Environmental Impact Assessment — Annexes

Bangladesh: Rupsha 800-Megawatt Combined Cycle Power Plant Project

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Annex 1

Approved Terms of Reference (ToR) of EIA for Component 1 by DoE

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, E-16 Agargaon
Dhaka-1207
www.doe.gov.bd

Memo No: Doe/Clearance/5584/2016/564 Date: 05/11/2017

Subject: Exemption from IEE and Approval of Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of Proposed Rupsha 800 MW Combined Cycle Power Plant Project at Khalishpur, Khulna.

Ref: Your Application dated 29/10/2017.

With reference to your letter dated 29/10/2017 for the subject mentioned above, the Department of Environment hereby gives Exemption from IEE and approval of TOR for Environmental Impact Assessment (EIA) in favour of Proposed Rupsha 800 MW Combined Cycle Power Plant Project at Khalishpur, Khulna subject to fulfilling the following terms and conditions:

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein.

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary.
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references).
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared).

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project.

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Noise, Vibration, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

   - Population: Demographic profile and ethnic composition
   - Settlement and housing
   - Traffic and transport
   - Public utilities: water supply, sanitation and solid waste
   - Economy and employment: employment structure and cultural issues in employment
   - Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

   Appropriate models shall be used for prediction of potential impacts of the project on surface water and ambient air quality using updated data. Model prediction shall be compared with national water and air quality standards and specific sensitivity data of the organisms known to be present in the project area (likely impacted area) for impact assessment.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Risk assessment, risk management, system of valuation of environmental and properties damage, damage compensation issues shall be addressed

11. Emergency Response Plan and Disaster Impact Assessment

12. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Khulna Divisonal Office of DOE in Khulna with a copy to the Head Office of DOE in Dhaka.

VI. A soft copy of the image data as well as the maps to be generated from the image shall be submitted to DOE Head Office along with the EIA report.

05.11.2017

(Syed Nazmul Ahsan)
Director (Environment Clearance)
Phone # 02-8181673

Project Director (Chief Engineer)
Rupsha 800 MW CCPP Project
North-West Power Generation Company Limited
UTC Building (Level-3&4), 8 Panthapath
Kawranbazar, Dhaka-1215.

Copy Forwarded to :

1) PS to The Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Secretary, Power Division, Ministry of Power, Energy & Mineral Resources, Bangladesh Secretariat, Dhaka.
3) Chairman, Bangladesh Power Development Board, Biddyut Bhaban, 1, Abdul Goni Road, Dhaka.
4) Director, Department of Environment, Khulna Divisonal Office, Khulna.
5) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Annex 2

‡ & K D Q)IE.KQ Procedure s for Physical Cultural Resources
Component 1 –800 MW Rupsha CCPP

1.0 Introduction

1. These procedures describe the measures to be undertaken if an accidental discovery or chance find, or an encounter with a physical cultural resource (PCR) occurred during the construction phase. The chance find procedures will be finalized as Physical Cultural Resources Plan (PCRP) by NWPGCL and the EPC Contractor, in consultation with the Department of Archaeology (DOA) or the Ministry of Cultural Affairs to ensure compliance to The Antiquities Act 1968 (amended 1976), National Cultural Policy 2006, and applicable regulations. The PCRP will be included in the Construction Management Plan that will be required by NWPGCL from the EPC Contractor. The objectives of these procedures are to identify and promote the preservation, protection, and recording of any PCR that may be discovered or exposed during excavation, demolition, other earthmoving works, and ground alteration within the project site for Component 1 – 800 MW Rupsha CCPP in Khalishpur, Khulna.

2.0 Orientation and/or Briefing of Workers

2. The EPC Contractor, with technical support from the DOA or Ministry of Cultural Affairs and PMU, NWPGCL will conduct an orientation or training for all workers, particularly those who will be involved in earth movements and excavation works on how to recognize artifacts that they may potentially encounter or discover. The EPC Contractor will be responsible for creating awareness to construction personnel on the ADB requirements for any unanticipated impacts such as discovery of a physical cultural resource. NWPGCL will ensure compliance of this ADB requirement.

3. An archeological map of Bangladesh (if available) will be obtained from the DOA or other relevant sources to examine if there are potential "hot spots" within the project area. This map will be part of the references on-site to guide the construction supervision staff in determining and recognizing the potential "hot spots."

3.1 Procedures

3.2 General

4. In case a PCR was encountered during excavation, construction activities including traffic within a 30.5-meter radius in the area will be stopped immediately by the EPC Contractor. The discovery will be reported by the site engineer or representative from the EPC Contractor to PMU, NWPGCL environment staff (or Consultant). The site or area discovered will be marked or demarcated using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken. The construction supervision staff of the EPC Contractor and PMU, NWPGCL site engineer/staff will secure the site to prevent damage, loss or pilferage of removable objects. Site Engineer of PMU, NWPGCL or designated staff will be responsible for coordinating with DOA.

5. If the encounter involves removable items, a security person will be posted until the representative of DOA or Ministry of Cultural Affairs arrives to assess and determine its value. The DOA staff will be responsible in determining the appropriate course of action. Further excavation or earth moving works may be conducted at the distance and demarcation area recommended by the DOA staff.

6. If the chance find will have significant cultural value, this may entail consequent changes in the lay-out particularly if the discovery is considered or assessed as remains of cultural or archeological importance that is not removable.

7. EPC Contractor will not be entitled for compensation due to work stoppage as a result of the discovery and its associated subsequent actions.

3.3 Assessment and Recovery

8. Appropriate heavy equipment such as wheel loader will be made available to recover the excavated material from the excavation site to allow the geologist onsite or the DOA staff to inspect, recover or conduct sampling. A safe storage area will be provided to protect the discovered object. If the chance find is part of a large artifact, deposit or structure, the inspection or recording will include photography and video on an "as-is, where is" manner. The exact location will be recorded using a GPS unit.

3.4 Resumption of Work

9. The Contractor can continue with excavation and construction works within the affected area after the DOA staff has given clearance. All the discovered objects of value will be given to the Government.

4.0 Reporting

10. The EPC Contractor will prepare a “Chance Find” Report within a week showing the date and time of discovery, specific location, description of the PCR, and interim protection measures implemented. This Report will be submitted to PMU, NWPGCL who will provide it to the DOA or Ministry of Cultural Affairs. The chance find including measures on how it was dealt with will be included in the environmental monitoring report submitted to ADB.

Annex 3

List of Species Found within the Study Area

Table 1: Terrestrial vegetation growing within the study area

No.	Scientific Name	Local Name	Habit
Homestead			
1	Abroma augusta	Ulatkambal	Shrub
2	Acacia moniliformis	Akashmoni	Tree
3	Aegle marmelos	Bel	Tree
4	Albizia lebbeck	Sirish	Tree
5	Albizia procera	Silkaroi	Tree
6	Albizia richrdiana	Gogon Sirish	Tree
7	Alstonia scholaris	Chatim	Tree
8	Annona reticulata	Ata	Tree
9	Areca catechu	Supari	Tree
10	Artocarpus heterophyllus	Kathal	Tree
11	Artocarpus lakoocha	Dewa	Tree
12	Averrhoa carambola	Kamranga	Tree
13	Azadirachta indica	Nim	Tree
14	Bambusa sp.	Bans	Tree
15	Barringtonia acutangula	Hijal	Tree
16	Bombax ceiba	Shimul	Tree
17	Borassus flabelifer	Tal	Tree
18	Carica papaya	Papay	Tree
19	Citrus grandis	Jambura	Tree
20	Citrus limon	Lebu	Shrub
21	Cocos nucifera	Narikel	Tree
22	Crataeva nurvala	Baroon	Tree
23	Dillenia indica	Chalta	Tree
24	Diospyros blancoi	Bilatigab	Tree
25	Diospyros perigrina	Deshigab	Tree
26	Erythrina ovalifolia	Talimandar	Tree
27	Ficus benghalensis	Bot	Tree
28	Ficus religiosa	Assawath	Tree
29	Lagerstromia speciosa	Jarul	Tree
30	Lennea coromandelica	Zika	Tree
31	Litchi chinensis	Lichu	Tree
32	Mangifera indica	Aum	Tree
33	Moringa oleifera	Sajna	Tree
34	Musa sapientum	Kala	Tree
35	Neolamarckia cadamba	Kadam	Tree
36	Ocimum americanum	Tulshi	Herb

No.	Scientific Name	Local Name	Habit
37	Phoneix sylvestris	Khejur	Tree
38	Phyllanthus reticulatus	Amloki	Tree
39	Polyalthia longifolia	Debdaru	Tree
40	Pongamia pinnata	Karoch	Tree
41	Psidium guajava	Peyara	Shrub
42	Spondias dulcis	Amra	Tree
43	Streblus asper	Sheora	Shrub
44	Swietenia mahagoni	Mahogoni	Tree
45	Syzygium cumini	Kalojam	Tree
46	Tamarindus indica	Tetul	Tree
47	Tectona grandis	Segun	Tree
48	Terminalia arjuna	Arjun	Tree
49	Terminalia catappa	Katbadam	Tree
50	Trema orientalis	Jiban	Tree
51	Trewia nudiflora	Pitali	Tree
52	Zizyphus mauritiana	Baroi	Tree
Crop field			
1	Acalypha indica	Muktajhuri	Herb
2	Achyranthes aspera	Apang	Herb
3	Alternanthera sessilis	-	Herb
4	Amaranthus spinosus	Kata note	Herb
5	Calotropis gigantea	Akand	Shrub
6	Calotropis procera	Akand	Shrub
7	Carissa carandas	Karamcha	Shrub
8	Chenopodium ambrosoides	Chapali ghash	Herb
9	Clerodendrum inerme	Bhant	Herb
10	Cotula hemispherica	Kancha ghash	Herb
11	Crotolaria retusa	Ban-san	Herb
12	Croton bonplandianum	Banjhal	Herb
13	Cuscuta australis	Swarnalata	Herb
14	Cynodon dactylon	Durba	Herb
15	Cyperus diformis	-	Herb
16	Dentella repens	Hachuti	Herb
17	Euphorbia hirta	Dudhia	Herb
18	Marsilea quadrifolia	Susnishak	Herb
19	Nicotiana plumbaginifolia	Bantamak	Herb
20	Nyctanthes arbortristris	Sefali	Herb
21	Rhynchospora rufescens	Shimbhatraji	Herb
22	Rorippa indica	Bansarisha	Herb
23	Saccharum spontaneum	Kash	Herb
24	Sacciolepis interrupta	Nardulla	Herb
25	Sesbania rostrata	Dhaincha	Herb

Table 2: The list of terrestrial and wetland wildlife occurring within the study area

No.	English Name	Scientific Name
	Birds	
1	Abbott's Babbler	Malacocincla abbotti
2	Ashy Wood swallow	Artamus fuscus
3	Asian Koel	Eudynamys scolopaceus
4	Asian Open bill	Anastomus oscitans
5	Asian Palm Swift	Cypsiurus balasiensis
6	Barn Owl	Tyto alba
7	Baya Weaver	Ploceus philippinus
8	Bengal Bush Lark	Mirafra assamica
9	Black Drongo	Dicrurus macrocercus
10	Black headed Ibis	Threskiornis melanocephalus
11	Black Kite	Milvus migrans
12	Black-crowned Night Heron	Nycticorax nycticorax
13	Black-headed Munia	Lonchura malacca
14	Black-hooded Oriole	Oriolus xanthornus
15	Black-naped Monarch	Hypothymis azurea
16	Black-winged Kite	Elanus caeruleus
17	Blue-throated Barbet	Megalaima asiatica
18	Brahminy Kite	Haliastur Indus
19	Bronze-winged Jacana	Metopidius indicus
20	Brown Fish Owl	Ketupa zeylonensis
21	Brown Shrike	Lanius cristatus
22	Brown-headed Gull	Larus brunnicephalus
23	Cattle Egret	Bubulcus ibis
24	Chestnut-tailed Starling	Sturnus malabaricus
25	Cinnamon Bittern	Ixobrychus cinnamomeus
26	Citrine Wagtail	Motacilla citreola
27	Clamorous Reed Warbler	Acrocephalus stentoreus
28	Common Black-headed Gull	Larus ridibundus
29	Common Greenshank	Numenius nebularia
30	Common Hawk-Cuckoo	Hierococcyx varius
31	Common Iora	Aegithina tiphia
32	Common Kestrel	Falco tinnunculus
33	Common Kingfisher	Alcedo atthis
34	Common Myna	LC Acridotheres tristis
35	Common Pigeon	Columba livia
36	Common Pochard	Atthya ferina
37	Common Redshank	Tringa tetanus

No.	English Name	Scientific Name
38	Common Sandpiper	Actitis hypoleucos
39	Common Shelduck	Tadorna tadorna
40	Common Snipe	Gallinago gallinago
41	Common Tailorbird	Orthotomus sutorius
42	Common Tern	Sterna hirundo
43	Coppersmith Barbet	Megalaima haemacephala
44	Cotton Pygmy Goose	Nettapas coromandelianus
45	Crested Serpent Eagle	Spilornis cheela
46	Dusky Warbler	Phylloscopus fuscatus
47	Eurasian Collared Dove	Streptopelia decaocta
48	Eurasian Hoopoe	Upupa epops
49	Fulvous Whistling Duck	Dendrocygna bicolor
50	Fulvous-breasted Woodpecker	Dendrocopos macei
51	Garganey	Anas querquedula
52	Great Egret	Casmerodius albus
53	Great Tit	Parus major
54	Greater Coucal	Centropus sinensis
55	Green Bee-eater	Merops orientalis
56	Grey Heron	Ardea cinerea
57	House Crow	Corvus splendens
58	House Sparrow	Passer domesticus
59	Indian Cormorant	Phalacrocorax fuscicollis
60	Indian Cuckoo	Cuculus micropterus
61	Indian Pond Heron	Ardeola grayii
62	Jungle Babbler	Turdoides striatus
63	Jungle Myna	Acridotheres fuscus
64	Large-billed Crow	Corvus macrorhynchos
65	Lesser Sand Plover	Charadrius mongolus
66	Lesser Whistling Duck	Dendrocygna javanica
67	Lineated Barbet	Megalaima lineata
68	Little Cormorant	Phalacrocorax niger
69	Little Egret	Egretta garzetta
70	Little Ringed Plover	Charadrius dubius
71	Long-tailed Shrike	Lanius schach
72	Northern Pintail	Anas acuta
73	Olive-backed Pipit	Anthus hodgsoni
74	Oriental Magpie-Robin	Copsychus saularis
75	Oriental White-eye	Zosterops palpebrosus
76	Pacific Golden Plover	Pluvialis fulva
77	Paddy field Pipit	Anthus rufulus

No.	English Name	Scientific Name
14	Greater Bandicot Rat	Bandicota indica
	Reptiles	
1	Indian Roofed Turtle	Pangshura tectum
2	Ganges softshell Turtle	Aspideteres gangeticus
3	Spotted Flapshell Turtle	Lissemys punctata
4	Common Garden Lizard	Calotes versicolor
5	Tokay Gecko	Gekko gecko
6	Common House Gecko	Hemidactylus frenatus
7	Keeled Grass skink	Mabuya carinata
8	Spotted Litter skink	Sphenomorphus maculatus
9	Bengal Monitor	Varanus bengalensis
10	Water Monitor	Varanus salvator
11	Jerdon's Blind Snake	Typhlops jerdoni
12	Olive Keelback	Atretium schistosum
13	Striped Keelback	Amphiesma stolatum
14	Common Smooth Water Snake	Enhydris enhydris
15	Common Wolf Snake	Lycodon aulicus
16	Indian Rat Snake	Ptyas mucosus
17	Checkered Keelback	Xenochropis piscator
18	Common Krait	Bungarus caeruleus
19	Indian Cobra	Naja naja
20	Monocled Cobra	Naja kaouthia
	Amphibians	
1	Indian Bull Frog	Hoplobactrachus tigerinus
2	Ornate Microhylid	Microhyla ornata
3	Two-striped Grass Frog	Sylvirana taipehensis
4	Asian Brown Tree Frog	Polypedates leucomystax
5	Indian Tree Frog	Polypedates maculatus
6	Large Tree Frog	Rhacophorus maximus

Table 3: The list of wetland plants occurring within the study area

No..	Scientific Name	Local Name	Habit
1	Alternanthera philoxiroides	Helencha	Herb
2	Arundo donax	Baranal	Herb
3	Ceratophyllum desmersum	Jhangi	Herb
4	Eclipta alba	Kalokeshi	Herb
5	Eichhornia crassipes	Kochuripana	Herb
6	Enhydra fluctuans	Helencha	Herb
7	Fimbristylis milliaceae	Joina	Herb

No..	Scientific Name	Local Name	Habit
8	Hygroryza aristata	Putki	Herb
9	Hydrocharis dubia	-	Herb
10	Ipomoea aquatica	Kalmi sak	Herb
11	Lemna perpusilla	Khudipana	Herb
12	Limnophila sessiliflora	Bijatighas	Herb
13	Ludwigia abscendens	Keshordam	Herb
14	Ludwigia hyssopifolia	Keshordam	Herb
15	Mersilea quadrifoliata	Susnisak	Herb
16	Monochoria hatata	Kechur	Herb
17	Myriophyllum tetrandrum	-	Herb
18	Nachamendra alternifolia	Kaisa	Herb
19	Nymphaea nouchali	Shapla	Herb
20	Nymphaea stellata	Nilshapla	Herb
21	Nymphoides indicum	Panchuli	Herb
22	Phragmites karka	Nol	Herb
23	Pistia stratiotes	Topapana	Herb
24	Polygonum barbatum	Bishkatali	Herb
25	Polygonum glabrum	Bishkatali	Herb
26	Polygonum lanatum	Bishkatali	Herb
27	Sagittaria sagittifolia	Chhotokul	Herb
28	Salvina cucullata	Kuripana	Herb
29	Scirpus juncoides	Chisra	Herb
30	Spirodela polyrhiza	Khudipana	Herb
31	Trapa natans	Singra	Herb
32	Vallisnaria spiralis	Bicha	Herb

Annex 4

Sample Advertisement of the Consultation in the Local Newspaper

দৈনিক পূর্বাঞ্চল

The Daily Purbanchal

www.purbanchal.com

বিজ্ঞপ্তি

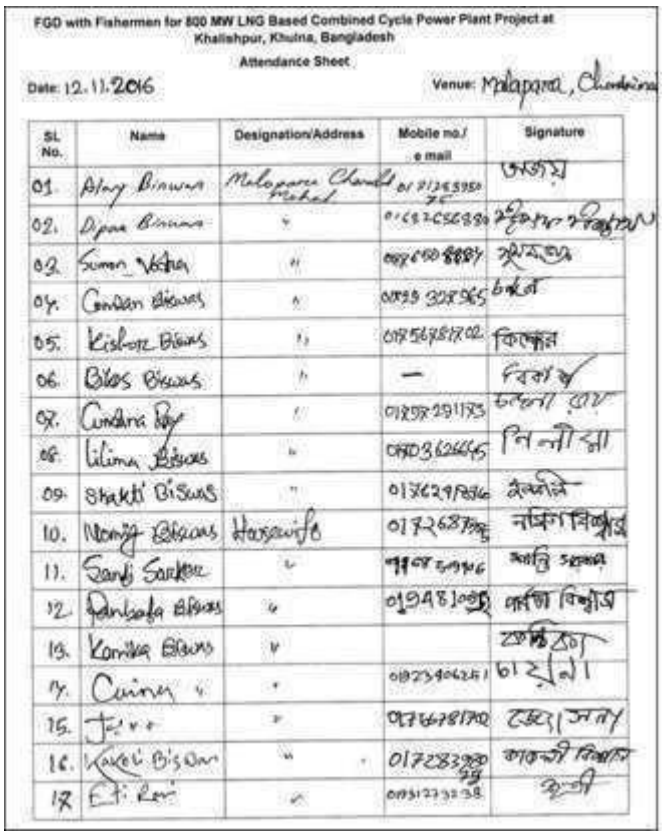
রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে ২০২১ সালের মধ্যে দেশের সকল ঘরে বিদ্যুৎ পৌঁছে দিতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সরকারের এ লক্ষ্য পূরণের উদ্দেশ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানি লিঃ (বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ডের একটি প্রতিষ্ঠান) খুলনার খালিশপুরে আশা ৮০০ মেঃ ওঃ কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র বাস্তবায়নের কাজ হাতে নিয়েছে। উক্ত প্রকল্প বাস্তবায়নের ফলে সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব সমীক্ষা করার জন্য পানি সম্পদ মন্ত্রণালয়ের অধীনস্থ CEGIS - কে দায়িত্ব দেয়া হয়েছে। এরই অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারী ও বেসরকারী প্রতিষ্ঠান এবং জনগণের সুচিন্তিত মতামত ও পরামর্শ গ্রহণের লক্ষ্যে আগামী ২১ অক্টোবর, ২০১৭ইং তারিখ রোজ শনিবার সকাল ১১:০০ ঘটিকায় খুলনার খালিশপুরস্থ ইঞ্জিনিয়ার্স ইন্সটিটিউট-এর সম্মেলন কক্ষে একটি মতবিনিময় সভার আয়োজন করা হয়েছে। উক্ত মতবিনিময় সভায় উপস্থিত থেকে এ বিষয়ে আপনাদের সুচিন্তিত মতামত প্রদান করার জন্য অনুরোধ করা যাচ্ছে।

আর-৩৩০১

Annex 5

List of Participants during Consultations

A. 12-13 November 2016



FGD with Fishermen for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016 Venue: Malapara, Chandkhola

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
01.	Alay Biswas	Malapara Chandi Mahal	01712653980	
02.	Dipa Biswas	"	01682256830	
03.	Suman Vaidya	"	[illegible]	
04.	Gautam Biswas	"	0133 328365	
05.	Kishor Biswas	"	01756781702	
06.	Bilas Biswas	"	—	
07.	Gautam Roy	"	01858291173	
08.	Lilima Biswas	"	01803626665	
09.	Shakti Biswas	"	01762978846	
10.	Monoj Biswas	Housewife	01726879[illegible]	
11.	Sandi Sarkar	"	[illegible]	
12.	Ranbala Biswas	"	01948100[illegible]	
13.	Komika Biswas	"		
14.	Quiney "	"	01823406261	
15.	Jeeva "	"	01766781702	
16.	Kakoli Biswas	"	01728383[illegible]	
17	Eti Rani	"	01931273238	

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
18	Anjona	Malapara Chandi Mahal	01770637454	
19	Mita	"	01801230056	
20	Monna	"	01761157285	
21	Manjna	"	[illegible]	
22	Biswajit	"	[illegible]	
23	Chandi	"	01768569106	
24	Jagannath	"	[illegible]	
25	Polok		01827704666	
26	Anup		01611621985	
27	Nikhil		01756607808	
28	Bishwa		01849233066	
29	Eti Biswas		01931273238	
30	Kalpana		01757721065	
31	Amoli		01766288[illegible]	
32	Robin Biswas		0	
33	Pappu		01931317281	
34	Mithun		01721933800	
35	Shanti		01961162185	

Fisherfolks in Dighalia

Imam and mosque adherents

Mosque

FGD with Imam and adherent for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016 Venue: IEB, Khulna

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
01.	NAZMUSSAHIB	[illegible]	[illegible]	
02.	MD. AMIRUL		01962530558	
03.	MD. SHALIM		01722[illegible]	
04.	MD. GAMAL		01774932670	
05.	MD. MOKLAS		01739563575	
06.	MD. [illegible]			
07.	MD. Rabor			
08.	MAMUNOR RAHIM		01918[illegible]	
09.	HABIBOR RAHMAN		01317[illegible]	
10.	ASAD HOSSEN			
11.	JAFOR IQBAL			
12.	Ismail [illegible]		[illegible]	
13.	[illegible]		[illegible]	
14.	[illegible]		01[illegible]	
15.	MD. [illegible]		01[illegible]	
16.	Mahmud Hasan		01[illegible]	
17.	MD. [illegible]		01[illegible]	

MOSQUE

Date: 12.11.2016 Venue: IEB, Khulna

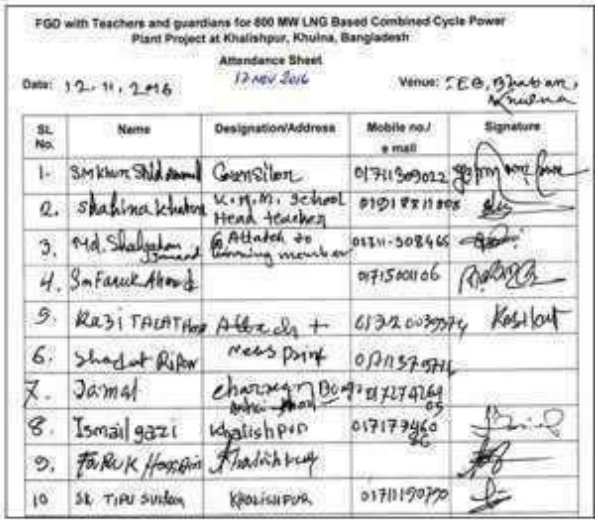
SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
18	MD. [illegible]		[illegible]	
19	G.M. [illegible]		[illegible]	
	[illegible]		01912916[illegible]	
20	[illegible] Hossain		[illegible]	
21	Dr. [illegible]	[illegible]	[illegible]	
22	[illegible]	ADB	[illegible]	
23	[illegible]	ADB	[illegible]	
24	[illegible]	[illegible]	[illegible]	
25	[illegible]	CERIS	[illegible]	
26	[illegible]	[illegible]	[illegible]	
27	[illegible]	ADB	[illegible]	

Government officials, school management committee, students, etc.

12 NOVEMBER 2016
16th CONFERENCE
KHULNA

800 MW KHULNA POWER PROJECT
STAKEHOLDERS' CONSULTATION MEETING
FGD (BOYS & GIRLS SCHOOL)
TEACHERS & PARENTS

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
1	[illegible]	[illegible]	[illegible]	
2	REISHA JONES	[illegible]	[illegible]	
3	MAHBUBUL HAQUE	K.N.M SCHOOL Ass. teacher	01915199985	
4	NAZMUSSAKIB	K.N.M school Ass. teacher	01961179775	Sakib
5.	MITHUN [illegible]	Asst teacher K.N.M school	01817-565659	
6.	Afsah Islam	student	01770750711	Afsah
7.	SALMA BEGUM	guardian; KNM school	01611180083	Salma
8.	SUFIA Begum	Guardian. KNM school	01947298516	
10.	Chowdhuri Habibur Rahman.	CEGIS	01911710944	
11.	Shahina Khatun	Head teacher K.N.M school	01918211805	
12	Fariha Rahman	student	01719139005	Fariha
13	Yongjung Jung	ADB	+63 999 999 2466	
14	Yuri Zhou	ADB	+63 999 999 3418	
15	Dr. Kazi NOOR [illegible]	CEGIS	01817549613	
16	Jalal Ahmed Choudhury	CEGIS	01938242229	Jalal
17.	Pronab K. [illegible]	Environmental Expert CEGIS	01717530[illegible]	
18.	S.M Khurshid [illegible]	Consultant	01711309022	
19.	Engr. Rafiul Islam	Electrical Engr.	01920 856066	



FGD with Teachers and guardians for 800 MW LNG Based Combined Cycle Power Plant Project at Khalishpur, Khulna, Bangladesh

Attendance Sheet

Date: 12.11.2016 — 12 NOV 2016 — Venue: [illegible], Khulna

SL No.	Name	Designation/Address	Mobile no./ e mail	Signature
1.	S.M Khurshid Shikdar	Consultant	01711309022	
2.	Shahina Khatun	K.N.M. School Head teacher	01918211805	
3.	Md. Shahjahan Jamadar	Attached to [illegible]	01711-508465	
4.	S.M Faruk Ahmed		01715001106	
5.	Kazi TALATHur	Advocate +	01712003974	
6.	Shadat Rifat	News Print	01713759716	
7.	Jamal	Chairman Boat	01727476405	
8.	Ismail gazi	Khalishpur	01717946006	
9.	Faruk Hossain	Khalishpur		
10	Md. Tipu Sultan	Khalishpur	01711190770	

B. 21 October 2017

খুলনা ৮০০ মেগাওয়াট কয়লাভিত্তিক সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১.	[illegible]	[illegible]	[illegible]	[illegible]
২.	[illegible]	[illegible]	01711-369022	[illegible]
৩.	[illegible]	[illegible]	01711-422 4670	[illegible]
৪.	[illegible]	[illegible]	01755-630023	[illegible] 21.10.17
৫.	[illegible]	[illegible]	01721-066787	[illegible] 21.10.17
৬.	Shoaib Islam	Consultant/ADB	01778586756	[illegible]
৭.	Ruby Dowlah Alica	ADB - Environment Consultant	—	[illegible]
৮.	Shamsuddin Ahmed	ADB - Consultant (Gas Sector Specialist)	shams7.bd@gmail.com	[illegible]
৯.	Monwar Zahur	ADB BMM	mzahur@adb.org	[illegible]
১০.	[illegible]	[illegible]	[illegible]	[illegible]
১১.	[illegible]	[illegible]	01733847272	[illegible]
১২.	[illegible]	[illegible]	[illegible]	[illegible]
১৩.	Sakhi Lasscio	Sakhi Lasscio	gmail.com	[illegible]
১৪.	Aziz Yusupov	Energy Spec ADB	[illegible]	[illegible]
১৫.	Md. Shahidul Morshed Jowder	[illegible]	[illegible]	[illegible]

1

খুলনা ৮০০ মেগাওয়াট কয়লাভিত্তিক সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সম্মেলন কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইন্সটিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি

সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	Syed Imdad Hossain	Manager, GTCL Avoy Ghata, KL	Gossain.uni@hotmail.com 01709639723	[illegible]
১৭.	Engr. Nizam Uddin	Manager, SOC 01711047998	uddin.nazim@gmail.com	[illegible]
১৮.	Abdullah Al Mamun	Asst. Teacher 01710027985	[illegible]	[illegible]
১৯.	[illegible]	HMS PBS	01713 [illegible]	
২০.	Mahbuba Parveen	Manager (Pay) NWPGCL	[illegible] 01777736409	[illegible] 21.10.17
২১.	MD. Jamal Uddin	AM (EHS) NWPGCL	Jamalamy666@gmail.com	[illegible] 21.10.17
২২.	MD. HAMMAT ALI	XEN NWPGCL	hammat [illegible]	[illegible] 21.10.17
২৩.	Jamal Alam Khan	Jamal Secretary AL 13		[illegible]
২৪.	Md. Zakir Hossain	13 no Ward office	01712179692	[illegible]
২৫.	[illegible]	[illegible]	[illegible]	[illegible]
২৬.	[illegible]	[illegible]	01733847272	[illegible]
২৭.	[illegible]	[illegible]	[illegible]	[illegible]
২৮.	[illegible]	[illegible]	01616229992	[illegible]
২৯.	[illegible]	[illegible]	01319606019	[illegible]
৩০.	[illegible]	[illegible]	01926291008	[illegible]

2

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সেমিনার কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি: সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
০১.	সুকুমার দাস	চন্দনীকরণ, ৬নং ওয়ার্ড		
০২.	নিত্য দাস	চন্দনীকরণ, ৬নং ওয়ার্ড		
০৩.	সচীন বিশ্বাস	চন্দনীকরণ, ৬নং ওয়ার্ড		
০৪.	[illegible]	১৬ ওয়ার্ড		
০৫.	মো: রিয়াজুল ইসলাম	১০নং ওয়ার্ড, চেয়ারম্যান		
০৬.	মো: [illegible]	[illegible]		
০৭.	[illegible]	[illegible]		
০৮.	[illegible]			
০৯.	মো: মুশফিকুর রহমান	[illegible]	০১৯১১৭১০৯৭৭	
১০.	[illegible]	সহকারী শিক্ষক, মো. [illegible]	০১৩১৪৩১১০০৪,	
১১.	জাহানারা [illegible]	সহকারী শিক্ষক, মো. [illegible]	০১৯২৭৭০৫০৪১	
১২.	মুক্তা	শিক্ষার্থী [illegible] কলেজ	০১৭৪২৫৫০৩৫২	Mukta
১৩.	সনিগুপ্ত	শিক্ষার্থী [illegible]	০১৭১৬৫১৭৪৫১	Sohinuna
১৪.	পুষ্পিতা [illegible]	শিক্ষার্থী [illegible]	০১৩৭৩৩৪৩৭১২	Puttu
১৫.	নুপুর	শিক্ষার্থী [illegible]	০১৭১৩৫২৩৫৪৬	Nupur

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সেমিনার কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি: সময়: সকাল ১১:০০

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	স্বাক্ষর
১৬.	[illegible]	[illegible]	[illegible]	
১৭.	[illegible]	[illegible]	০১৩১৭৭৭৭৮৮৫	
১৮.	[illegible]	[illegible]	০১৯১৭-[illegible]	
১৯.	[illegible]	[illegible]	০১৭১১৫৭৭৭৬	
২০.	[illegible]	[illegible]	০১৭২০০৩৯৩৯	
২১.	[illegible]	[illegible]	০১৯৫৪৭৭৯৫০	
২২.	[illegible]	[illegible]	০১৭১৬১৭০০৩৪	
২৩.	[illegible]	[illegible]	০১৭৭৭৭৩৬৭৬	
২৪.	[illegible]	[illegible]	০১৭৪৪১৭৭১০	
২৫.	[illegible]	[illegible]	—	
২৬.	Yanjung Jang	ADB - HQ	[illegible]@adb.org	
২৭.	ZHAOJING MU	ADB	zhaojing[illegible]@adb.org	
২৮.	SM Faruk Ahmed	MISSNESS	০১৭১৫০০৭০৬	
২৯.	[illegible]	[illegible]	০১৯২৩৩০৭৬৭	
৩০.	[illegible]	[illegible]	০১১৬-১৯৬৭৩	

খুলনা ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক মতবিনিময় সভা উপস্থিতির তালিকা

স্থান: সেমিনার কক্ষ, ইঞ্জিনিয়ার্স ইনস্টিটিউট ইনস্টিটিউট, খালিশপুর, খুলনা।

তারিখ: ২১ অক্টোবর, ২০১৭ খ্রি: সময়: সকাল

ক্রমিক নং	নাম	পদবী/ঠিকানা	ইমেইল ও মোবাইল নং	
৩১.	[illegible]	[illegible]	[illegible]@[illegible].com ০১৭১৩৪৬৫৫২৯	
৩২.	একেএম [illegible] ইসলাম	Electrical [illegible] CEGIS	01810-564066	
৩৩.	ড. [illegible]	Advisor, CEGIS	[illegible]@cegisbd.com	21/10/17
৩৪.	Md. Hasan	AGM. IEB KLN.	01558[illegible]	
৩৫.				

