mongla Point	48	0	0	22	30	0	0

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Pangas	Mongla Point	0	0	0	0	0	100	0
Pheksa	Maidara	0	0	0	0	100	0	0
Poma	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	0	0	25	75	0	0
	Maidara	0	0	0	7	86	7	0
	Mongla Point	0	0	0	0	100	0	0
Potka	Chandpai	0	0	100	0	0	0	0
Sada Gule	Chandpai	0	0	0	0	0	100	0
Tapsi	Chalna Point	0	0	0	0	0	0	100
	Maidara	0	0	0	3	20	0	78
	Mongla Point	0	0	0	0	0	0	100
Telcupa	Chandpai	0	0	0	0	0	100	0
Tit Punti	Mongla Point	100	0	0	0	0	0	0

Source: CEGIS field survey, 2015

Table D.4: Purpose, timing and extent of migration for different year-class of migratory fish species

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
Tapsi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-		-	-	-		
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	-	-	Feeding	-	-	-		
		Adult	-	-	-	-	-	-	-	Feeding	-	-		
	Chalna Point	Age-1 adult and Brood fish	Feeding and Growing	Spawning	-	-	-	Feeding	Feeding and Spawning	-	-	Breeding		
		Adult	-	-	Feeding and Growing	-	-	Feeding	Feeding	-	-	Breeding		
	Harbaria	Juvenile and Age-1 adult	Feeding and Growing	Feeding and Growing		-	-	-	-	-	-	-		
		Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-	-		
	Chandpai	Juvenile	-	-	Feeding and Growing	-	-	-	Feeding	-	-	-		
	South-west of the Project	Age-1 adult	Feeding and Growing	Feeding and Growing	Feeding and Growing	-	-	Feeding	-	-	-	Feeding		
		Brood Fish	-	-	-	-	-	Breeding and Spawning	-	-	-	Breeding and Spawning		
Bairagi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-	-		
		Juvenile and Adult	-	-	-	-	-	-	-	Growing and Feeding	-	-		
	Chandpai	Fry	Breeding and Spawning	Breeding and Spawning	Feeding and Growing	Feeding	-	Feeding	-	-	-	-		
		Juvenile	-	-	-	-	-	-	-	-	-	Feeding		
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-	-		
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-	Feeding	-	-	-	-		
	Mongla Point	Fry	-	Nursing	-	Feeding	-	-	-	-	-	-		
		Juvenile	-	-	-	-	-	-	-	Feeding	-	Feeding		
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-	-		
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-	-		
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-	-		
	Mongla Point	Fry	-	Nursing	-	-	-	-	-	-	-	-		
	South-west of the Project	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-	-	-		
Loitta	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-	-	-		
	Akram Point	Juvenile	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-	-		
	Akram Point	Age-1 adult	-	-	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-		
	Chandpai	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-	-		
	Harbaria	Fry, Juvenile and Age-1 adult	-	Nursing, Feeding and Growing	-	-	-	-	-	-	-	-		
	Chalna Point	Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-	-	-		
		Fry	-	-	-	-	-	-	-	-	Nursing	-		
Poma	Haldikhali	Juvenile	Feeding and Growing	-	-	Feeding	-	-	-		-	-		

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Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	Growing and Feeding	-	-		
		Age-1 adult	-	-	Feeding and Growing	-	-	-	Feeding	Feeding	-	-		
		Adult	-	-	-	-	-	-			-	-		
	Chandpai	Fry and Juvenile	Breeding and Spawning	Nursing	-	-	-	Feeding	-	-	-	Feeding		
		Juvenile	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing		-		-	
		Adult	-	-	-	-	-	-	Feeding		-		-	
	Haldikhali	Fry and Juvenile	-	-	Nursing	-	-	-	-	-	-	-		
	Harbaria	Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-	-		
		Adult	-	-	-	-	-	-	Feeding		-		-	
		Fry and Juvenile						Spawning and Nursery	-	-	Feeding and Growing	-		
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-	-	-	Nursing	-	-		
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-		-	
		Age-1 Adult	-	-	-	-	-	-	Feeding	Feeding	-	-		
		Adult	-	-		Feeding	-	Feeding	-	-	-	Feeding		
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Feeding	-	-	-	Feeding		
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-	-	-	-	-	-		
		Juvenile and Adult	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing	-	-	-		
		Fry	-	-	-	-	-	-	-	-	Nursery	-		
Chhuri	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-	-		
	Akram Point		Feeding	-	Feeding	-	-	-	-	-	-	-		
Chela	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Juvenile and Adult	Feeding and Growing	-	-	-	-	-	-	-	-	-		
	Harbaria	Fry and Juvenile	-	Feeding and Growing	-	-	-	Nursery	-	-	-	-		
	Chandpai		-	-	-	-	-	-	-	Growing and Feeding	Nursery	-		
Gang Tengra	Haldikhali	Adult	Feeding	-	Feeding	Feeding	-	-	-	-	-	-		
	Akram Point	Adult	Feeding and Breeding	-	-	Feeding	-	-	-	-	-	-		
	Harbaria	Adult	-	-	Feeding	-	-	-	-	-	-	-		
	Chandpai	Adult	-	-	Feeding	Feeding	-	-	-	-	-	-		
Gagra Tengra	Chandpai	Juvenile and Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-	-	-		
	Chalna Point	Age-1 adult	-	-	-	-	Feeding and Growing	-	-	-	-	-		
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-	-	-		
	Akram Point	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-	-	-		
		Adult	-	-	-	-	-	-	Feeding	-	-	-		
	Haldikhali	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-	-		
	Harbaria	Adult	-	-	Feeding	-	Feeding and Growing	-	-	-	Feeding	-		
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-	-		
	Akram Point	Adult		-	-	-	-	-	-	-	-	-		
	Chandpai	Age-1 adult	-	-	-	Feeding	-	Feeding	Feeding and Growing	-	-	Feeding		
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-	-		
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding and Growing	-	Feeding and Growing		-	Feeding and Growing	Feeding and Growing		
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-	-		
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing		-	-		
		Age-1 adult	-	-	-	-	-	-	-	-	Feeding and Growing	-		
	Maidara	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing	-		-		
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-	-	-	-	-	-		
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-	-		
		Adult	-	-	-	Feeding	-	-	-	-	-	Feeding		
	Mongla Point	Fry	Spawning	-	-	-	-	-	-	-	-	-		
		Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing	-		
	Harbaria	Fry	-	-	-	-	-	Nursery	-	-	-	-		
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-	-		
Paira Chanda	Akram Point	Adult	Feeding	-	-	-	-	-	-	-	-	-		
	Chandpai	Fry	Breeding and Spawning	-	-	-	-	-	-	-	-	-		
Chewa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	-	-	-	-	-		-		
	Chandpai	Fry and Juvenile	Spawning	-	Feeding and Growing	-	Nursing and Grazing	Nursery	Feeding and Growing	-	Nursing	-		
		Adult	-	-	-	Feeding	-	Feeding	-	Feeding	-	Feeding		
	Haldikhali	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-	-	-		
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	-	Feeding and Nursery	-	Feeding	-	-		
	Mongla Point	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-	-		
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-	-		
	Chalna Point	Adult	-	-	-	-	Feeding	-	-	-	-	-		
		Age-1 Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing	-		
Bele	Akram Point	Adult	Feeding	-	Feeding	Feeding	-	-	-	-	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-	-		
	Haldikhali	Juvenile-1, Juvenile and Adult	-	-	Nursing and Growing	Feeding	-	-	-	-	-	-		
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	Feeding and Growing	Nursery and Feediing	Feeding and Growing	-	-	-		
	Chandpai	Fry	Breeding and Spawning	Nursing	-	-	Nursing	Nursery	-	-	Nursery	-		
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	Feeding	-	Feeding	-	Feeding	-	Feeding		
	Harbaria	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing			-		
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-	-	Nursery		
	Mongla Point	Fry, Juvenile-1 and Juvenile			Nursing and Growing	-	-	-	-	-	-	-		
	Mongla Point	Juvenile and Adult	-	-	-	Feeding	Feeding and Growing	Feeding	Feeding and Growing	-	-	Feeding		
	Chalna Point	Fry	Breeding and Spawning	Nursing	-	-	Nursing	-	-	Nursing	-	-		
	Chalna Point	Adult	-	-	-	Feeding	-	-	-	-	-	-		
	Maidara	Juvenile and Age-1 adult	-	Feeding and Growing	Feeding and Growing	Feeding	Feeding and Growing	-	-	-	Feeding and Growing	-		
		Fry	-	-	-	-	-	-	-	Nursing	-	-		
Tular Dandi (Nona bele)	Akram Point	Adult	Feeding	-	-	-	-	-	-	-	-	-		
	South-west of the Project	Adult	-	-	Feeding	-	-	-	-	-	-	-		
	Chalna Point	Adult	Feeding	-	Feeding	-	Feeding	-	Feeding	-	-	-		
Tairel	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding	-	-		
	Harbaria	Age-1 Adult	-	-	-	-	-	-	-	-	Feeding and Growing	-		
	Mongla Point	Juvenile	Feeding	-	-	-	-	-	-	-	-	-		
Phekssa	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding	-	-		

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Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-	-		
	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-	-		
	Haldikhali	Adult	-	-	-	Feeding	-	-	-	-	-	-		
	Harbaria	Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing	-		
	Chalna Point	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	Feeding and Growing	-		-		
	Chalna Point	Adult	-	-	Feeding	Feeding	Feeding	-	Feeding	-	-	-		
	Mongla Point	Adult	-	-	Feeding	Feeding	-	-	Feeding and Growing	-	-	-		
	Chandpai	Juvenile and Adult	Feeding	Feeding and Growing	-	-	Feeding and Growing	-		-	-	-		
	Maidara	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	-	-	-	-		
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-	-		
		Adult	-	-	Feeding	Feeding	-	Feeding	-	-	-	Feeding		
Paissa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	Feeding and Growing	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	-	-	-	-	Feeding and Growing			-	-	
	Haldikhali	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	-	-	-		
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-	-		
	Harbaria	Juvenile-1 and Juvenile	-	-	Feeding	-	Feeding and Growing	-	Feeding and Growing	-	-	-		
		Adult	-	-	-	-	-	-	-	Feeding	-	-		
	Chandpai	Fry	Breeding and Spawning	-	-	-	Nursing	-	-	-	Nursery	-		
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	-	-	Nursery and Feeding	-	-	-	Feeding		
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-	-		
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-	Nursery	Nursery		
		Age-1 Juvenile	-	-	-	-	-	-	-Nursing, Feeding and Growing	-	Feeding and Growing	-		
		Age-1 Adult	-	-	-	-	Feeding and Growing	Feeding	-	-		Feeding		
	Maidara	Fry, Juvenile and Age-1 adult	Breeding and Spawning	Feeding and Growing	-	-	Feeding and Growing	-	-	-		-		
		Age-1 Juvenile, Juvenile and Age-1 Adult	-	-	-	-	-	-	Nursing, Feeding and Growing	-	-	-		
		Adult	-	-	-	-	-	Feeding	-	-	-	Feeding		
Banshpata	Chandpai	Juvenile	Feeding	-	-	-	-	-	-	-	-	-		

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Adult	-	-	-	Feeding	-	Feeding	-	-	-	Feeding		
	Akram Point	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-	-		
		Adult	-	-	-	-	-	-	-	Feeding	-	-		
	Haldikhali	Juvnile and adult	-	-	Feeding and Growing	Feeding	-	-	Feeding and Growing	-	-	-		
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding	Feeding	-		
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-	-	-	-	-	-		
	Mongla Point	Adult	-	-	-	Feeding	-	-	-	-	Feeding	-		
	Maidara	Adult	-	-	Feeding	Feeding	-	Breeding and Spawning	-	-	-	Feeding		
	Chalna Point	Adult	-	-	Feeding	Feeding	-	-	-	-	-	-		
Hilsa	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-	-		
	Chandpai	-	-	-	-	-	-	-	Feeding and Breeding	-	-	-		
	Mongla Point	Adult	-	-	Feeding	-	-	-	-	-	-	-		
	Chalna Point	Brood fish	-	-	-	-	-	Breeding and Spawning	-	-	-	-		
Pangas	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-	-		
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding	-	-		
	Mongla Point	Juvenile and Adult	-	-	Feeding	-	-	-	-	-	-	Feeding and Breeding		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

**Only Age-1 to Brood fish has been allowed to interpret the migration purpose; F = Feeding; Sp = Spawning*

Table D.5: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (ton)																					
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton
1	Bagda	5	Bagda	6.42	Bagda	4.8	-	-	Bagda	-	Bagda	1.6	Bagda	2	Catla	2	-	0	Bagda	3				
	Vetki	1.57	Bele	0	Gusha Chingri	-	-	-	Horina Chingri	1	Horina Chingri	1	Horina Chingri	3.2	Glass Carp	0.1	-	0	Horina Chingri	1				
	Bele	0.98	Cheng	0	Harina Chingri	-	-	-	Tengra	-	Chali Chingri	0.5	Gusha Chingri	0.8	Horina Chingri	0.8	-	0	Chali Chingri	0.3				
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-	-	-	Paissa	-	Paissa	0.25	Paissa	24	Minar Carp	0.1	-	0	-	-				
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-	-	-	Chela	-	Bele	0.25	Vetki	0.2	Nilotica	1.6	-	0	-	-				
	Chaka Chingri	0.08	-	-	-	-	-	-	Vetki	-	-	-	Kailla	0.4	Paissa	0.6	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Bele	0	Rui	3	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Tilapia	0	Vetki	0.8	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Catla	0	-	0	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Minar Carp	0	-	0	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Glass Carp	0	-	0	-	0	-	-				
	-	-	-	-	-	-	-	-	-	-	-	-	Kakra	0.4	-	0	-	0	-	-				
Sub-total =		**8.52**		**6.42**		**4.8**	**-**	-		**1**		**3.06**	**-**	**31**	**-**	**9**	**-**	**0**	**-**	**4.3**				
2	Bagda	4	Bagda	1	Bagda	7	-	-	Bagda	-	Bagda	1.67	Bagda	0	-	0	Bagda	1	Bagda	3,4				
	Harina Chingri	2	Harina Chingri	0.33	Vetki	1	-	-	-	-	Chali Chingri	0.30	Horina Chingri	0	-	0	Horina	0.14	Horina	12				
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10	-	-	-	-	Horina Chingri	0.50	Chali Chingri	0	-	0	-	0	Chali	10				
	-	-	Golda Chingri	0.01	Phessa	2.4	-	-	-	-	Bele	0.30	Tilapia	0	-	0	-	0	Tilapia	3.6				
	-	-	Bele	0.08	Bhangan	1.7	-	-	-	-	Paissa	0.25	Vetki	0	-	0	-	0	Bele	0.4				