Annex 6

Photo documentation of Consultations

A. 12-13 November 2016

Consultation workshop

FGD with KNM School Management Committee and teachers

FGD with Imam and KNM mosque adherents

FGD with fisherfolks

Annex 7

Handout in Bengali Given During Consultation, 21 October 2017

নর্থওয়েস্ট পাওয়ার জেনারেশন কোম্পানী কর্তৃক অত্র এলাকায় গৃহীত খুলনা ৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিক কম্বাইন্ড সাইকেল বিদ্যুৎ কেন্দ্র এবং সংশ্লিষ্ট উপাদান সমূহের তথ্য, খুলনা

✓ সভার মূল উদ্দেশ্য

- আজকের সভার মূল উদ্দেশ্য হচ্ছে প্রস্তাবিত ২ x ৪০০ (৮০০) মেগাওয়াট গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প ও অন্য প্রকল্প সংশ্লিষ্ট উপাদান সমূহ স্থানীয় হলে প্রকল্প সংলগ্ন এলাকায় কী ধরণের পরিবেশগত ও আর্থ-সামাজিক প্রভাব পড়তে পারে এ সম্বন্ধে এলাকার জনসাধারণের মতামত গ্রহণ করা।
- একই সাথে প্রকল্প নকশা ও নির্মাণ পর্যায়ে জনগণের প্রভাব নেওয়া যাতে প্রকল্প বাস্তবায়নে তাদের অংশগ্রহণে প্রতিফলন ঘটে।

✓ প্রস্তাবিত প্রকল্প ও সংশ্লিষ্ট বিষয়াদি

- বাংলাদেশ সরকার ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের লক্ষ্যে একটি মহাপরিকল্পনা, *Power System Master Plan* প্রণয়ন করে, যার মূল প্রতিপাদ্য বিষয় হচ্ছে:
  - জ্বালানীর বহুমুখীকরণ যেমন: গ্যাস, এলএনজি, কয়লা, এইচএসডি, ফার্নেস অয়েল নবায়নযোগ্য জ্বালানি ইত্যাদি।
  - জ্বালানীর উৎস সম্প্রসারণ ও এর সর্বোত্তম ব্যবহার নিশ্চিত করণ।
  - জ্বালানী উৎসের ও সরবরাহের সুবিধাদির ভিত্তিতে বিদ্যুৎ প্রকল্প নির্বাচনের স্থান নির্ধারণ।
  - বিদ্যুতের ক্রমবর্ধমান চাহিদার উপর ভিত্তি করে উৎপাদন ক্ষমতা বৃদ্ধি করা, যা জাতীয় বিদ্যুৎ গ্রীডের মাধ্যমে নিরবিচ্ছিন্নভাবে বিদ্যুৎ সরবরাহ করতে পারবে।
- রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, '২০১০ ও ২০১৬' এর আলোকে দেশের সর্বত্রে বিদ্যুৎ পৌঁছে দেয়ার লক্ষ্যে নর্থ-ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লিঃ (*NWPGCL*) খুলনা জেলায় গ্যাস ও তেল ভিত্তিক বিদ্যুৎ প্রকল্প নির্মাণ করে ১০০০ মেগাওয়াটের অধিক বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে।

✓ পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণ সংক্রান্ত তথ্য সংগ্রহ ও প্রয়োজনীয় পরীক্ষানিরীক্ষা

- *CEGIS এই প্রকল্পটির পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণে দায়িত্বপ্রাপ্ত হয়ে বিভিন্ন পর্যায়ে এলাকার জনগণের সাথে এই বিষয়ে আলাপ আলোচনা করে পরিবেশ ও আর্থ-সামাজিক প্রেক্ষাপটের বর্তমান অবস্থা বিশ্লেষণ করার চেষ্টা করেছে এবং পরিবেক্ষণ করার জন্য সংশ্লিষ্ট অফিসগুলো থেকেও তথ্য সংগ্রহ করে, যেমন:*
  - কৃষি অফিস থেকে ফসল, ফসলী জমি ও সেচ সংক্রান্ত তথ্য।
  - মৎস্য অফিস থেকে মাছ ও মাছের আহরণ সংক্রান্ত তথ্য।
  - ইউনিয়ন পরিষদ থেকে সামাজিক ও অর্থনৈতিক বিষয়াদি সংক্রান্ত বিভিন্ন তথ্য।
  - বিভিন্ন প্রকার শিল্প থেকে নির্গত দূষণ সম্পর্কিত তথ্য সংগ্রহ।
- *প্রকল্প এলাকার বিভিন্ন বৈশিষ্ট সঠিকভাবে বিশ্লেষণ করার নিমিত্তে নিম্নলিখিত পরীক্ষা-নিরীক্ষা করা হয়:*
  - ভূ-তাত্ত্বিক জরিপ যার মাধ্যমে প্রকল্প এলাকার মাটি ভূ-গর্ভস্থ পানি সম্বন্ধে ধারণা পাওয়া।
  - বন্যার পানির সর্বোচ্চ উচ্চতার বিষয়টি বিশ্লেষণ করে কতটুকু মাটি ভরাট করতে হবে তা জানা।
  - পানির গুণাগুণ বোঝার জন্য ভূ-গর্ভস্থ ও ভূ-পরিস্থ পানি পরীক্ষা-নিরীক্ষা করা হয়।
  - বায়ুর দূষণ মাত্রা বোঝার জন্য বায়ু পরীক্ষা-নিরীক্ষা করা হয়।
  - শব্দ দূষণ মাত্রা বোঝার জন্য শব্দ দূষণ যন্ত্র ব্যবহার করা এবং প্লান্ট থেকে ৫০০ মি. চারপাশে শব্দ দূষণ পরিমাপক যন্ত্রের মাধ্যমে শব্দের তীব্রতা মাপা হয়।
- *পরিবেশগত ও সামাজিক প্রভাব বিশ্লেষণের জন্য প্লান্টকে কেন্দ্র করে চারপাশে ১০ কি.মি এলাকা পরিবেক্ষণ করা হয়েছে*

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (পরিবেশগত প্রভাব বিশ্লেষণ)

- *৮০০ মেগাওয়াট গ্যাস ও তেল ভিত্তিকবিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*
  - বিভিন্ন সংবেদনশীল এলাকায় বায়ু দূষণের মাত্রা মাপা হয়েছে এবং বায়ু দূষণের ক্ষেত্রে আন্তর্জাতিক মানদণ্ডের মাধ্যমে CO_2, SO_x, NO_x বিশ্লেষণ করে দেখা গেছে উল্লিখিত দূষণের মাত্রা বাংলাদেশ ও আন্তর্জাতিক গ্রহণযোগ্য সীমার নীচে আছে।
  - শব্দ দূষণের মাত্রা উল্লিখিত শব্দ দূষণ নিয়ন্ত্রণ বিধি-২০০৬ এর গ্রহণযোগ্য সীমার নীচে থাকবে।
  - ফেন্সিং চালুকালে ভূ-কম্পনের মাত্রা সহনশীল পর্যায়ে থাকবে।
  - প্রকল্প চালু করার সময় কুলিং টাওয়ার এর জন্য টেবিল নল থেকে একশীন ৬০,০০০ ঘন মিটার পানি উত্তোলন করা হবে এবং পরবর্তীতে প্রকল্প চালু অবস্থায় টেবিল নল থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তোলন করা হবে যা খুবই কম এবং চলমান নদী প্রবাহের মাত্র ০.১২%।
  - ভূ-গর্ভস্থ পানিস্তরের মাত্রা বর্তমানে উল্লিখিত ইলিয়াস- ১৯৯৭ এর গ্রহণযোগ্য সীমার নীচে থাকবে।
  - বিদ্যুৎ কেন্দ্র থেকে নির্গমিত সকল তরল পদার্থ পরিশোধিত করে গ্রহণযোগ্য সীমার মধ্যে রাখতে হবে নচেৎ পরিবেশ বিপন্ন হবে।
  - বৃষ্টিপাতের পানির কোন সংকট হবে না এবং মাছ চাষের উপর কোন বিরূপ প্রভাব পড়বে না।
  - ২১০ টি গাছের উপর প্রভাব পড়বে যা আইইনিএর এর পাশ তালিকা বহির্ভূত।
- *গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*
  - উল্লিখিত গ্যাস পাইপলাইন প্রকল্প বাস্তবায়নের ফলে বায়ু দূষণ, শব্দ দূষণ, মৃত্তিকা দূষণ, পানি দূষণ অথবা সংশ্লিষ্ট এলাকায় পানির কোন অভাব দেখা দেবে না। এছাড়া উক্ত প্রকল্পের কারণে কৃষি জমি ও মাছ চাষ প্রকল্পের কোন ক্ষতি হবে না। তবে ১৮.৫৬ কিমি পাইপলাইনের জন্য কিছু গাছের উপর প্রভাব পড়বে যা বাংলাদেশ সরকার উল্লিখিত সিডিউল বহির্ভূত। উল্লেখ্য, উক্ত প্রকল্পের কারণে কোন প্রাণি বা সর্বস্তরে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব পড়বে না।
- *ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী পরিবেশগত প্রভাব বিশ্লেষণ*
  - উল্লিখিত ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়নের ফলে বায়ু দূষণ, শব্দ দূষণ, মৃত্তিকা দূষণ, পানি দূষণ অথবা পানির কোন অভাব দেখা দেবে না। উক্ত ২৯ কিমি ২৩০ কেভি লাইন কোন প্রাণি, কৃষি জমি এবং নদীসহ সার্বিকভাবে পরিবেশের উপর তাৎপর্যপূর্ণ কোন প্রভাব ফেলবে না।

✓ পরিবেশগত ও আর্থসামাজিক প্রভাব বিশ্লেষণ - প্রকল্প বাস্তবায়ন পরবর্তী অবস্থা বিশ্লেষণ (আর্থসামাজিক প্রভাব বিশ্লেষণ)

- গ্যাস ও তেল ভিত্তিক ৮০০ মেগাওয়াট কম্বাইন্ড সাইকেল বিদ্যুৎ প্রকল্প স্থাপনের জন্য খুলনা সদরস্থ নিউজিল্যান্ড মিলের পরিত্যক্ত ৫০ একর জমি নেয়া হয়েছে। উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি পরিবার স্থানান্তরিত হওয়ার কারণে আর্থসামাজিকভাবে প্রভাবিত হবে। অত্র প্রস্তাবিত প্রকল্প এলাকায় কোন জলিবাড়ি ও কৃষিপূর্ণ পরিবার নেই।
- অত্র প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প এলাকার বর্তমানে অবস্থিত ০১ টি বাণক উচ্চ বিদ্যালয় ও ০১ টি কলিজা উচ্চ বিদ্যালয় স্থানান্তরিত করা হবে। ২১৫ টি গাছ ক্ষতিগ্রস্থ হবে।
- গ্যাস ট্রান্সমিশন লাইন (১৮.৫৬ কিমি) মূলত রাস্তা সংলগ্ন সড়ক ও জনপথের জমির উপর স্থাপিত হবে। এ ক্ষেত্রে মূর্তি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে নিকটবর্তী পরিত্যক্ত জায়গায় স্থানান্তরিত করা হবে এবং ৩২৯ টি গাছ ক্ষতিগ্রস্থ হবে। ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ী নিকটবর্তী স্থানে স্থানান্তরিত হবে ও ৮০ টি গাছ ক্ষতিগ্রস্থ হবে। উল্লেখ্য কোন স্থাপনা ক্ষতিগ্রস্থ হবে না।
- ২৯ কিমি ওভারহেড ট্রান্সমিশন লাইন প্রকল্প কৃষি জমি, নদী এবং কিছু বাড়ী, সামাজিক প্রতিষ্ঠানের উপর দিয়ে যাবে তবে কোন প্রত্নতাত্ত্বিক এবং ঐতিহাসিক স্থাপনার উপর দিয়ে যাবে না। উল্লিখিত প্রকল্পের আওতায় উপযোগ স্থাপনের ফলে ০৭ টি পরিবার স্থায়ীভাবে ক্ষতিগ্রস্থ হবে যার মধ্যে ০৫ টি পরিবারের ঘনবসতীর ক্ষতিগ্রস্থ হবে এবং ক্ষতিগ্রস্থদের মধ্যে ০২ টি পরিবার কৃষিপূর্ণ। এছাড়া উক্ত প্রকল্পের কারণে পশু ও ০১ টি মাছের ঘের সামাজিকভাবে ক্ষতিগ্রস্থ হবে।

- **বায়ু দূষণ মোকাবেলায় করণীয়:**

  - Advance Dry Low NOx Burner যা বায়ুর একরকম দূষণ (NOx)-কে নিয়ন্ত্রণ করবে।
  - প্রান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা বায়ু দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - প্রধান ও বাইপাস চিমনীর উচ্চতা যথাক্রমে ন্যূনতম ৬০ মি. ও ৫০ মি. হতে হবে যাতে প্রান্ট নির্গমিত ধোঁয়া আকাশে মিশিয়ে যায় এবং পরিবেশের উপর ক্ষতিকর প্রভাব না ফেলে।

- **পানি দূষণ মোকাবেলায় করণীয় :**

  - কুলিং টাওয়ারের কারণে কোন প্রকার গরম পানি নদীতে পড়বে না।
  - প্রান্ট হতে নির্গত পানি যথাযথ পরীক্ষা-নীরিক্ষার পর পুণ:ব্যবহার করা হবে/যা পরিবেশের উপর কোন ক্ষতিকর প্রভাব ফেলবে না।
  - তেল ও গ্রীজ পানি থেকে আলাদা করণের জন্য সেডিমেন্টেশন যন্ত্রের ব্যবহারের ব্যবস্থা রাখা হয়েছে। আলাদাকৃত তেল এলাকার ডেকরনের কাছে বিক্রি করা হবে।
  - বিদ্যুৎকেন্দ্র থেকে নির্গমিত তরল আধুনিক বর্জ্য ব্যবস্থাপনার (ETP) মাধ্যমে পরিশুদ্ধ করা হবে। ফলে নদীর মাছ ও পানির কোন কোন ক্ষতি হবে না।
  - প্রস্তাবিত বিদ্যুৎকেন্দ্রে পয়:নিষ্কাশন ব্যবস্থাপনারও সুবিধা থাকবে।

- **পানি উত্তোলন নীতিমালা ব্যবস্থা:**

  - প্রকল্প চালু অবস্থায় তৈরব নদ থেকে প্রতি ঘন্টায় ২১০ ঘন মিটার পানি উত্তলন করা হবে যা খুবই কম এবং প্রমান নদী প্রবাহের মাত্র ০.১২%।
  - উল্লেখ্য, সর্ব অনুমোদে প্রকল্প চালু রাখার জন্য কখনই ভূ-গর্ভস্থ পানি উত্তলন করা হবে না।
  - উক্ত বিদ্যুৎ কেন্দ্রে ব্যবহৃত জলসাধারনের খাবার পানির জন্য খুলনা ওয়াসা কতৃক পাইপ লাইন দ্বারা সরবরাহকৃত পানি ব্যবহার করা হবে।

- **শব্দ দূষণ মোকাবেলায় করণীয়:**

  - আধুনিক প্রযুক্তি সম্বলিত মেশিনারী স্থাপন করা।
  - ঘূর্ণন মেশিনারীর জন্য শব্দ দূষণ প্রতিরোধী ছাদ বা চালকের ব্যবস্থা করা।
  - প্রান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা শব্দ দূষণের প্রভাবকে নিয়ন্ত্রণ করবে।
  - শব্দ দূষণ কমানোর জন্য প্রয়োজন স্থানে কম ডিজিল জেনারেটর ব্যবহার লাগানো।
  - ঘূর্ণন মেশিনারীর ভিতরে যারা কাজ করবে তাদেরকে অবশ্যই সিনিই (PPE) যেমন: ইয়ার প্লাগ, মাফলার ইত্যাদি পরতে হবে।
  - ধোঁয়া বের হওয়ার পথে চিমনীতে সাইলেন্সার লাগানো।
  - শব্দ প্রশমনীয় দেয়াল নির্মাণ করা।

- **জলদূষণ মোকাবেলায় করণীয়:**

  - বীম (প্রতি ১/১০০০ ইঞ্চি) প্রযুক্তির ব্যবহার করা।

- **পরিবেশ ও জলজ প্রাণি ব্যবস্থাপনায় করণীয়:**

  - প্রস্তাবিত ৮০০ মেগাওয়াট বিদ্যুৎ কেন্দ্র হতে নির্গমিত সকল তরল বর্জ্য ও পয়:নিষ্কাশন যথাক্রমে ইটিপি (ETP) ও এসটিপি (STP) এর মাধ্যমে পরিশোধিত করে যথাসম্ভব বাংলাদেশ বিধি ও আইএফসি (IFC) গাইডলাইনের গ্রহণযোগ্য সীমার মধ্যে রাখা হবে যাতে জলজিব সহ পরিবেশ ও জীববৈচিত্র দূষণের প্রভাব মুক্ত থাকে।

  - গ্যাস পাইপ ও OHT line এর ক্ষেত্রে প্রকল্প এলাকার কর্মচারীদের বসবাসের পয়:নিষ্কাশন পরিশোধনের মাধ্যমে বাংলাদেশ বিধি (ECR,1997) গ্রহণযোগ্য সীমার মধ্যে রাখা হবে।
  - অত্র প্রকল্প চালু অবস্থায় EMP সংশ্লিষ্ট পর্যবেক্ষণ ব্যবস্থা নিয়মিত কলবৎ থাকবে এবং উক্ত পর্যবেক্ষণ এর আওতায় প্রকল্প এলাকার পরিবেশ ও জীববৈচিত্র (জলজিব সহ) এর উপর নিরীক্ষা করা হবে এবং প্রয়োজনীয় প্রশমন পরিকল্পনা অনুযায়ী ব্যবস্থা নেয়া হবে।

✓ **আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা**

- ***৮০০ মেগাওয়াট বিদ্যুৎ প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - অত্র প্রকল্পটি বাস্তবায়নের জন্য উপযুক্ত খুলনা সরকারি মিউনিসিপ্যাল মিলের পরিত্যক্ত ৫০ একর জমি সরকারি প্রথা অনুসারে নির্ধারিত মূল্য পরিশোধ সাপেক্ষে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লি: এর অনুকূলে বরাদ্দ দেয়া হয়েছে।
  - অত্র প্রস্তাবিত প্রকল্প এলাকায় উপ্তিষ্ঠিত ০২ টি বিদ্যালয় (০১ টি বালক ও ০১ টি বালিকা) পরিত্যক্ত গেগার মিলের অবশিষ্ট (৩৭.৬০ একর) জমির উপর পুনর্নির্মিত হবে যা পাওয়ার প্লান্টের পীছনের দীঘানার ধইরে অবস্থিত। এবং উক্ত বিদ্যালয় দুটিতে উন্নতমানের শাকা ইমারতসহ প্রয়োজনীয় আধুনিক সুযোগ সুবিধা যথা, কম্পিউটার ল্যাব, বিজ্ঞানাগার, পাঠাগার, খেলার মাঠ, সুপেয় পানি,শৌচাগার, ইত্যাদির সুব্যবস্থা থাকবে।
  - উক্ত এলাকায় পরিত্যক্ত মিলের ০৫টি স্থানান্তরিত পরিবারকে নর্থ ওয়েস্ট পাওয়ার জেনারেশন কোম্পানী লি: কতৃক ক্ষতিপূরণ দেয়া হবে।
  - উক্ত প্রকল্প এলাকা সালস্ত মসজিদ ও কবরস্থানের সংস্কার করা হবে এবং প্রকল্পের সর্বসাধারনের ব্যবহারের জন্য ব্যবস্থা থাকবে।

- ***গ্যাস পাইপলাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - গ্যাস ট্রান্সমিশন লাইন (১০.৫০ কিমি) মূলত সড়ক ও জনপথের জমির উপর অনুমতি সাপেক্ষে স্থাপিত হবে। উক্ত প্রকল্পে মুটি সহ মোট ২৪ টি ক্ষুদ্র ব্যবসায়িকে অর্থনৈতিক ক্ষতির জন্য ক্ষতিপূরণ প্রদান করা হবে। এছাড়া ৩২৬ টি গাছের ক্ষতিপূরণ প্রদান করা হবে । উল্লেখ্য, ২ কিমি পাইপ লাইনের ক্ষেত্রে রাস্তার পাশের ০৯ টি ক্ষুদ্র দোকান ব্যবসায়ীকে অর্থনৈতিক ক্ষতিপূরণ ও ৪০ টি গাছের জন্য ক্ষতিপূরণ দেয়া হবে।

- ***ওভারহেড ট্রান্সমিশন লাইন প্রকল্প বাস্তবায়ন পরবর্তী আর্থসামাজিক সম্পর্কীয় প্রশমনব্যবস্থা***

  - অত্র প্রকল্পের আওতায় টাওয়ার স্থাপনের ফলে ০৭ টি পরিবারকে ক্ষতিপূরণ দেয়া হবে যারা স্থায়ীভাবে ক্ষতিগ্রস্থ হবে এবং এদের মধ্যে ০২টি পরিবার ভূমিহীন। এছাড়া উক্ত প্রকল্পের কারণে পশা ও ০১ টি মাছের ঘেরের সাময়িকভাবে ক্ষতির ক্ষতিপূরণ দেয়া হবে।

সারসংক্ষেপ

- ❖ প্রকল্পের পরিবেশগত প্রভাব প্রশমনের সুপারিশসমূহ যথাযথভাবে বাস্তবায়ন করা।
- ❖ প্রকল্পের আর্থ-সামাজিকসুপারিশসমূহ, সরকারি ও উন্নয়নযোগ্য উদাহরণ/অনুশীলন বাস্তবায়ন করা।
- ❖ যথাযথভাবে পরিবেশগত নিরীক্ষণ কার্যক্রম পরিচালনা করা এবং প্রয়োজনীয় পদক্ষেপ গ্রহন করা।
- ❖ আর্থ-সামাজিক বিষয় সংক্রান্ত অভিযোগ ও অসন্তুষ্ট নিপত্তি করা ও তা প্রশমনের ব্যবস্থা নেয়া।
- ❖ অত্রত্র প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক বিষয়ের উপর আপনার মূল্যবান মতামত/মন্তব্য প্রদান করবেন যা EIA প্রতিবেদনে লিপিবদ্ধ করা হবে।
- ❖ অত্র প্রকল্প চলাকালীন ইমেপি (EMP) সংশ্লিষ্ট বিষয়ের সার্বক্ষণিক পর্যবেক্ষণ ব্যবস্থা জারবং থাকবে এবং জলজিব সহ পরিবেশ ও জীববৈচিত্রের জন্য প্রয়োজনীয় টেকসই রক্ষণাবেক্ষণ পরিকল্পনা করা হবে।

Annex 8

Format of Environmental Monitoring Report

Environmental Monitoring Report

{Annual/Semestral} Report
{Month Year}

BAN: Rupsha 800 MW Combined Cycle Power Plant Project

Prepared by the North-West Power Generation Company Limited for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of {Day Month Year})

{The date of the currency equivalents must be within 2 months from the date on the cover.}

Currency unit	–	{currency name in lowercase (Symbol)}
{Symbol}1.00	=	$\{ \}
$1.00 =	{Symbol_____}	

ABBREVIATIONS

{AAA}	–	{spell out (capitalize only proper names)}
{BBB}	–	{spell out}
{CCC}	–	{spell out}

WEIGHTS AND MEASURES

{symbol 1 (full name 1)}	–	{Definition 1}
{symbol 2 (full name 2)}	–	{Definition 2}
{symbol 3 (full name 3)}	–	{Definition 3}

GLOSSARY

{Term 1}	–	{Definition 1}
{Term 2}	–	{Definition 2}
{Term 3}	–	{Definition 3}

NOTE

In this report, "$" refers to US dollars.

This environmental monitoring report is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

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x Brief status of environmental compliance during the coverage period

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1.2 Project Progress Status and Implementation Schedule

2.0 Compliance to National Regulations

2.1 Environmental Conservation Rules 1997

3.0 Compliance to Relevant Environmental Requirements from the ADB Loan Agreement

3.1 Schedule 5 (prepare a matrix to show how compliance was achieved)

4.0 Compliance to Environmental Manag ement Plan

(Refer to the EMP of the Project)

5.0 Safeguards Monitoring Results and Unanticipated Impacts

(Refer to the Environmental Monitoring Plan and document any exceedance to environmental standards (if any), or any unanticipated impact not included in the EMP and any correction action/measures taken)

6.0 Implementation of Grievance Redress Mechanism and Complaints Received from Stakeholders

(Summary of any complaint/grievance and the status of action taken)

7.0 Conclusion and Recommendations

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		flammable waste, construction debris, food waste etc.) prior to the commencement of construction works. x Dispose all construction related wastes in the designated disposal sites approved by the Project authority. x Minimize the production of waste materials via 3R (Reduce, Recycle and Reuse) approach. x Segregate all wastes, wherever practical. x Transport wastes in fully covered vehicles to prevent spilling waste along the route. x Train all personnel on waste management practices and procedures. x Provide refuse containers/ bins at each worksite. x Request suppliers to minimize packaging where practicable. x Place a high emphasis on good housekeeping practices. x Clean and maintain construction sites x Provide and maintain appropriate facilities for temporary storage of all wastes before being transported for final disposal. x Avoid use of non-biodegradable plastic bag wherever possible.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices.	The Contractor shall x Store chemical wastes in a sealed container. x Label all chemical containers for easy recognition. x Store, transport and handle all chemicals avoiding potential environmental pollution. x Store all hazardous wastes/ chemicals appropriately in bunded areas away from water sources. x Maintain and document Material Safety Data Sheets (MSDS) for all hazardous materials/ chemicals on-site during construction period. x Construct concrete or other impermeable hard-stand to prevent

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		seepage of hazardous chemicals/ lube oils in case of any accidental spills. x Keep sufficient stock of absorbents for generally used chemicals or for petrochemicals (e.g., dirt, sawdust, etc.) within the storage area to contain accidental spills.

ECP 2: Hazardous Goods Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Hazardous goods and equipment.	Improper storage and handling of lubricants, chemicals, hazardous goods/materials on-site, wash down of plant and equipment, and potential spills may harm the environment or health of construction workers.	The Contractor shall x Prepare spill control procedures and Hazardous Substance Management Plan. x Train the relevant construction personnel in spill control procedures. x Store dangerous goods in bunded areas on top of a sealed plastic sheet away from water sources. x Store all liquid fuels in fully bunded storage containers. x Store and use chemicals in accordance with the information provided in material safety data sheets (MSDS). x Make sure all containers, drums, and tanks that are used for storage are in good condition. x Check the containers regularly for leakage, dents or any other abnormalities. Any container, drum, or tank that is dented, cracked, or rusted should be notified to the supervisors immediately and replaced promptly. x Take all precautionary measures (e.g. hazard labeling, wearing of personal protective equipment (PPEs) etc.) when handling and storing fuels and lubricants, avoiding environmental pollution. x All machinery is to be stored away from any water body, drainage inlets or natural drainage area, where practical. x Transport waste of hazardous/ dangerous goods to an approved waste disposal facility.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
construction sites	sewerages from construction sites and work camps may affect the surface water quality. The construction works will modify groundcover and topography, changing the surface water drainage patterns of the area. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, and effect habitat of fish and other aquatic biology.	x Install temporary drainage system (channels and check dams) in areas required for sediment and erosion control and around storage areas for construction materials. x Install temporary sediment lagoons, where appropriate, to capture sediment-laden run-off from work site. x Divert runoff from undisturbed areas around the construction site. x Stockpile materials away from drainage lines. x Prevent all solid and liquid wastes entering waterways by collecting spoils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot. x Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. The contractor shall also ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall x Stabilize the cleared areas, not used for construction activities, with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. x Ensure that roads used by construction vehicles are swept regularly to remove dust and sediment. x Water the loose material stockpiles, access roads and bare soils on a required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
Drinking water	Untreated surface water is not suitable for drinking	The Contractor Shall xProvide drinking water that meets

Project Activity/Im pact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	purposes due to presence of suspended solids and E. coli.	National and WHO Drinking Water standards.

ECP 4: Drainage Management

Project Activity/Impact Source	Environmental I mpacts	Mitigation Measures/Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities may harm environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall x Prepare drainage management procedures. x Prepare a program to prevent standing waters, which the project proponent will verify in advance and confirm during implementation. x Provide alternative drainage for rainwater if the construction works/ earth-fillings cut the established drainage line. x Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. x Rehabilitate road drainage structures immediately if damaged. x Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. x Ensure wastewater quality conforms to National Standards, before being discharged into the recipient water bodies. x Ensure that there is no water stagnation at the construction sites and camps. x Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. x Protect natural slopes of drainage channels to ensure adequate storm water drains. x Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.
Ponding of	Health hazards due to	xDo not allow ponding of water

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
water	mosquito (vector) breeding.	especially near the waste storage areas and construction camps. xDiscard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals might contaminate the soils.	The Contractor shall x Strictly maintain the waste management plans proposed in ECP 1: Waste Management and ECP 2: Hazardous Goods Management . x Construct appropriate spill containment facilities for all fuel storage areas. x Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. x Train personnel and implement safe work practices for minimizing the risk of spillage. x Identify the cause of contamination and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site. x Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils.	The Contractor shall x Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible to erosion of top soils, which affects the growth of vegetation and causes ecological imbalance.	The Contractor shall x Prepare site specific erosion and sediment control measures and submit them for supervision consultant for approval. x Reinstate and protect cleared areas as

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		soon as possible. x Cover unused area of disturbed or exposed surfaces immediately with mulch /grass turf/ tree plantations.
Construction activities and material stockpiles	The impacts of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream and silt accumulation and (ii) destruction of aquatic environment by erosion and/or deposition of sediment damaging the spawning grounds of fish.	The Contractor shall x Relocate stockpiles away from drainage lines. x Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds. x Remove debris from drainage paths and sediment control structures. x Cover the loose sediments of construction material and water them if required. x Divert natural runoff around construction areas prior to any site disturbance. x Install protective measures on site prior to construction, for example, sediment traps. x Install 'cut off drains' on large cut/fill batter slopes to control water runoff speed and hence erosion. x Observe the performance of drainage structures and erosion controls during rain and modify as required.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall x Stabilize the cleared areas, not used for construction activities, with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. x Ensure that roads used by construction vehicles are swept regularly to remove sediment. x Water the material stockpiles, access roads and bare soils on a required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).

ECP 7: Top Soil Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Land clearing	The top portion of soil is	The Contractor shall

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
and earth works	generally enriched with plant growth essential nutrient. Earth work might degrade the fertile top soil.	x Top soil removal from project site might not exceed 35 cm and store in stoke piles height not exceed 2 m. x The stockpiles should be done in slops of 2:1, so that, rate of surface runoff reduces and percolation rate increases. x Removed top soil should be stored outside of the core project facilities and drainage line. This soil mass should also be protected from erosion. x Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. x Construct diversion channels and silt fences around the top-soil stockpiles to prevent erosion and loss of topsoil. x Spread the topsoil to maintain the physic-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. x Prior to the re-spreading of topsoil, the ground surface should be ripped to assist the bunding of the soil layers, water penetration and re-vegetation.
Transport	Vehicular movement outside ROW or temporary access roads might affect the soil fertility of the agricultural lands.	x All kind of unnecessary vehicular movement should be restricted within the construction facility. x Limit equipment and vehicular movements to within the approved construction zone. x Planed construction for road alignment should be maintained from the beginning to minimize the loss of top soil. x Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural	The Contractor shall x Prepare landscaping and plantation plan and submit the plan to supervision consultant for approval.

Project Activity /Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	rainwater/flood water drainage as well as change the local landscape.	x Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water. x Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. x Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. x Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and better landscaping. xReinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Air Quality Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measure s/Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall x Prepare air quality management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant approval. x Fit vehicles with suitable exhaust systems and emission control devices. Keep these devices in better working condition. x Function the vehicles in a fuel productive way. x Cover pulling vehicles conveying dusty materials moving outside the development site. x Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. x Control the movement of construction traffic. x Water construction materials prior to loading and transport.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		x Service all vehicles regularly to minimize emissions. x Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall x Fit hardware with suitable fumes frameworks and discharge control devices. Keep up these devices in great working condition as per the details characterized by their makers to amplify ignition productivity and limit the contaminant discharges. Verification of support enlist should be required by the hardware providers and temporary workers/sub-contractors. Pay special consideration to manage emissions from fuel generators. x Machinery causing over the top contamination (e.g., unmistakable smoke) will be restricted from development destinations. x Service all equipment regularly to minimize emissions. x Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages, including unloading, collection, aggregate handling, cement application, circulation of trucks and machinery inside the installations.
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard, and also can affect the adjacent water bodies.	The Contractor shall x Water the material stockpiles, access roads and bare soils as needed basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. x Minimize the extent and period of exposure of the bare surfaces. x Restore disturbed areas as soon as practicable by grasses or trees. x Store the cement in silos and minimize

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		the emissions from silos by equipping them with filters. x Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust generation is minimized during such operations. x Use water as dust suppression in such way that will never produce any liquid waste stream. x Crushing of rock and aggregate materials shall be wet-crushed, or performed with particle emission control systems. x Not permit on burning of solid waste.

ECP 10: Noise and Vibration Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic.	The Contractor shall x Prepare a noise and vibration management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant/Owner's Engineer (OE) for approval. x Keep up all vehicles to keep it in great working condition as per produces support strategies. x Ensure all drivers will conform to the activity codes concerning most extreme speed restrain, driving hours, and so on. x Perform the loading and unloading of trucks, and handling operations minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall x Appropriately organize all noise generating activities to avoid noise pollution to local residents. x Utilize the calmest accessible hardware and gear in development work. x Maintain all equipment in order to keep them in good working order in accordance with manufactures maintenance procedures. Equipment

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		suppliers and contractors shall present proof of maintenance register of their equipment. x Install acoustic fenced in areas around generators to decrease noise levels. x Fit high productivity suppressors to fitting development hardware. x Avoid superfluous utilization of alerts, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall x Notify nearby landholders preceding normal noise events outside of light hours. x The operator should be educated about the construction equipments and technique to reduce noise level. x Employ best accessible work practice nearby to limit work related noise levels. x Install temporary noise control barriers where appropriate. x Notify affected people if major noisy activities will be undertaken, e.g. blasting. x Plan activities on site and deliveries to and from site to minimize impact. x Monitor and consider noise and vibration come about and modify development practices as required. Avoid undertaking the noisiest exercises, where conceivable, when working during the evening close to the neighborhoods.

ECP 11: Protection of Flora

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guideli nes
Vegetation clearance for site preparation	Clearance of vegetation for materials storing, labour shed construction and all kind of civil structures construction.	The Contractor shall x Prepare a plan of vegetation clearance supervised by experienced botanist. x Use comparatively barren places for storing/ labour shed to minimize vegetation damage. x Clear only the vegetation that needs to be cleared in accordance with the engineering plans and designs. These measures are applicable to both the

Project Acti vity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		construction areas as well as to any associated activities such as sites for storing, labour movement and construction vehicle running. x Aware and train the workers regarding nature protection and the need of avoid vegetation damage during construction. x Implement proper plantation with native species after completion of construction works prior to engaging experienced plantation planner (Landscape ecologist).

ECP 12: Protection of Fauna

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction activities	Damage of wildlife habitat and relocation wildlife from the construction site due to vegetation damage and demolition of physical structures.	The Contractor shall x Survey faunal communities at first before site clearing and prepare a plan for protection of fauna supervised by experienced consultant. x Use comparatively barren places for storing/ labour shed to minimize vegetation damage. x Limit the construction works within the designated sites allocated to the contractors. x Check the site for trapped animals, rescue them by the help of a qualified person and release them in nearer protected area. x Appoint wildlife biologist and wildlife capture and relocation experts. x Demolish buildings one after another in order to save natural relocation of wildlife.
Night time lighting	Disturbance to nocturnal animals for excess lightening at the site.	The Contractor shall xUse lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution. xAvoid floodlights unless they are required. xUse motion sensitive lighting to minimize unneeded lighting. xInstall light shades or plan the direction of lights to reduce light spilling outside

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		the construction area. xAvoid working in night time.
Excess level noise	Scaring wildlife like dolphins, birds and rodents due excess noise.	The Contractor shall xUse sound limiter with gas stacks. xImplement green belt with dense canopy plants surround the proposed power unit.

ECP 13: Protection of Fish and Aquatic Ecosystems

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Movement of vessels	Deterioration of aquatic habitat quality of nearby river channel due to disposal of waste like ballast and bilge water.	The contractor shall x Warn the vessel sailors about spillage in the river. x Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water. x Prepare an emergency oil spill containment plan (under the Hazardous Substances Management Plan).
Accidental discharge of hazardous effluents and hot water	Aquatic dolphins/fishes may be affected and habitat quality may deteriorate.	The Contractor shall x Follow mitigation measures proposed ECP 3: Water Resources Management and ECP 4: Drainage Management.

ECP 14: Road Transport and Road Traffic Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction vehicular traffic	Increased traffic may affect the safety of the road-users and obstruct their daily movement.	The Contractor shall x Prepare a traffic management plan and implement them strictly. xEnsure uninterrupted traffic movement during construction and shall include in the traffic plan: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc. x Provide signs at strategic locations of the roads complying with National

Project Activity/Impact Source	Environmental Impacts	Mitig ation Measures/Management Guidelines
		Traffic Regulations.
	Accidents and spillage of fuels and chemicals.	The Contractor shall x Restrict heavy vehicle movement, where practicable, to day time working hours only. x Restrict the transport of oversized loads. x Enforce on-site speed limit, especially close to the sensitive receptors, schools, health centers, etc.

ECP 15: Construction Camp Management

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Set-up of construction camps	Health, safety and security of workers might be affected due to the set-up of construction camps.	The Contractor shall x Prepare a construction camp management plan. x Set-up camps within the designated sites or at areas which are acceptable from environmental, cultural or social point of view and approved by the supervision consultant/OE or the Client. x Conduct consultation with communities including local government institutes bodies prior to set-up/ construction of the camp. x Submit a detailed layout plan to the project authorities for approval in order to develop the construction camp, which should include relative locations of all temporary buildings and facilities along with the location of access roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities. x Inform local authorities the setup of camp facilities so as to maintain effective surveillance over public health, social, and security matters.
Provision of construction camp facilities	Lack of basic facilities, such as housing, water supply, and sanitation facilities may lead to substandard living conditions and possible health hazards.	Contractor shall provide the following facilities in the campsites x Adequate housing for all workers. x Safe and reliable drinking water supply, conforming to national and

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		international (e.g. WHO) standards. x Hygienic sanitary facilities and sewerage system. x Separate toilet facilities for males and females. The minimum number of toilet facilities required is one toilet for every ten persons as per Labour Rules, 2015. x Treatment facilities for sewerage of toilet and domestic wastes. x Storm water drainage facilities. x Paved internal roads. x . x In-house community/ common entertainment facilities.
Disposal of waste	Waste run-off to nearby water sources, leading to pollution	The Contractor shall x Ensure solid wastes are properly collected and disposed of within the construction camps. x Ensure waste segregation at source. Wastes should be segregated on separate color-coded bins as per national waste management laws/ rules. x Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipment/vehicles needed.
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna.	The Contractor shall x Provide alternative fuels like natural gas or kerosene to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. x Conduct awareness campaigns to educate workers on preserving the protection of biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	Spreading of vector borne diseases such as, malaria, due to inadequate health and safety practices.	The Contractor shall x Provide adequate health care facilities within construction sites. x Provide first aid facility round the

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	Risk of spreading of sexually transmitted diseases (STD), such as HIV/AIDS.	clock. x Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. x Provide ambulance facility for the labours so that they can be transported to nearest hospitals in case of an emergency health hazard. x Conduct health screening of the laborers coming from outside areas. x Train all construction workers about basic sanitation and health care issues and safety matters, and on the specific hazards of their work. x Provide awareness on sexually transmitted diseases, such as HIV/ AIDS to all workers on a regular basis. x Provide and maintain adequate drainage facilities throughout the camps to minimize the spread of vector borne diseases. The contractor shall also regularly spray mosquito repellant during rainy season in offices, construction camps and yards. x Provide awareness drives and training on personal hygiene and waste disposal.
Security and Safety	Inadequate security and safety provision in construction camps may create security and safety problems of workforces and assets.	The Contractor shall xProvide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry into the camp area. xMaintain register to keep a track of entry and exit of people within the camp at any given time. xEncourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. xProvide appropriate type of firefighting equipment suitable for the construction camps. xDisplay emergency contact numbers clearly and prominently at strategic places in camps.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		x Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Demolition of construction camps may lead to dust emission, elevated noise levels and possible health hazard.	The Contractor shall x Dismantle and remove all the established facilities from the site of the construction camp ensuring minimum dusts emission. Wet spray grounds to minimize dust emission. x Dismantle camps in phases instead of waiting for the entire work to be completed. x Provide prior notice to the laborers before demolishing their camps/units. x Maintain the noise levels within the national standards during demolition activities. x Hire different contractors to demolish different structures to promote recycling or reuse of demolished material. x Dispose excess debris at the designated waste disposal site. x Restore the site to its condition prior to commencement of the works.