Sampling Site	Total Catch (ton)																					
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton
	-	-	Tengra&Paissa	0.04	Golda Chingri	0.9	-	-	-	-	-	-	Tengra	0	-	0	-	0	Paissa	0.08				
	-	-	-		Gulsha Tengra	0.2	-	-	-	-	-	-	Paissa	0	-	0	-	0	Tengra	0.08				
Sub-total =		**6.00**		**2.00**		**23**		-	-	**-**		**3.02**	**-**	**0**	**-**	**0**		1.14	-	**29.56**				
3	Bagda	1.38	Bagda	2.4	Bagda	1.5	-	-	Bagda	-	Bagda	3.5	Bagda	0.4	-	0	Bagda	2	Bagda	1.6				
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10	-	-	-	-	-	-	Paissa	3.2	-	0	-	0	Tilapia	2				
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10	-	-	-	-	-	-	Vetki	0.4	-	0	-	0	-	-				
	-	-	-	-	Bele	20	-	-	-	-	-	-	Tilapia	0.06	-	0	-	0	-	-				
	-	-	-	-	Tilapia	22	-	-	-	-	-	-	Horina Chingri	0.35	-	0	-	0	-	-				
	-	-	-	-	Rui	28	-	-	-	-	-	-	Chali Chingri	0.6	-	0	-	0	-	-				
	-	-	-	-	Vetki	-	-	-	-	-	-	-	Chaka Chingri	0.1	-	0	-	0	-	-				
	-	-	-	-	Harina Chingri	-	-	-	-	-	-	-	Tengra	0	-	**0**	-	**0**	-	-				
	-	-	-	-	Chami Chingri	-	-	-	-	-	-	-	Bele	0	-	0	-	0	-	-				
	-	-	-	-	Catla	56	-	-	-	-	-	-	Tairel	0.06	-	0	-	0	-	-				
	-	-	-	-	Mrigel	50	-	-	-	-	-	-	Bhangan	0	-	0	-	0	-	-				
Sub-total =		**1.89**		**2.91**		**197.5**	-	-	-	-	-	-	-	**5.17**	-	0		**2**	**-**	**3.6**				
Grand-total =		**17.00**		**11.33**		**226.5**	-	-		**1**		**3.5**		**36.17**	-	**0**		**3.14**	**-**	**37.46**				

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

CEGIS

(E) Land Resource Monitoring Data

Table E.1: Detailed Information of the Selected Monitoring Plot

Plot No.	Location	GPS	Distance from the plant location(km)	Plot size (ha)	Plot owner
1	Mouza: Baran Para Union:Gongarampur Upazila-Batiaghata District:Khulna	E-89° 30′59.1″ N-22° 37′57.0″	About 3.5	About 0.4	Name: Anil Krishna Roy Father: Keshab Lal Roy
2	Mouza:Chunkuri-2 Union:Bajua Upazila:Dacope District:Khulna	E-89° 32′20.0″ N-22° 34′51.0″	About 1.0	About 0.93	Name: Md. Abul Sheikh Father: Md. Jamir Sheikh
3	Mouza:Kapalirmet Buridmial Union: Burirdanaga Upazila:Mongla District:Bagerhat	E-89° 36′8.8″ N-22° 32′18.9″	About 5.5	About 0.14	Name: Panesh Biswas Father: Nishikanto Biswas
4	Mouza: Chakgona Union:Rajnagar Upazila:Rampal District:Bagerhat	E-89° 34′25.3″ N-22° 34′18.3″	About 1.0	About 0.28	Name: Manoj Das Father: Mahendra Nath Das
5	Mouza: Basherhula Union:Rajnagar Upazila:Rampal District: Bagerhat	E-89° 34′25.0″ N-22° 36′14.0″	About 1.0	About 0.47	Name: Amjad Hajra Father: Chirman Ali Hajra Share cropper: Md. Oliur Rahman Hajra

Source: Field survey; 2014

Table E.2: Chemical Properties of Soil on Monitoring Land

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
1	Top soil(0-15cm)												
Baran para	EC(ds/m)	9.1	Moderately saline	1.8	Non saline	10.01	Moderately saline	2.54	Very slightly saline	2.46	Very slightly saline		
	pH	4.2	Very strongly acid	6.7	Neutral	7.6	Slightly alkaline	6.9	Neutral	7.0	Neutral		
	OM (%)	3.1	Medium	2.5	Medium	0.93	Very low	1.27	Low	1.35	Low		
	N (%)	0.16	Low	0.12	Low	0.05	Very low	0.06	Very low	0.08	Very low		
	K (meq/100g)	1.00	Very high	0.59	Very high	1.61	Very high	0.57	Very high	0.69	Very high		
	Ca (meq/100g)	11.3	Very high	14.3	Very high	31.50	Very high	14.75	Very high	15.12	Very high		
	Mg (meq/100g)	10.7	Very high	8.6	Very high	6.00	Very high	2.06	Very high	2.58	Very high		
	Na(meq/100g)	5.50	*	2.7	*	10.01	*	4.76	*	4.43	*		
	P(µg/gm)	2.7	Very low	14.3	Medium	8.19	Low	4.60	Very low	5.33	Low		
	S(µg/gm)	523.2	Very high	41.4	Very high	354.40	Very high	210.0	Very high	212.18	Very high		
	B(µg/gm)	0.45	Medium	0.55	Very high	2.37	Very high	2.11	Very high	2.05	Very high		
	Fe(µg/gm)	150.3	Very high	258.6	Very high	49.72	Very high	78.25	Very high	42.96	Very high		
	Mn(µg/gm)	7.2	Very high	11.3	Very high	24.72	Very high	6.89	Very high	11.90	Very high		
	Zn(µg/gm)	1.4	Medium	1.2	Medium	1.88	High	2.47	Very high	1.82	High		
	Lead(Pb) (µg/gm)	31.8	*	33.7	*	32.21	*	25.95	*	24.23	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.39	*	00	*	00	*		
	Chloride (Cl-) (µg/gm)	762.2	*	0	0	0	0	00	0	00			
	Subsurface soil(15-30cm)												
	EC(ds/m)	8.4	Moderately saline	2.0	Non saline	7.90	Slightly saline	4.65	Slightly saline	2.23	Very slightly saline		
	pH	4.3	Very strongly acid	6.9	Neutral	7.8	Slightly alkaline	7.4	Slightly alkaline	7.1	Neutral		
	OM (%)	2.9	Medium	2.2	Medium	1.46	Low	1.53	Low	1.67	Low		
	N (%)	0.15	Low	0.2	Medium	0.08	Very low	0.08	Very low	0.09	Very low		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	K (meq/100g)	1.0	Very high	0.61	Very high	1.46	Very high	0.59	Very high	0.58	Very high		
	Ca(meq/100g)	10.48	Very high	14.3	Very high	26.84	Very high	12.31	Very high	12.67	Very high		
	Mg(meq/100g)	8.8	Very high	8.2	Very high	5.30	Very high	2.15	Very high	2.10	Very high		
	Na(meq/100g)	5.00	*	2.7	*	8.95	*	6.32	*	4.22	*		
	P(µg/gm)	2.9	Very low	22.8	High	9,23	Low	4.65	Very low	4.74	Very low		
	S(µg/gm)	513.7	Very high	31.4	High	307.65	Very high	221.0	Very high	210.06	Very high		
	B(µg/gm)	0.36	Medium	0.49	Optimum	1.86	Very high	0.90	Very high	1.02	Very high		
	Fe(µg/gm)	39.1	Very high	60.9	Very high	26.60	Very high	29.27	Very high	22.53	Very high		
	Mn(µg/gm)	3.3	High	10.9	Very high	41.87	Very high	5.75	Very high	7.11	Very high		
	Zn(µg/gm)	1.5	Optimum	0.87	Low	1.56	Optimum	1.69	Optimum	1.31	Medium		
	Lead(Pb) (µg/gm)	31.8	*	32.1	*	31.54	*	22.56	*	22.35	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.42	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	398.4	*	0	0	0	0	0	0	0			
	Substratum(30-45cm)												
	EC(ds/m)	9.6	Moderately saline	5.8	Slightly saline	9.26	Moderately saline	5.56	Slightly saline	4.32	Slightly saline		
	pH	5.7	Slightly acid	6.9	Neutral	7.7	Slightly alkaline	7.0	Neutral	7.0	Neutral		
	OM (%)	1.6	Low	1.1	Low	1.62	Low	1.48	Low	1.69	Low		
	N (%)	0.08	Very low	0.06	Very low	0.09	Very low	0.07	Very low	0.09	Very low		
	K (meq/100g)	1.0	Very high	0.6	Very high	2.00	Very high	0.60	Very high	0.51	Very high		
	Ca(meq/100g)	12.6	Very high	16.3	Very high	28.69	Very high	14.06	Very high	13.78	Very high		
	Mg(meq/100g)	15.9	Very high	8.8	Very high	5.57	Very high	2.71	Very high	3.03	Very high		
	Na(meq/100g)	6.00	*	3.7	*	9.91	*	6.83	*	5.51	*		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	P(µg/gm)	2.00	Very low	13.3	Medium	8.24	Low	2.99	Very low	3.13	Very low		
	S(µg/gm)	490.9	Very high	31.9	High	307.29	Very high	262.0	Very high	279.37	Very high		
	B(µg/gm)	0.73	High	0.77	Very high	1.67	Very high	1.16	Very high	1.34	Very high		
	Fe(µg/gm)	51.3	Very high	113.9	Very high	33.91	Very high	73.87	Very high	52.21	Very high		
	Mn(µg/gm)	3.9	Very high	5.2	Very high	88.75	Very high	6.21	Very high	6.34	Very high		
	Zn(µg/gm)	1.6	Optimum	0.49	Low	1.74	Optimum	3.19	Very high	2.94	Very high		
	Lead(Pb) (µg/gm)	37.8	*	31.5	*	32.29	*	18.89	*	19.18	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.17	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	692.9	*	0	0	0	0	0	0	0			
2	Top soil (0-15cm)												
	EC(ds/m)	11.2	Moderately saline	5.6	Slightly saline	13.05	Strongly saline	8.20	Moderately saline	6.92	Slightly saline		
	pH	6.1	Slightly acid	6.4	Slightly acid	5.9	Slightly acid	6.0	Slightly acid	6.3	Slightly acid		
	OM (%)	2.1	Medium	1.2	Low	3.22	Medium	1.75	Low	1.98	Medium		
	N (%)	0.11	Low	0.06	Very low	0.18	Low	0.09	Very low	0.11	Low		
	K (meq/100g)	1.5	Very high	1.14	Very high	2.97	Very high	0.79	Very high	0.86	Very high		
	Ca(meq/100g)	12.3	Very high	12.9	Very high	27.15	Very high	11.88	Very high	11.89	Very high		
	Mg(meq/100g)	9.8	Very high	8.9	Very high	6.33	Very high	2.50	Very high	2.47	Very high		
	Na(meq/100g)	8.5	*	9.4	*	12.51	*	8.16	*	7.11	*		
	P(µg/gm)	2.7	Very low	12.8	Medium	8.34	Low	6.89	Low	8.05	Low		
	S(µg/gm)	401.9	Very high	16.9	Medium	673.58	Very high	500.0	Very high	574.26	Very high		
	B(µg/gm)	0.57	Optimum	0.74	High	0.75	High	1.52	Very high	1.88	Very high		
Chunkuri-2													

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Fe(µg/gm)	60.2	Very high	223.6	Very high	52.46	Very high	89.23	Very high	48.75	Very high		
	Mn(µg/gm)	5.3	Very high	12.8	Very high	74.59	Very high	7.05	Very high	7.44	Very high		
	Zn(µg/gm)	1.7	Medium	2.5	Very high	2.66	Very high	5.32	Very high	4.36	Very high		
	Lead(Pb) (µg/gm)	0.00	*	29.2	*	31.34	*	14.09	*	15.12	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.31	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	1957.6	*	0	0	0	0	0	0	0			
	Subsurface soil(15-30cm)												
	EC(ds/m)	9.1	Moderately saline	5.6	Slightly saline	10.48	Moderately saline	6.97	Slightly saline	5.74	Slightly saline		
	pH	6.7	Neutral	6.4	Slightly acid	6.4	Slightly acid	6.7	Neutral	7.00	Neutral		
	OM (%)	1.8	Low	0.95	Very low	3.08	High	1.64	Low	1.66	Low		
	N (%)	0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low	0.10	Low		
	K (meq/100g)	1.6	Very high	1.1	Very high	2.68	Very high	0.75	Very high	0.77	Very high		
	Ca(meq/100g)	12.6	Very high	13.8	Very high	26.29	Very high	15.65	Very high	16.44	Very high		
	Mg(meq/100g)	9.5	Very high	8.9	Very high	6.29	Very high	3.13	Medium	3.16	Very high		
	Na(meq/100g)	8.5	*	9.9	Very high	10.61	*	7.89	*	6.88	*		
	P(µg/gm)	2.7	Very low	18.4	Optimum	7.32	Low	6.67	Low	5.77	Low		
	S(µg/gm)	280.5	Very high	23.8	Optimum	487.29	Very high	298.0	Very high	311.15	Very high		
	B(µg/gm)	1.1	Very high	1.7	Very high	0.92	Very high	1.44	Very high	1.37	Very high		
	Fe(µg/gm)	133.9	Very high	193.3	Very high	52.20	Very high	75.51	Very high	35.34	Very high		
	Mn(µg/gm)	2.8	Optimum	11.6	Very high	17.75	Very high	8.29	Very high	11.21	Very high		
	Zn(µg/gm)	0.99	Medium	1.4	Optimum	2.00	High	1.71	Optimum	1.28	Medium		
	Lead(Pb) (µg/gm)	0.00	*	29.9	*	31.52	*	16.63	*	17.07	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.35	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	1,472.5	*	0	0	0	0	0	0	0			
	Substratum(30-45cm)												