ECP 16: Cultural and Religious Issues

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites leading to annoyances. Contractors lack of knowledge on cultural issues leading to social disturbances.	The Contractor shall x Avoid activities that may lead to the blocking of access to cultural and religious sites. x Avoid construction works during prayer time. x Avoid working in areas where there is any church/mosque/religious/ educational institutions and health centers close to the construction sites, if possible. Project proponent should issue warning to the people before commencing construction activities. x Establish a mechanism that allows local people to raise grievances arising from the construction process.

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		x Provide compensations or relocate, whichever is best, if any grievances are raised by the community where any culturally important areas are to be demolished. x Take special care and use appropriate equipment when working next to a cultural/ religious center. x Stop work immediately and notify the site manager, if during construction, an archaeological or burial site is discovered. x Provide independent prayer facilities to the construction workers. x Show appropriate behavior with all construction workers especially women and elderly people. x Allow the workers to participate in praying during construction time, if there is a request. x Resolve cultural issues in consultation with local leaders and supervision consultants. x Inform the local authorities before commencement of civil works so as to maintain effective surveillance over public health, social, and security matters.

ECP 17: Worker Health and Safety

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction work at Plant site	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g., noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases, etc.), (ii)	The Contractor shall x Prepare an Occupational Health and Safety and Hazard and Risk Assessment plan. x Implement suitable safety standards for all workers and site visitors, with sufficient provisions to comply with international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; International Finance Corporation/World Bank Group Environmental, Health, and Safety General Guidelines') and contractor's

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
	risk factors resulting from human behavior (e.g., STD, HIV/AIDS, etc.) and (iii) road accidents from construction traffic.	own safety standards, in addition to complying with national standards. x Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. x Conduct tool box meeting before starting any construction related work. Maintain a registry of the person present during the toolbox meeting. Anyone not participating in the tool box meeting will not be allowed to work. x Provide personal protective equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing the damaged ones. x Implement safety procedures including provision of training and protective clothing to workers involved in hazardous operations and proper performance of their job. x Appoint an environment, health and safety manager to look after the health and safety of the workers. x Inform the local authorities before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.
	Child and pregnant labor.	The Contractor shall x Not hire children of less than 18 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims.	The Contractor shall x Ensure health care facilities and first aid facilities are readily available. x Document and report occupational accidents, diseases, and incidents. x Prevent accidents, injury, and disease

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidel ines
		arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. x Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. x Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.
Provision of construction camp facilities	Lack of basic facilities, such as housing, water supply, and sanitation facilities may lead to substandard living conditions and possible health hazards.	The Contractor shall provide facilities in the camp sites to improve health and hygienic conditions as mentioned in ECP 16: Construction Camp Management.
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce may make them susceptible to potential diseases.	The Contractor shall x Train all construction workers in basic sanitation and healthcare issues (e.g., protection against malaria and other vector borne diseases, transmission of sexually transmitted infections (STI) etc. x Train all construction workers in general health and safety practices and about specific hazards related to their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. x Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled workforces, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.

ECP 18: Construction and Operation Phase Security

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Construction work	Inadequate construction site security poses a significant risk to assets, construction materials and property. Theft/ vandalism of assets, materials and property may increase construction costs and may cause delays in project completion.	The Contractor shall: x Provide appropriate security personnel (i.e. security guards) to prevent unauthorized entry into the camp area. x Ensure all assets (i.e., tools, equipment, etc.) and construction materials at construction site are identified, recorded and tracked as closely as possible. All assets should be clearly labeled and marked. Keep records of tool serial numbers and check inventory on a regular basis. x All tools and equipment should have a check out/in system. If they are not in use, they should be securely stored in a proper place to prevent theft or loss. x Ensure that there is proper fencing around construction site perimeter. Fencing should be chain-link at least 2.4 m high and secured with a steel chain and lock. x The entire site should be fenced, if possible. If not, at least the construction trailer and equipment storage areas should be fenced. x Ensure construction site has controlled access points (one or two entry points at most), allowing for close monitoring of comings and goings from the site. x Workers should be easily identified and have credentials that indicate site access. x List of employees who have after hour access to the property should be available to the PMU and local authorities. x Ensure job site is properly lighted at night. Well-lit areas should include any office trailers and equipment storage trailers. Floodlights operated by sensors should also be installed where appropriate. x Pre-employment screening

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		investigations should be used to verify the applicants relating to their employment, education and criminal history background.
Operation Phase	Vandalism/damage (including use of explosives) of RMS, Gas Pipeline, Plant transfer station and storages.	x Routinely conduct patrols and inspections of transmission mains Plant area and facilities. x Monitor suspicious activity and notify local authorities and NWPGCL in event of any such occurrence/incident of vandalism or theft. x Ensure strategic infrastructure sites such as RMS, Gas Pipelines, and main Plant transfer stations, storages are secured and fenced with controlled access points. Fencing should be chain-link at least 2.4m high and secured with a steel chain and lock.

ECP 19: Demolit ion of Structures

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
Demolition of structures	Rubbles and dust raised from the demolition/ decommissioning of structures may affect the surrounding environment (air, water resources, landscape, agricultural lands etc.), flora, fauna and health of the surrounding communities.	The Contractor shall: x Provide appropriate demolition/ decommissioning plan. x Inform nearby communities 5 days prior to the start of any demolition/ decommissioning activities. x Conduct thorough investigation of site and site history to identify potential risks and hazards to workers, local people and the environment. x Use of techniques to minimize compaction of soil. If necessary, soil should be carefully removed and stored for subsequent works. x Use dust control strategies (e.g. wet technique). x Set the route and time of movement of heavy trucks carrying demolition debris off site for disposal so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes). x Avoid building of access roads near

Project Activity/Impact Source	Environmental Impacts	Mitigation Measures/Management Guidelines
		riparian zones. x Implement adequate site security x Recover, reuse and recycle salvaged materials, whenever possible. x Install and implement appropriate water management system as early as possible. Effectively stabilize altered landforms so as to minimize soil erosion and the potential for water pollution from suspended solids. x Incorporate existing habitat features into site design and protect them from any adverse change. x Preserve sites of archaeological or cultural interest where possible. If not, relocation should be considered where damage is unavoidable. x Implement management system that should aim to minimize disturbance to adjacent residential and recreational areas.

Annex 10

Fauna Rescue and Handling Procedures
Component 1 –800 MW Rupsha CCPP

1.0 Introduction

1. The following outlines the actions and measures that will be undertaken in the event of an accidental encounter with a threatened fauna during the construction phase of Component 1. This chance find procedures will be finalized in consultation with among others, IUCN Bangladesh, Bangladesh Wildlife Advisory Board, Forest Department (DoF), and DoE to ensure compliance with applicable regulations.

2. These procedures will be included in the Construction Management Plan that will be required by Project Management Unit (PMU), NWPGCL from the EPC Contractor and will be an integral part of the bid documents. NWPGCL will ensure compliance of this ADB requirement. These procedures aim to identify and promote the protection and recording of threatened fauna that may be encountered during the site preparation and construction activities.

2.0 Scope

3. This will be applicable to construction activities by workers or personnel who may have the potential to encounter or contact with threatened species from the construction activities for Component 1.

3.0 Orienta tion of Workers

4. The EPC Contractor, with the assistance from relevant authorities of GoB such as DoE and DOF, will conduct an orientation of all workers, particularly those who will be involved in the site preparation for Component 1, on how to recognize and identify the potential threatened species that may be encountered including the appropriate actions to be done. The orientation will be done prior to construction works and during the regular toolbox talks/meetings.

5. Clear pictures of the threatened species, with sightings in the project site, including a brief description of their habitats will be posted at strategic locations within the construction site (about 50 acres or 20.23 hectares). This will help workers and staff in creating awareness and familiarity with the species. These pictures will be part of the references on-site to guide construction supervision staff. Local people recruited during pre-construction and construction phase may be familiar with these species and can provide assistance with their local knowledge and experience.

4.0 Procedures

6. The environmental staff (or consultant) of EPC Contractor together with the environmental staff of PMU, NWPGCL will be responsible for implementing these procedures. ADB will monitor compliance of NWPGCL.

7. Table 4.1 lists the species of conservation status according to IUCN Bangladesh 2015. The EPC Contractor will post the pictures of these species to assist the workers in identifying them.

Annex 11

Table 4: List of species of conservation status

English Name	Scientific Name	Bangladesh Wildlife (Preservation) Order 1973	IUCN Bangladesh Status (2015)	IUCN Global Status	Distribution	
					Project Site	Study area
Mammals						
Fishing Cat	Prionailurus viverrinus	Third Schedule[1] [1]Protected animals not to be hunted, killed, or captured	Endangered	Vulnerable	Temporary visitor but core habitat is within the study area outside project site	Yes
Smooth-coated Otter	Lutrogale perspicillata	Third Schedule	Vulnerable	Critically Endangered	No	Yes
Ganges River Dolphin	Platanista gangetica	Third Schedule	Vulnerable	Endangered	No	Yes
Small Indian Civet	Viverricula indica	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Jungle Cat	Felis chaus	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Birds						
Black headed Ibis	Threskiornis melanocephalus	---	Vulnerable	Near Threatened	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Reptiles						
Water Monitor	Varanus salvator	Third Schedule	Vulnerable	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Bengal Monitor	Varanus bengalensis	Third Schedule	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Black Krait	Bungarus niger	---	Near Threatened	Not Assessed	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Monocled Cobra	Naja kaouthia	---	Near Threatened	Least Concern	Reported by Interviewee as temporarily found as visitor for hunting of preys	Yes
Indian Cobra	Naja naja	---	Near Threatened	Not Assessed	Reported by Interviewee as	Yes

Englis h Name	Scientific Name	Bangladesh Wildlife (Preservation) Order 1973	IUCN Bangladesh Status (2015)	IUCN Global Status	Distribution	
					Project Site	Study area
					temporarily found as visitor for hunting of preys	
Floral species						
West Indian Mahogany	Swietenia mahagoni	---	Not Assessed	Endangered	Cultivated species in Bangladesh and non-native in Bangladesh and also not listed in the IUCN Red list of Bangladesh	Yes

Source: CEGIS field survey from 29-30 October 2016 and secondary information from IUCN (2015)

8. In the event a threatened species is encountered or discovered during construction activities, the following steps will be done:

a) Stop the work within the vicinity of the species and immediately notify the environmental staff (or consultant) of the EPC Contractor and the construction supervision staff or site engineer.

b) The environmental staff will assess the impacts; identify the species, and the appropriate management measures such as relocation. The location where the species was encountered will be identified using a global positioning system (GPS) unit to determine the exact coordinates and photographs will be taken.

c) The construction supervision staff will secure the approval of the environmental staff of PMU, NWPGCL (in consultation with relevant agencies of GoB) before resuming the construction works.

d) Construction works will resume as soon as the environmental staff (from EPC Contractor and PMU, NWPGCL) has done the following actions:

- Secured the approval/permit (if required)
- Corrective actions and/or management measures identified
- Complete the rescue event record/report to include: date and time the species was found, location, type of fauna (e.g., snake, fish, turtle, etc.) and species name, actions taken (e.g., treated by fauna specialist, fauna relocated and where, etc.)

9. The EPC Contractor will not be entitled for compensation due to work stoppage as a result of the encounter and the associated subsequent actions.

Final Report

Biodiversity Assessment for Rupsha800 MW Combined -Cycle Power Plant Project

IUCN Bangladesh Country Office February 2018

Final Report

Biodiversity Assessment for Rupsha 800 MW Combined -Cycle Power Plant Project

Submitted to

North -West Power Generation Company Limited (NWPGCL)

Prepared by

IUCN, International Union for Conservation of Nature and Natural Resources
Bangladesh Country Office
House B-138, Road 22, MohakhaliDOHS,Dhaka 1206
Tel:+880 2 48810194, Fax: +880 2 48810197
Web: www.iucn.org/bangladesh

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Executive Summary

IUCN Bangladesh has been awarded a nine-month-long project entitled 'Biodiversity Assessment for Rupsha 800MW Combined-Cycle Power Plant' by North-West Power Generation Company Limited (NWPGCL) to be funded by Asian Development Bank (ADB). The project is designed to conduct dolphin and other related surveys on the project site and vicinity of this power plant to assess possible impacts of this project on aquatic biodiversity and to identify ways to mitigate these impacts. The survey will be conducted in a total of 30 km length along the Bhairab, Atai and Rupsha Rivers and their confluence in different seasons. As per contract the pre-monsoon, monsoon, post-monsoon and comprehensive survey reports were submitted to NWPGCL.

A total of seven surveys were conducted during pre-monsoon (one survey), monsoon (two surveys), post-monsoon (two surveys) and winter (two surveys). The survey period was May 2017 to January 2018. These results include data on dolphins, other animal presence, fish and fishing gears, fishing areas, physical and chemical water quality parameters, vegetation, plankton and watercrafts from the surveys. Water depth was also measured and pollution sources were also identified.

The survey results show a total of 284 sightings from four surveys (one pre-monsoon, two monsoon and first post-monsoon) of Ganges River Dolphins , with overall encounter rate is 1.18/ km including 13.76% calves. The most important area determined from the surveys for dolphins is the confluence of Atai-Bhairab-Rupsha Rivers where feeding behavior was recorded and a large number of calves were seen.

Three surveys (second post-monsoon, first and second winter) were conducted using the mark-recapture method and the results of three surveys are used in this report. An average 47 and 34 dolphins were calculated for the project area by using the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' and the 'Huggins Conditional Likelihood Model', respectively.

In the second winter survey, a group of four Irrawaddy Dolphin was recorded from the project site opportunistically. This species is considered globally Endangered and nationally Near Threatened.

Critical Habitat Analysis was done following the IFC guidelines and using the dolphin number as 34 from the mark-recapture method. The results of the analysis indicate that the project site is not a Critical Habitat for Ganges River Dolphins under any criteria of the guidelines.

Long term continuous monitoring of the project area is needed to understand the effects of construction of the power plant especially in the important dolphin areas that were identified.

Other wildlife includes a total of 41 species of birds and four other wildlife species were recorded during the survey period.
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Watercrafts were also counted during the survey period. A total of 676 watercrafts comprised of mechanized and non- mechanized were recorded. The highest was mechanized boats with a total of 373. Rupsha River had the highest number of water vessels with a total of 253.

Fishing gears and fish species were counted during the surveys. A total of 19 types of fishing gears was identified along transects. A total of 50 fish species was also recorded based on direct field visit and questionnaire survey, out of which ten are nationally threatened. Water depth readings were recorded and presented in this report. The depth was measured in every 1 km using an echo sounder.

A total of 117 individuals of 29 species of vegetations were enumerated from six sample plots. Syzygiumcumini L. (Jam), Areca catechu L. (Supari), Cocosnucifera L. (Narkel), LanneacoromandelicaMerr. (Jial) and Mangiferaindica L. (Aam) are the five most abundant species in the study area.

Water quality parameters were tested to measure the concentration of different pollutants among the listed areas and illustrated the difference between two seasons. Furthermore, 15 genera of phytoplankton and two unknown genera of zooplankton were found in the study sites.

Additionally this report includes the potential impact and mitigation measures as well as some recommendations.

1. Introduction

An 800 MW combined-cycle power plant is proposed to be built in Khalishpur Thana, Khulna District along the Bhairab River by North-West Power Generation Company Limited (NWPGCL) and is funded by the Asian Development Bank (ADB). A draft Environmental Impact Assessment (EIA) prepared in December 2016 by the Center for Environmental and Geographic Information Services (CEGIS) showed the presence of the Ganges River Dolphin (Platanista gangetica gangetica) in the Bhairab River within the immediate vicinity of the proposed power plant site.

Dolphin survey at the Rupsha River, 22 October 2017. ©IUCN/ A.B.M. Sarowar Alam

The Ganges River Dolphin is a freshwater dolphin which occurs in all connected rivers and tributaries of Ganges-Brahmaputra-Meghna river system, and Karnaphuli-Sangu river system.[1] In 2012, International Union for Conservation of Nature (IUCN) classified the Ganges River Dolphin as Endangered globally.[2] In Bangladesh, the species is considered as Vulnerable[3]. It is estimated that there are 225 individuals in Sundarbans and 125 in Karnaphuli-Sangu Rivers. There has been no study done on the species in the present study site that is in the Bhairab-Atai-Rupsha river system.

[1]Sinha, Ravindra and Kurunthachalam Kannan. Ganges River Dolphin: An Overview of Biology, Ecology, and Conservation Status in India. Ambio.2014, 43:1029-1046.Royal Swedish Academy of Sciences.
[2] Smith, B.D. and Braulik, G.T. 2012. Platanista gangetica. The IUCN Red List of Threatened Species 2012: e.T41758A17355810. http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T41

758A17355810.en. (Accessed 17 August 2017)
[3]Alom, Z.M.2015. (Platanista gangetica).In:IUCN Bangladesh. Red List of Bangladesh, Volume 2: Mammals, p. 107.

A land-based sighting survey was done in October 2016 in the confluence of the Bhairab and Atai Rivers close to the project site. The survey showed 33 surfing occurrences of the species, out of which 11 were at the confluence and the rest along the Bhairab River. Another line-transect survey was conducted in March 2017.
About 20 km stretch of the Bhairab River from the confluence of Bhairab-Madhumati Rivers (covering 10 km upstream) to the confluence of Bhairab-Atai Rivers until the Rupsha River at Khanjahan Ali Bridge (covering 10 km downstream) was covered. A total of 25 dolphins was recorded from different points of the survey.

The Safeguard Policy Statement 2009 (SPS 2009) of ADB sets out the requirements for environmental safeguard that applies to all the projects considered for financing. Under the SPS 2009, impacts and risks of projects are analyzed within the context of the project's area of influence.

The dolphin population in the proposed power plant project's area has the potential to be significantly impacted by the construction of the power plant. The impacts need to be adequately assessed and mitigated for in accordance with the biodiversity requirements of the SPS 2009. These include specific requirements for projects located within a critical habitat, and thus ensuring no net loss of biodiversity.

In June 2017, IUCN Bangladesh was awarded a nine-month-long project to conduct dolphin and other related surveys in the power plant project sites with the main aim to determine if the project site and vicinity is a critical habitat for dolphins and to identify the potential impact of the power plant on dolphins. A total of seven surveys were conducted from May 2017 to January 2018, where three surveys were done using Mark-recapture method. The results of all the surveys are presented in this report. Alsoincluded in this report are the literature review, survey methodology, Critical Habitat Analysis, important dolphin areas, impact and mitigation, and recommendations.

Surfing of a Irrawaddy Dolphin at the Atai River on 24 January 2018. ©IUCN/Sakib Ahmed

2. Literature Review

Smith et al. (1998) referred in a paper called “River Dolphins in Bangladesh: Conservation and the Effects of Water Development” that a vast survey was done in the upstream of the confluence of the Jamuna River and in some sections of downstream of Kushiyara River where 38-68 dolphins were seen in Jamuna river where the sighting rate was 0.13 sightings/km. Also 34-43 dolphins were found in Kushiyara River with a sighting rate 0.08 (sightings/km). The study also included that they found 2 or 3 dolphins during a short visit to Burhiganga River near Dhaka.

Smith et al. (2006) in another paper referred that a survey was done in mangrove channels of Sundarbans delta in Bangladesh. The title of the paper was “Abundance of Irrawaddy Dolphins (Oecaella Brevirostris) and Ganges River Dolphins (Platanista Gangetica Gangetica)” estimated using concurrent counts made by independent teams in waterways of the Sundarbans mangrove forest in Bangladesh”. This paper shows that 451 individuals of Irrawaddy Dolphins and 225 individuals of Ganges River Dolphins were found in the survey area.

In addition, a paper named “Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh” written by Smith et al. (2009) mentioned that a survey was made in Sundarbans mangrove forest to identify the presence of Ganges River Dolphins and Irrawaddy Dolphins. During low water season survey 62 Ganges River Dolphins were found and the encounter rate was 15.1 individuals/100 km. 236 Irrawaddy Dolphins were detected and the encounter rate was 8.6 individuals/100 km. During high water season survey, 71 individuals of Ganges River Dolphins and 52 individuals of Irrawaddy Dolphins were seen and their encounter rate was 7.0 and 9.6 individuals/100 km respectively.

Smith et al. (2010) stated in the paper titled “Identification and channel characteristics of cetacean hotspots in waterways of the eastern Sundarbans mangrove forest, Bangladesh” that a survey was executed in the Eastern Sundarbans Mangrove forest. Six 5-km segments were selected for the survey. From the study it was found that the encounter rate of Ganges River Dolphins was 0.46 (sightings/survey) and the encounter rate of Irrawaddy Dolphins was 0.06 (sightings/survey).

Aziz et al. (2014) stated in the paper entitled “Biodiversity in the floodplain Ecosystem of Bera, Santhia and Sujanagar Upazilas of Pabna District in Bangladesh” that a survey was done in the 4 hotspots in the Padma-Jamuna River section. The study found that the estimated population of Ganges River dolphins was between 58-103.

Alom et al. (2014) mentioned in “Identification and Ecological Characteristics of Freshwater Dolphin ‘Hotspots’ in the Sundarbans, Bangladesh”, that a survey was done in 6 hotspots and 6 non hotspot segments in the Eastern Sundarbans Reserved Forest. In the hotspot 334 Ganges River Dolphins including 67 calves, 41 Irrawaddy Dolphins and in non hotspot segments 62 Ganges River Dolphins including 18 calves and 17 Irrawaddy Dolphins were found. During dry, pre-monsoon, monsoon and post-monsoon seasons the encounter rate of Ganges River Dolphins in hotspot segments

was 3.0-4.0 individuals/survey and in non hotspot segments was 0.3-1.0 individuals/survey. The study highlighted that the encounter rate of Irrawaddy Dolphins was 0.4 individuals/survey in the hotspots and the encounter rate was 0.2 individuals /survey in the non hotspot segments.

3. Objectives of the Study

The study aims to determine if the stretch of the Bhairab River along the power plant project site and the adjoining rivers at the confluence are a critical habitat to the survival of the Ganges River Dolphins.The study will provide a baseline in understanding of the following:

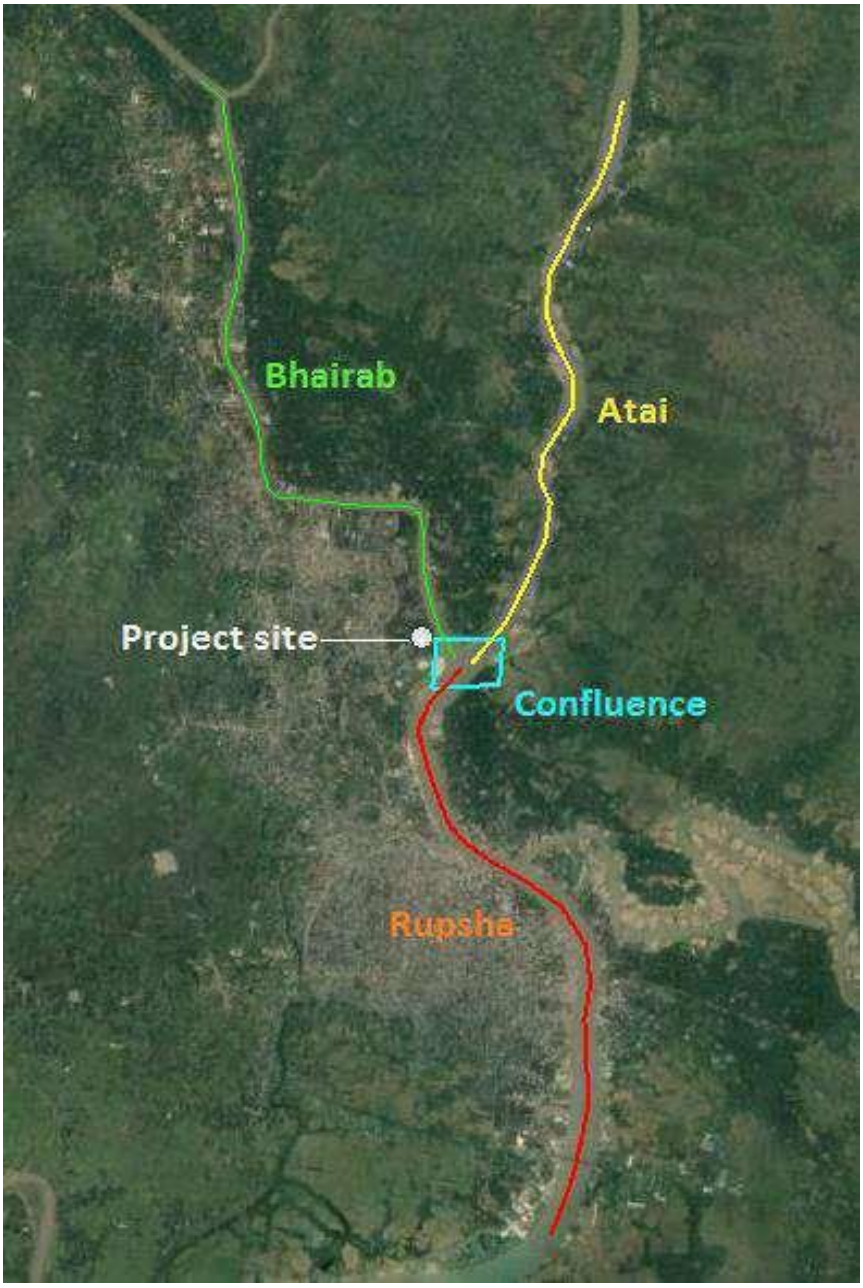
(i) Presence and persistence of Ganges River Dolphins within the 10 km upstream (the Bhairab and Atai Rivers total 20 km) and 10 km downstream (Rupsha River) of the proposed power plant site;
(ii) Ecological requirements of the Ganges River Dolphins prey, and the composition and status of fish and fishing activities co-existing with them;
(iii) Changes in the way the Ganges River Dolphins use the Bhairab, Atai and Rupsha Rivers according to season, water level, water flow, water quality, and nature and extent of human activities such as fishing and navigation; and
(iv) Potential impacts of construction and operation of the proposed power plant operations such as construction of jetty, heavy equipment transport, intake, discharge, etc. to Ganges River Dolphins.

A section of the confluence of the Bhairab, Atai and Rupsha Rivers on 31 May 2017.

4. Study Area

The area to be surveyed (Map 1) will cover the following transects:

- x 10 km of the Rupsha River (downstream of the power plant site),
- x 10 km of theBhairab River (upstream of the power plant site),
- x Confluence of Bhairab-Atai-Rupsha Rivers, and
- x 10 km of the Atai River (upstream from the confluence of station).



Map 1: Map of thearea to be surveyed under the present study.

5. Scope of Work

The following activities will be undertaken during the present survey project:

(i) Dolphin survey : Conduct dolphin surveys covering seasonal variations to determine habitat use, distribution, abundance, as well as record environmental conditions during the surveys (i.e. overcast, windy, glare);

(ii) Other wildlife survey : List species identified along the Bhairab, Atai and RupshaRivers according to its conservation status both from IUCN and national requirements including endemism/range restriction/migration/congregation, if any, and provide inputs to the determination of the presence of any critical habitat;

(iii) Fish and fisheries resources survey : Conduct surveys (once per season) on each section of the three rivers to describe and identify the fish and fisheries resources, fishing gears used by the fisher community, map the existing fishing areas, and record fishing practices including daily and seasonal variations;

A boat carrying fishing traps on the Bhairab River, 31 May 2017.

(iv) Plankton and riparian vegetation survey : Conduct survey for phytoplankton and zooplankton, and riparian vegetations along transect;

(v) Watercraft survey : Separately record the number and type of watercraft users including their movements/directions during the time dolphin surveys are conducted;

(vi) Water quality analysis : Conduct river water surveys/sampling and insitu water quality measurements (once per season) on each section of river to understand the physico-chemical characteristics of the Bhairab, Atai and RupshaRivers. Water quality parameters will include temperature, pH, salinity, dissolved oxygen, hardness, electrical conductivity, nitrates, phosphates, turbidity, suspended sediment, biological oxygen demand (BOD), chemical oxygen demand (COD), coliforms, and other relevant parameters include water depth and flow direction;

Fishingat the BhairabRiver, 23 October2017.©IUCN/ A.B.M. SarowarAlam

(vii) Pollution mapping : Identify/map existing sources of river water pollution and identify/map the presence of any meanders, eddies, and hydrogenological complexities;

(viii) Impact assessment : Assess potential impacts of proposed power plant activities during construction and operation, such as dredging, heavy equipment transport, withdrawal of river water, discharges, and construction of jetty and intake channel along the Bhairab, Atai and RupshaRivers on aquatic flora and fauna and provide inputs to the determination of whether critical habitat (if any) requirements are met; and

(ix) Mitigation measure : Identify mitigation measures and/or conservation management measures for species of conservation status. This may include mitigation measures as a part of the project design or offsets in the project area of influence or further afield to ensure the SPS 2009 requirement of no net loss of biodiversity is met.

6. Methodology and Workplan

This following sectionpresents the detailed methodology of the surveys that will be conducted. In addition, a detailed workplan is also provided showing the timeline of stipulated activities to be carried out during the project period.

6.1 Survey Methodology

6.1.1 vey

The dolphin survey is to be conducted in monsoon, post-monsoon and winter in the study area. A total of six surveys are to be conducted in July, September, October, November, December and February. A pre-monsoon survey has already been facilitated by NWPGCL following the same methodology. The dolphin surveys follow the standard methodology set by Smith et al.(2006and 2009)[4]. The first four surveys (pre-monsoon, first and second monsoon and first post-monsoon) were conducted by calculating encounter rate, and the last three surveys (second pre-monsoon, first and second winter) were conducted using Mark-recapture method.

To Analyze Encounter Rate

To conduct the survey, three transects are set (the Bhairab River Transect, the Atai River Transect and the Rupsha River Transect) and each transect is 10 km long. Three observers stand and actively search for dolphins along transects at all times and record sighting data. One observer is stationed on the port and one on starboard side of the vessel. These two observers search with handheld binoculars and naked eye from the beam to about 10˚ past the bow. The third observer stands in the centre and scans with the naked eye in about a 20˚ cone in front of the bow. This observer also keeps records in specialized data sheets. The observers are rotated through the three positions every half an hour. The height from the water level tothe observer is approximately 3 meters. The speed is set to 10 km/hour.

[4]Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B. and Mansur, R. 2006. Abundance of Irrawaddy dolphins (Orcaellabrevirostris) and Ganges river dolphins (Platanistagangeticagangetica) estimated using concurrent counts from independent teams in waterways of the Sundarbans mangrove forest in Bangladesh, Marine Mammal Science 22(3): 527-547.

Smith, B.D., Braulik, G., Strindberg, S., Mansur, R., Diyan, M.A.A. and Ahmed, B. (2009). Habitat selection of freshwater dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquatic Conservation: Marine and Freshwater Ecosystems, 19, pp. 209-225.

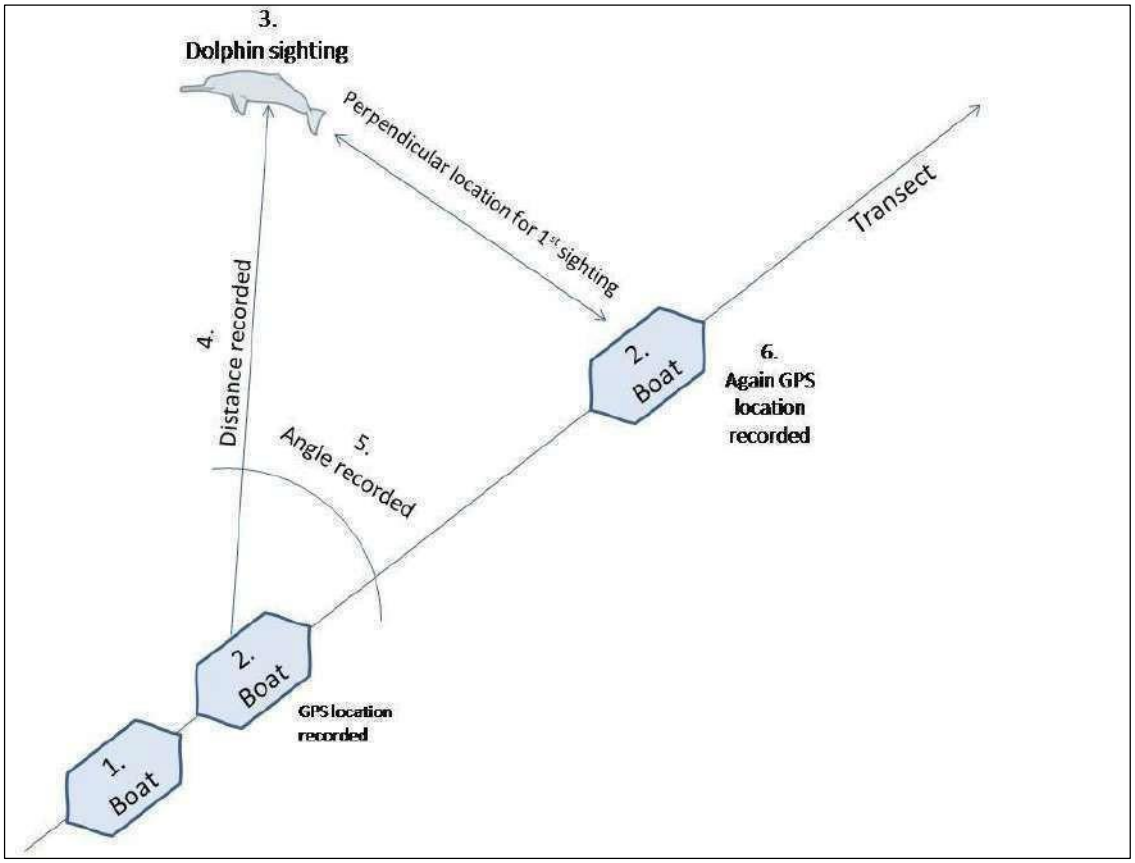


Illustration of the detailed methodology for dolphin survey described in Smith et al.(2006)

Once dolphins are spotted, the GPS coordinates of the exact spot where the animals were seen is recorded. The group size and the age class are then estimated.

To Calculate Population Number using Mark-recapture Method

The detailed methodology is in Appendix 2.

Along with this, weather conditions (wind, glare, and rain/fog) are recorded as well. These factors are given codes of 0, 1, or 2, where '0' corresponds to good (no effect on sighting conditions), '1' corresponds to fair (small effect on sighting conditions), and 2 corresponds to poor (large effect on sighting conditions) conditions, respectively.

6.1.2 her Wildlife Survey

This survey will be done with the dolphin survey in July, September, October December and January. During the survey, the presence of other wildlife will be recorded along the transect by direct observation or call (for birds).The vessel will cover the transects at 10 km/hour and one observer will survey for other wildlife using binoculars and naked eyes. Furthermore, opportunistic encounters will be recorded as well. Locals will be interviewed for further information on the presence of other species in the area during the survey as well.

A fishing boat on the Rupsha River, 31 May 2017.

6.1.3 sh and Fishing Gear Survey

This survey will be done three times, in July, October, and November. Fishing communities and fishermen will be targeted for questionnaire surveys to gather information on fish species that are caught in various seasons and types of fishing gear used. Also, direct sampling will be done by visiting fishing boats and collecting data on fish species and fishing gears.

6.1.4 ian Vegetation Survey

For determining the riparian vegetation species diversity, quadrate method will be applied. This survey will be done in October. The size of each quadrate will be considered as 2 x 2 meter.The survey will be conducted 500m zone from the proposed power plant. The detailed methodology is in Appendix 11.

Different types of vegetation alongside the Atai River,31 May 2017.

6.1.5 ace Water Quality Parameters

Water quality samples will be collected and analyzed during monsoon, post-monsoon and winter surveys. The surface water quality parameters are evaluated for physical, chemical, and biological characteristics of aquatic systems in relation to ecological conditions, and designated uses. Before the samples are collected for evaluation, the total area is mapped and ten stations are selected based on the concentration of pollution sources and confluences.

Sample Collection Seasons: Samples will be collected during monsoon, post-monsoon and winter seasons from 10 selected stations to assess the real concentration of different types of pollutants and their spatial distribution.

Sources of pollution at the Rupsha River, 31 May 2017.

Selecting Sample Sites: The first round of water samples will be collected from ten different locations along the entire river course. Spatial information of all sample sites will be collected using a handy GPS to prepare GIS maps. Quality of the river water will be assessed by comparing the selected parameters with the industrial water standard prepared by the Department of Environment (MoEF,1997)[5]. Location information of all the pollution sources as well as water sample collection points should be collected using GPS to develop pollution GIS maps.

Field Measurements: The field parameters, such as water temperature, pH, dissolved oxygen, and specific conductance will be measured using multi-probe instruments. For

[5]MoEF(1997).The Environment Conservation Rules. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh.

each sampling trip, field measurements and observations will be recorded in a field data logbook or on a field data sheet.

For each visit to a specific station where field measurements and samples will be collected, the following information are needed to be noted:

- Station ID,
- Sampling date, location,
- Sampling depth,
- Sampling time, and
- Samplecollector's name.

All measured field parameters and their respective values and observationswill be recorded.

Brick field on the bank of the Atai River, 31 May 2017.

Field physicochemical parameters include part or all of the following:

- Dissolved oxygen,
- Temperature,
- Specific conductance,
- pH, and
- Salinity.

General Observation : It is always important to record field observations to aid in the interpretation of water quality information. Some common observations will be noted:

1) Water appearance: General observations on water might include colour or an unusual amount of suspended matter, debris, or foam.

2) Unusual odours: Examples include hydrogen sulphide, mustiness, sewage, petroleum, chemicals, or chlorine.

3) Observations related to water quality: If the water quality conditions are exceptionally poor, note that standards are not met in the observations—for example; dissolved oxygen is below minimum criteria. Uses may include swimming, wading, boating, fishing, irrigation pumps, or navigation. This type of information may be used in evaluating compliance with standards.

Collecting Samples : The 250 ml plastic bottles were washed properly and rinsed with 1-2 ml 2% industrial HCl. The bottles will be rinsed again with sampled water and will be properly labelled. Aeration during sampling will be avoided as much as possible. The water samples will be carefully transported to the laboratory and will be preserved for physical and chemical analyses. Water samples (including bacteriological) are generally collected before field measurements are taken.

Water samples to be collected at the same location for both bacteriological and chemical analysis. Water samples to be collected at the centroid of flow. The centroid is defined as the midpoint of that portion of the river width which contains 50 percent of the total flow. For river samples, the centroid of flow must be accessible for sampling physicochemical parameters, either by wading, from a bridge, or from a boat. If the water depth at the sampling point is less than 0.5 m, collect samples at a depth equal to one-third of the water depth measured from the water surface. If the water depth is greater than 0.5 m, collect samples at a depth of 0.3 m below the surface.

Sample containers should be new, unused, clean polyethylene containers or glass jars or used laboratory cleaned containers. Prior to sample collection, collectors should rinse containers three times with ambient water and discard water away from the sample location. However, new, unused containers or those cleaned in a laboratory may be used without rinsing.

Collection of Water Samples.

Collecting Water-Chemistry Samples: Examples of routine (baseline) conventional parameters include total suspended solids (TSS), chloride, sulfate, total nitrate, total phosphate (TP), total organic carbon (TOC), and chlorophyll a. Laboratory measured total dissolved solids (TDS) and orthophosphate (OP) are not routine parameters. Both laboratory analyzed TDS and field-filtered OP may be sampled and analyzed as needed for specific purposes.

Sample Preservation :
Ice: Samples must be placed on ice immediately after collection. Place all samples that require cooling only on ice before preserving other samples with acid. Sufficient ice will be needed to lower sample temperature to < 6ºC but not to the freezing point. Sample temperature must be maintained at < 6ºC until delivery to the laboratory. Take care at all times during collection, handling, and transport to prevent exposure of the sample to direct sunlight.

Acid: Label samples requiring preservation with sulphuric acid (H2SO4) in a way that lets the laboratory know that acid has been added. For example, put an X on the container cap to signify that acid was used for preservation, or label container "2 mL H_2SO_4 added." Add approximately 2 mL of 1:1, analytical reagent grade H_2SO_4 to each litre of sample to be analyzed for ammonia, total Kjeldahl nitrogen, total phosphorus, and total organic carbon. This amount is adequate to reduce the pH to less than 2. Maintain the temperature at < 6ºC until arrival at the laboratory. Preservation with acid must occur in the field within 15 minutes of collection. Samples must be cooled to < 6ºC, but should never be frozen.

Surfing of a Ganges River Dolphin at confluence of the Rupsha, Bhairab and Atai Rivers, 23 October 2017.

Water sample for anion and cation analysis: At each sampling point, water will be collected in two different bottles. One will be acidified properly for heavy metal analysis and the other non-acidified water sample was preserved for anion.

Physical properties such as color, odor and temperature, and chemical properties such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand and total dissolved solids are important quality parameters of water. The pH will be determined by digital pH meter (HANNA Instrument 211, Microprocessor pH). Total dissolved solids and electrical conductivity will be determined by digital TDS meter and EC meter (HM digital). Temperature will be determined by Thermometer. Dissolved oxygen will be determined by Winkler's Iodometric method, and biological oxygen demand (BOD) and alkalinity will be determined by titrimetric method as described by Huq and Alam (2005)[6].

There are lots of organic materials in river water. In order to assess BOD and chemical oxygen demand (COD), the organic materials in the river water will needed to be oxidized by oxidizing agent like sulphuric acid, potassium dichromate. Later, titrimetric method will be used after digestion (150°C for 2 hours) and cooling the samples properly. Alkalinity will be measured and reported in terms of CaCO3 equivalent. Analysis of water samples for Cation will be done using AAS machine and the anion using IC machine.

6.1.6 Biological Parameters

Collecting and Analyzing Biological Samples : The indicator organisms used for determining support of the recreation use are Escherichiacoli in freshwater and Enterococcus in marine waters and some saline inland waters. Baseline bacteriological samples should be collected at all monitoring sites under all flow conditions. To maximize the processing time for the laboratory, bacteriological samples will be collectedlast at a site. In streams and rivers, care should be takento find an undisturbed location if other work, like flow or sediment collection, will be done at the site. When collecting samples from a bucket of water (bridge site), the bacteriological sample should be collected before other samples. Water into the bacteriological-sample container will be poured. water-sample containers should never be immersed in the bucket; doing so could introduce contamination.

Sample Collection : Few important measures to be undertaken while collecting samples. They are as follows:

Clean hands: Bacteria samples are the easiest to contaminate. Take steps to help eliminate possible contamination by using either an alcohol-based hand sanitizer that contains at least 60 percent alcohol prior to sample collection or wearing disposable latex gloves when collecting a sample.

Never pre-rinse the sample container: When submerging the sample container, take care to avoid contamination by surface scum. The surface film is enriched with particles and bacteria not representative of the water mass.

*

[6]Huq, S. and Alam, M. (2005).A Handbook on Analyses of Soil, Plant and Water. BACER-DU, University of Dhaka, Bangladesh.

Leave sufficient headspace: The lab needs to mix the sample prior to processing to redistribute bacteria in the sample. Fill the sample container to the top. This allows the lab to process the sample according to their procedures.

Flowing streams: Dip the open sample container to a depth of 0.3 m, or roughly half the depth in very shallow streams. Avoid contact with the sediment. With the open end facing upstream, push the mouth of the bag upstream at this depth until full. Always hold the mouth of the sample container upstream of the sampler, the sampling apparatus, and any disturbed sediments.

Abandoned cargo vessels on the Atai River,31 May 2017.

Sample Labeling : Each sample will be labeled with the sample number, date, and time collected.

Sample Preservation : Place samples on ice immediately after collection. No more than one bacteria sample per gallon of cooler capacity may be placed inside the cooler; these should be evenly spaced inside the cooler and completely covered with wet ice. Cool the samples as quickly as possible to < 6ºC but do not allow the samples to freeze.

Sample Holding Time: Holding time is defined as the amount of time between collection and the initiation of analysis. Plan sample collection so that samples are set up within the required holding time. Do not report samples that are not prepared within the time limit or are reported from the laboratory as exceeding the holding time. Laboratories are required to process bacteriological samples within eight hours of sample collection whenever possible. The 8-hour holding time includes 6 for transporting and 2 for processing. Field personnel should submit samples to the lab within 6 hours when possible. When transport conditions cause delays in sample preparation longer than 8 hours, the holding time may be extended up to 48 hours for E. coli. However, any extension should be minimized.

Foggy condition in the Atai River which affects dolphin sighting on 31 May 2017.

Collecting and Analyzing Phytoplankton and Zooplankton : To identify and quantify phytoplankton and zooplankton in the river water, concentrated one litrewater sample will be collected in plastic bottles by concentrating 20 litres of water into one litre. The water samples will be immediately preserved by adding formalin so that concentration becomes 8%. Water samples will be immediately transported to laboratory and will beworked out to enumerate both phytoplankton and zooplankton.

In the laboratory, water will be taken out with the help of 1 ml pipette and then one drop of it will be spread onto a Sedgewick/Rafter chamber. A cover slip will be placed on the slide. Finally, the slide will be observed under microscope to get results about the abundance of targeted species (Zeiss microscope with digital camera, Nikon).

6.1.7 th

Water depth will be measured in pre-monsoon, monsoon, post-monsoon and winter periods. It will be measured during the dolphin survey. The water depth is measured by an echo-sounder every 1 km on the transects during high and low tides.

An eddy observed where highest depth recorded at the AtaiRiver, 31 May 2017.

6.1.8 Watercraft Survey

Survey for watercrafts and other water transports will be done in monsoon, post-monsoon and winter months in July, October and November, respectively. This survey coincides with three dolphin surveys and will be done simultaneously. The vehicles are categorized as cargo (C), non-cargo (NC), mechanized (M), and non-mechanized (NM).

Motorized cargo vessel carrying sand on the Bhairab River, 31 May 2017.

6.1.9 Pollution Mapping

Sources that will be identified during collection of water samples will be used to produce GIS-based maps, which will show the pollution sources. Along with this, the results from the water samples analysis will be used to produce GIS maps.

Existing power plant by the Bhairab River,31 May 2017.

6.1.10 Assess Potential Impacts and Identify Mitigation Measure

Using the results of the surveys, criteria for determining critical habitat will be analyzed as per IFC Guidance Notes[7]and through various literature reviews, and potential impacts and mitigation measures will be shared.

A portion of fishing area in the Atai River, 31 May 2017.

[7]International Finance Corporation, http://www.ifc.org/wps/wcm/connect/e280ef804a0256609709ffd1a5d13d27/GN_English_2012_Full-Document.pdf?MOD=AJPERES.

6.2 Workplan

The workplan below provides the timeline when each of the activity will be done during the project period (June 2017-February 2018)

Workplan for Biodiversity Assessment																																				
Season	Monsoon																Post-monsoon								Winter											
Month	June				July				August				September				October				November				December				January				February			
Action / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Study team formation, background information collection and mapping																																				
Dolphin Survey																																				
Fish/Fisheries/Fishing Gears/Vegetation																																				
Watercraft																																				
Water quality Parameters Collection and analysis																																				
Mapping																																				
Other Species Survey																																				
Data analysis																																				
Report preparation and Submission																																				
Submission of pre-monsoon and monsoon survey Report												X																								
Submission of post monsoon report(1)																		X																		
Submission of post monsoon report(2)																					X															
Submission of winter survey report																												X								
Final Report																																				X

7. Surveys

The surveys include dolphins, other wildlife, watercrafts, water depth, eddies, fish species, fishing areas, fishing gears, vegetation, and surface water quality parameters and biological parameters.

Post-monsoon survey Dolphin survey 09 November 2017

8. Survey Findings

8.1 Dolphin Survey

A total of 284 sightings of Ganges River Dolphins were recorded during pre-monsoon, monsoon and first post-monsoon surveys (May-October 2017) (Map 1 and Figure 1). The overall encounter rate is 1.18/ km (Table 1).Calculation is in Appendix 1.

In the second winter survey, a group of Irrawaddy Dolphin consisting of four individuals was recorded from Atai river opportunistically. The species is considered globally Endangered and nationally Near Threatened.

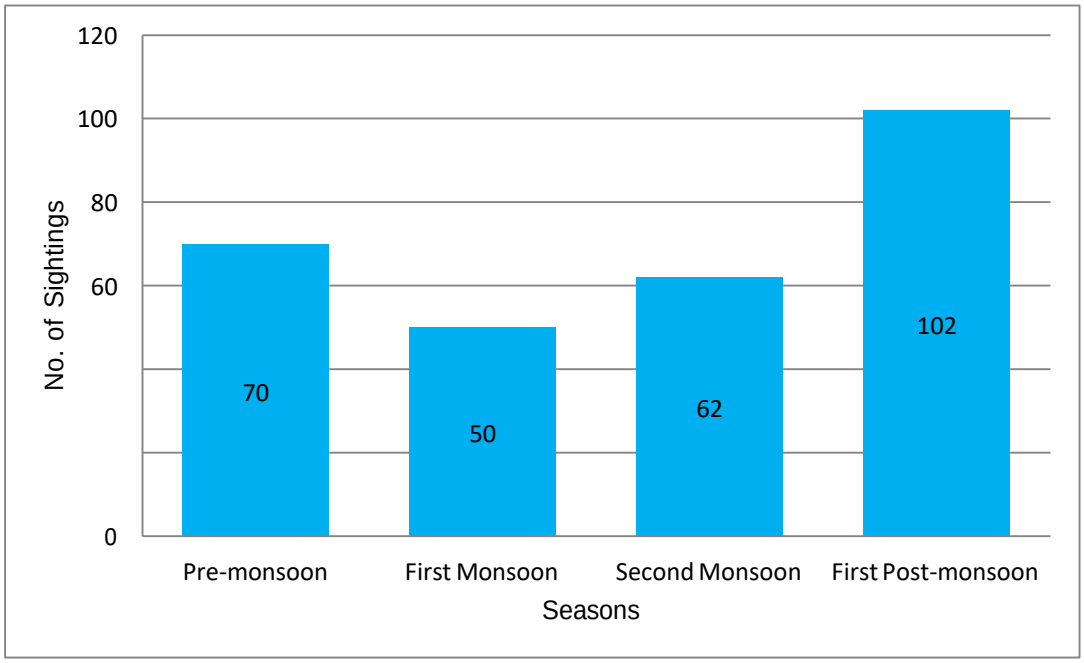


Figure 1. Graph showing seasonal variation of dolphin sightings during the survey period.

Table1. Table showing encounter rates of dolphins in all surveyed seasons and tides.

Survey season	Encounter rate (High Tide)	Encounter Rate (Low Tide)	Encounter Rate (Average)
Pre-monsoon survey	1.40	0.93	1.16
First monsoon survey	1.33	0.33	0.83
Second monsoon survey	1.03	1.03	1.03
First post-monsoon survey	1.23	2.16	1.70
Total	4.99	4.45	4.72
Average	1.24	1.11	1.18

Three surveys were conducted using the mark-recapture method (Details in Section 6.1.1) and the result of three surveys is used in this report.

An average of 47 and 34 dolphins were calculated for the project area by using the 'Chapman's Modified Lincoln-Petersen Mark-Recapture Estimator' and the 'Huggins Conditional Likelihood Model', respectively (Table 2 and 4).

The 'Chapman's modified Lincoln-Petersen Estimator' revealed that the sum of groups detected by both the groups($n_p + n_s$)was always greater than the corrected number of groups(G_c).

$$n_p + n_s > G_c$$

$$G_c = (n_{p+1})(n_{s+1})/(m_{ps} + 1) - 1$$

Where, “n_p”is the number of groups detected by the primary observer team and “n_s” for the secondary observer team. Also, $m_{ps}$is the total number of group detected by both teams

The correction factor 1.26, 1.18 and 1.69 were used for the groups missed by primary and secondary observer team during the second post-monsoon, first winter and second winter respectively. This number was then multiplied with the mean group size to calculate the dolphin abundance in the survey area (A_d). The upper (19) and lower range (8) of dolphin abundance (Table 2)at the 95% confidence interval then calculate using

$$A_d \pm \sqrt{VAR(A_d)} \ .$$

Table2: Estimated dolphin population using Chapman’s Modified Lincoln-Petersen model

Model	Dolphin population		
	Second post-monsoon survey	First winter survey	Second winter survey
Chapman’s Modified Lincoln-Petersen model	28 ~ 58	41 ~ 51	38 ~ 64
No. of Dolphin (Mean)	43	46	52
Average	47		

‘Huggins Conditional Likelihood Model’ has the advantage of incorporating covariates directly into the modeling process by maintaining the link between individual mark-recapture records (here, five occasions were considered) and their respective covariate values (three covariates: group size, channel width, and sighting conditions). So, considering the maximum likelihood Huggins Model, average 34 dolphins were estimated for the study area.

Apparently, the ‘Chapman’s Modified Lincoln-Petersen Mark-Recapture Estimator’ is relative less rigorous and straight forward, as it does not consider the variables. Both the models were done to compare the results.

Although, the ‘Chapman’s Modified Lincoln-Petersen Mark-Recapture Estimator’ showed a little over-abundance than the Huggins Conditional Likelihood Model’, we rely more on the probabilistic ‘Huggins Conditional Likelihood Model’ for estimating dolphin population and Critical Habitat analysis.

Table 3: The number of Ganges River Dolphin detected by the primary and secondary observer teams during search effort in second post-monsoon, first winter and second winter, the number of corrected groups and their associated co-efficient of variations from the Chapman’s modified Lincoln-Petersen mark-recapture estimator.

Second post-monsoon survey					
Ganges River Dolphin	Number of Sighting (Primar	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)

	y Team, n_p)				
Group Size (1)	8	11	7	13	0.069
Group Size (2-3)	8	5	4	10	0.112
Group Size(>3)	2	1	1	2	0
First winter survey					
Ganges River Dolphin	Number of Sighting (Primary Team, n_p)	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)
Group Size (1)	11	7	6	13	0.087
Group Size (2-3)	5	7	4	9	0.113
Group Size(>3)	3	2	2	3	0
Second winter survey					
Ganges River Dolphin	Number of Sighting (Primary Team, n_p)	Number of Sighting (Secondary Team, n_s)	Number of Sighting detected by Both Teams, m_{ps}	Corrected No. of Groups (G_c)	Coefficient of Variation (CV_c)
Group Size (1)	7	7	5	10	0.104
Group Size (2-3)	6	8	4	12	0.158
Group Size(>3)	2	2	1	4	0.247

The 'Huggins Conditional Likelihood Model', in the MARK software, ran to derive the probabilities under closed capture condition. The Horvitz-Thomson estimator was used to calculate the abundance, it was considered that, capture probability equals to recapture probability (p = c), total Dolphin Abundance ($\tilde{N}$) = M_{t+1}.

Nine different models with different number of parameters simulated (built-in models in the MARK software) and compared with the selected model having the lowest AIC value. The likelihood ratio test revealed that the chosen model performs better than other compared models considering both the number of parameters and the AIC value (Appendix 6,7,8).

According to the model result, an average 34 (Table 4) dolphin found in the mark-recapture (closed abundance) analysis. The detailed results, parameters, covariates are summarized in Appendix 3,4,5.

Table 4:Estimated dolphin population using Huggins conditional likelihood model

Huggins conditional likelihood model	**Dolphin population**		
	Second post-monsoon survey	First winter survey	Second winter survey
Lowest AIC Value	123.8927	96.589	106.726
Dolphin number	35	35	32
Average	**34**		

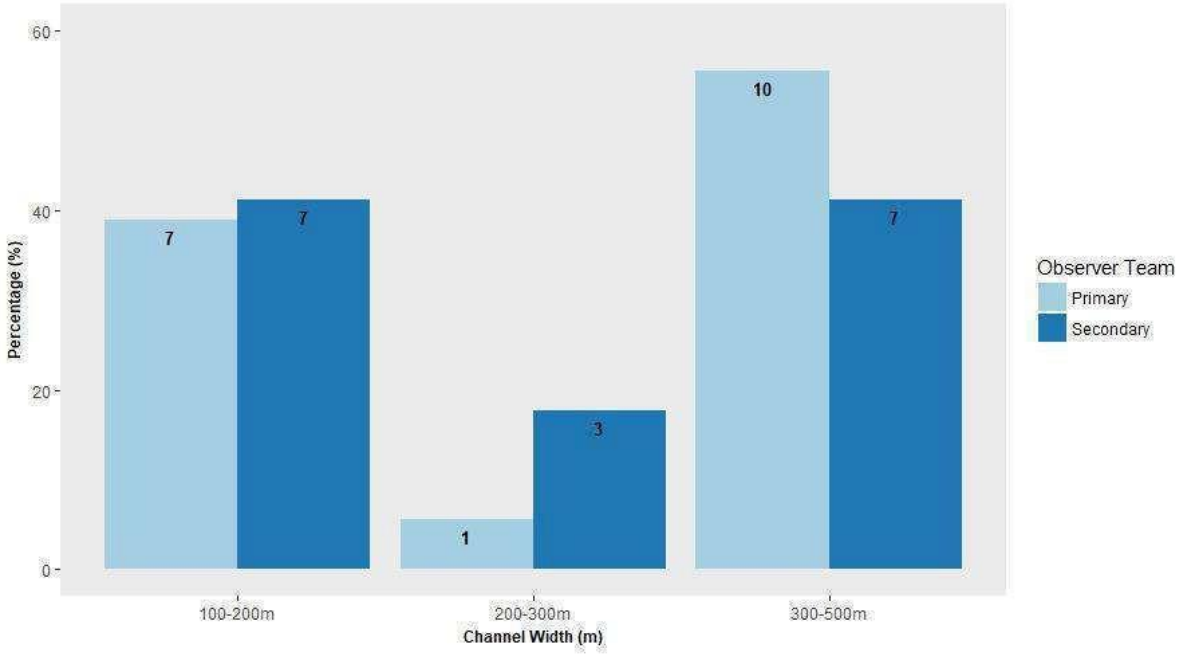


Figure 2. Channel width (m) measured by primary and secondary team during post-monsoon survey

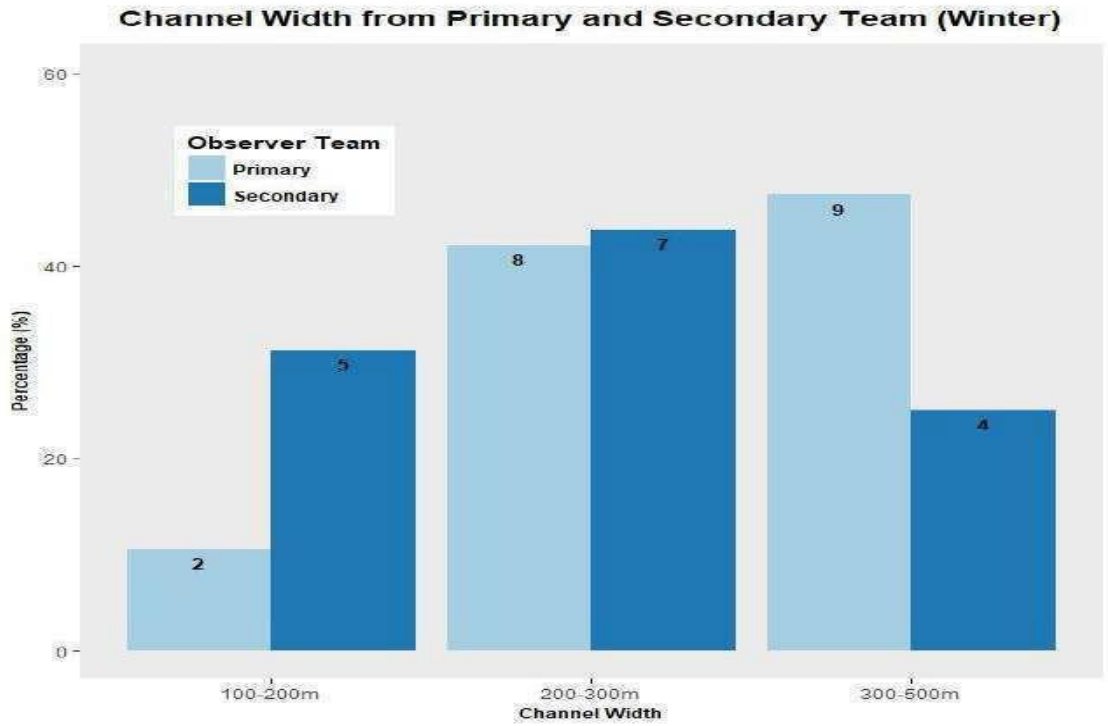


Figure 3. Channel width (m) measured by primary and secondary team during first winter survey

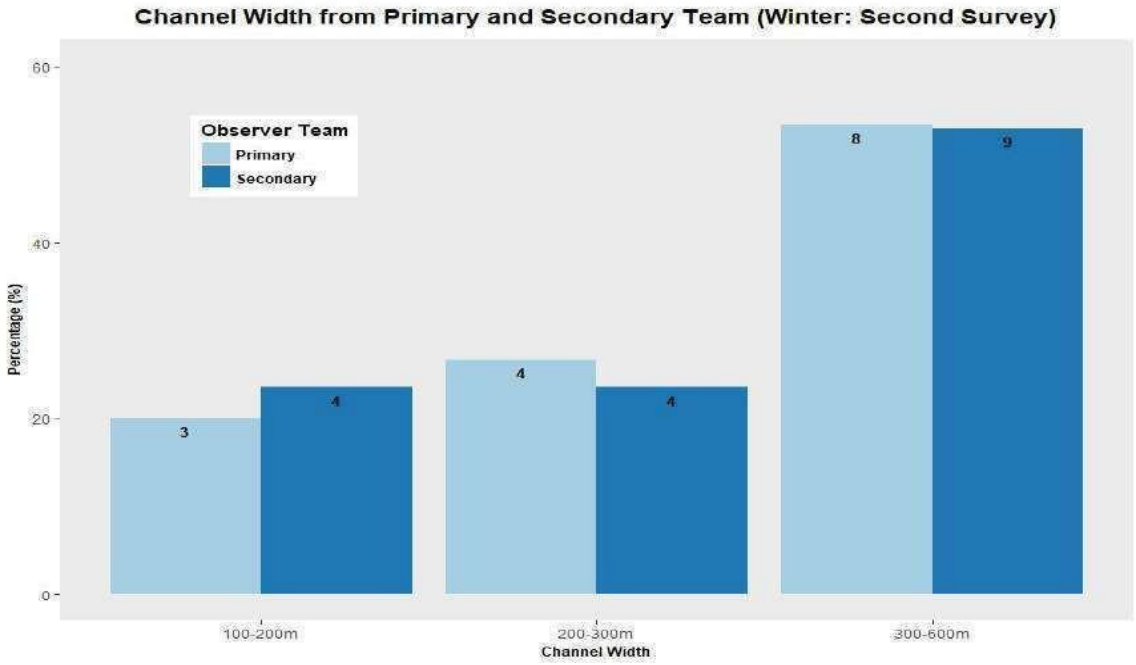


Figure 4.Channel width (m) measured by primary and secondary team during second winter survey

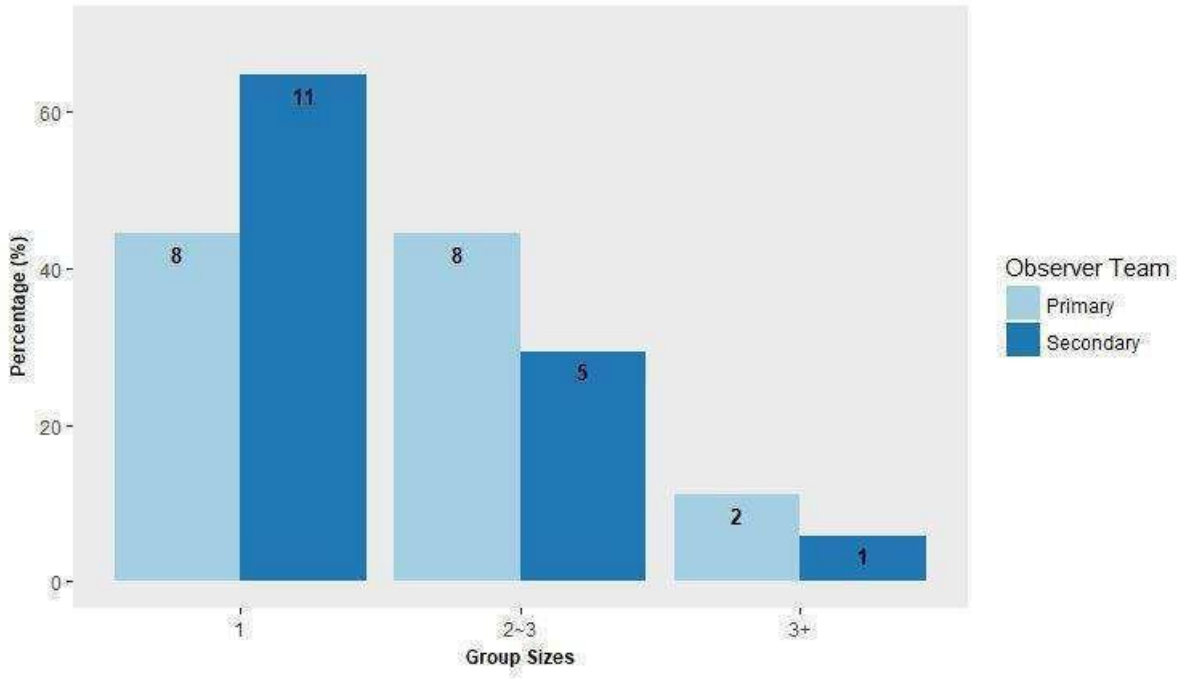


Figure 5. Group sizes recorded by the primary and secondary team during second post-monsoon survey

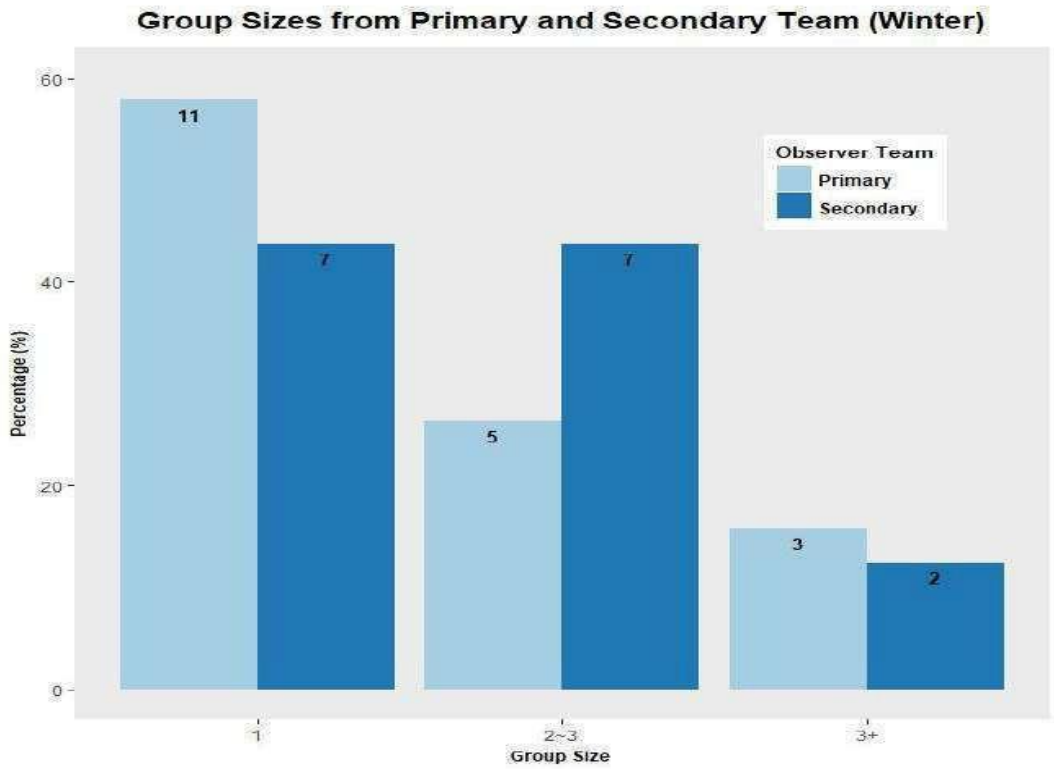


Figure 6. Group sizes recorded by the primary and secondary team during second post-monsoon survey

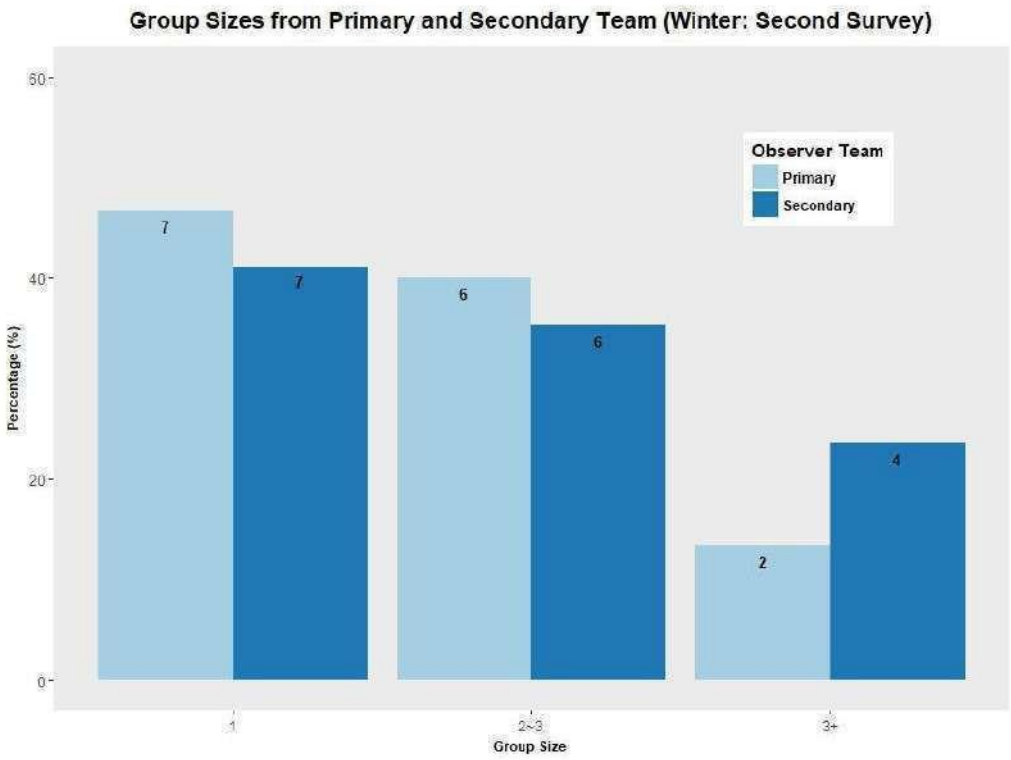


Figure 7. Group sizes recorded by the primary and secondary team during second post-monsoon survey

Important Dolphin Area

From all the surveys, specific areas within the total area have been identified with high concentration of dolphin sighting including calves. The areas can be considered as important dolphin areas based on the number of sightings and considering the channel width and other parameters (Map 3 and Table 5).The most important area is the confluence of Atai-Bhairb-Rupsha Rivers which is c.500m from the project site.

From the surveys, it was understood that the dolphin population in the area is <7.5% of the total known national population. So, the entire 30 km area should be considered as an important area.

Table 5. Details of important dolphin areas

Rank	Name of important dolphin site	Location in Map	Sighting number in pre-monsoon , monsoon and post monsoon surveys
1	Confluence of the Bhairab-Atai-Rupsha	Confluence	75
2	Atai river	Atai	59
3	Near Rupsha bridge	Rupsha 2	47
4	Bhairab-Madhumati Confluence	Bhairab 1	27
5	JelkhanaGhat confluence	Rupsha 1	20
6	Near Daulatapur	Bhairab 2	17

of the global population and the habitat cannot be considered as a discrete management unit. The project site holds less than 0.68% (Table 6) of the global population of the species. Furthermore, the project area is not one of 10 or fewer global discrete management site for this species.

The project site cannot be declared as Critical Habitat under Tier 2 sub-criteria of Criterion 1, as it does not support an regionally important concentration of this species (in comparison to densities of the species elsewhere in Bangladesh and beyond). There is also no other reason to consider the area of significant importance to the species.

Finally, the loss of this habitat will not significantly impact the long-term survivability of the species owing to its small population at the project site compared to global population.

The habitat does not contain nationally important concentration of CR or EN species, as the species is considered nationally Vulnerable.

Lastly, the species is nationally Vulnerable and globally Endangered. If the species was considered as nationally CR or EN, the area would have been considered Critical Habitat under Tier 2 sub-criteria of Criterion 1.

Criterion 2: Endemic and/or restricted-range species

The project site cannot be considered as Critical Habitat under Criterion 2, as there was no record of any endemic or restricted-range species from the surveys.

Criterion 3: Migratory and/or congregatory species

The project site cannot be considered as Critical Habitat under Tier 1 of Criterion 3 as no migratory or congregatory species were recorded whose ≥ 95% population relies on this habitat.

The project site cannot be considered as Critical Habitat under Tier 2 of Criterion 3, as the project site were fulfill the standers of Tier 2.

Criterion 4: Highly threatened and/or unique ecosystems

The project site cannot be considered as Critical Habitat under Criterion 5, as it cannot be considered as a highly threatened and/or unique ecosystem under the given standards.

Criterion 5: Key evolutionary processes

The project site cannot be considered as Critical Habitat under Criterion 5, as area does not fulfill the standards set under criterion.