Sl .No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		EC(ds/m)	10.1	Moderately saline	5.3	Slightly saline	10.00	Moderately saline	6.91	Slightly saline	6.59	Slightly saline		
		pH	6.6	Neutral	6.2	Slightly acid	6.6	Neutral	6.4	Slightly acid	6.2	Slightly acid		
		OM (%)	1.9	Medium	1.4	Low	3.36	High	1.53	Low	1.68	Low		
		N (%)	0.09	Low	0.08	Low	0.19	Medium	0.08	Low	0.10	Low		
		K (meq/100g)	1.5	Very high	1.2	Very high	2.60	Very high	0.72	Very high	0.67	Very high		
		Ca(meq/100g)	13.7	Very high	34.4	Very high	18.87	Very high	13.16	Very high	11.99	Very high		
		Mg(meq/100g)	11.8	Very high	6.4	Very high	6.34	Very high	3.08	Very high	3.12	Very high		
		Na(meq/100g)	8.5	*	9.3	*	10.92	*	7.69	*	6.98	*		
		P(µg/gm)	1.3	Very low	19.5	Optimum	6.11	Low	5.71	Low	7.70	Low		
		S(µg/gm)	320.4	Very high	32.8	High	428.10	Very high	262.0	Very high	265.61	Very high		
		B(µg/gm)	1.14	Very high	1.5	Very high	1.12	Very high	1.36	Very high	1.28	Very high		
		Fe(µg/gm)	125.3	Very high	175.5	Very high	117.70	Very high	91.20	Very high	71.63	Very high		
		Mn(µg/gm)	2.7	Optimum	12.2	High	46.08	Very high	6.09	Very high	8.79	Very high		
		Zn(µg/gm)	1.8	Optimum	0.5	Low	2.15	High	2.83	Very high	2.09	High		
		Lead(Pb) (µg/gm)	31.3	*	29.7	*	32.46	*	14.10	*	13.58	*		
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.12	*	00	*	00	*		
		Chloride (Cl-)(µg/gm)	1715.0	*	0	0	0	0	0	0	0			
		Top soil(0-15cm)												
		EC(ds/m)	4.8	Slightly saline	8.5	Moderately saline	3.89	Very slightly saline	8.29	Moderately saline	8.22	Moderately saline		
		pH	7.0	Neutral	7.6	Slightly alkaline	6.2	Slightly acid	8.0	Slightly alkaline	8.1	Slightly alkaline		
		OM (%)	3.0	Medium	1.5	Low	2.01	Medium	1.75	Low	2.03	Medium		
		N (%)	0.2	Low	0.07	Very low	0.11	Low	0.09	Very low	0.11	Low		
3	Kapalirmet	K (meq/100g)	1.5	Very high	1.7	Very high	1.32	Very high	0.92	Very high	0.89	Very high		
		Ca(meq/100g)	18.2	Very high	19.9	Very high	27.04	Very high	10.77	Very high	11.09	Very high		
		Mg(meq/100g)	15.3	Very high	10.0	Very high	6.21	Very high	2.67	Very high	3.48	Very high		
		Na(meq/100g)	12.0	*	11.9	*	5.22	*	7.77	*	7.87	*		
		P(µg/gm)	3.2	Very low	7.3	Low	6.76	Very high	5.01	Very low	6.26	Low		
		S(µg/gm)	545.2	Very high	20.8	Medium	216.69	Very high	700.0	Very high	710.40	Very high		
		B(µg/gm)	1.2	Very high	1.3	Very high	0.95	Very high	1.69	Very high	2.03	Very high		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Fe(µg/gm)	37.3	Very high	230.2	Very high	34.56	Very high	94.22	Very high	45.52	Very high		
	Mn(µg/gm)	3.8	Very high	6.6	Very high	10.26	Very high	7.28	Very high	6.05	Very high		
	Zn(µg/gm)	2.0	High	1.0	Low	1.64	Optimum	3.58	Very high	2.68	Very high		
	Lead(Pb) (µg/gm)	12.5	*	28.9	*	47.12	*	8.17	*	6.89	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.86	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	3741.9	*	0	0	0	0	0	0	0			
	Subsurface soil(15-30cm)												
	EC(ds/m)	11.1	Moderately saline	6.3	Slightly saline	4.26	Slightly saline	7.43	Slightly saline	8.60	Moderately saline		
	pH	7.2	Neutral	7.9	Slightly alkaline	6.3	Slightly acid	8.0	Slightly alkaline	8.1	Slightly alkaline		
	OM (%)	2.6	Medium	1.3	Low	3.36	High	1.69	Low	1.95	Medium		
	N (%)	0.2	Low	0.06	Very low	0.19	Medium	0.08	Very low	0.10	Low		
	K (meq/100g)	1.5	Very high	1.6	Very high	1.13	Very high	0.98	Low	0.98	Very high		
	Ca(meq/100g)	11.7	Very high	14.4	Very high	25.16	Very high	16.89	Very high	16.12	Very high		
	Mg(meq/100g)	7.1	Very high	9.9	Very high	6.22	Very high	3.94	Very high	3.88	Very high		
	Na(meq/100g)	8.5	*	9.8	*	5.45	*	7.86	*	7.89	*		
	P(µg/gm)	3.8	Very low	5.6	Low	5.29	Low	5.52	Low	6.21	Low		
	S(µg/gm)	341.4	Very high	52.1	Very high	236.58	Very high	655.0	Very high	666.23	Very high		
	B(µg/gm)	0.86	Very high	1.6	Very high	0.21	Low	1.93	Very high	2.11	Very high		
	Fe(µg/gm)	140.2	Very high	249.0	Very high	30.03	Very high	93.15	Very high	73.04	Very high		
	Mn(µg/gm)	3.7	High	5.9	Very high	11.23	Very high	6.95	Very high	8.16	Very high		
	Zn(µg/gm)	0.94	Medium	0.5	Low	1.04	Medium	2.39	Very high	1.96	High		
	Lead(Pb) (µg/gm)	0.00	*	29.3	*	33.66	*	9.58	*	10.03	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.18	*	00	*	00	*		
	Chloride (Cl-) (µg/gm)	2217.4	*	0	0	0	0	0	0	0			
	Substratum(30-45cm)												
	EC(ds/m)	10.8	Moderately saline	7.5	Slightly saline	3.99	Very slightly saline	7.06	Slightly saline	6.77	Slightly saline		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	pH	7.3	Neutral	7.8	Slightly alkaline	6.3	Slightly acid	7.9	Slightly alkaline	7.9	Slightly alkaline		
	OM (%)	2.8	Medium	1.3	Low	4.03	High	2.38	Medium	2.42	Medium		
	N (%)	0.15	Low	0.06	Very low	0.23	Medium	0.12	Low	0.13	Low		
	K (meq/100g)	1.5	Very high	1.6	Very high	1.16	Very high	0.87	Very high	0.88	Very high		
	Ca(meq/100g)	12.9	Very high	15.4	Very high	27.13	Very high	17.20	Very high	16.88	Very high		
	Mg(meq/100g)	10.4	Very high	9.7	Very high	6.25	Very high	3.90	Very high	4.12	Very high		
	Na(meq/100g)	8.5	*	9.6	*	5.76	*	7.27	*	7.03	*		
	P(µg/gm)	3.4	Very low	5.8	Low	9.24	Optimum	3.65	Very low	3.81	Very low		
	S(µg/gm)	345.1	Very high	5.6	Very low	231.67	Very high	732.0	Very high	764.07	Very high		
	B(µg/gm)	1.4	Very high	1.1	Very high	1.55	Very high	1.83	Very high	1.56	Very high		
	Fe(µg/gm)	120.3	Very high	247.8	Very high	33.82	Very high	87.26	Very high	38.64	Very high		
	Mn(µg/gm)	2.9	Optimum	7.2	Very high	53.90	Very high	7.31	Very high	9.43	Very high		
	Zn(µg/gm)	0.88	Low	0.79	Low	1.00	Medium	2.09	High	2.35	High		
	Lead(Pb) (µg/gm)	0.00	*	27.6	*	34.37	*	7.88	*	7.57	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.20	*	00	*	00	*		
	Chloride (Cl-) (µg/gm)	1801.6	*	0	0	0	0	0	0	0			
4	Top soil(0-15cm)												
Chalkghona	EC(ds/m)	11.5	Moderately saline	7.2	Slightly saline	7.36	Slightly saline	7.31	Slightly saline	7.67	Slightly saline		
	pH	7.7	Slightly alkaline	8.0	Slightly alkaline	5.7	Slightly acid	8.5	Strongly alkaline	8.6	Strongly alkaline		
	OM (%)	1.5	Low	1.5	Low	2.13	Medium	2.17	Medium	2.15	Medium		
	N (%)	0.08	Low	0.08	Low	0.12	Low	0.11	Low	0.11	Low		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	K (meq/100g)	1.5	Very high	1.4	Very high	1.72	Very high	0.86	Very high	0.88	Very high		
	Ca(meq/100g)	22.2	Very high	14.3	Very high	18.79	Very high	14.58	Very high	15.31	Very high		
	Mg(meq/100g)	11.7	Very high	9.4	Very high	6.29	Very high	3.87	Very high	3.89	Very high		
	Na(meq/100g)	8.5	*	8.4	*	9.81	*	6.56	*	6.33	*		
	P(µg/gm)	5.6	Very low	9.2	Low	4.11	Very low	10.88	Medium	11.26	Medium		
	S(µg/gm)	444.2	Very high	4.1	Very low	440.19	Very high	975.0	Very high	982.55	Very high		
	B(µg/gm)	0.98	Very high	1.2	Very high	0.85	Very high	1.65	Very low	1.88	Very high		
	Fe(µg/gm)	55.3	Very high	189.0	Very high	41.14	Very high	68.05	Very high	43.62	Very high		
	Mn(µg/gm)	4.3	High	16.4	Very high	32.04	Very high	7.23	Very high	8.34	Very high		
	Zn(µg/gm)	0.76	Low	4.8	Very high	4.33	Very high	3.28	Very high	2.14	High		
	Lead (Pb) (µg/gm)	0.00	*	27.2	*	30.99	*	14.94	*	14.88	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.38	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	1576.4	*	0	0	0	0	0	0	0			
	Subsurface soil(15-30cm)												
	EC(ds/m)	**11.3**	**Moderately saline**	**6.2**	**Slightly saline**	**7.81**	**Slightly saline**	**7.38**	**Slightly saline**	**7.02**	**Slightly saline**		
	pH	7.7	Slightly alkaline	8.2	Slightly alkaline	5.9	Slightly acid	8.6	Strongly alkaline	8.5	Strongly alkaline		
	OM (%)	2.6	Medium	1.3	Low	1.88	Medium	1.90	Medium	1.88	Medium		
	N (%)	0.13	Low	0.07	Very low	0.10	Low	0.10	Low	0.10	Low		
	K (meq/100g)	1.5	Very high	1.1	Very high	1.54	Very high	0.81	Very high	0.84	Very high		
	Ca(meq/100g)	22.6	Very high	17.8	Very high	18.96	Very high	16.05	Very high	16.00	Very high		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Mg(meq/100g)	16.3	Very high	8.3	Very high	6.30	Very high	4.25	Very high	4.33	Very high		
	Na(meq/100g)	8.5	*	8.6	*	9.23	*	6.93	*	6.56	*		
	P(µg/gm)	13.6	Medium	9.4	Low	3.23	Very low	9.23	Low	8.27	Low		
	S(µg/gm)	415.6	Very high	47.7	Very high	393.37	Very high	886.0	Very high	990.48	Very high		
	B(µg/gm)	0.66	High	0.97	Very high	0.79	Very high	1.46	Very high	1.17	Very high		
	Fe(µg/gm)	124.1	Very high	172.7	Very high	25.52	Very high	77.47	Very high	55.06	Very high		
	Mn(µg/gm)	6.1	Very high	13.8	Very high	26.59	Very high	6.78	Very high	7.05	Very high		
	Zn(µg/gm)	1.1	Medium	3.2	Very high	1.09	Medium	3.37	Very high	2.73	Very high		
	Lead(Pb(µg/gm)	6.3	*	28.4	*	30.81	*	11.83	*	12.43	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.35	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	2113.5	*	0	0	0	0	0	0	0			
	Substratum(30-45cm)												
EC(ds/m)		10.9	Moderately saline	5.1	Slightly saline	7.14	Slightly saline	7.12	Slightly saline	7.45	Slightly saline		
pH		7.5	Slightly alkaline	8.2	Slightly alkaline	6.0	Slightly acid	8.9	Strongly alkaline	8.7	Strongly alkaline		
OM (%)		1.7	Low	1.0	Very low	2.94	Medium	1.53	Low	1.57	Low		
N (%)		0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low	0.09	Very low		
K (meq/100g)		1.5	Very high	0.95	Very high	1.57	Very high	0.89	Very high	0.90	Very high		
Ca(meq/100g)		13.9	Very high	14.4	Very high	19.10	Very high	15.95	Very high	16.25	Very high		
Mg(meq/100g)		11.1	Very high	7.2	Very high	6.26	Very high	4.15	Very high	4.06	Very high		
Na(meq/100g)		8.5	*	6.7	*	9.33	*	7.20	Very high	7.39	*		
P(µg/gm)		4.1	Very low	9.5	Low	5.67	Low	11.26	Medium	12.33	Medium		
S(µg/gm)		334.6	Very high	8.3	Low	343.00	Very high	465.0	Very high	543.04	Very high		
B(µg/gm)		0.67	High	0.63	High	1.05	Very high	1.14	Very high	1.11	Very high		
Fe(µg/gm)		75.3	Very high	160.0	Very high	29.70	Very high	90.55	Very high	67.84	Very high		
Mn(µg/gm)		3.6	Very high	14.1	Very high	25.22	Very high	6.03	Very high	7.03	Very high		
Zn(µg/gm)		1.7	Optimum	2.9	Very high	1.78		2.94	Very high	2.00	High		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Lead(Pb) (µg/gm)	6.3	*	26.5	*	32.23	*	15.50	*	14.71	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.55	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	1715.0	*	0	0	0	0	0	0	0			
5	Top soil(0-15cm)												
	EC(ds/m)	11.7	Moderately saline	6.0	Slightly saline	7.14	Slightly saline	5.58	Slightly saline	9.10	Moderaely saline		
	pH	7.7	Slightly alkaline	8.3	Slightly alkaline	7.3	Neutral	8.7	Strongly alkaline	8.8	Strongly alkaline		
	OM (%)	1.7	Low	1.2	Low	1.74	Low	1.59	Low	1.79	Medium		
	N (%)	0.09	Low	0.06	Very low	0.10	Low	0.08	Very low	0.09	Very low		
	K (meq/100g)	1.5	Very high	1.2	Very high	1.67	Very high	0.75	Very high	0.81	Very high		
	Ca(meq/100g)	23.6	Very high	31.4	Very high	25.26	Very high	15.11	Very high	16.53	Very high		
	Mg(meq/100g)	11.9	Very high	7.9	Very high	5.50	Very high	4.05	Very high	4.42	Very high		
	Na(meq/100g)	8.5	*	8.1	*	7.06	*	6.32	*	8.24	*		
	P(µg/gm)	4.5	Very low	7.4	Low	7.12	Low	5.92	Low	5.47	Low		
	S(µg/gm)	272.3	Very high	21.8	Medium	454.19	Very high	607.0	Very high	623.73	Very high		
	B(µg/gm)	0.94	Very high	1.1	Very high	1.00	Very high	1.19	Very high	1.32	Very high		
	Fe(µg/gm)	50.3	Very high	205.6	Very high	53.37	Very high	85.08	Very high	48.00	Very high		
	Mn(µg/gm)	3.4	High	5.9	Very high	49.22	Very high	6.50	Very high	5.22	Very high		
	Zn(µg/gm)	1.4	Medium	1.1	Medium	2.27	Very high	1.86	High	1.04	Medium		
	Lead(Pb(µg/gm)	18.8	*	25.1	*	30.55	*	6.19	*	5.77	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.21	*	00	*	00	*		
	Chloride (Cl-)(µg/gm)	2442.6	*	0	0	0	0	0					
	Subsurface soil(15-30cm)												
	EC(ds/m)	10.7	Moderately saline	7.0	Slightly saline	7.44	Slightly saline	7.16	Slightly saline	6.29	Slightly saline		
	pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.7	Slightly alkaline	8.7	Strongly alkaline	8.6	Strongly alkaline		
	OM (%)	1.5	Low	0.9	Low	2.01	Medium	1.43	Low	1.31	Low		
	N (%)	0.08	Very low	0.05	Very low	0.11	Low	0.07	Very low	0.07	Very low		
	K (meq/100g)	1.0	Very high	1.2	Very high	2.20	Very high	0.76	Very high	0.77	Very high		