Critical Habitat for Fish and Other Wildlife

A total of 6 species of fish were found to be included in the recently published National IUCN Redlist (2015). These six fish species have EN status as per the National RedList, but the global status of these 6 species are: four Least concerned (LC) and two Near threatened (NT)(Detail Appendix 10). The data collected on these species is inadequate to analyze the species abundance as well as Critical Habitat. Due to the unavailability of the data, the Critical Habitat analysis was done using the national/regional range of these species as a proxy. When considering the range of the species, the project site cannot be considered as critical habitat for these species. Details in the Table 6a.

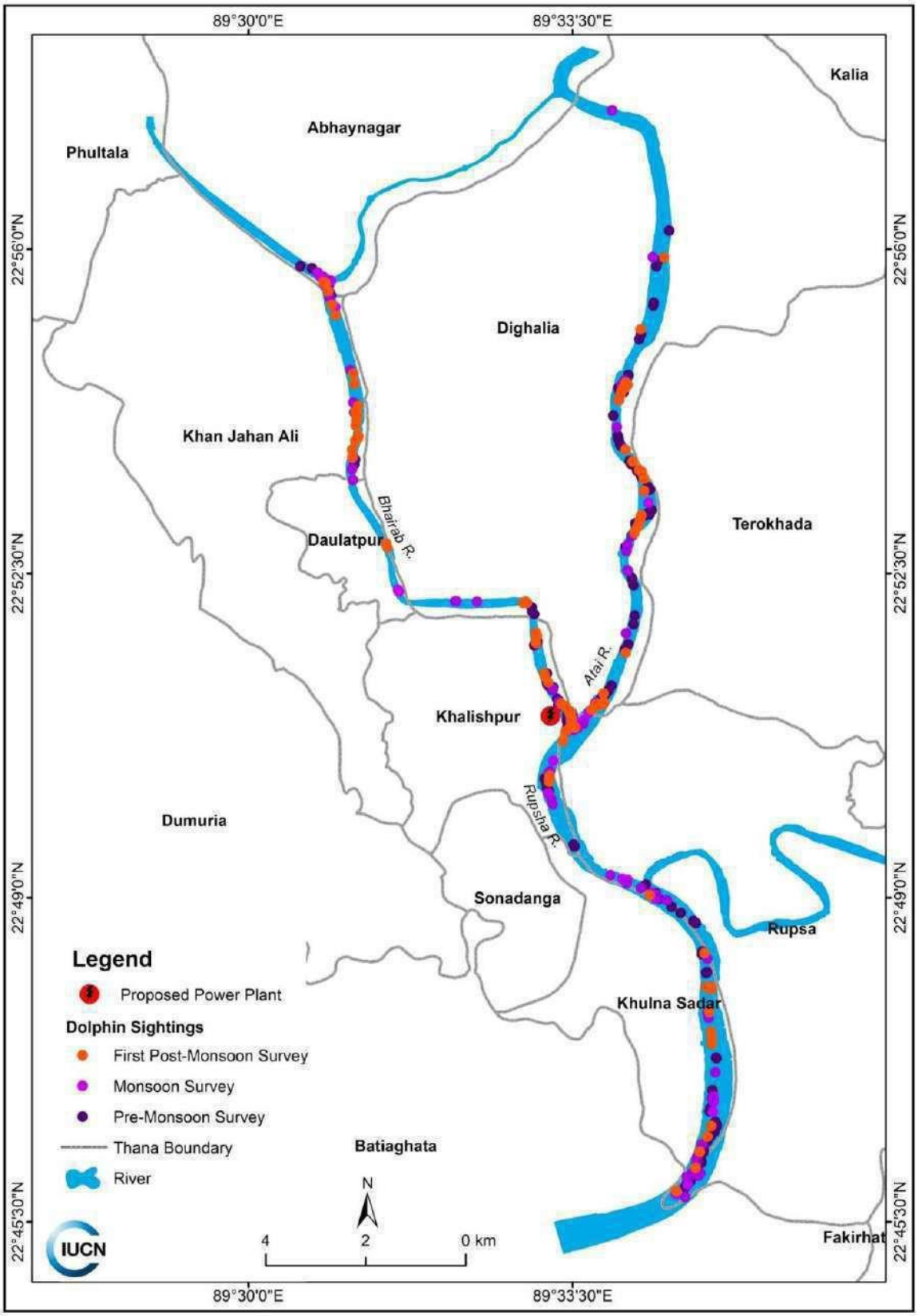
Regarding Smooth-coated Otter, we have no direct evidence/sighting during field survey period. Due to the unavailability of the data, the Critical Habitat analysis was done using the national/regional range of these species as a proxy. When considering the range of the species, the project site cannot be considered as critical habitat for these species.

Regarding Irrawaddy Dolphin, only one sighting of a group consisting of four individuals was recorded. This sighting was only during the second winter survey. There was no other sightings from previous six surveys. Although the species is globally Endangered, and nationally Near Threatened, the population in the project area is not large enough to fall under any criterion of Critical Habitat. The national population of this species is around 6000 individuals (IUCN 2015).

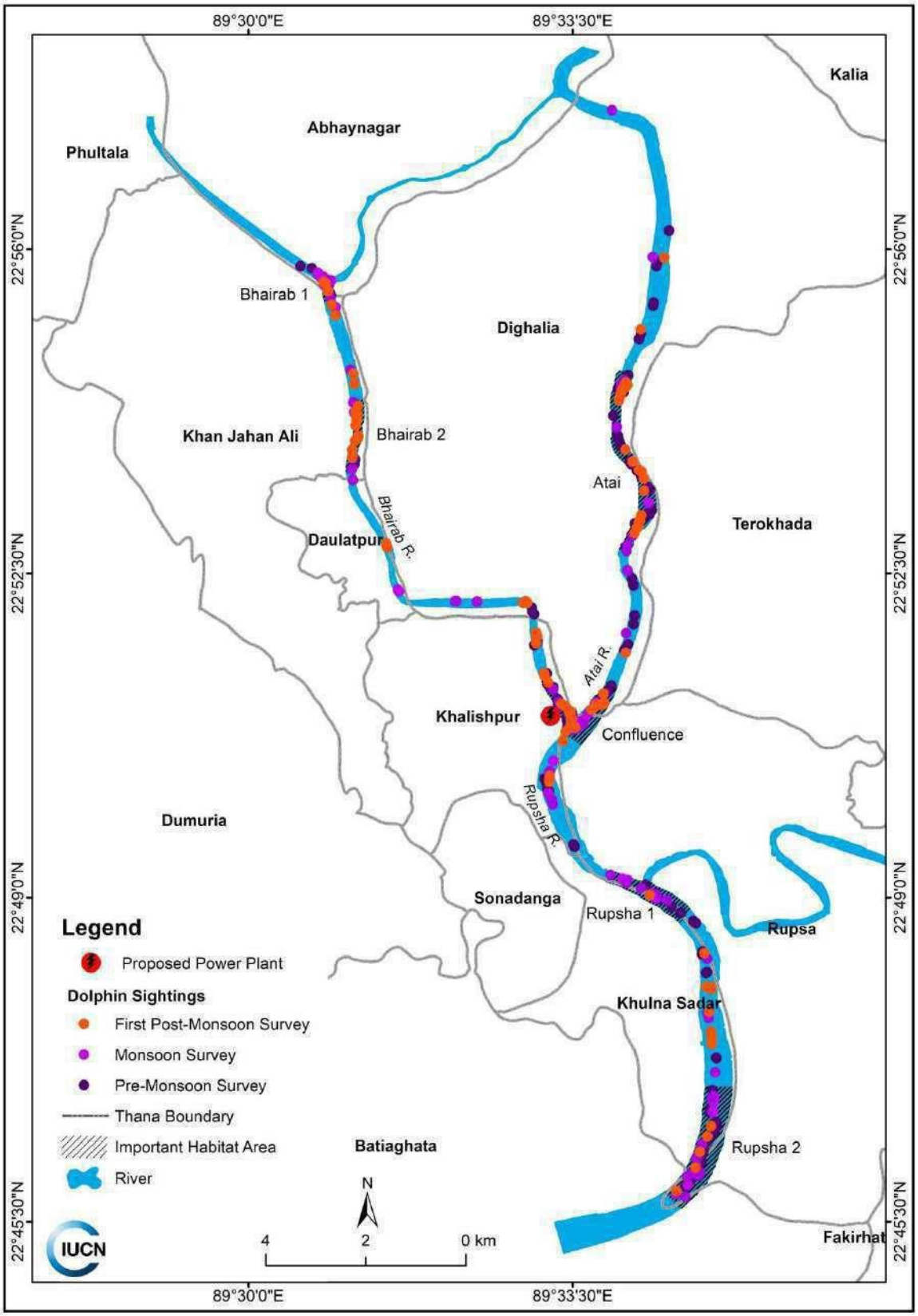
Table.6a. Species distribution range in Bangladesh

Species Name	Distribution range in Bangladesh (IUCN 2015 Redlist)	Remarks
Smooth-coated Otters(Lutrogale perspicillata)	This species is mainly found in hilly areas of northeast, southeast coastal region with the largest population is in Sundarbans. The total extent of occurrence is 1,34,973 km^2	Although the species is considered as CR nationally, it still has a large area of occupancy, and thus cannot be considered for the Critical Habitat assessment. Furthermore, there have no direct evidence/sighting during field survey period. Interviews of local people were held and only one person had claimed(out of 6 interview surveys) that the species was sometimes found in the area
Fish		
Tire-track Spinyeel (Mastacembelus armatus)	Found in rivers, canals, beels, ponds, and inundated fields throughout Bangladesh. The total extent of occurrence is 2,17,468 km^2	Although the species is considered EN nationally, the species has a fairly large area of occupancy and found throughout Bangladesh. Considering

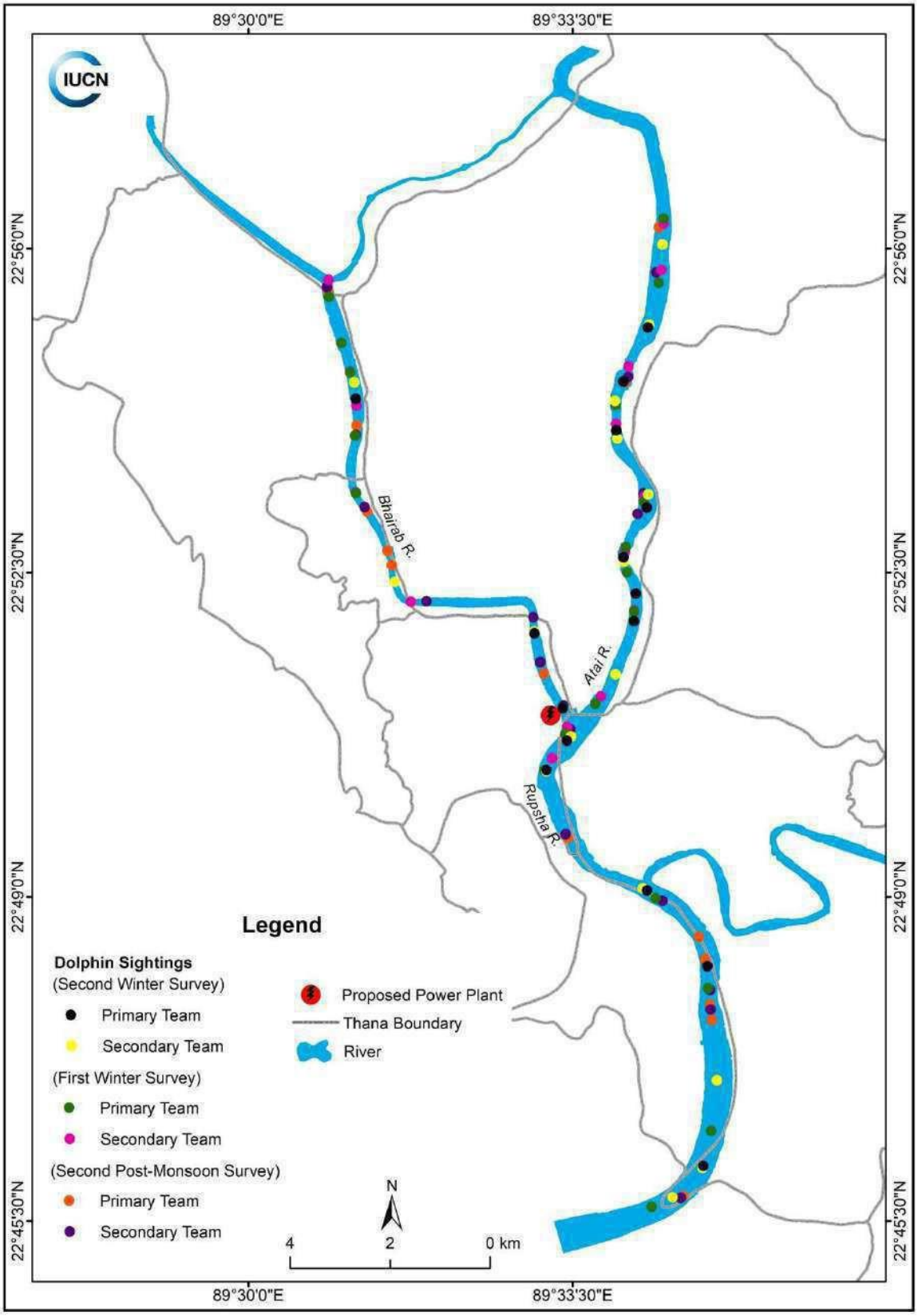
		the range of this species, the area cannot be considered CH for this species.
Humped Featherback (Chitala chitala)	Considered as a widely distributed species in rivers, beels, haors, reservoirs, canals and ponds. The total extent of occurrence is 1,31,403 $km^{2.}$	The species is recorded through interview survey (2 out 3 surveys) and there was no direct evidence of the project site. Furthermore, the species is widely distributed through out the country and considering the range and area of occupancy, this species, the area cannot be considered CH for this species.
Giant Snakehead (Channa marulius)	The Padma, Padma distributaries, Borulia haor (Nikli, Kishorganj), Mahananda, Choto Jamuna, Ichanoi Beel (Gaibandha), Dogger Beel (Chandpur), Titas, larger haors in Greater Sylhet and Mymensingh Districts, beels and larger water bodies in Dhaka, Manikganj and Tangail Districts. The total extent of occurrence is 70254 $km^{2.}$	The species is recorded through interview survey (1 out 3 surveys) and there was no direct evidence of the project site. According to the national distribution, this species is not found in or near the project area.
Pabda catfish (Ompok pabda)	The species is widely distributed throughout Bangladesh and reported from Padma, Jamuna, Meghna, Surma, Kushira, Manu Ichamati, Banglali, Turag, Baral, Choto Jamuna, Mahananda, Muhuri, Barnai and Titas Rivers Feni Reserviour, Tanguar Haor, Hakaluki Haor, Chalan Beel and Medha Beel. The total extent of occurrence is 1,21,601$km^{2.}$.	The species has a large EOO and found throughout Bangladesh. Considering the range of this species, the area cannot be considered CH for this species.



Map2. Map showing dolphin sightings of pre-monsoon, monsoon and first post-monsoon surveys along the three transects



Map 3. Map showing important dolphin areas in the project area.



Map4. Map showing dolphin groups observed by primary and secondary team in the second post-monsoon and winter survey along the transect

8.2 Other Wildlife

Other wildlife includes a total of 41 species of birds among which are 8 are migratory species and four other species (Water Monitor, Indian Flying Fox, Smooth-coated Otters and Irrawaddy Dolphin) were recorded during the survey period. The highest number of species recorded was from monsoon (28 species) followed by post-monsoon (26 species), winter (17 species) and pre-monsoon (11 species). The highest number counted was of Little Cormorant with 241individuals. Details are in Appendix 9.

8.3 Watercraft Survey

Watercrafts were also counted during the survey period. A total of 676 watercrafts comprised of mechanized and non- mechanized were recorded. The highest was mechanized boats with a total of 373 from all surveys. Rupsha River had the highest number of water vessels with a total of 253, followed by Atai River with 225 and Bhairab River with 198. The details of water vessels are given in (Table 7).

Table 7. Table showing number water vessels recorded during the surveys.

Survey season		Non-Cargo		
	Cargo	Mechanized	Non-mechanized	Total
Pre-monsoon survey	11	32	19	62
First monsoon survey	20	53	62	135
Second monsoon survey	8	71	15	94
First post-monsoon survey	40	90	42	172
Second post-monsoon survey	19	30	9	58
First winter survey	06	52	11	69
Second winter survey	32	45	9	86
Total	136	373	167	676

8.4 Water Depth

Water depth was measured along transects every 1km intervals using an echo-sounder. Table 8 presents the details of the water depth surveys.

Table 8. Table showing the water depth recorded during the surveys.

Transect	Tide	Pre-monsoon		Monsoon (1st & 2nd monsoon average)		Post-monsoon	
		Max	Min	Max	Min	Max	Min
Rupsha	High	34.4	3	22.75	8.8	30.8	8.2
	Low	23.9	10	27.1	8.8	29.3	11.9
Bhairab	High	20.1	6.6	12.65	6.45	13.5	5.2
	Low	17.3	6.3	12.95	5.65	19.5	5.9
Atai	High	30.4	18.7	32.1	8.65	27.6	6.8
	Low	24.3	6.6	43.9	9.8	34.6	10

8.5 Eddy

Eddies were recorded in five surveys in the project areas. The number of eddies found in each rivers in high and low tides in the surveys is presented in Table 9.

Table 9. Table showing number of eddies in each river during five surveys

Transect	Tide	Pre-monsoon	First monsoon	Second monsoon	First post-monsoon	Second post-monsoon
Rupsha	High	0	0	0	0	0
	Low	0	1	0	0	0
Bhairab	High	0	0	0	0	0
	Low	0	0	0	2	0
Atai	High	0	0	0	0	0
	Low	4	3	4	6	5

8.6 Fishing Gear and Fishing Area

Fishing at Atai River, 09 November 2017. ©IUCN/ A B M Sarowar Alam.

A total of 19 types of fishing gears were recorded in the three seasons that were surveyed. Table 10 shows types of gears used in the project areas. Fishermen catch fish in the rivers by using different types of fishing gears as mentioned below. Among these, small-mesh drifting gill net (jatkailishjal), monofilament gill net (current jal), set bag net (bheundi jal) and long shore net (charpatajal) are widely and illegally used for fishing. The mesh size of small-mesh drifting gill net and monofilament gill net is very small. The hand set bag net and long shore net are zero mesh size net. These net are used to catch eggs, spawn and larvae of all the fish species along with adult fish. Fishing areas were identified and a map was prepared. Map 5 shows the identified fishing areas of the three transects.

Table 10. Table showing the types of fishing gears recorded from the surveys.

S.N	Gear Type	Local Name	Operational Fishermen	Monsoon	Post-monsoon	Winter
1	Big-mesh drifting gill net	Ilishjal	2 or 3	√	√	√
2	Small-mesh drifting gill net	Jatkailishjal	2	√	√	√
3	Medium–mesh drifting gill net	Faksha/Poajal/Phasajal	2 or 3	√	√	√
4	Monofilament gill net	Current jal	2	√	√	√
5	Long shore net	Charpatajal	2	√	√	√
6	Creek net	Khalpatajal	2	√	—	—
7	Set bag net	Behundi/Bhadajal	2 or 3	—	√	√
8	Drag net	Moijal	1	√	—	√
9	Hand push net	Thelajal	1	√	—	—
10	Post-larvae seine net	Parse ponarjal	2 or 4	√	√	—
11	Large lift net	Vesaljal	2 or 3	√	—	√
12	Small lift net	Saine/Khotjal	1	√	√	√
13	Cast net	Jhaki/Kheplajal	1	√	√	√
14	Drag net	Pangaserponarjal	2 or 3	√	—	√
15	Gill net	Pangaserjal	2 or 3	√	√	√
16	Long line with many hooks	Doriborshi/Donborshi/Tanaborshi	2	√	√	—
17	Hook and rod	Chhipborshi	1	√	—	—
18	Hand fishhook	Hath borshi	1	—	√	—
19	Box trap	Chai	1 or 2	—	—	√

Table 11. Ranking of five most abundant species in the study area

Species rank	Species name	Tree/ha
1	Syzygiumcumini L.(Jam)	317
2	Areca catechu L. (Supari)	233
3	Cocosnucifera L. (Narkel)	200
4	LanneacoromandelicaMerr. (Jial)	167
5	Mangiferaindica L. (Aam)	133

Cocosnucifera L. (Narkel), Mangiferaindica L. (Aam), Swieteniamahagoni (L.) Jacq. (Mehgoni), FicushispidaL.f. (Dumur) and Leucaenaleucocephala (Lam.) de Wit (Ipilipil) are the five high frequency species in the study area. Natural regeneration is higher and frequently available in the study area. The natural regeneration is occurred by the mother tree available here. The regeneration is higher in the newsprint mill area because of fewer disturbances by the human.

Table 12.List of identified species in the study site

Sl. No.	Scientific Name	Family
1	Cocos nucifera	Palme
2	Mangifera indica	Anacardicaea
3	Swietenia mahagoni	Annonaceae
4	Ficus hispida	Moraceae
5	Leucaena leucocephala	Leguminoceae
6	Phoenix sylvestris	Palmae
7	Albizia saman	Leguminoceae
8	Dalbergia sissoo	Leguminoceae
9	Phyllanthus emblica	Euphobiaceae
10	Spondias pinnata	Anacardiaceae
11	Terminalia arjuna	Combretaceae
12	Ziziphus mauritiana	Rhamnaceae
13	Aegle marmelos	Rutaceae
14	Punica granatum	Lythraceae
15	Polyalthia longifolia	Meliceae
16	Terminalia chebula	Combretaceae
17	Syzygium cumini	Annonaceae
18	Lannea coromandelica	Anacardiaceae
19	Trema orientalis	Ulmaceae
20	Ficus racemosa	Moraceae
21	Limonia acidissima	Rutaceae
22	Citrus aurantiifolia	Rutaceae
23	Artocarpus heterophyllus	Myrtaceae
24	Azadirachta indica	Meliaceae
25	Elaeis guineensis	Arecaceae
26	Psidium guajava	Myrtaceae
27	Moringa oleifera	Moringaceae
28	Areca catechu	Palme
29	Borassus flabellifer	Palmae

Table 13.Water sample collection along the transects with GPS coordinates and major infrastructure on the river bank.

Stations	GPS Co-ordinates		Major infrastructures in the River bank
	Latitude	Longitude	
Station 1 (Rupsha)	22°47.115' N	89°34.958' E	Khulna shipyard, Seven ring cement industry, Fish processing zone
Station 2 (Rupsha)	22°49.060' N	89°34.281' E	Jelkhanaghat, Purobi Salt Factory
Station 3 (Rupsha)	22°49.719' N	89°33.400' E	5 no. fishery ghat, goods load and unload zone
Station 4 (Confluence)	22°50.898' N	89°33.459' E	Brick field, Khalishpurghat, Power plant
Station 5 (Bhairab)	22°52.174' N	89°32.243' E	Padma, Meghna and Jamuna petroleum industry, Jute mill
Station 6 (Bhairab)	22°53.857' N	89°31.130' E	CSD ghat, F.R. jute mil
Station 7 (Bhairab)	22°55.352' N	89°30.921' E	Sheikh cement industry, Brick field
Station 8 (Atai)	22°55.968' N	89°34.370' E	Human settlements
Station 9 (Atai)	22°53.924' N	89°34.051' E	Human settlements, Brick field
Station 10 (Atai)	22°51.758' N	89°34.052' E	Brick field, human settlements

8.10 Water Quality Test Result

Physio-Chemical Parameters

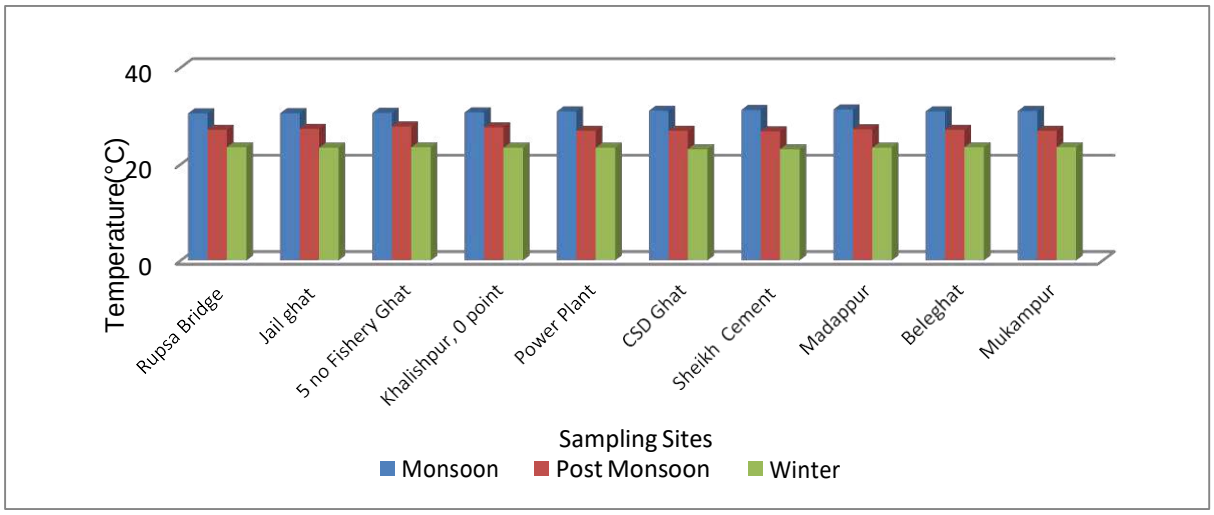


Figure 8. Temperature at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 8illustrates the temperature difference during thethree different time periods i.e. monsoon,post-monsoon and winter season of different river points of the study area. The highest temperature difference was found in Madappur point. The mean

temperature value in monsoon,post-monsoon and winter season was 30.87°C, 27.17°C and 23.38°C, respectively. However, the temperature was found within the permissible limit for both monsoon and post-monsoon season.

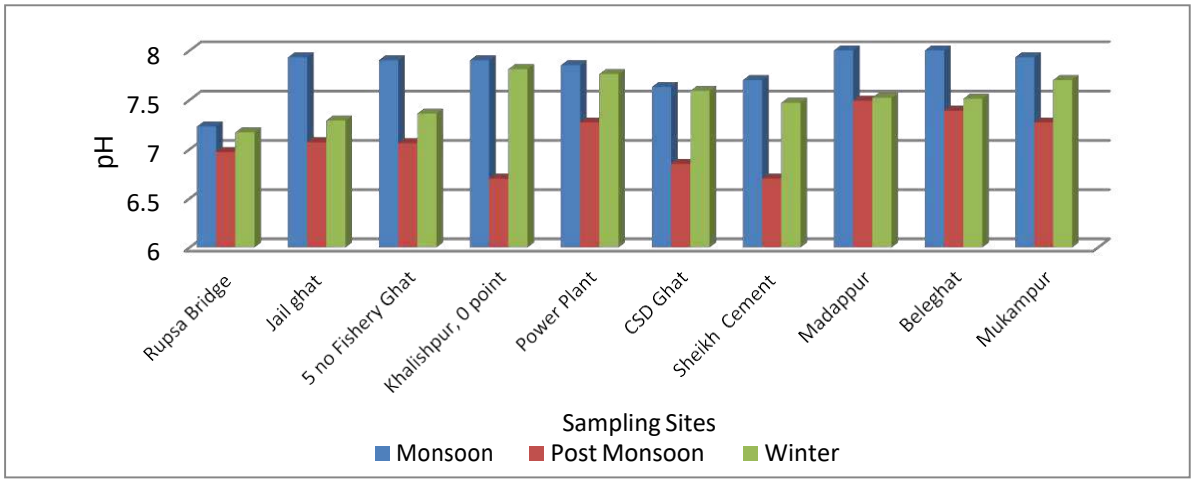


Figure 9. pH at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 9illustrates the pH values during monsoon, post-monsoon and winter season at different sample points of survey area. The pH value did not cross the standard value for Bangladesh in all three seasons. The average pH value was found a bit higher in monsoon season (mean value 7.8) than that of both post-monsoon season (mean value 7.07) and winter season (mean value 7.52). The maximum pH value in monsoon and post-monsoon seasons was found in Madappur Point. But in case of winter season, the maximum pH value (7.81) was found in Khalishpur Zero Point. The mean pH value in monsoon, post-monsoon and winter season was 7.807, 7.077 and 7.518 respectively. The cause of such may be related to the effluent water discharge from the cement factory. The standard pH value of surface water ranges from 6.5-8.5 (ECR, 1997).

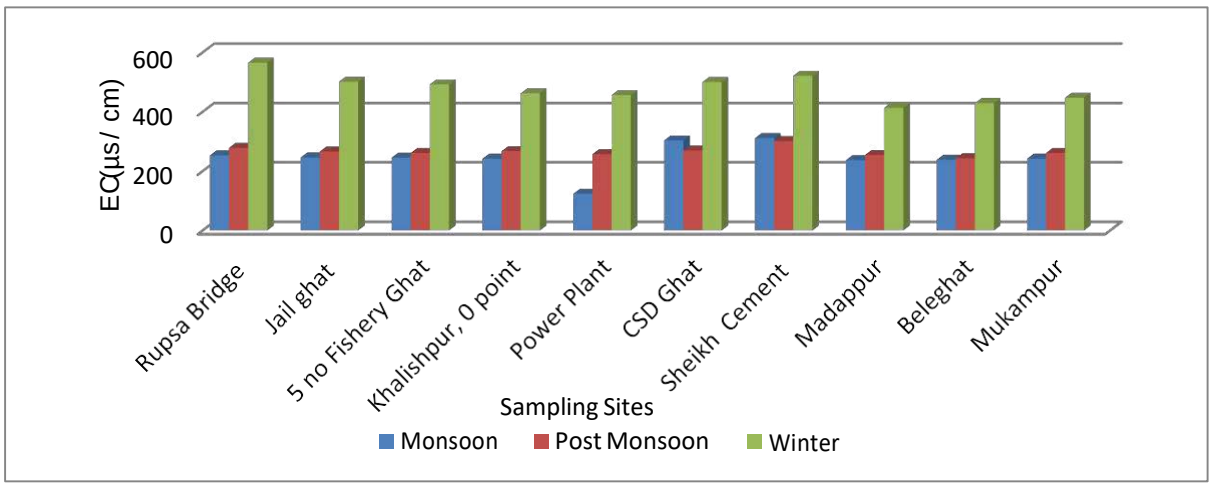


Figure 10. Electrical conductivity at the sample sites of the project area in monsoon, post-monsoon and winter/dry season surveys.

Figure 10 illustrates the EC values during dry, post-monsoon and monsoon season at different sample sites of project area. The EC value was found very high in dry season than that of the monsoon and post-monsoon season. Highest value of electrical conductivity (565) was found in Rupsha Bridge point. The mean EC value in monsoon, post-monsoon and dry season was 243.8, 265.7 and 478.6, respectively. However, in all other sample points, the EC value was below the standard EC value of river water for Bangladesh.

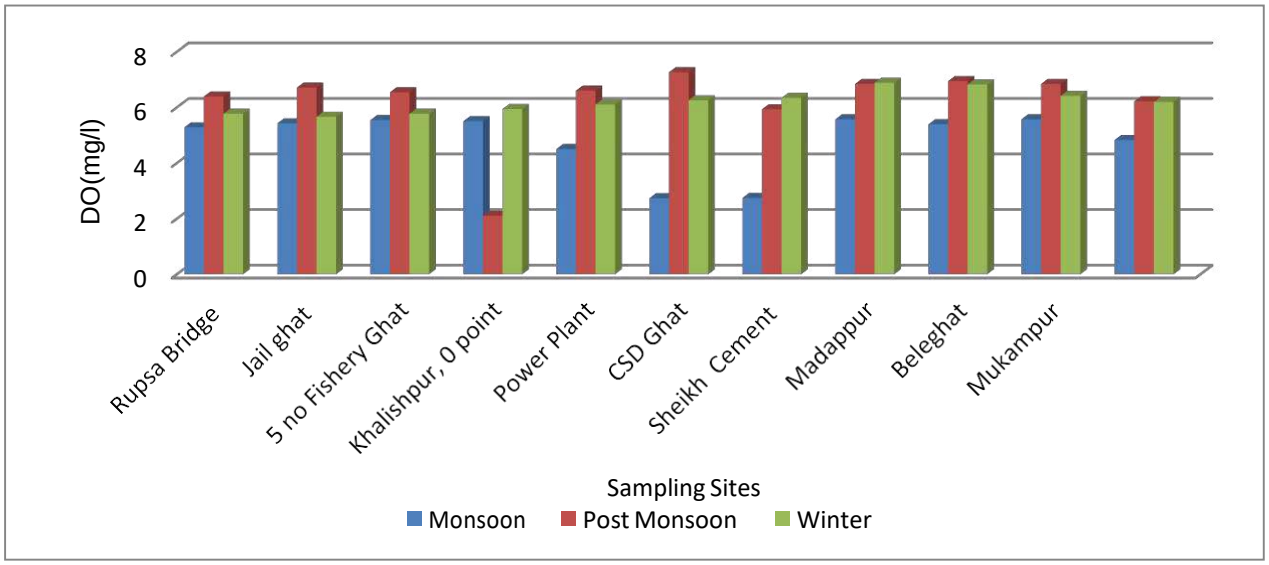


Figure 11. Dissolved oxygen at the sample sites of the project area in monsoon, post-monsoon and winter season surveys.

Figure 11 illustrates the DO values during dry, post-monsoon and monsoon survey at different sample sites of the study area. As we know, the level of Do required for survival of aquatic life is between 5 to 6 mg/l and DO level below 1.0 mg/l will not support any aquatic species. DO in the sampled water was found satisfactory during monsoon season. However, this concentration increases for all sample location in both post-monsoon and dry seasons with a maximum concentration at CSD Ghat (i.e. 7.26) in post-monsoon season and at Madappur point (i.e. 6.88) in dry season. The average concentration of DO in post-monsoon season was 6.22 mg/l whereas it was 4.8 mg/l in monsoon season and 6.19 mg/l in dry season. Therefore, it can be said that the concentration of Dissolved Oxygen (DO) was found higher in post-monsoon season and winter season and thus indicates water pollution at moderate level in the sampled river water.

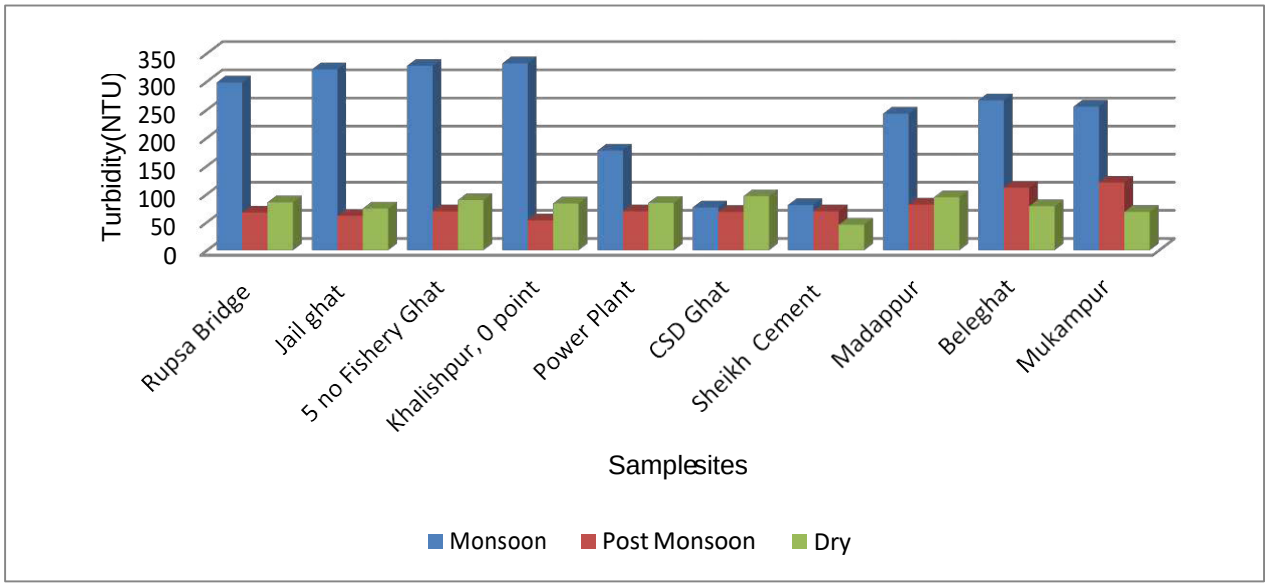


Figure 12. Turbidity at the sample sites of the project area in area in monsoon, post-monsoon and winter/dryseason surveys.

Figure 12 illustrates the turbidity values during dry, post-monsoon and monsoon surveys at different sample sites of project area. Though in dry and post-monsoon season turbidity was found almost steady at all sampled locations, it varied widely in the monsoon season with highest concentration at Khalishpur (327 NTU). The mean Turbidity value in monsoon, post-monsoon and winter season was 237.62 NTU, 76.8 NTU and 79.62 NTU, respectively.