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Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Ca(meq/100g)	24.0	Very high	32.6	Very high	33.28	Very high	14.75	Very high	13.87	Very high		
	Mg(meq/100g)	11.7	Very high	8.4	Very high	6.10	Very high	3.76	Very high	3.69	Very high		
	Na(meq/100g)	7.0	*	10.1	*	8.66	*	7.06	*	6.93	*		
	P(µg/gm)	3.9	Very low	5.3	Low	8.19	Low	6.82	Low	7.03	Low		
	S(µg/gm)	317.2	Very high	2.8	Very low	379.38	Very high	627.0	Very high	652.28	Very high		
	B(µg/gm)	0.71	High	1.0	Very high	1.38	Very high	1.31	Very high	1.08	Very high		
	Fe(µg/gm)	121.4	Very high	307.0	Very high	53.18	Very high	83.13	Very high	50.12	Very high		
	Mn(µg/gm)	3.9	Very high	15.5	Very high	45.34	Very high	5.98	Very high	5.62	Very high		
	Zn(µg/gm)	1.8	Optimum	0.8	Low	1.99	High	2.27	Optimum	2.34	Very high		
	Lead(Pb) (µg/gm)	18.8	*	23.7	*	31.49	*	16.35	*	17.15	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.32	*	00	*	00	*		
	Chloride (Cl-) (µg/gm)	1611.1	*	0	0	0	0	0	0	0			
	Substratum(30-45cm)												
	EC(ds/m)	10.9	Moderately saline	6.3	Slightly saline	6.68	Slightly saline	6.96	Slightly saline	6.38	Slightly saline		
	pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.8	Slightly alkaline	8.8	Strongly alkaline	8.7	Strongly alkaline		
	OM (%)	1.5	Low	1.0	Low	2.81	Medium	2.17	Medium	2.18	Medium		
	N (%)	0.08	Very low	0.06	Very low	0.16	Low	0.11	Low	0.11	Low		
	K (meq/100g)	1.5	Very high	1.2	Very high	2.20	Very high	0.86	Very high	0.85	Very high		
	Ca(meq/100g)	24.4	Very high	32.1	Very high	30.68	Very high	13.95	Very high	12.92	Very high		
	Mg(meq/100g)	12.9	Very high	8.3	Very high	6.11	Very high	3.80	Very high	4.01	Very high		
	Na(meq/100g)	7.5	*	9.8	*	8.76	*	7.68	*	7.01	*		
	P(µg/gm)	6.1	Low	5.9	Low	11.14	Medium	9.12	Low	8.77	Low		
	S(µg/gm)	321.1	Very high	3.1	Very low	305.69	Very high	182.0	Very high	230.62	Very high		
	B(µg/gm)	0.63	High	0.85	Very high	2.95	Very high	1.40	Very high	1.54	Very high		
	Fe(µg/gm)	77.3	Very high	162.4	Very high	42.36	Very high	66.29	Very high	39.40	Very high		
	Mn(µg/gm)	3.2	High	16.9	Very high	31.74	Very high	5.69	Very high	7.16	Very high		
	Zn(µg/gm)	2.1	High	2.7	Very high	1.62	Optimum	2.04	High	1.46	Optimum		
	Lead(Pb) (µg/gm)	25.00	*	22.2	*	31.54	*	14.96	*	16.02	*		
	Cadmium (Cd)(µg/gm)	0	0	0	0	2.44	*	00	*	00	*		