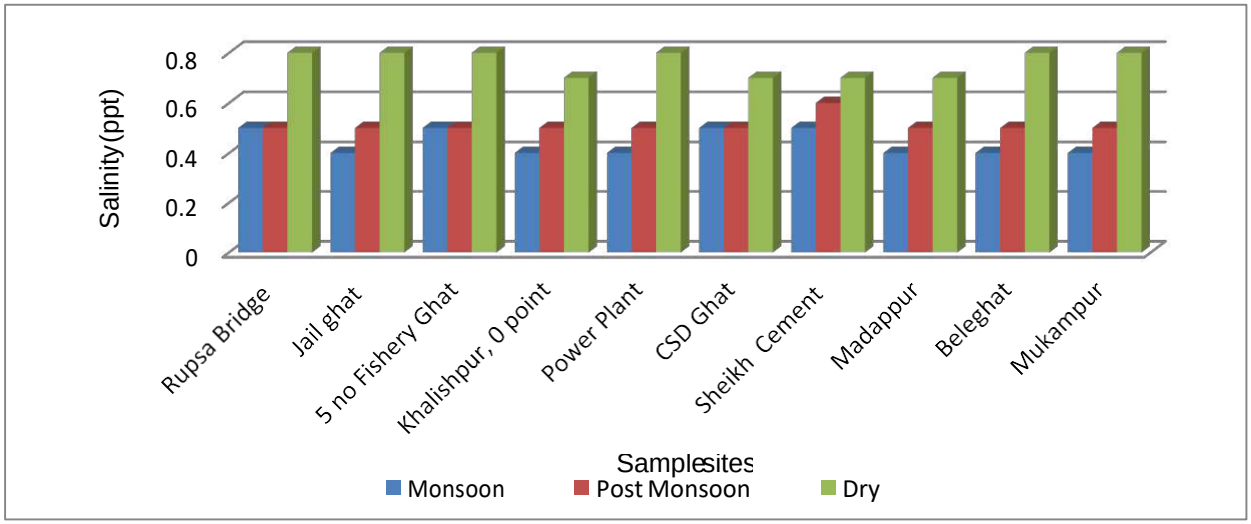


Figure 13. Salinity at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 13 illustrates the difference in salinity during dry, post-monsoon and monsoon season at different sample sites of the project areas. The salinity concentration in the river water was found higher in winter season, whereas slightly higher in post-

monsoon season than in monsoon season. The mean salinity concentration in monsoon, post-monsoon and dry season was found 0.44, 0.51 and 0.76, respectively.

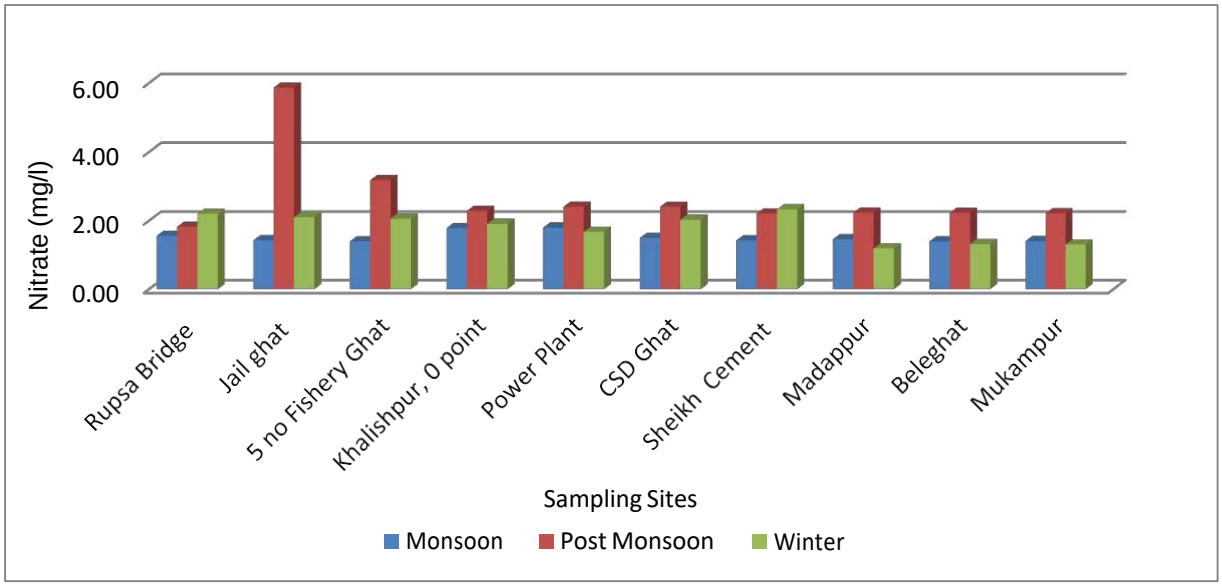


Figure 14. Nitrate value at the sample sites of the project area in area in monsoon, post-monsoon and winter season surveys.

Figure 14 illustrates the nitrate values during dry, post-monsoon and monsoon surveys at different sample sites of the project areas. Nitrate concentration of sample water ranges from lowest of 1.40 mg/l to a maximum 1.80 mg/l in the monsoon, from a lowest of 1.82 mg/l to a maximum of 5.87 mg/l in post-monsoon and from a lowest of 1.19 mg/l to a maximum of 2.20 mg/l in winter season. The standard nitrate value is 10 mg/l. The post-monsoon season nitrate concentration was found a little bit higher than that of the monsoon and dry season (2.68, 1.51 and 1.81 mg/l, respectively). This small amount of nitrate was probably coming from the adjacent agricultural land. However, the highest concentration of nitrogen was found in Jail Ghat (5.87 mg/l) and the probable cause might be the obvious direct discharge of agricultural waste into the river.

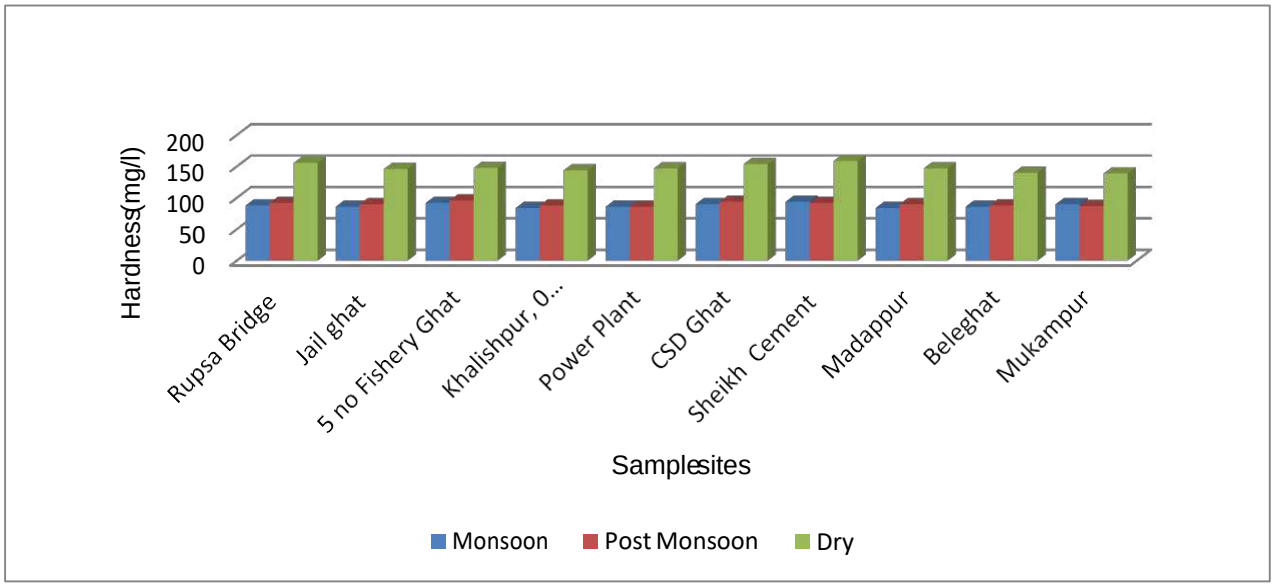


Figure 15. Hardness at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 15 illustrates the hardness value during winter, post-monsoon and monsoon season at different sample sites of project area. Significant difference in hardness of the river water was found between post-monsoon and monsoon season with dry season. The mean Hardness value in monsoon, post-monsoon and dry season was found 88, 90.3 and 148, respectively. Highest value of Hardness (i.e. 159 mg/l) was found in Sheikh Cement point at winter season.

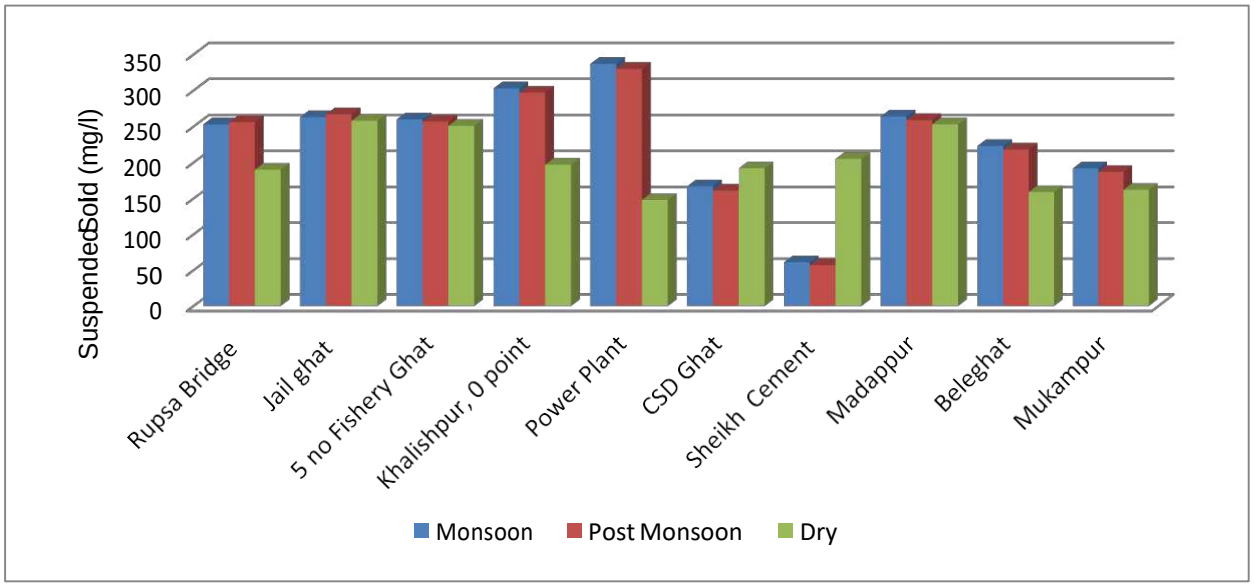


Figure16. Suspended solid at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 16 illustrates the suspended solid values during post-monsoon and monsoon season at sample sites of project area. Concentration of suspended solid was found higher than the standard value (150 mg/l) at all sample sites, irrespective of the season. However, no significant seasonal difference was found in concentration of the suspended solid. The average suspended solids in post-monsoon and monsoon season was 228.9mg/l and 232.3 mg/l, respectively.

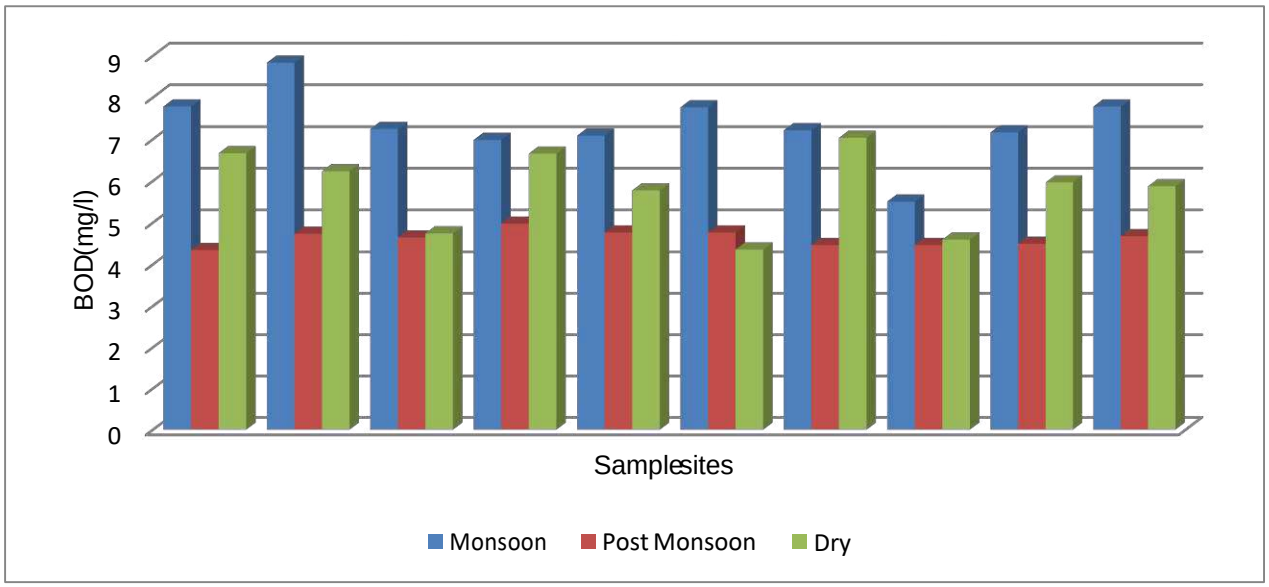


Figure 17. Biological Oxygen Demand at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 17 illustrates the BOD values during winter, post-monsoon and monsoon season at different sampled sites of the project area. The standard limit of BOD concentration in surface water is 50mg/l. None of the water samples collected in the dry, post-monsoon and monsoon season crossed the standard value for BOD. However, it is observed from the data that the BOD level in monsoon season decreases compared to other seasons. The average BOD level was 7.33, 4.62 and 5.8 mg/l of monsoon, post-monsoon and dry season, respectively. The maximum difference in BOD concentration was found in Jail Ghat location (8.83 mg/l). However, the overall BOD concentration in the river water was found satisfactory and it was well below the standard limit for surface water quality.

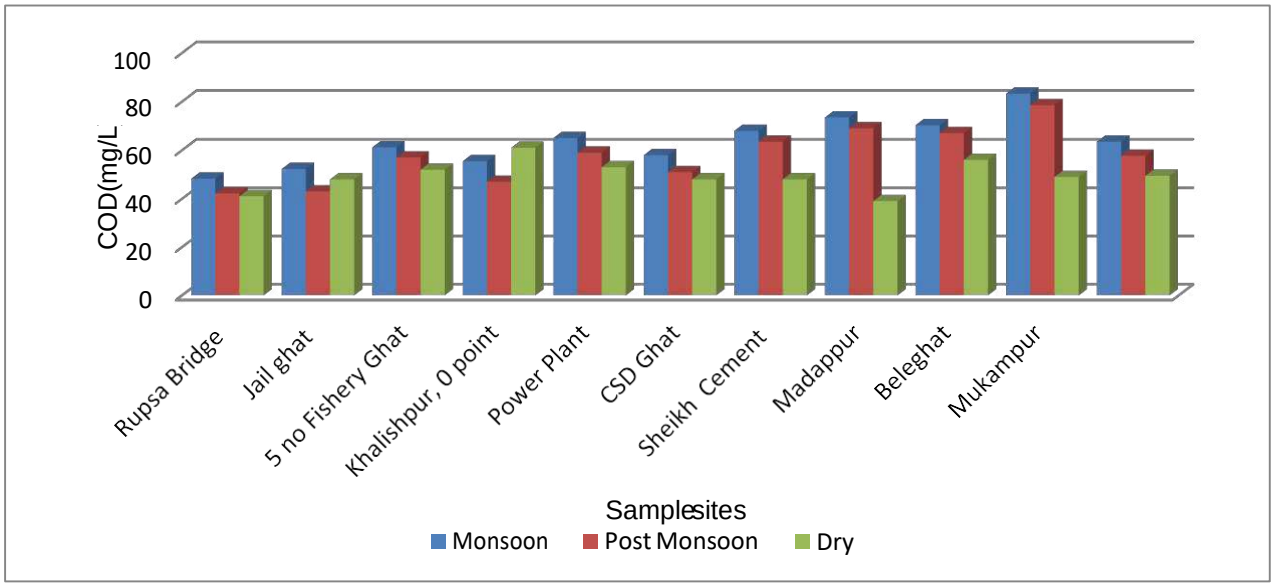


Figure 18. Chemical Oxygen Demand at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 18 illustrates the difference in COD value during dry, post-monsoon and monsoon season at the sample sites of project area. Average COD of the collected water samples for winter, post-monsoon and monsoon season was found to be 49.5 mg/l, 57.53 mg/l and 63.53mg/l, respectively; which is much lower than the national average of 200 mg/l.

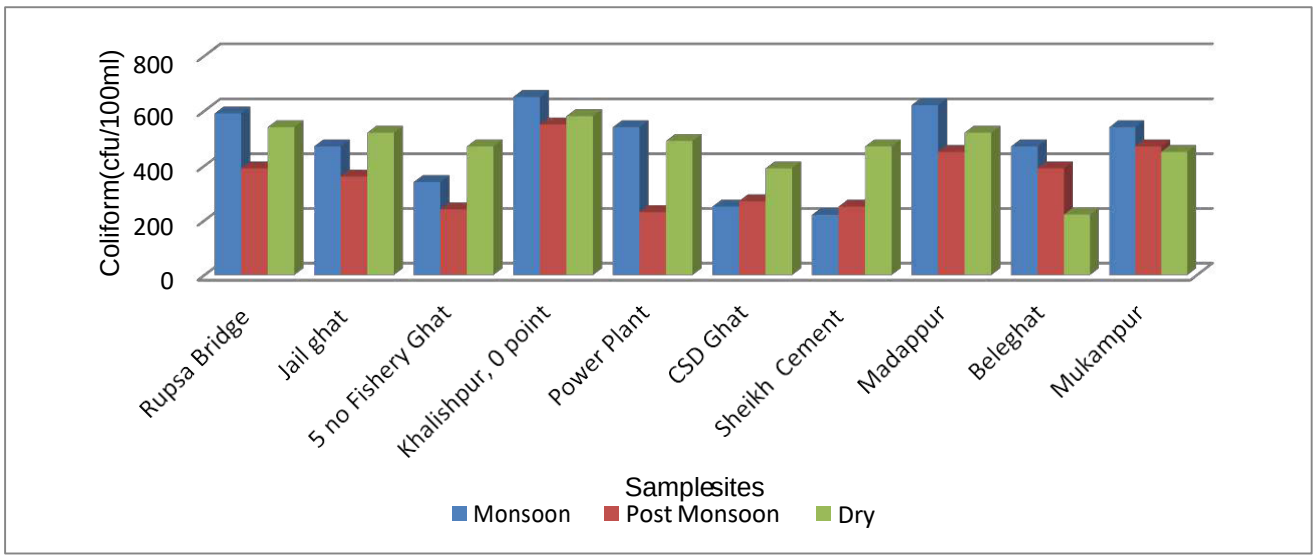


Figure19. Coliform at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 19 illustrates the total coliform value during winter, post-monsoon and monsoon season at the sample sites of project area. Average coliform concentration was found to be higher in the monsoon season (469 cfu/100 ml) which is close to the concentration of winter season (465.1 cfu/100 ml). The minimum average coliform concentration was in post monsoon season (360 cfu.100 ml).

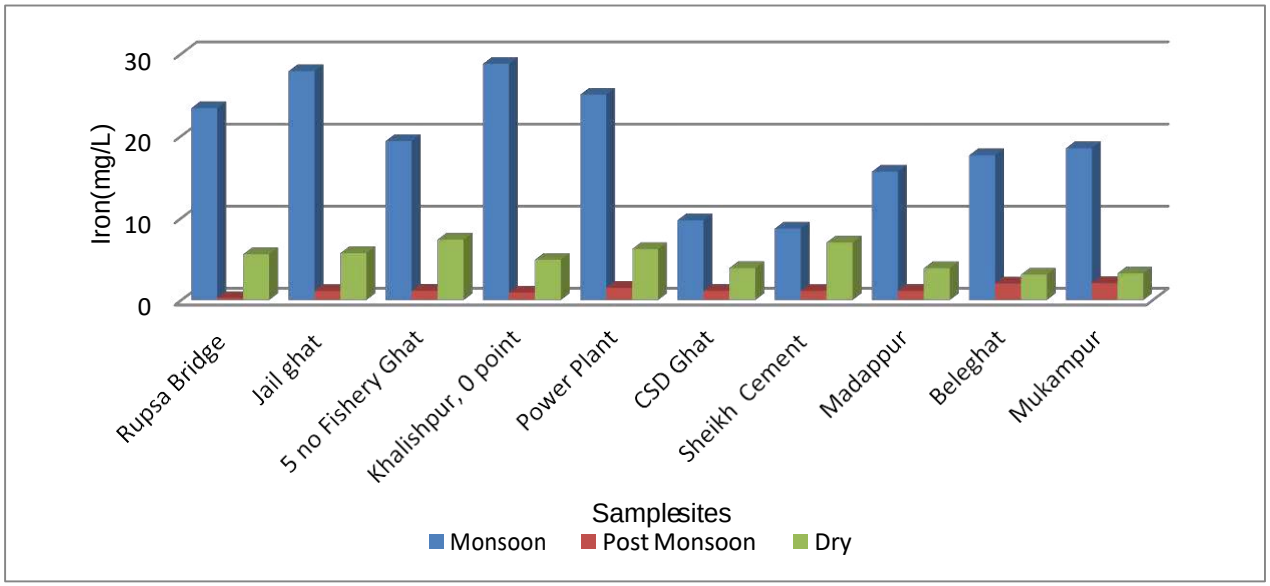


Figure 20. Salinity at the sample sites of the project area in area in monsoon, post-monsoon and winter or dry season surveys.

Figure 20 illustrates the iron value during winter, post-monsoon and monsoon season at the sample sites of the project areas. Average concentration of iron in the collected water sample in monsoon season was much higher than that of the post-monsoon and dry season concentration (average 19.44 mg/l, 1.219 mg/l and 5.08 mg/l, respectively). Flood water brings lot of sediments and minerals from the upstream region and this might be the reason for high concentration of iron in the river water during monsoon season.

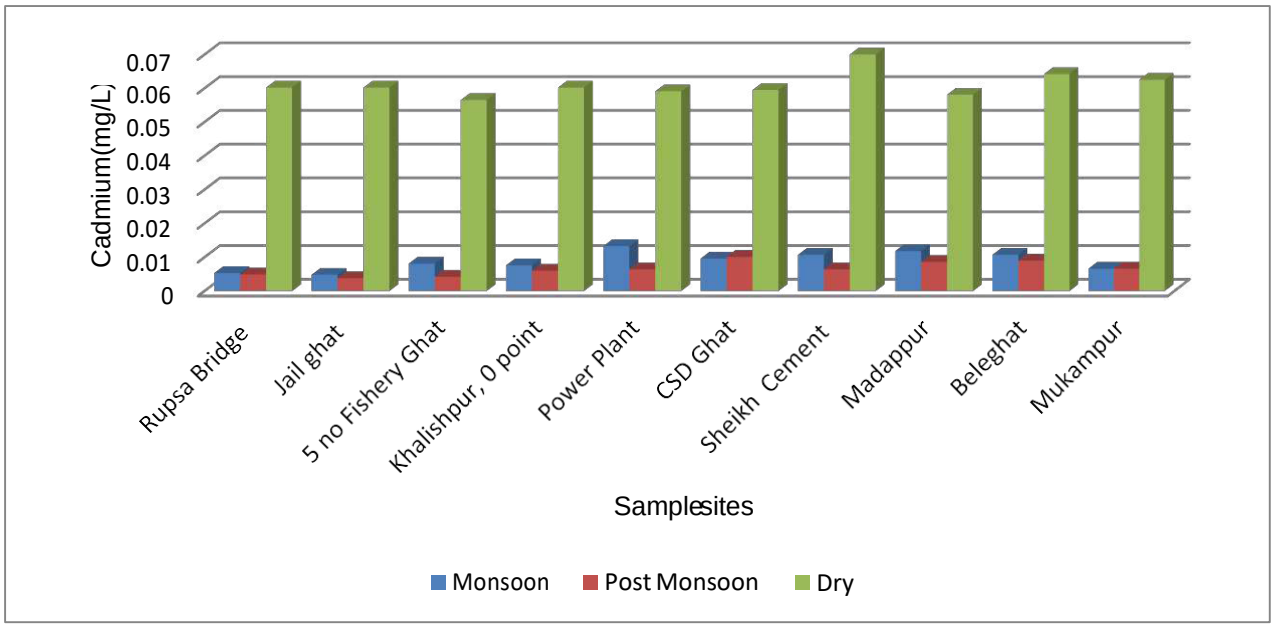


Figure 21. Cadmium at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry season surveys.

Figure 21 illustrates the Cadmium values during dry, post-monsoon and monsoon season at sample sites of the project area.Average Cadmium concentration was found to be very high in the dry season (0.06mg/l) which is little over the surface water quality standard for Bangladesh of 0.05 mg/l. Although elevated iron concentration was found in some water samples, however in general, concentration of cadmium in the river water did not exceed relevant quality standard during monsoon (0.009 mg/l) and post-monsoon season (0.007 mg/l), beyond which it becomes a threat to freshwater life. The highest cadmium concentration (i.e. 0.0642 mg/l) was found in the Beleghat point.

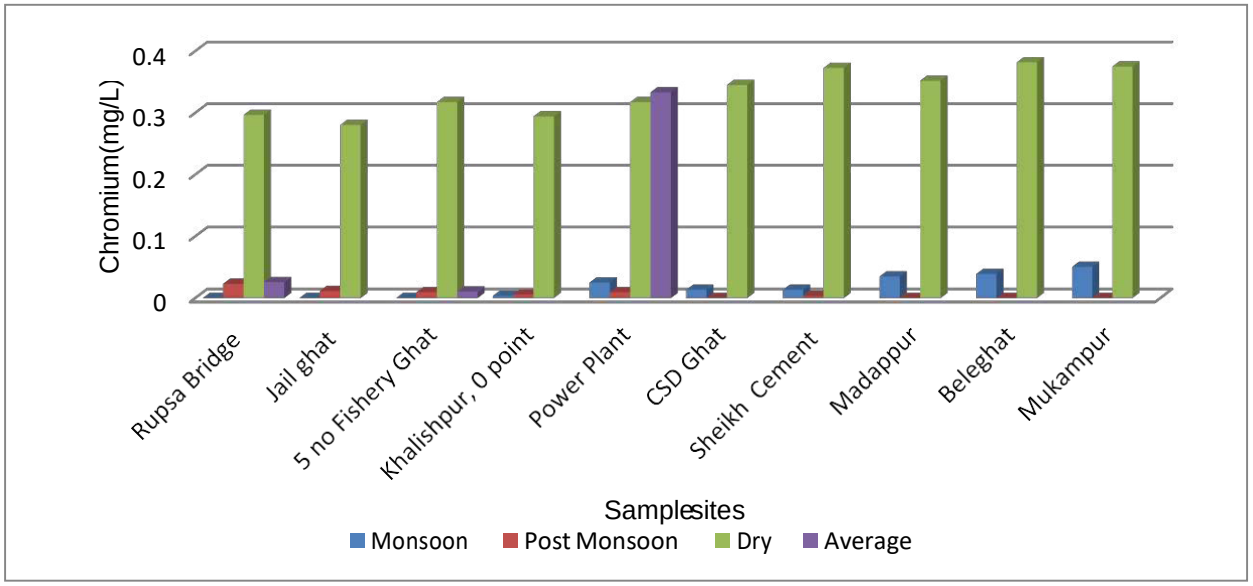


Figure 22. Chromium at the sample sites of the project area in area in monsoon, post-monsoon and winter/dry period surveys.

Figure 22 illustrates the Chromium values during winter, post-monsoon and monsoon season at sample sites of the project area. Average Chromium concentration was found to be very high in the dry season (0.33 mg/l) than that of the monsoon (0.026 mg/l) and post-monsoon (0.01 mg/l) season, which is much below than the national standard of 0.5 mg/l.

8.11 Biological Parameters

A total of 15 genera of phytoplankton and two unknown genera of zooplankton were found in the 6 study sites. Among the plankton, Oscillatoria and Melosira were found in all 6 study sites indicating that these two genera are common in the study area. On the other hand, Nostoc, Pediastrum,Cymbella and Volvox were found only in single site indicating that these genera are less common in the study area. Maximum number of genera (10) were found in 5 No. Fishery ghat, Rupsha and minimum number of genera (4) were found in the site of Rupshabridge, Rupsha. Microsystis sp. is considered as indicator of water pollution. This genus was found more abundantly in 5 No. Fishery ghat, Rupsha than other sites indicating that water of this site might be polluted.

Table 14. Abundance (individuals/litre water) of plankton in the study sites

Sl. No	Name of organisms	Family	Rupsa bridge, Rupsa	Jail ghat, Rupsa	5 no. fishery ghat, Rupsa	Khalispur, Confluence	Power plant, Bairab	CSD ghat, Bairab
1	Oscillatoria sp.	Oscillatoriaceae	8.8×10^4	1.84×10^5	1.2×10^5	1.36×10^5	4.0×10^4	6.4×10^4
2	Melosira sp.	Melosiraceae	1.12×10^5	1.04×10^5	1.2×10^5	1.12×10^5	1.44×10^5	1.28×10^4
3	Gloeocapsa sp.	Microcystaceae	1.6×10^4	-	-	-	-	-
4	Closterium sp.	Desmidiaceae	8.0×10^3	8.0×10^3	8.0×10^3	-	3.2×10^4	-
5	Microsystis sp.	Microcystaceae	-	8.0×10^3	1.6×10^4	1.6×10^4	8.0×10^3	8.0×10^3
7	Navicula sp.	Naviculaceae	-	8.0×10^3	8.0×10^3	-	-	8.0×10^3
8	Anabaena sp.	Nostocaceae	-	1.6×10^4	-	-	-	-
9	Synedra sp.	Fragilariaceae	-	-	8.0×10^3	1.6×10^4	8.0×10^3	8.0×10^3
10	Gyrosigma sp.	Naviculaceae	-	-	-	8.0×10^3	-	-
11	Nostoc sp.	Nostocaceae	-	-	8.0×10^3	-	-	-
12	Pediastrum sp.	Hydrodictyaceae	-	-	8.0×10^3	-	-	-
13	Cymbella sp.	Cymbellaceae	-	-	-	-	8.0×10^3	-
14	Scenedesmus sp.	Scenedesmaceae	-	-	8.0×10^3	-	-	8.0×10^3
15	Volvox sp.	Volvocaceae	-	-	-	-	-	1.6×10^4
16	Zooplankton (unknown)		-	-	-	-	1.6×10^4	1.6×10^4
17	Unknown		-	-	2.4×10^4	8.0×10^3		

'-' organism not found

9. Impact and Mitigation

On the basis of literature review and analysis of the survey results, the potential impacts and mitigation for different phases of the power plant is given below.

Pre-construction Phase				
Parameter	Source	Overall Impact	Impact on dolphins	Mitigation
Ambient Air quality	Dust and gases generated from demolition works and transportation of the debris	The emitted dust from the demolishing areas will disperse to the ambient environment. The particulate matters inhaled by the human may cause respiratory problem. Moreover, the dust will fall over the leaves of the vegetation and water bodies, including rivers, near to the project site causing pollution and may affect aquatic ecosystem.	These emitted dust particles may include nitrogen, mercury compounds which may deposit on the river and accelerate etrophication. It will result in excess algae blooms which depletes oxygen levels and kills aquatic life. It will hamper the food chain and deplete fish stock which in turn will affect prey population of dolphins.	-Avoid the demolition works in the evening especially during the dry season or watering to the possible sources of fugitive emission. -Regular water spraying on the adjacent vegetation, roads andunpaved groundespecially during dry season to avoid dust. -The transportations carrying debris should be moved as soon as possible to avoid accumulation and being blown by wind. -Impact and compliance monitoring should be done as per the recommended guideline at all the sensitive locations.
Ambient Noise quality	Demolishing buildings and other structures using heavy machineries. Heavy movement of traffic and machineries.	Loud noise will affect the behavior of Ganges River Dolphins and other the nocturnal animals. Generation of impulse noise will harm the community people.	Dolphins rely on echolocation for detecting prey, communication and navigation. Noise pollution may cause trouble for them to hunt, navigate and communicate.	-The procedure of demolition should be conducted as per the guidelines. -Noise level must not exceed a set threshold. -The machines/ equipment/ vehicles

	During transportation by ships			should be turned off when not in use. -All sound-reducing devices and restrictions should be properly maintained throughout the demolition period. -Limit the hours of demolition works. -Use rubber-tired equipment rather than track equipment -Reduce the use of large cargo water vessels for the transportation of materials. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site. -Keep loading and staging areas on site within the perimeter protected by the recommended temporary noise barrier and away from the noise-sensitive sidesofsite.
Loss of vegetation	Dispersion of the dust particles during destruction of building Chop down of terrestrial vegetation	The normal photosynthesis and the transpiration process of plant will be affected due to dust particle Chop down of terrestrial	There are no direct impact	In the significant portion of the proposed power plant area green belt should be developed which will ultimately makeup the loss of carbon dioxide sequestration due to clearing of

	construction machinery and vehicles used for mobilization of equipment. Air pollution arising from incineration of construction.	workers might suffer from lung diseases including shortness of breath, coughing, wheezing; chest pain; loss of appetite; tiredness due to the prolonged inhalation of dusts by the site. Particulate matter, dust will fall on the leaves, vegetation and water bodies near to the project site. Gasses in air may mix with rain and fall on waterbodies causing contamination.	mercury that affects aquatic plants, microorganisms and fish species. As a result, the food chain is affected which might have an impact on the dolphins.	for the transportation raw materials. -Regular maintenance and management of all the construction machinery andvehicles -Prohibit open burning -Impact and compliance monitoring should be done as per the recommended guideline at the sensitive location. -Reduce the use of large cargo water vessels for the transportation of materials. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site.
Ambient noise quality	Construction machinery such as pumps, generators, compressors ,pile drivers, rock drills etc. Vehicles transporting equipments and workers	Communities settled beside proposed project will be effected. Noise pollution will directly cause health hazards to the nearby residents and construction workers on the site. Loud noise will affect the behavior of Ganges River Dolphins and other the nocturnal animals.	Dolphins use echolocation for communication, navigation and finding prey. Noise pollution will effect dolphin populations, interrupt their normal behavior, way of movement, hunting behavior and driving them away from the important areas.	-Optimizing construction schedule work during daytime, especially piling work. -Using low-noise/ low vibration equipment as much as possible. -Reduce the use of large cargo water vessels for the transportation of materials.

				-Proper waste disposal management plan should be implemented.
Operational Phase				
Parameter	Source	Overall Impact	Impact on dolphins	Mitigation
Ambient air quality	Oxides of Nitrogen (NOx), Oxides of Sulfur (SOx), Carbon Monoxide (CO), particulate matters may be emitted from stacks and chimneys of power plant.	Emission of exhaust gas from the stack may contribute elevated ground level concentration of CO, CO_2, NOx, particulate matter etc. at the down wind direction. The emission of SOx, NOx and PM may have significant impact on vegetation and other species. NOx, SOx, CO and PM can be washed into the river through rain. Particulate matter, dust will fall on the leaves, vegetation and water bodies near to the project site.	Emitted dust particles from the plant site include nitrogen, mercury compounds which can be deposited into the water bodies causes eutrophication and kills aquatic life. When excess mercury deposits in river it may turn into methyl mercury that affects aquatic plants, microorganisms and fish species. As a result, the whole food chain is affected and can adversely effect dolphin and dolphin prey.	-Power plant should adopt inbuilt pollution control measures like Low-NOx burner, Wet injection process etc -Cleaner fuel should be used to run the power plant -Emission from the stacks must belimited to the IFC, 2008 standard for thermal power plant. -All measures for limiting the emission of SOx, NOx and PM should be within the GOB standards and IFC guidelines -On the other hand, significant portion of greenbelt in and around the project area should be developed to improve the vegetation coverage and enhance the capacity of carbonsinking.
Ambient water quality	Thermal effluents from cooling system. Wastewater from plant process.	Discharge of wastewater, effluents and accidental spillage of oil and chemical materials into river and open water reduces the productivity of fish habitats.	Oil spillage from water vehicle contains heavy metals such as mercury, copper and selenium might have direct harmful effects on dolphins.	-Thermal effluents should be discharged far from the intake point of cooling water to reduce the impact on surrounding area. -No waste water should be

	Leakages of oil and chemical materials. Abstraction of river water. Collection of fresh water.	Water intake from the river would entrap fish, crustaceans and other aquatic organisms. Predator-prey relationship might be affected due to spread of invasive species through ballast water. Direct discharge of hot water into the river might have harmful effects on fish population.	Effects on fish population will also have adverse effects on prey of dolphins. Water extraction from river particularly during dry season for cooling and makeup process of power plant may affect aquatic ecosystem, aquatic species including dolphin and their prey.	discharged to the river without treatment. Installation of waste water treatment system by neutralization, settling and oil separation so any wastewater produced complies with wastewater standards and IFC and GOB guidelines. -Storage of oil and chemical materials in appropriate tanks with retaining walland method to prevent permeation into ground and leaching into the river. -Temporary water reservoir can be built for water storage rather than direct abstraction from river. -Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intakevelocities should be as low as possible
Ambient Noise quality	Noise from steam turbines generators, and pumps, etc. Transportation of power plant equipment	Hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from the plant.	Transportation of power plant equipment, other materials may affects habitat quality of aquatic species due to creation of underwater noise. As dolphins rely on echolocation for detecting prey,	-Installation of low noise/low vibration type equipment -Adequate enclosure ofequipment to reduce noise -All the vessels must follow the standard of IMO, MARPOL during transportation

			communication and navigation. Noise pollution threats their survival.	of materials up to the port of delivery of foreign imported machinery and equipment. -Cargo can be offloaded from ships away from the identified important dolphin areas and if possible be transported by land to the site to avoid spillage.
Waste disposal	Waste water, waste oil, sludge and other untreated effluent. Solid waste generated from the workers living within the region such as cans, bottles and food. Hydrazine added in boiler water.	Hydrazine is a known carcinogen and a mutagen which is added in the boiler water in power plant. Workers may be exposed to hydrazine from the boiler blow down. Generation of waste may affect the fish habitats and surrounding aquatic species	Wastes may leach into nearby canal and river, affecting aquatic life. Toxic algae outbreaks may take place and reduce oxygen in the water, driving dolphins from important areas. Also debris, including plastic bags, tarps and other non-degradable objects dumped along shorelines and in coastal areas will trap or choke dolphins, especially young animals	-Waste management program consisting of -reduction, reuse, and recycling of materials -Systematic collection and protected storage -Waste disposal should be at appropriate location -Installation of wastewater treatment system by neutralization, settling and oil separation so any wastewater produced complies with wastewater standards and IFC guidelines -Hazardous waste should be treated under the related regulations.

*Source:1)DRAFT REPORT ON ENVIRONMENTALIMPACT ASSESSMENTRUPSHA 800 MW COMBINED CYCLE POWER PLANTVOLUME – I (BOOK 1 OF 2)
2) Report onEnvironmental Impact AssessmentofConstruction of Matarbari 600X2 MW Coal FiredPower Plant and Associated FacilitiesVolume 1 and 2
3)Whalesorg(2017).*WDC, Whale and Dolphin Conservation*. Retrieved14 December2017,from http://uk.whales.org/issues/pollution

10. Recommendations

From the field surveys, analysis and the results, recommendations are provided below:

- Regular long-term monitoring of dolphins following the current methodology and other wildlife should be continued during construction phase. This is important to know whether there are any effects on the dolphin population in the area. The results of the surveys that are presented in this report will act as a baseline. Long-term monitoring will also show the effectiveness of mitigation measures implemented. Regular monitoring will also help to propose conservation measures if there is a decrease in dolphin population.

- Important dolphin areas have been identified from the surveys (Map 2), where there is high concentration of dolphins, including calves. It should be ensured that these areas are disturbed as less as possible by following the mitigation measures as well as close monitoring.

- As stated in the mitigation section, it is not recommended that large cargo water vessels/Berge carrying heavy equipments for Rupsha 800 MW CCPP Project should move through the important dolphin areas. The movement of high number of large cargo water vessels will create a lot of noise. As dolphins use echolocation (a process where an animal uses calls for navigation, communication and hunting), loud noises will disrupt their normal behaviour, causing adverse effects to the dolphin population. If there is movement of large cargo vessels, specific routes will have to be identified in the areas, during specific time of the day so that disturbance is limited.

- It is recommended that the large cargo water vessels be docked in a more suitable place away from the important dolphin areas, and the materials be transported via roads to the construction sites, where applicable.

- No waste or chemicals can be discharged during O&M of Rupsha 800 MW CCPP into the river without treatment and following standard guidelines from the project site or transport vehicles.

- Mitigation measures stated in section 4 (Impact and Mitigation) should be followed to ensure that the adverse effects are mitigated and the dolphins are not harmed.

Appendix 1: Dolphin individuals recorded during the survey period

Survey season	Number of Sighting	Area (low and high tide) (km)	Encounter Rate/km in each survey
Pre-monsoon survey	70	60	1.17
First monsoon survey	50	60	0.833
Second monsoon survey	62	60	1.03
First post-monsoon survey	102	60	1.70
Total	285	240	4.18
Average Encounter Rate	1.18 (the total area will be 30kmx8=240km and Encounter rate will be 284/240=1.18)		

Appendix 2: Dolphin survey methodology

Teams	1. A primary observer team will be stationed on the upper deck (approximately 4.4 m above the waterline) 2. A secondary observer team will be stationed on the lower deck (c.2.3 m above the waterline) 3. The two independent observer teams will not be in visual contact and observers will be instructed to avoid alerting the other team about dolphin sightings. (Note: this will maintain the independence of results.)
Observer position	1. Three observers will stand watch at all times while "on-effort" (i.e., actively searching for dolphins along the transect line and recording effort and sighting data) 2. One will be stationed on each the port and starboard sides, searching with handheld binoculars and naked eye from the beam to about 10^0 past the bow 3. One in the centre searching by naked eye in about a 20^0 cone in front of the bow 4. The centre observer will also serve as the data recorder. Both primary and secondary teams will be comprised of the same structure.
Observer rotation	1. Observer will be rotated through the three different positions every 30 min followed by at least an hour of rest before switching teams. 2. Each team will have 3 observers. There will be a back up team who will switch positions during rotation every 30 mins.
Transect and Boat Speed	1. Transect will start from the lower part of Rupsha river and finish at upper part of Bhairab river. We will cover a total 20 km in favor of the tide. We will then move into Atairiver where we will not be in favor of the tide.

	Then we will cover the last 10 km of Atairiver. The boat speed will be controlled accordingly. 2. Boat speed will be on average 10 km/hour.
Survey Equipment	x Handheld 7 x 43 binoculars x Laser Range Finder (will be used if less than 500m) x Handheld GPS (GARMIN GPSmap62s) x Double decked boat will be used in the survey.
Sighting conditions	Every 30 min, at the location of dolphin sightings, or when there will be a significant change in sighting conditions we will record our position with a Global Positioning System and information on sighting conditions, human activities, channel width, and the distance cover along the transect line.
Channel width	Channel width will be recorded according to the sum of distance measurements to the right and left banks using a laser range finder, if less than 500 m, or the sum of estimates will be made by naked eye, if greater. We can also use satellite image to measure the channel width according to the GPS coordinates if both options are not feasible.
Sighting condition codes	Wind, glare, or rain/fog conditions will be given codes of 0, 1, or 2 corresponding to good, fair and poor respectively.
Dolphins data record	1. Species; 2. Time; 3. Radial distance to the first dolphin sighted; 4. the location of the estimated position (GPS) where the dolphins located when first observed; and 5. Group size (according to best, high and low)Specialized data sheet is attached.
Model Use	The following models will be used for analysis and estimation of population size. 1. A stratified Lincoln-Petersen model 2. Huggins conditional likelihood model 3. Horvitz-Thomson Estimator (to obtain the abundance)

Smith et al, 1994; Smith 2000; Smith et al. 2006

Appendix 3:The chosen model (highlighted in blue) and the results from other compared models in the MARK software (second post-monsoon survey)

Results Browser: Huggins' p and c with Random Effects

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{Phi(t),p(t)}	123.8927	0.0000	0.99408	1.0000	6	111.3927
{Mt}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mtb}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mtbh2}	136.5541	12.6614	0.00177	0.0018	4	128.3188
{Mth2}	138.6738	14.7811	0.00061	0.0006	5	128.3188
{Mbh2}	157.2414	33.3487	0.00000	0.0000	1	155.2183
{Mb}	159.2880	35.3953	0.00000	0.0000	2	155.2183
{M0}	174.3360	50.4433	0.00000	0.0000	1	172.3129
{M0RE}	174.3360	50.4433	0.00000	0.0000	1	172.3129
{Mh2}	176.3826	52.4899	0.00000	0.0000	2	172.3129

Appendix 4. The chosen model (highlighted in blue) and the results from other compared models in the MARK software (first winter survey)

Program MARK Interface - Winter_Mark_Estimation (F:\MARK_CR_Dolphin\Winter_Data\Winter_DMARK1.DBF)

File Delete Order Output Retrieve PIM Design Run Simulations Tests Adjustments Window Help

Results Browser: Huggins' p and c with Random Effects

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{phi(t),p(t)}	96.5888	0.0000	0.32553	1.0000	4	88.3536
{MtRE}	96.5889	0.0001	0.32552	1.0000	4	88.3536
{Mtb}	98.7086	2.1198	0.11279	0.3465	5	88.3536
{MtbRE}	98.7086	2.1198	0.11279	0.3465	5	88.3536
{Mth2}	100.6807	4.0919	0.04208	0.1293	6	88.1807
{Mt}	102.4333	5.8445	0.01752	0.0538	9	83.3424
{Mtbh2}	102.8513	6.2625	0.01421	0.0437	7	88.1807
{g*Mt}	103.5815	6.9927	0.00987	0.0303	8	86.7140
{g*Mtb}	103.5815	6.9927	0.00987	0.0303	8	86.7140
{g*Mth2}	103.8855	7.2967	0.00847	0.0260	9	84.7946
{g*Mtbh2}	103.8855	7.2967	0.00847	0.0260	9	84.7946
{g*MtRE}	104.4366	7.8478	0.00643	0.0198	9	85.3457

Appendix 5. The chosen model (highlighted in blue) and the results from other compared models in the MARK software (second winter survey)

Program MARK Interface - Second_Winter_Dolphin_Estimate_MarkCC (F:\Research_Ongoing\MARK_CR_Dolphin\2nd_winter\SecondWinter_MarkCR.DBF)

File Delete Order Output Retrieve PIM Design Run Simulations Tests Adjustments Window Help

Results Browser: Huggins' p and c with Random Effects

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Par.	Deviance
{phi(t),p(t)}	106.7261	0.0000	0.60756	1.0000	8	89.9392
{Mtb}	109.5366	2.8105	0.14904	0.2453	4	101.3227
{MtRE}	109.5366	2.8105	0.14904	0.2453	4	101.3227
{Mt}	111.6453	4.9192	0.05193	0.0855	5	101.3227
{MtbRE}	113.7144	6.9883	0.01845	0.0304	6	101.2603
{Mth2}	113.7767	7.0506	0.01789	0.0294	6	101.3227
{Mtbh2}	115.9314	9.2053	0.00609	0.0100	7	101.3227
{Mbh2}	181.9683	75.2422	0.00000	0.0000	1	179.9473
{Mb}	184.0107	77.2846	0.00000	0.0000	2	179.9473
{MbRE}	184.0107	77.2846	0.00000	0.0000	2	179.9473
{M0}	198.5240	91.7979	0.00000	0.0000	1	196.5030
{M0RE}	198.5240	91.7979	0.00000	0.0000	1	196.5030
{Mh2}	200.5664	93.8403	0.00000	0.0000	2	196.5030

Appendix 6: Mark-recapture Analysis (Second post-monsoon)

Program MARK - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017 13-Dec-2017 15:51:36 Page 001
- -

This version was compiled by GCC version 5.3.0 using the options:
-cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
-U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2

```
   -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
   -ffpe-summary=invalid,zero,overflow,underflow       -fno-unsafe-math-optimizations
   -frounding-math -fsignaling-nans -fopenmp.

 This problem will use 4 of 4 possible threads.

 INPUT --- proc title Dolphin_Estimation;

   CPU Time in seconds for last procedure was 0.00

INPUT --- procchmatrix occasions=5 groups=2 etype=Huggins mixtures=2
 INPUT --- Nodes=101 icovar=3 ICMeansNoHisthist=300;

 INPUT ---    glabel(1)=Primary;

 INPUT ---    glabel(2)=Secondary;

 INPUT ---    time interval 1 1 1 1;

 INPUT ---       icovariatesGSizeCWidthSCon;

     Number of unique encounter histories read was 35.

     Number of individual covariates read was 3.
     Time interval lengths are all equal to 1.

     Data type number is 12
     Data type is Huggins' p and c

    CPU Time in seconds for last procedure was 0.00

Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36      Page  002
Dolphin_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  INPUT --- proc estimate link=Logitvarest=2ndPart ;
 INPUT --- model={Phi(t).p(t)};
 INPUT ---    group=1 p rows=1 cols=5 Square Time=1;
 INPUT ---    group=2 p rows=1 cols=5 Square Time=6;
 INPUT ---    group=1 c rows=1 cols=4 Square Time=11;
 INPUT ---    group=2 c rows=1 cols=4 Square Time=15;
 INPUT ---    design matrix constraints=18 covariates=18 identity;
 INPUT ---       blabel(1)=p;
 INPUT ---       blabel(2)=p;
 INPUT ---       blabel(3)=p;
 INPUT ---       blabel(4)=p;
 INPUT ---       blabel(5)=p;
 INPUT ---       blabel(6)=p;
 INPUT ---       blabel(7)=p;
 INPUT ---       blabel(8)=p;
 INPUT ---       blabel(9)=p;
 INPUT ---       blabel(10)=p;
 INPUT ---       blabel(11)=c;
 INPUT ---       blabel(12)=c;
 INPUT ---       blabel(13)=c;
 INPUT ---       blabel(14)=c;
 INPUT ---       blabel(15)=c;
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 INPUT ---      blabel(16)=c;
 INPUT ---      blabel(17)=c;
 INPUT ---      blabel(18)=c;
 INPUT ---      rlabel(1)=p;
 INPUT ---      rlabel(2)=p;
 INPUT ---      rlabel(3)=p;
 INPUT ---      rlabel(4)=p;
 INPUT ---      rlabel(5)=p;
 INPUT ---      rlabel(6)=p;
 INPUT ---      rlabel(7)=p;
 INPUT ---      rlabel(8)=p;
 INPUT ---      rlabel(9)=p;
 INPUT ---      rlabel(10)=p;
 INPUT ---      rlabel(11)=c;
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36     Page  003
Dolphin_Estimation
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 INPUT ---      rlabel(12)=c;
 INPUT ---      rlabel(13)=c;
 INPUT ---      rlabel(14)=c;
 INPUT ---      rlabel(15)=c;
 INPUT ---      rlabel(16)=c;
 INPUT ---      rlabel(17)=c;
 INPUT ---      rlabel(18)=c;
 INPUT ---      dlabel(1)=Grp 1 N;
 INPUT ---      dlabel(2)=Grp 2 N;

 Link Function Used is LOGIT

 Variance Estimation Procedure Used is 2ndPart

M(t+1):
    18     17

 -2logL(saturated) = -0.0000000
 Effective Sample Size = 175

 Number of function evaluations was 43 for 18 parameters.
 Time for numerical optimization was 0.03 seconds.
 -2logL {Phi(t).p(t)} = 111.39272
 Penalty {Phi(t).p(t)} = -0.0000000
 Gradient {Phi(t).p(t)}:
   0.000000      0.000000      0.000000      0.000000      0.000000
   0.000000      0.000000      0.000000      0.000000      0.000000
   0.000000     0.6308189E-06  0.000000      0.000000     0.9427072E-06
   0.000000      0.000000      0.000000
 S Vector {Phi(t).p(t)}:
   4.235293      3.999999      3.611111      3.111111      1.764706
   1.764706     0.8827028E-07 0.8051994E-07 0.6681132E-07 0.6681059E-07
  0.6523502E-07 0.6315005E-07 0.4948998E-07 0.2262376E-07 0.1477314E-07
  0.4738380E-08 0.4026128E-08 0.1484434E-08
 Time to compute number of parameters was 0.09 seconds.
   Threshold =  0.3800000E-06     Condition index =  0.3504914E-09     New Threshold =  0.6297919E-08
 New Guessimate of Estimated Parameters {Phi(t).p(t)} = 13
 Conditioned S Vector {Phi(t).p(t)}:
```

1.000000 0.9444446 0.8526237 0.7345681 0.4166669
0.4166668 0.2084160E-07 0.1901166E-07 0.1577490E-07 0.1577473E-07
0.1540272E-07 0.1491043E-07 0.1168514E-07 0.5341724E-08 0.3488104E-08
0.1118784E-08 0.9506140E-09 0.3504914E-09
Number of Estimated Parameters {Phi(t).p(t)} = 6
DEVIANCE {Phi(t).p(t)} = 111.39272
DEVIANCE Degrees of Freedom {Phi(t).p(t)} = 29
c-hat {Phi(t).p(t)} = 3.8411282
AIC {Phi(t).p(t)} = 123.39272
AICc {Phi(t).p(t)} = 123.89272
BIC {Phi(t).p(t)} = 142.38143
Pearson Chisquare {Phi(t).p(t)} = 245.89617

LOGIT Link Function Parameters of {Phi(t).p(t)}

Parameter	Beta	Standard Error	95% Confidence Interval Lower	Upper
1:p	19.442761	1698.6670	-3309.9446	3348.8301
2:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
3:p	-3.9814670	0.0000000	-3.9814670	-3.9814670
4:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
5:p	-3.9815082	0.0000000	-3.9815082	-3.9815082
6:p	23.996232	0.1625529E-004	23.996200	23.996264
7:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
8:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
9:p	-3.7437660	0.0000000	-3.7437660	-3.7437660
10:p	-3.7437833	0.0000000	-3.7437833	-3.7437833
11:c	0.9555113	0.5262348	-0.0759090	1.9869316
12:c	1.2527629	0.5669467	0.1415473	2.3639785
13:c	-0.6931474	0.5000000	-1.6731474	0.2868527
14:c	20.731936	7970.8080	-15602.052	15643.516
15:c	2.0149031	0.7527727	0.5394686	3.4903375
16:c	-0.1177833	0.4859127	-1.0701723	0.8346057
17:c	2.0149028	0.7527726	0.5394685	3.4903372
18:c	25.140963	0.0000000	25.140963	25.140963

- -

Real Function Parameters of {Phi(t).p(t)}

Parameter	Estimate	Standard Error	95% Confidence Interval Lower	Upper
1:p	1.0000000	0.6112579E-005	0.9999880	1.0000120
2:p	0.0183158	0.0000000	0.0183158	0.0183158
3:p	0.0183165	0.0000000	0.0183165	0.0183165
4:p	0.0183158	0.0000000	0.0183158	0.0183158
5:p	0.0183158	0.0000000	0.0183158	0.0183158
6:p	1.0000000	0.6159766E-015	1.0000000	1.0000000
7:p	0.0231177	0.0000000	0.0231177	0.0231177
8:p	0.0231177	0.0000000	0.0231177	0.0231177
9:p	0.0231177	0.0000000	0.0231177	0.0231177
10:p	0.0231173	0.0000000	0.0231173	0.0231173

```
   11:c                0.7222222      0.1055718      0.4810319      0.8794181
   12:c                0.7777778      0.0979908      0.5353279      0.9140389
   13:c                0.3333333      0.1111111      0.1580050      0.5712255
   14:c                1.0000000      0.7902001E-005 0.9999845      1.0000155
   15:c                0.8823529      0.0781425      0.6316888      0.9704116
   16:c                0.4705882      0.1210578      0.2553703      0.6973279
   17:c                0.8823529      0.0781425      0.6316888      0.9704116
   18:c                1.0000000      0.0000000      1.0000000      1.0000000
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   13-Dec-2017 15:51:36     Page  005
Dolphin_Estimation
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                 Estimates of Derived Parameters
             Population Estimates of {Phi(t).p(t)}
                                 95% Confidence Interval
   Group     N-hat        Standard Error      Lower          Upper
--------- -------------- -------------- -------------- --------------
     1    18.000000      0.2640368E-003 18.000000      18.000184
     2    17.000000      0.2422045E-004 17.000000      17.000005

Attempted ordering of parameters by estimatibility:
 16 13 11 12 17 15  9 10  3  5  2  4  8  7 14  6  1 18
Beta number 18 is a singular value.

   CPU Time in seconds for last procedure was 0.14

 INPUT --- proc stop;

   CPU Time in minutes for this job was 0.00

   Time Start = 15:51:36.679   Time End = 15:51:36.810

   Wall Clock Time in minutes for this job was 0.00


      E X E C U T I O N   S U C C E S S F
```

Appendix 7: Mark-recapture Analysis (First Winter)

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   17-Jan-2018 18:17:28     Page  001
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  This version was compiled by GCC version 5.3.0 using the options:
    -cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
    -U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2
    -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
    -ffpe-summary=invalid,zero,overflow,underflow       -fno-unsafe-math-optimizations
    -frounding-math -fsignaling-nans -fopenmp.

  This problem will use 4 of 4 possible threads.


  INPUT --- proc title Winter_Mark_Estimation;
```

```
  CPU Time in seconds for last procedure was 0.00


INPUT --- proc chmatrix occasions=5 groups=2 etype=Huggins mixtures=2
INPUT --- Nodes=101 icovar=3 ICMeansNoHisthist=300;

INPUT ---    glabel(1)=Primary;

INPUT ---    glabel(2)=Secondary;

INPUT ---    time interval 1 1 1 1;

INPUT ---       icovariatesGSizeCWidthSiteCon;

   Number of unique encounter histories read was 35.

   Number of individual covariates read was 3.
   Time interval lengths are all equal to 1.

   Data type number is 12
   Data type is Huggins' p and c

  CPU Time in seconds for last procedure was 0.00
```

- -

```
INPUT --- proc estimate link=Logit varest=2ndPart ;


INPUT --- model={phi(t).p(t)};

INPUT ---    group=1 p rows=1 cols=5 Square Time=1;

INPUT ---    group=2 p rows=1 cols=5 Square Time=6;

INPUT ---    group=1 c rows=1 cols=4 Square Time=11;

INPUT ---    group=2 c rows=1 cols=4 Square Time=15;

INPUT ---    design matrix constraints=18 covariates=5;
INPUT ---          1 1 0 0 0;
INPUT ---          1 0 1 0 0;
INPUT ---          1 0 0 1 0;
INPUT ---          1 0 0 0 1;
INPUT ---          1 0 0 0 0;
INPUT ---          1 1 0 0 0;
INPUT ---          1 0 1 0 0;
INPUT ---          1 0 0 1 0;
INPUT ---          1 0 0 0 1;
INPUT ---          1 0 0 0 0;
INPUT ---          1 0 1 0 0;
INPUT ---          1 0 0 1 0;
INPUT ---          1 0 0 0 1;
INPUT ---          1 0 0 0 0;
INPUT ---          1 0 1 0 0;
INPUT ---          1 0 0 1 0;
INPUT ---          1 0 0 0 1;
INPUT ---          1 0 0 0 0;
INPUT ---      blabel(1)=p Intercept;
INPUT ---      blabel(2)=p Occasion 1;
INPUT ---      blabel(3)=p Occasion 2;
INPUT ---      blabel(4)=p Occasion 3;
INPUT ---      blabel(5)=p Occasion 4;
INPUT ---      rlabel(1)=p;
INPUT   ---    rlabel(2)=p;
INPUT   ---    rlabel(3)=p;
INPUT   ---    rlabel(4)=p;
INPUT   ---    rlabel(5)=p;
INPUT ---      rlabel(6)=p;
```

- -

```
 INPUT ---      rlabel(7)=p;
 INPUT ---      rlabel(8)=p;
 INPUT ---      rlabel(9)=p;
 INPUT ---      rlabel(10)=p;
 INPUT ---      rlabel(11)=c;
 INPUT ---      rlabel(12)=c;
 INPUT ---      rlabel(13)=c;
 INPUT ---      rlabel(14)=c;
 INPUT ---      rlabel(15)=c;
 INPUT ---      rlabel(16)=c;
 INPUT ---      rlabel(17)=c;
 INPUT ---      rlabel(18)=c;

 Link Function Used is LOGIT

 Variance Estimation Procedure Used is 2ndPart

M(t+1):
    19    16


 -2logL(saturated) = -0.0000000
 Effective Sample Size = 175

 Number of function evaluations was 38 for 5 parameters.
 Time for numerical optimization was 0.02 seconds.
 -2logL {phi(t).p(t)} = 88.353555
 Penalty {phi(t).p(t)} = -0.0000000
 Gradient {phi(t).p(t)}:
  0.2110236E-05  0.000000      0.000000     -0.8625427E-06  0.000000
 S Vector {phi(t).p(t)}:
   15.53201      3.661730      2.180378      0.5687458      0.2314120E-07
 Time to compute number of parameters was 0.01 seconds.
   Threshold =  0.1200000E-06      Condition index =  0.1489904E-08      New Threshold =  0.5174529E-07
 New Guessimate of Estimated Parameters {phi(t).p(t)} = 4
 Conditioned S Vector {phi(t).p(t)}:
   1.000000      0.2357538      0.1403797      0.3661767E-01 0.1489904E-08
 Number of Estimated Parameters {phi(t).p(t)} = 4
 DEVIANCE {phi(t).p(t)} = 88.353555
 DEVIANCE Degrees of Freedom {phi(t).p(t)} = 31
c-hat {phi(t).p(t)} = 2.8501147
 AIC {phi(t).p(t)} = 96.353555
AICc {phi(t).p(t)} = 96.588849
BIC {phi(t).p(t)} = 109.01270
 Pearson Chisquare {phi(t).p(t)} = 480.92057


                    LOGIT Link Function Parameters of {phi(t).p(t)}
                                          95% Confidence Interval
 Parameter                  Beta        Standard Error      Lower          Upper
 -------------------------  --------------  --------------  --------------  --------------
1:p Intercept          2.3671248       0.6038076       1.1836620       3.5505877
```

2:p Occasion 1	19.296656	6573.6576	-12865.072	12903.666
3:p Occasion 2	-.1529803E-005	0.8539126	-1.6736703	1.6736672

Program MARK - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017 17-Jan-2018 18:17:28 Page 004
Winter_Mark_Estimation
- -

4:p Occasion 3	-3.9426613	0.7521522	-5.4168797	-2.4684429
5:p Occasion 4	0.4362349	0.9459841	-1.4178938	2.2903637

Real Function Parameters of {phi(t).p(t)}

	Estimate	Standard Error	95% Confidence Interval Lower	Upper	Parameter
1:p	1.0000000	0.2566531E-005	0.9999950	1.0000050	
2:p	0.9142857	0.0473188	0.7656054	0.9720933	
3:p	0.1714286	0.0637049	0.0791035	0.3325925	
4:p	0.9428571	0.0392347	0.7983560	0.9856658	
5:p	0.9142858	0.0473187	0.7656056	0.9720934	
6:p	1.0000000	0.2566531E-005	0.9999950	1.0000050	
7:p	0.9142857	0.0473188	0.7656054	0.9720933	
8:p	0.1714286	0.0637049	0.0791035	0.3325925	
9:p	0.9428571	0.0392347	0.7983560	0.9856658	
10:p	0.9142858	0.0473187	0.7656056	0.9720934	
11:c	0.9142857	0.0473188	0.7656054	0.9720933	
12:c	0.1714286	0.0637049	0.0791035	0.3325925	
13:c	0.9428571	0.0392347	0.7983560	0.9856658	
14:c	0.9142858	0.0473187	0.7656056	0.9720934	
15:c	0.9142857	0.0473188	0.7656054	0.9720933	
16:c	0.1714286	0.0637049	0.0791035	0.3325925	
17:c	0.9428571	0.0392347	0.7983560	0.9856658	
18:c	0.9142858	0.0473187	0.7656056	0.9720934	

Estimates of Derived Parameters
Population Estimates of {phi(t).p(t)}

Group	N-hat	Standard Error	95% Confidence Interval Lower	Upper
1	19.000000	0.1606274E-005	19.000000	19.000000
2	16.000000	0.1474608E-005	16.000000	16.000000

Attempted ordering of parameters by estimatibility:
1 4 3 5 2
Beta number 2 is a singular value.

CPU Time in seconds for last procedure was 0.02

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017   17-Jan-2018 18:17:28      Page  005
Winter_Mark_Estimation
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  INPUT --- proc stop;
     CPU Time in minutes for this job was 0.00
     Time Start = 18:17:28.166   Time End = 18:17:28.197
     Wall Clock Time in minutes for this job was 0.00

        E X E C U T I O N   S U C C E S S F U L
```

Appendix 8: Mark-recapture Analysis (Second winter)

```
Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017     2-Feb-2018 18:27:34     Page  001
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   This version was compiled by GCC version 5.3.0 using the options:
     -cpp -iprefix c:\tdm-gcc-64\gcc\bin\../lib/gcc/x86_64-w64-mingw32/5.3.0/ -D_MT
     -U_REENTRANT -D IEEE -m64 -mtune=generic -march=x86-64 -mthreads -O2
     -fimplicit-none -fbounds-check -funroll-loops -ftree-vectorize
     -ffpe-summary=invalid,zero,overflow,underflow       -fno-unsafe-math-optimizations
     -frounding-math -fsignaling-nans -fopenmp.

   This problem will use 4 of 4 possible threads.

  INPUT --- proc title Second_Winter_Dolphin_Estimate_MarkCC;

     CPU Time in seconds for last procedure was 0.00

  INPUT --- proc chmatrix occasions=6 groups=2 etype=HugFullHet
  INPUT --- mixtures=2 Nodes=101 icovar=3 ICMeansNoHisthist=300;

  INPUT ---     glabel(1)=PrimaryTeam;

  INPUT ---     glabel(2)=SecondaryTeam;

  INPUT ---     time interval 1 1 1 1 1;

  INPUT ---        icovariatesGroupSizeChWidthSCon;

      Number of unique encounter histories read was 32.

      Number of individual covariates read was 3.
      Time interval lengths are all equal to 1.

      Data type number is 26
      Data type is Huggins' Heterogeneity pi, p, and c

     CPU Time in seconds for last procedure was 0.01

Program  MARK  - Survival Rate Estimation with Capture-Recapture Data
gfortran(Win64) Vers. 8.2 Sep 2017     2-Feb-2018 18:27:34     Page  002
Second_Winter_Dolphin_Estimate_MarkCC
```

- -

```
INPUT --- proc estimate link=Logit varest=2ndPart ;

INPUT --- model={phi(t).p(t)};

INPUT ---    group=1 pi rows=1 cols=1 Square Constant=1;

INPUT ---    group=2 pi rows=1 cols=1 Square Constant=2;

INPUT ---    group=1 p rows=2 cols=6 Square;
INPUT ---            3  4  5  6  7  8;
INPUT ---            9  10  11  12  13  14;

INPUT ---    group=2 p rows=2 cols=6 Square;
INPUT ---           15  16  17  18  19  20;
INPUT ---           21  22  23  24  25  26;

INPUT ---    group=1 c rows=2 cols=5 Square;
INPUT ---           27  28  29  30  31;
INPUT ---           32  33  34  35  36;

INPUT ---    group=2 c rows=2 cols=5 Square;
INPUT ---           37  38  39  40  41;
INPUT ---           42  43  44  45  46;

INPUT ---    design matrix constraints=46 covariates=46 identity;
INPUT ---    blabel(1)=pi;
INPUT ---      blabel(2)=pi;
INPUT ---      blabel(3)=p;
INPUT ---      blabel(4)=p;
INPUT ---      blabel(5)=p;
INPUT ---      blabel(6)=p;
INPUT ---      blabel(7)=p;
INPUT ---      blabel(8)=p;
INPUT ---      blabel(9)=p;
INPUT ---      blabel(10)=p;
INPUT ---      blabel(11)=p;
INPUT ---      blabel(12)=p;
INPUT ---      blabel(13)=p;
INPUT ---      blabel(14)=p;
INPUT ---      blabel(15)=p;
INPUT ---      blabel(16)=p;
INPUT ---      blabel(17)=p;
```

- -

```
INPUT ---     blabel(18)=p;
INPUT ---     blabel(19)=p;
INPUT ---     blabel(20)=p;
INPUT ---     blabel(21)=p;
INPUT ---     blabel(22)=p;
INPUT ---     blabel(23)=p;
INPUT ---     blabel(24)=p;
INPUT ---     blabel(25)=p;
INPUT ---     blabel(26)=p;
INPUT ---     blabel(27)=c;
INPUT ---     blabel(28)=c;
INPUT ---     blabel(29)=c;
INPUT ---     blabel(30)=c;
INPUT ---     blabel(31)=c;
INPUT ---     blabel(32)=c;
INPUT ---     blabel(33)=c;
INPUT ---     blabel(34)=c;
INPUT ---     blabel(35)=c;
INPUT ---     blabel(36)=c;
INPUT ---     blabel(37)=c;
INPUT ---     blabel(38)=c;
INPUT ---     blabel(39)=c;
INPUT ---     blabel(40)=c;
INPUT ---     blabel(41)=c;
INPUT ---     blabel(42)=c;
INPUT ---     blabel(43)=c;
INPUT ---     blabel(44)=c;
INPUT ---     blabel(45)=c;
INPUT ---     blabel(46)=c;
INPUT ---     rlabel(1)=pi;
INPUT ---     rlabel(2)=pi;
INPUT ---     rlabel(3)=p;
INPUT ---     rlabel(4)=p;
INPUT ---     rlabel(5)=p;
INPUT ---     rlabel(6)=p;
INPUT ---     rlabel(7)=p;
INPUT ---     rlabel(8)=p;
INPUT ---     rlabel(9)=p;
INPUT ---     rlabel(10)=p;
INPUT ---     rlabel(11)=p;
INPUT ---     rlabel(12)=p;
INPUT ---     rlabel(13)=p;
INPUT ---     rlabel(14)=p;
INPUT ---     rlabel(15)=p;
INPUT ---     rlabel(16)=p;
```

- -

```
 INPUT ---      rlabel(17)=p;
 INPUT ---      rlabel(18)=p;
 INPUT ---      rlabel(19)=p;
 INPUT ---      rlabel(20)=p;
 INPUT ---      rlabel(21)=p;
 INPUT ---      rlabel(22)=p;
 INPUT ---      rlabel(23)=p;
 INPUT ---      rlabel(24)=p;
 INPUT ---      rlabel(25)=p;
 INPUT ---      rlabel(26)=p;
 INPUT ---      rlabel(27)=c;
 INPUT ---      rlabel(28)=c;
 INPUT ---      rlabel(29)=c;
 INPUT ---      rlabel(30)=c;
 INPUT ---      rlabel(31)=c;
 INPUT ---      rlabel(32)=c;
 INPUT ---      rlabel(33)=c;
 INPUT ---      rlabel(34)=c;
 INPUT ---      rlabel(35)=c;
 INPUT ---      rlabel(36)=c;
 INPUT ---      rlabel(37)=c;
 INPUT ---      rlabel(38)=c;
 INPUT ---      rlabel(39)=c;
 INPUT ---      rlabel(40)=c;
 INPUT ---      rlabel(41)=c;
 INPUT ---      rlabel(42)=c;
 INPUT ---      rlabel(43)=c;
 INPUT ---      rlabel(44)=c;
 INPUT ---      rlabel(45)=c;
 INPUT ---      rlabel(46)=c;
 INPUT ---      dlabel(1)=Grp 1 N;
 INPUT ---      dlabel(2)=Grp 2 N;

 Link Function Used is LOGIT

 Variance Estimation Procedure Used is 2ndPart

M(t+1):
    15    17


 -2logL(saturated) = -0.0000000
 Effective Sample Size = 192

 Number of function evaluations was 43 for 46 parameters.
 Time for numerical optimization was 0.16 seconds.
```

- -

-2logL {phi(t).p(t)} = 89.939240
Penalty {phi(t).p(t)} = -0.0000000
Gradient {phi(t).p(t)}:
-0.2969045E-05 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 -0.2842165E-05 0.000000
0.000000 0.1933445E-05-0.1050808E-05 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.7533742E-06 0.5593844E-06-0.3766871E-06 0.1678153E-05
0.000000
S Vector {phi(t).p(t)}:
3.076923 2.470588 2.470588 1.733332 1.692307
0.9411769 0.9411764 0.5000003 0.1405864E-05 0.7240347E-06
0.7130144E-06 0.4434888E-06 0.3585167E-06 0.3235718E-06 0.3178967E-06
0.3178892E-06 0.3178892E-06 0.3074423E-06 0.1496835E-06 0.1314289E-06
0.1202430E-06 0.1172966E-06 0.1171686E-06 0.6247524E-07 0.6063276E-07
0.5458477E-07 0.5458477E-07 0.5458291E-07 0.2283143E-07 0.1573467E-07
0.1169571E-08 0.1153389E-08 0.8287850E-09 0.5064499E-09 0.5064497E-09
0.4531770E-09 0.4268930E-09 0.3780729E-09 0.2005165E-09 0.1179552E-09
0.1072146E-09 0.1064020E-09 0.7240969E-10 0.3993209E-10 0.3381622E-10
0.2674458E-10
Time to compute number of parameters was 0.36 seconds.
Threshold = 0.9400000E-06 Condition index = 0.8691988E-11 New Threshold = 0.1813906E-09
New Guessimate of Estimated Parameters {phi(t).p(t)} = 33
Conditioned S Vector {phi(t).p(t)}:
1.000000 0.8029410 0.8029409 0.5633329 0.5499997
0.3058825 0.3058823 0.1625001 0.4569059E-06 0.2353113E-06
0.2317297E-06 0.1441338E-06 0.1165179E-06 0.1051608E-06 0.1033164E-06
0.1033140E-06 0.1033140E-06 0.9991875E-07 0.4864714E-07 0.4271439E-07
0.3907897E-07 0.3812139E-07 0.3807978E-07 0.2030445E-07 0.1970564E-07
0.1774005E-07 0.1774005E-07 0.1773944E-07 0.7420213E-08 0.5113768E-08
0.3801105E-09 0.3748514E-09 0.2693551E-09 0.1645962E-09 0.1645961E-09
0.1472825E-09 0.1387402E-09 0.1228737E-09 0.6516784E-10 0.3833543E-10
0.3484475E-10 0.3458064E-10 0.2353315E-10 0.1297793E-10 0.1099027E-10
0.8691988E-11
Number of Estimated Parameters {phi(t).p(t)} = 8
DEVIANCE {phi(t).p(t)} = 89.939240
DEVIANCE Degrees of Freedom {phi(t).p(t)} = 24
c-hat {phi(t).p(t)} = 3.7474683
AIC {phi(t).p(t)} = 105.93924
AICc {phi(t).p(t)} = 106.72612
BIC {phi(t).p(t)} = 131.99920
Pearson Chisquare {phi(t).p(t)} = 174.23540