Sl .No. Location	Parameter	2013-2014				2014-2015				2015-2016			
		Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
	Chloride (Cl-)(µg/gm)	1489.8	*	0	0	0	0	0	0	0			

*Source: SRDI Laboratory analysis, 2014, 2015 and July 2016 * Not specified*

Table E.3: Different Concentrations of metals in the agricultural soil of the study area over three seasons in 2013-14, 2014-15 and 2015-16(dry season)

Parameter	Safe limit of India(mg/kg/ µg/gm/ppm)	Maximum Acceptable Concentration of Agricultural soil in Austria (mg/kg/µg/gm/ppm)	2013-2014							2014-2015							2015-2016					
			Dry season (April)			Wet season (October)				Dry season (April)			Wet season (October)				Dry season (March)			Wet season (October)		
			Mean(mg/kg/µg/gm/ppm)	SD	Min(mg/kg/µg/gm/ppm)	Max(mg/kg/µg/gm/ppm)	Mean(mg/kg/µg/gm/ppm)	SD	Min(mg/kg /µg/gm/ppm)	Max(mg/kg /µg/gm/ppm)	Mean(mg/kg/µg/gm/ppm)	SD	Min(mg/kg /µg/gm/ppm)	Max(mg/ kg/µg/gm/ppm)	Mean(mg/kg/ µg/gm/ppm)	SD	Min(mg/kg /µg/gm/ppm)	Maxi(mg/kg /µg/gm/ppm)	Mean(mg/kg/ µg/gm/ppm)	SD	Min(mg/kg /µg/gm/ppm)	Max(mg/kg /µg/gm/ppm)	Mean(mg/kg/ µg/gm/ppm)	SD	Min(mg/kg/µg/gm/ppm)	Max(mg/kg/µg/gm /ppm)
Fe	75-150	*	90.77	3.5	37.3	150.3	196.6	7.1	60.9	307	45.1	10.4	26.6	117.7	73.7	6.6	29.27	90.55	73.7	10.2	22.35	73.04			
Mn	*	*	3.88	2.06	2.7	7.2	10.3	1.8	5.3	16.9	37.1	7.04	10.26	88.75	6	3.1	5.75	7.31	6	3.2	5.22	11.9			
Zn	300-600	300	1.75	1.13	0.76	2.1	3.2	1.5	0.49	4.8	3.9	2.18	1.09	4.33	3.3	2.5	1.69	5.32	3.3	1.6	1.04	4.36			
Pb	250-500	100	14.7	5.4	6.3	37.8	26.6	2.3	22.2	33.7	30.8	2.98	29.9	34.37	12.7	5.4	7.88	25.95	12.7	3.0	5.77	24.23			
Cd	3.0-6.0	5.0	14.7	0	6.3	37.8	26.6	0	22.2	33.7	30.8	0.24	29.9	34.37	12.7	0.6	7.88	25.95	12.7	0.0	5.77	24.23			

*Source: SRDI laboratory analysis (2016), Awashthi (2000) and Kabata-Pendias, A. and H.Pendias, (1992) *Not specified*

Appendix V: Monitoring Data observed During EIA Study

Table F.1: Air quality monitoring results of different location

Date	Sample location	SPM (µg/m^3)	SO_x (µg/m^3)	NO_x (µg/m^3)
01/05/2012	Shibbari More, Khulna	410.0	<25	46.0
	College More, Khulna	320.0	<25	36.0
	Natunrasta More, Khulna	350.0	<25	33.0
	Sonadanga Bus stand	335.0	<25	41.0
Bangladesh Standard (ECR 1997) for residential and rural area		200	80	80
02/05/2012	Bus stand more, Sharankhola Sadar	155.0	10.0	21.0
	In front of Upazila Palli Unnoyon Board Office, Sharankhola Sadar	140.0	11.0	20.
	Thana More, Sharankhola Sadar	150.0	09.0	18.0
	In front of Upazila Health Complex Office, Sharankhola Sadar	148.0	08.0	16.0
Bangladesh Standard (ECR 1997) for sensitive area as the location is within the ECA of Sundarbans		100	30	30
ECR Amendment, 2005		150 (24-hr)	365 (24-hr)	100 (Annual)

Source: CEGIS investigation, 2012

Note: Experts from DoE, Khulna collected samples and all the parameters were tested in the labs of DoE, Khulna. During sample collection, the day was sunny and gentle wind was flowing northwestwards.

Table F.2: Water quality monitoring results

location	Date	Temp.	pH	EC	Cl^-	T.Alkalinity	Turbidity	T S	TDS	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	7-Jan	27.4	7.74	3010	879	36	68.7	1565	1510	55	5.1	0.8	55	1.6
2	7-Jan	27.1	7.72	3020	878.8	36	68.5	1570	1510	60	5.1	0.8	55	1.6
3	7-Jan	27.8	7.71	3030	879	36	68.8	1565	1510	55	5.1	0.8	55	1.6
1	11-Feb	29.8	7.66	4380	1262	36	182	2390	2180	210	4.7	1	76	2.3
2	11-Feb	29.2	7.63	4380	1268	36	178	2390	2190	200	4.7	1	76	2.3
3	11-Feb	29.1	7.65	4380	1263	36	179	2380	2180	200	4.7	1	76	2.3
1	9-Mar	32.6	7.56	11780	2944.4	38	176	6080	5890	190	4.7	1.2	76	6.7
2	9-Mar	32.6	7.57	11780	2945.2	38	178	6080	5890	190	4.7	1.2	76	6.7
3	9-Mar	32.1	7.55	11780	2946.4	38	177	6090	5890	200	4.7	1.2	76	6.7
1	17-Apr	32.6	7.59	25300	8273	36	185.6	12950	12700	250	4.6	0.7	136	15.5
2	17-Apr	32.6	7.59	25300	8273	36	186.2	12950	12700	250	4.6	0.7	138	15.5
3	17-Apr	32.6	7.59	25300	8273	36	184.8	12950	12700	250	4.6	0.7	136	15.5
1	5-May	32.6	7.59	29200	9480	36	198.6	14900	14600	300	4.5	1.2	177	17.6
2	5-May	32.9	7.54	29200	9470	36	198.6	14900	14600	300	4.4	1.2	177	17.6
3	5-May	33.2	7.57	29200	9470	36	199.6	14900	14600	300	4.5	1.2	177	17.6
1	13-Jun	31.6	7.69	18000	5820	36	112.6	9200	9000	200	4.7	1.1	97	10.8
2	13-Jun	31.6	7.69	18000	5800	36	113.2	9200	9000	200	4.7	1.1	97	10.8
3	13-Jun	31.6	7.69	18000	5810	36	112.4	9200	9000	200	4.7	1.1	97	10.8
1	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
2	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
3	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
1	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
2	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
3	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
1	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
2	8-Sep	31.6	7.76	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
3	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
1	12-Oct	30.6	7.79	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
2	12-Oct	30.6	7.78	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
3	12-Oct	30.6	7.78	290	25.6	36	62.6	192	145	47	5.6	0.7	22	-
1	5-Nov	24.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
2	5-Nov	26.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
3	5-Nov	25.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
1	12-Dec	21.5	772	520	62.6	36	72.6	320	260	60	5.1	0.9	25	0.4
2	12-Dec	20.9	7.71	520	62.6	36	73.6	320	260	60	5.1	0.9	25	0.4
3	12-Dec	21.1	7.72	520	62.6	36	71.6	320	260	60	5.1	0.9	25	0.4

Source: DOE, 2010

Note: All samples collected from Mongla port (location 1 - Port side river sample, location 2 – middle of the river and location 3 - Opposite of Mongla port) during high tide period in 2010