LOGIT Link Function Parameters of {phi(t).p(t)}

Parameter	Beta	Standard Error	95% Confidence Interval Lower	Upper

1:pi	-1.8718031	0.7595548	-3.3605305	-0.3830757
2:pi	-41.092522	0.1341568E-005	-41.092525	-41.092519
3:p	56.564278	0.0000000	56.564278	56.564278

4:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
5:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
6:p	-1.5512644	0.0000000	-1.5512644	-1.5512644
7:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
8:p	-1.5511992	0.0000000	-1.5511992	-1.5511992
9:p	28.474750	94.454163	-156.65541	213.60491
10:p	-0.7411186	0.0000000	-0.7411186	-0.7411186
11:p	-0.7411377	0.0000000	-0.7411377	-0.7411377
12:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
13:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
14:p	-0.7413039	0.0000000	-0.7413039	-0.7413039
15:p	-27.652989	7.5940723	-42.537371	-12.768607
16:p	0.0571189	0.0000000	0.0571189	0.0571189
17:p	0.0571511	0.0000000	0.0571511	0.0571511
18:p	0.0571511	0.0000000	0.0571511	0.0571511
19:p	0.0571636	0.0000000	0.0571636	0.0571636
20:p	0.0571636	0.0000000	0.0571636	0.0571636
21:p	20.772807	7968.5714	-15597.627	15639.173
22:p	-0.4750927	1133.1592	-2221.4671	2220.5169
23:p	-0.4750927	1022.7672	-2005.0988	2004.1486
24:p	-0.4750927	1068.5058	-2094.7466	2093.7964
25:p	-0.4750249	1326.3821	-2600.1839	2599.2339
26:p	-0.4750249	1520.2949	-2980.2530	2979.3030
27:c	79.441290	0.0000000	79.441290	79.441290
28:c	-69.045743	0.0000000	-69.045743	-69.045743
29:c	-.2238521E-005	1.4142132	-2.7718602	2.7718557
30:c	-98.251477	0.0000000	-98.251477	-98.251477
31:c	56.783687	0.0000000	56.783687	56.783687
32:c	0.4700039	0.5700877	-0.6473680	1.5873757
33:c	-1.7047485	0.7687063	-3.2114128	-0.1980842
34:c	93.323316	0.0000000	93.323316	93.323316
35:c	59.560680	0.1258984E-005	59.560677	59.560682
36:c	28.347807	0.0000000	28.347807	28.347807
37:c	-25.485731	0.0000000	-25.485731	-25.485731
38:c	16.428773	0.0000000	16.428773	16.428773
39:c	-25.485724	0.0000000	-25.485724	-25.485724
40:c	-19.821643	0.0000000	-19.821643	-19.821643
41:c	-27.848325	0.0000000	-27.848325	-27.848325
42:c	2.7725888	1.0307764	0.7522670	4.7929107
43:c	-1.5404451	0.6362090	-2.7874148	-0.2934754
44:c	2.7725883	1.0307762	0.7522669	4.7929097
45:c	1.5404454	0.6362091	0.2934756	2.7874152
46:c	20.497756	6618.0719	-12950.923	12991.919

- -

Real Function Parameters of {phi(t).p(t)}

	Estimate	Standard Error	95% Confidence Interval Lower	Upper
1:pi	0.1333332	0.0877707	0.0335520	0.4053853
2:pi	0.1424769E-017	0.1911424E-023	0.1424765E-017	0.1424773E-017
3:p	1.0000000	0.0000000	1.0000000	1.0000000
4:p	0.1749131	0.0000000	0.1749131	0.1749131
5:p	0.1749131	0.0000000	0.1749131	0.1749131
6:p	0.1749037	0.0000000	0.1749037	0.1749037
7:p	0.1749131	0.0000000	0.1749131	0.1749131
8:p	0.1749131	0.0000000	0.1749131	0.1749131
9:p	1.0000000	0.4062477E-010	1.0000000	1.0000000
10:p	0.3227596	0.0000000	0.3227596	0.3227596
11:p	0.3227554	0.0000000	0.3227554	0.3227554
12:p	0.3227191	0.0000000	0.3227191	0.3227191
13:p	0.3227191	0.0000000	0.3227191	0.3227191
14:p	0.3227191	0.0000000	0.3227191	0.3227191
15:p	0.9782720E-012	0.7429068E-011	-.1358270E-010	0.1553925E-010
16:p	0.5142758	0.0000000	0.5142758	0.5142758
17:p	0.5142839	0.0000000	0.5142839	0.5142839
18:p	0.5142839	0.0000000	0.5142839	0.5142839
19:p	0.5142870	0.0000000	0.5142870	0.5142870
20:p	0.5142870	0.0000000	0.5142870	0.5142870
21:p	1.0000000	0.7583419E-005	0.9999851	1.0000149
22:p	0.3834116	267.88691	0.6131017E-304	1.0000000
23:p	0.3834116	241.78946	0.6131017E-304	1.0000000
24:p	0.3834116	252.60241	0.6131017E-304	1.0000000
25:p	0.3834276	313.57115	0.6131433E-304	1.0000000
26:p	0.3834276	359.41424	0.6131433E-304	1.0000000
27:c	1.0000000	0.0000000	1.0000000	1.0000000
28:c	0.1032321E-029	0.0000000	0.1032321E-029	0.1032321E-029
29:c	0.4999994	0.3535533	0.0588639	0.9411359
30:c	0.2137597E-042	0.0000000	0.2137597E-042	0.2137597E-042
31:c	1.0000000	0.0000000	1.0000000	1.0000000
32:c	0.6153847	0.1349320	0.3435829	0.8302466
33:c	0.1538461	0.1000682	0.0387385	0.4506402
34:c	1.0000000	0.0000000	1.0000000	1.0000000
35:c	1.0000000	0.0000000	1.0000000	1.0000000
36:c	1.0000000	0.0000000	1.0000000	1.0000000
37:c	0.8544520E-011	0.0000000	0.8544520E-011	0.8544520E-011
38:c	0.9999999	0.0000000	0.9999999	0.9999999
39:c	0.8544579E-011	0.0000000	0.8544579E-011	0.8544579E-011

40:c	0.2463597E-008	0.0000000	0.2463597E-008	0.2463597E-008
41:c	0.8046855E-012	0.0000000	0.8046855E-012	0.8046855E-012
42:c	0.9411765	0.0570672	0.6796725	0.9917798
43:c	0.1764706	0.0924594	0.0580081	0.4271533
44:c	0.9411764	0.0570672	0.6796725	0.9917798
45:c	0.8235295	0.0924594	0.5728468	0.9419920
46:c	1.0000000	0.8292185E-005	0.9999837	1.0000163

Estimates of Derived Parameters
Population Estimates of {phi(t).p(t)}

Group	N-hat	Standard Error	95% Confidence Interval Lower	Upper
1	15.000000	0.8922051E-006	15.000000	15.000000
2	17.000000	0.3970944E-004	17.000000	17.000010

Attempted ordering of parameters by estimatibility:
32 43 45 1 33 44 42 29 24 23 22 25 26 16 18 17 20 19 14 11 12 10 13 7 8
5 4 6 46 21 38 36 40 39 37 9 15 41 2 3 31 35 28 34 27 30
Beta number 30 is a singular value.

CPU Time in seconds for last procedure was 0.53

INPUT --- proc stop;

CPU Time in minutes for this job was 0.01

Time Start = 18:27:34.419 Time End = 18:27:34.925

Wall Clock Time in minutes for this job was 0.01

E X E C U T I O N S U C C E S S F U L

Appendix 9: Other wildlife recorded during the survey period

Other Animal presence			Pre-monsoon (No. of individuals)	Monsoon (No. of individuals)	Post-monsoon (No. of individuals)	Winter (Number of individuals)	National Status (IUCN Red List 2015)	Migratory/ Resident
Sl. No.	Common Name	Scientific Name						
1	Collared King Fisher	Todiramphus chloris	3	2			LC	R
2	White Throated King Fisher	Halcyon smyrnensis	4					R
3	Pied Kingfisher	Ceryle rudis	1	3	2	4	LC	R
4	Brahminy Kite	Haliastur Indus	3	17	12	2	LC	R
5	Yellow Bittern	Ixobrychus sinensis	1					R
6	Asian Pied Starling	Sturnus contra	8	9	29	2	LC	R
7	Black Kite	Milvus migrans	6	37	57	23	LC	R
8	Common Kingfisher	Alcedo atthis	3		1		LC	R
9	Greater Coucal	Centropus sinensis	1				LC	R
10	House Crow	Corvus splendens	1	65	90	55	LC	R
11	Little Cormorant	Microcarbo niger	16	175	50	2	LC	R
12	Jungle Crow	Corvus levaillantii		18	3	7	LC	R
13	Spotted Dove	Spilopelia chinensis		5	2	3	LC	R
14	Indian Pond Heron	Ardeola grayii		12	4		LC	R
15	Little Egret	Egretta garzetta		9	50	2	LC	R
16	Red Vented Bulbul	Pycnonotus cafer		9	10	1	LC	R
17	House Swift	Apus nipalensis		7	30		LC	R
18	Common Myna	Acridotheres tristis		6	2		LC	R
19	Black Drongo	Dicrurus macrocercus		6	6	2	LC	R
20	Sand Martin	Riparia riparia		6				M
21	White Wagtail	Motacilla alba		3	2	1	LC	M
22	Common Sandpiper	Actitis hypoleucos		3	18	8	LC	M

23	Palm Swift	Cypsiurus balasiensis		30		3	LC	R
24	Striated Heron	Buto ridesstriata		2			LC	R
25	Common Bittern	Ixobrychus cinnamomeus		2			LC	R
26	Magpie Robin	Copsychus saularis		1	9		LC	R
27	Chestnut Tailed Starling	Sturnia malabarica		2			LC	R
28	Cattle Egret	Bubulcus ibis		4			LC	R
29	Stork Billed Kingfisher	Pelargopsis capensis		1			LC	R
30	Barn Swallows	Hirundo rustica		7		2	LC	M
31	Gray Headed Lapwing	Vanellus cinereus		2			LC	R
32	Black Capped Kingfisher	Halcyon pileata		1				R
33	Wood sandpiper	Tringa glareola			1		LC	M
34	Brown headed gull	Larus brunnicephalus			2		LC	M
35	Baya weaver	Ploceus philippinus			20		LC	R
36	Black headed ibis	Threskiornis melanocephalus			50		VU	M
37	RufousTreepie	Dendrocitta vagabunda			1		LC	R
38	Rock pigeon	Columba livia			5		LC	R
39	Black Hooded Oriole	Oriolus xanthornus			1	1	LC	R
40	Great Cormorant	Phalacrocorax carbo			5		LC	M
41	Little Grebe	Tachybaptus ruficollis				1	LC	R
Total			47	444	462	119		

Appendix 10. A list of identified fish species recorded during the survey period

S. N	Common Name	Scientific Name	Monsoon	Post-monsoon	Winter	IUCN 2015 (National Status)	IUCN (Global Status)
1	Long-whiskered Catfish	Sperata aor*	X	Ar, Rr	X	VU	LC
2	Tengara catfish	Mystus tengara	X	Ar, Rr	X	LC	LC
3	Fresh Water Goby	Glossogobius giuris	Ar	Ar	Br, Ar, Rr	LC	LC
4	Tire-track Spinyeel	Mastacembelus armatus	X	Ar	Ar, Rr	EN	LC
5	Bata Labeo	Labeo bata	Ar	Ar	Br, Ar, Rr	LC	LC
6	Sind Danio	Devario devario	X	Br, Ar, Rr	X	LC	LC
7	Barramundi	Lates calcarifer	Ar, Rr	Ar, Rr	X	NO+	
8	Freshwater shark	Wallago attu	Ar	Ar	X	VU	NT
9	Chola Barb	Puntius chola	X	Ar, Rr	Ar, Rr	LC	LC
10	Indian river shad	Gudusia chapra	X	Br, Ar, Rr	Br, Ar, Rr	VU	LC
11	Moonsoon River Prawn	Macrobrachium malcomsonii	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	
12	Lanceolate goby	Pseudapocryptes elongates	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
13	Humped Featherback	Chitala chitala*	X	Ar, Rr	Ar, Rr	EN	NT
14	Grey Featherback	Notopterus notopterus	X	Ar	X	VU	LC
15	Giant Snakehead	Channa marulius*	X	X	Ar	EN	LC
16	Menoda Catfish	Hemibagrus menoda	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
17	Kuria labeo	Labeo gonius	Ar, Rr	Ar, Rr	X	NT	LC
18	Giant Freshwater Shrimp	Macrobrachium rosenbergii	Br, Ar	Br, Ar, Rr	Br, Ar, Rr	LC	LC
19	Gangetic Mystus	Mystus cavasius	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
20	River Shad	Tenualosa ilisha	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
21	Ganges River-sprat	Corica soborna	Br	Br	Br, Ar	LC	LC
22	Gangetic Ailia	Ailia coila	X	Br	Br, Ar	LC	NT
23	Canine Catfish Eel	Plotosus canius*	X	Rr		NT	
24	Silver Needle Fish	Xenentodon cancila	X	Ar	Ar, Rr	LC	LC

25	Himalayan Glassy Perchlet	Pseudambassis baculis	Ar, Rr	Ar, Rr	Ar, Rr	NT	LC
26	Banded gourami	Trichogaster fasciata	X	Ar, Rr	Ar, Rr	LC	LC
27	Catla	Catla catla*	X	Ar, Rr	Ar, Rr	LC	LC
28	Climbing Perch	Anabas testudineus*	X	X	Ar	LC	DD
29	Rubicundus Eelgoby	Odontamblyopus rubicundus	X	Br, Ar, Rr	Br, Ar, Rr	LC	-
30	Mottled Nandus	Nandus nandus	Ar, Rr	Ar, Rr	Ar	NT	LC
31	Mrigal Carp	Cirrhinus cirrhosus	Rr	Ar, Rr	Ar, Rr	NT	VU
32	Mola Carplet	Amblypharyngodon mola	X	Ar, Rr	X	LC	LC
33	Glass barb	Pethia guganio	X	Br, Ar, Rr	X	LC	LC
34	Pabda catfish	Ompok pabda	X	X	Br, Ar	EN	NT
35	Bar-tailed Flathead	Platycephalus indicus	X	Ar	X	LC	DD
36	Pungas Catfish	Pangasius pangasius	Ar, Rr	Ar, Rr	Ar, Rr	EN	LC
37	Goldspot Mullet	Liza parsia	Rr	Ar, Rr	Rr	LC	
38	Gangetic Hairfin Anchovy	Setipinna phasa	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
39	Spotted Snakehead	Channa punctatus	X	Ar	X	LC	
40	Striped Dwarf Catfish	Mystus vittatus	X	Br, Ar, Rr	X	LC	LC
41	Pama Croaker	Otolithoides pama	Ar, Rr	Ar, Rr	Br, Ar, Rr	LC	
42	Ocellated pufferfish	Tetraodon cutcutia	X	Ar	Ar, Rr	LC	LC
43	Rita	Rita rita*	X	Ar, Rr	Ar, Rr	EN	LC
44	Rohu	Labeo rohita	Ar, Rr	Ar, Rr	Ar, Rr	LC	LC
45	Silond catfish	Silonia silondia	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	LC
46	Stinging Catfish	Heteropneustes fossilis*	X	X	Ar, Rr	LC	LC
47	Snakehead Murrel	Channa striatus*	X	Ar, Rr	Ar, Rr	LC	
48	Silver carp	Hypophthalmichthys molitrix*	X	X	Ar, Rr		DD
49	Paradise Threadfin	Polynemous paradiseus	Ar, Rr	Br, Ar, Rr	Br, Ar, Rr	LC	-
50	Flathead Sillago	Sillaginopsis panijus*	X	Ar, Rr	X	LC	-

Status code: LC-Least Concern, VU-Vulnerable, EN-Endangered, NT-Near Threatened, DD- Data Deficient, NO-Not Threatened,'+'= IUCN List 2000

N.B.: 'Br' = Present in the Bhairab River, 'Ar' = Present in the Atai River, 'Rr' = Present in the Rupsha River' X' = Absent in the River&'*' = Questionnaire survey

Appen dix 11: Vegetation Survey Methodology

Sampling design and sample size

A total of 6 plots were selected in 500 m zone from the proposed power plant. The plots are equal in size (10m x 10m).

Data collection

Every individual of woody species as well as the number of herbs and shrubs was counted. The number of seedling and sapling that is regenerated naturally was recorded.

Data analysis

Density, Relative Density, Frequency and Relative Frequency is calculated by following equations.

$$1.\ \text{Density (stem/ha)} = \frac{\text{Total no. of individuals of one species in all the plots}}{\text{Plot area} \times \text{Total no. of plots studied}}$$

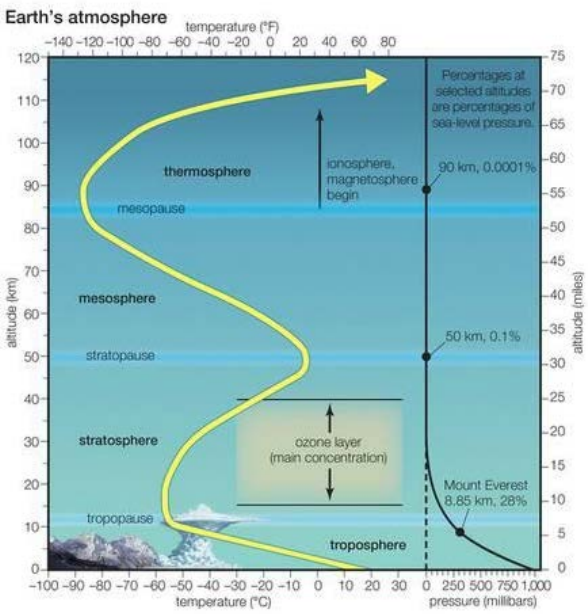
$$2.\ \text{Relative density (\%)} = \frac{\text{Total no. of individuals of one species in all the plots}}{\text{Total no. of plots studied}} \times 100$$

$$3.\ \text{Frequency (\%)} = \frac{\text{Total no. of plots in which the species occurs}}{\text{Total no. of plots studied}} \times 100$$

$$4.\ \text{Relative frequency (\%)} = \frac{\text{Frequency of one species}}{\text{Sum of frequency of all species}} \times 100$$

Annex-XIII

	Comments from DOE	Response
1	How the SEA of South-western coastal zone of Bangladesh linked to this project and how the outcome of the SEA will the included in this project?	Ministry of Environment, Forest and Climate change has already taken the initiative to conduct the Strategic Environment Assessment of South-western region of Bangladesh including Sundarbans. The proposed Rupsha 800MW will be constructed in Khalishpur of Khulna beside the Bhairab river which belongs to South-west region. This project assess the not only the environmental impacts of the proposed project but also the cumulative impacts considering other existing and future installation. However, the outcome of the SEA study will be obliged by this proposed project *if any*. NWPGCL will accommodate the Strategic EMP of the approved SEA study rightfully at the project construction and operation stages(Section- 571 of Article) Chapter 9: Environmental Management Plan (EMP), 9.2 Implementation arrangement, Section-15: Executive Summary of the Volume-1: EIA of the Power Plant Project)
2	How this project fit with the delta plan?	The National Economic Council (NEC) approved the Delta Plan 2100 in September 2018 with the chair of the Hon'ble Prime Minister to secure the future of water resources and mitigate against the likely effects of climate change including natural disasters. A total of 26 studies were carried out by local experts and at least 80 projects have been selected for implementation. Of them, 65 would be infrastructure projects while 15 others would aim to enhance institutional capacity, efficiency and research. Therefore, the government will need to raise $37 billion by 2030 to implement the plan over three phases: a short-term plan by 2030, a mid-term plan by 2050, and a long-term plan by 2100. At present, however, the government spends only 0.8% of GDP on delta management projects and programs. This figure will need to be more than tripled - to 2.5% of GDP - if the 80 projects of the plan are to be implemented. The Delta plan highlighted six hotspots: coastal areas; Barind Tract and drought-prone region; haor (back swamp) and flash flood prone areas; Chittagong Hill Tracts region; river region and estuaries; and the urban region. The proposed Rupsha project is falling under urban hotspots and linked with the water uses, effluent discharge and financial growth with the Delta Plan 2100 objectives. It is to be noted that, the proposed project is a high efficient combined cycle duel fuel power plant with minimum consumptive water use (Use of air cooling system) and implementation effective and efficient pollution control technologies like ETP, STP etc. (Chapter 1: Article -1.1: Project Justification and Chapter-3: Article-3.3: Project Component, Section-5: Executive Summary in Volume-1: EIA of the Power Plant Project)
3	Does jetty include in this EIA report?	The existing jetty will be renovated to unload the construction materials and heavy equipment. Besides, a new jetty will be constructed for unloading of heavy equipment during construction phase and handling HSD unloading operation during Power Plant operation phase. Therefore, renovation of existing jetty and construction of new jetty has been included as an activities during the construction stage. The impacts of jetty renovation/construction

		and operation of the jetty during construction stage are assessed in order to formulate the EMP (Figure-3.1: Layout Plan (No-47 in Legend); Section-63:of Article 3.3: Project Component, Section -81 of Article 3.6.3:Transportation of equipment and machineries in Chapter-3 of Volume-1: EIA of Power Plant)
4	Air cooling system should be included in the Final EIA report and its associated impact?	In order to reduce the pressure on the surface water resources of Bhairab river the project proponent has included air cooling system which is much costly than water cooling system. Impacts of air cooling system has been detailed out at the relevant section of the EIA report as well as the EMPs. The amended parts are presented in Section -14, 68 of Executive Summary; Section-112 of Article 3.8.5: Water system and Water Balance in Chapter-3, Section-450 of Article 5.5.2: Ambient Noise of Chapter-5 and Chapter- 9: EMP (Mitigation during operation stage O1).
5	How much particulate matter emit from this power plant? Describe how the particulate matter impact on this power plant project during operation period.	Gas based combined cycle power plants are usually emit insignificant amount of Particulate Matter (Maximum 3.2gm/s) due to use of clean fuel (Table 5.20: Emission from the Component-1: Power Plant of Chapter-5 in Volume-1). The smooth operation of the power plant, the air intake systems is crucial for the efficiency of gas turbine combined cycle power plants. However, use of air filter systems play a special role in protecting the sensitive turbine components. The air intake system of Rupsha power plant guarantee the required level of purity of the combustion air for efficient operation of the gas turbines. At the same time, these systems to keep noise levels for staff and the environment as low as possible.
6	Revised the water extraction and water balance diagram due to use of air cooling system?	Use of air cooling will reduce the water consumption nearly 92% than the close cycle water cooling system (Section – 11 of Article 3.8.5: Water System and water Balance in Chapter – 3 and Section –14: Executive summary of Volume-1). Since the project design has been finalized based on air cooling system, the water extraction, water balance and discharge are also changed as per requirement on the relevant sections (Figure 3.10: Water Balance Diagram in Chapter-3 of Component-1: Power Plant of Volume-1).
7	Pointing out the abandon area inside the project boundary?	Article 3.7.1: Site Preparation and Table - Table 3.5: Description of Abandoned Structures in the Proposed Project Site of Chapter-3 in Volume-1 (EIA of Power Plant) details the abandon area inside the project boundary.
8	Is there any scope to figure out the thermal emission from the flue gas system?	Flue gases inside the stacks are much hotter than the ambient outside air and therefore less dense than the ambient air. That causes the rise of plume from the chimney to have a lower pressure than the corresponding pressure column of outside air. The plume rise with the adiabatic expansion and reduce the temperature up to the effective stack height until the density gradient remain similar with the ambient 

		condition. During the simple cycle GT operation the bypass stack of 50 m release flue gas at temperature of 886 deg C. This flue gas temperature (1,159^{0}K) will rise upwards where the effective stack height (i.e., physical stack height + plume rise) for simple cycle operation will be 513m. During the Combined cycle operation the HRSG stack of 70 m release flue gas at temperature of 102 degC. In this flue gas temperature the effective stack height will be 243.4 m. Section – 415 of Chapter-5 in Volume-I (EIA of Power Plant) The downturn movement of the flue gas depends on increasing the density gradient of the flue gas. At the ground level the temperature of the flue gas is almost similar with ground level wind. Therefore, no chance of heat disperse from flue gas emission to the ground level ambient atmosphere during operation stages of Rupsha Power Plant.
9	Stakeholder consultation should be rearranged as per the TOR of this project	Stakeholder consultation has been conducted as per TOR including all relevant participants Chapter 7: INFORMATION DISCLOSURE, CONSULTATION, and PARTICIPATION in Volume-1 (EIA of Power Plant). The approach of the stockholder consultation has been conducted after classification of Primary stakeholder and secondary stakeholder. The consultation procedure and document have been presented in Annex-4 to Annex-7 of Volume-1: EIA of the Power Plant)
10	All of the reports should be in Volume with numbering	All the reports are shelved into sequential volume for comprehensive manner. Please see the Section-33 of Article 1.5: Structure of the Report of Chpater-1 in Volume-1. where - Volume 1: EIA of Component 1- EIA of Rupsha 800 MW Gas-fired Combined Cycle Power Plant Volume 2: EIA of Component 2- EIA of Gas Supply to the Power Plant Volume 3: EIA of Component 3- EIA of Power Transmission Interconnection
11	Include ecological issues for selecting alternative options especially for gas pipeline	Table 6.2: Route options for the gas pipeline from Khulna CGS to Rupsha 800 MW CCPP in Article 6.2 of Chapter-6 in the Volume -2 (EIA of Gas pipeline) has included in the ecological issues for finalizing the route.
12	Are the existing culvert and bridges sufficient for preventing water logging is the project area?	During field visit no water logging has been recorded in the study area of gas pipeline route.Section-55 of Article 4.2.4: Water resources in Chapter-4 of Volume-2 (EIA of Gas Pipeline) has been pointed out the baseline water logging situation. However, the impact and mitigation of pipeline construction have been detailed out in Article 5.23.4: Drainage System of Chapter-5 in volume -2 with respect to water logging perspective. Post construction impact on drainage system is insignificant for Gas pipe line.
13	Justify the selection of the 10.5km Gas pipeline	In the Chapter-6: Analysis of Alternatives in Volume-2 (EIA of Gas pipeline), clearly specify the reasoning behind selection of 10.5km gas pipeline route. In Article –6.2: “With project” options considered for the gas distribution pipeline route of Chapter-6 in Volume-2 includes all the technical, social and ecological aspects for finalizing the route proposed gas pipeline. However, Social issues are the key determining factors for selecting

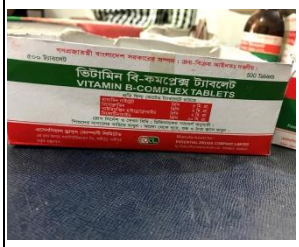
		the proposed 10.5km route.
14	Detail description of the EIA team members with phone number	A detail description of the EIA team member has been addressed in the introduction chapter where the expert name, expertise, experiences and phone number have been clearly pointed out (Section 35; Article 1.6 of Chapter-1 in volume -1(EIA of Power Plant).
15	Whether the vessels used for construction stages, make any problem or not?	Vessel movement for materials and equipment transportation trough the Bhairab river will be taken places (Article-3.6.3: Transportation of Equipment, Machinery, etc.of Chapter 3 in volume -1: EIA of Power Plant). The number of vessel movement for this purposes will be insignificant percentages during construction stage with respect to the present vessel movement though the river. However, impact of vessel movement during construction period has been addressed and subsequent EMP has been suggested in the relevant chapters (Table-9.4: Mitigation Plan of Chapter-9 and Table 10.1: Potential hazard and risk during construction and erection of Chapter 10 in Volume -1)
16	Specify the location of Sundarbans Reserve Forest and World Heritage Site in Sundarbans from the proposed Rupsha 800 MW Power Plant	Sundarbans Reserve Forest (SRF) is located around 40km and World Heritage Site (WHS) in Sundarbans is located around 90Km aerial distance from the Proposed Rusha 800MW Combined Cycle Power Plant Project (Figure 4.43, Page-117)

Annex 13
Health Impact Assessment (HIA)

NORTH-WEST POWER GENERATION COMPANY LIMITED

North-West Power Generation Company Ltd.

Health Impact Assessment (HIA) for Rupsha 800-Megawatt Combined Cycle Power Plant, Khulna, Bangladesh



Prepared By

EQMS

EQMS Consulting Limited

www.eqmsbd.com

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CHAPTER ONE: INTRODUCTION

1. Introduction

1.1. The Project

NWPGCL is going to establish a new gas-fired power plant to enhance the power generation capacity of Bangladesh and address its growing demand for electricity. This new power plant, "Rupsha 800-megawatt (MW) Combined Cycle Power Plant" in Khalishpur Upazila, Khulna District, South-Western Bangladesh, will use natural gas as main fuel and high-speed diesel as back-up fuel to be used only for about 500 hours maximum annually during maintenance or emergency.

The project will construct:

1. a 10-km, 24-inch gas distribution pipeline to connect the Khulna city gas station to the Rupsha power plant;
2. an additional 2 km, 20-inch gas pipeline (off take) from the Rupsha power plant to NWPGCL"s existing 225 MW power plant at Khulna, which is currently operating on high speed diesel (HSD);
3. 230-kilovolt switchyard at the Rupsha power plant site; and
4. a 29 km of 230-kilovolt high-capacity double-circuit transmission lines.

1.2. The Project Area

The project site is an area formerly used by the Khulna Newsprint Mills (KNM) Limited located in Khalishpur Thana, Khulna Division. The total area occupied by KNM from its previous operations is about 87 acres (or 35.2077 hectares (ha)). NWPGCL will only require about 50 acres (or 20.2343ha) to accommodate Component 1. The power block will occupy 6.37 acres, switch yard at 4.3 acres, gas supply facility at 2.31 acres, HSD supply facility at 2.72 acres, water treatment facility at 5.61 acres, and the balance of plant at 3.16 acres.

The initial Area of Influence (AOI) for the components of the proposed project has been considered as follows;

Table 1: Project Components

Component	Description	Features	Influenced Upazila
Component 1	Rupsha 800 MW Power Plant	(Gas and High-speed diesel) duel fuel-based power plant	Bhatiaghata, Dighalia, Dumuria, Fultala, Rupsha (5km AOI)
Component 2	Gas Supply to the Power Plant	A new 24-inch (0.6 m) underground gas pipeline about 10km long will be installed from Khulna CGS to the Rupsha 800 MW power plant.	Khalishpur (City corporation) (250m AOI)
Component 3	Power Transmission Interconnection	A new 29 km transmission line will be built from Rupsha 800 MW CCPP to the existing Khulna South substation	Bhatiaghata, Dighalia, Rupsha (250M AOI)

1.3. Background of the Health Impact Assessment (HIA) Study

The project is Category A for environment; and an environmental impact assessment was undertaken with the draft report disclosed at the ADB website. The EIA identified the need to undertake a Health Impact Assessment (HIA) to better characterize the potential health impacts associated with the project and additional mitigation measures and monitoring indicators to be included in the EMP. The HIA should be completed before civil works commence to provide a baseline for monitoring health impacts and confirm significant impacts on human health. Using a broad, socio-environmental definition of health; the assessment will include an analysis of both project and cumulative health and safety impacts/risks covering both geographic and temporal dimensions, beyond the project area and continuing into the operation phase.

1.4. Objective of the HIA Study

- Characterize the health status and vulnerability of project-affected populations.
- Assess health impacts, including quantifying air quality-related health effects.
- Identify additional mitigation options and health enhancing opportunities, as relevant.
- Strengthen involvement of health stakeholders in the process of impact assessment, management and monitoring (e.g. strengthen diseases prevention, health promotion and diseases surveillance in the project area), and
- Leverage positive health outcomes from infrastructure development in line with ADB's Operational Plan for Health

1.5. Study Area and Period

It was a descriptive cross-sectional study among adult population located within the 1-kilometer radius of proposed project, *Rupsha 800-Megawatt Combined Cycle Power Plant and transmission line (both gas and power line),* who might be affected by the project interventions. With one kilometers radius there are fourteen numbers of villages/Mahallas*(Khalishpur H.e Area Uttar, Khalishpur H.e (purba Block), Khalishpur Housing East Block, Khalishpur H.e (central Block, Khalishpur H.e.(old Colany), Platinum Jublee Mill Gate, Daulatpur Jute Mill, Hardboard Mill Area, Newsprint Mills (project boundary area), Uttar Alamnagar, Charer Hat, Dakshin Alamnagar, Palpara and Chandani Mahal)* situated surrounding to the proposed power plant. Survey was conducted within all these villages/Mahallas with representative sample size. Data was collected at a single point in a specified time. Considering time period and resource availability, cross-sectional study design was the most feasible for this study. Moreover, this study also considered Newsprint Mill High School and its students since this institution is going to be displaced and restored adjacent to the proposed project site. For being close to the project area, school children might be affected in long term. Thus, primary school children from Newsprint Mill High School (experimental group) and Nurnagar Gov. Primary School (control group) were surveyed for collecting some physical measurements (like, height, weight, auditory level, visual level) for developing their baseline health status for future monitoring purposes.

The duration of the study was two months from July–September, 2019. Preparatory activities including questionnaire development, recruitment of data collectors, training and pretesting was

done for 2weeks. Data collection period was 2 weeks. Rest of the time spent for data processing, analysis and report writing. Literatures were also reviewed during the whole study period.

1.6. Outcome of the HIA Study

- The project will have important health benefits: improve energy security (a critical determinant of health);
- Offsetting emissions from the existing diesel-fired power plant (emissions reductions of Sox and PM with important environmental and health benefits);
- A project health clinic serving workers and 400 schoolchildren;
- Social investment initiatives undertaken as part of the project will positively influence many wider determinants of health.

1.7. Strength and Weakness of This Study:

The present HIA study conducted among the local residents of Khalishpur, Khulna this study was done based on WHO HIA guideline. All age group and sexes respondents were included in this study so that, the health condition of different group can be narrated properly. This study followed the both qualitative and quantitative methods so that the real picture can be assessed. In qualitative study key informed interview (KII) and focus group discussion were conducted among the local residents. In KII, the health manager, health care provider, other allied health care providers and other departments related to health were included so that the present health care situation of Khlishpur can be assessed. The anthropometric, hearing and vision data were also collected from two schools (one nearby to the project and another 3 kilometers far from the project) children to understand their health situation.

Like any others epidemiological study this HIA study also has some limitations. Regarding the disease's history, we rely on just participants history (subjective assessment), did not review their medical records and it was not possible to diagnosis (objective assessment) directly which may chance of over and under representation. No biological (blood, urine and stool) sample were collected to understand the underlying diseases process of the participants which may mislead the diseases pattern in case of noncommunicable diseases. Vibration, that may be very big challenge to the local residents and school students; for this type of power project which, could not be possible to measure visiting any other this type of powerplant, for this reason, we rely on only the existing literature. Effect on pregnant mothers and their babies were also not measured as the methodology was not supported but next study should be included this pregnant group.

CHAPTER TWO: POLICY FRAMEWORK

2. Policy and Framework

The Safeguard Policy Statement (SPS) 2009 of ADB sets out the requirements for environmental safeguard that applies to all ADB-financed projects. As Rupsa 800 MW power plant constructions will be financed by ADB thus the HIA study for this proposed power plant will be guided by The Safeguard Policy Statement (SPS) 2009, Health Impact Assessment, A Good Practice Sourcebook, 2018 and relevant policies.

CHAPTER THREE: METHODOLOGY

3. Methodology

3.1. Methods and Materials

As there is no single agreed method for undertaking Health Impact Assessment (HIA), here the consultants followed World Health Organization (WHO) stages. The stages are:

3.1.1. Screening: Identify health relevance of the project (Review documents such as EIA).

3.1.2. Scoping: To clarify and prioritize health issues to focus on. The health determinants are important to the surrounding community that can be impacted by the Rupsha 800-Megawatt Combined Cycle Power Plant Project (as per EIA), such as;

- Water quality (water quality impacts are the important issue for this project; health effects of arsenic contaminated water may be potential concern for the project personnel and construction workers. For this reason, appropriate mitigation measures should be addressed based on this HIA.
- Air quality (Air quality impacts are the key issue for the project; health effects from changes in ground level concentrations of PM, NO_2 and SO_2 have been identified as a potential concern. The power plant is proposed for an area with a degraded airshed for PM, NO_2 and SO_2. The plant will mainly use natural gas as fuel resulting in increased ground level concentration of NO_2. In emergency situation and for up to 21 days per year, the plant will use high-speed diesel (HSD) resulting in increased ground level concentrations of these pollutants. For these reasons, this Health impact Assessment (HIA) is going to be conducted to better characterize these impacts and identify any additional mitigation measures, as relevant.)
- Apart from the major concern from HSD, there are other potential health impacts associated with the project. Some are already address in EIA; the HIA tried to identify and assess any outstanding health impacts and proposed additional mitigation measures, as relevant. Potential health impacts include:
  - ✓ HIV and STI associated with construction workforce behavior;
  - ✓ Tuberculosis and other respiratory infection associated with sub-standard worker accommodation;
  - ✓ Vector-borne diseases (e.g. dengue) from poorly managed/cleaned construction sites so, construction waste management system;
  - ✓ Road traffic injuries associated with poor construction traffic behavior;
  - ✓ Strengthening of local health services based on resourced available and large workforce to service catchment area;
  - ✓ Noise-related health effects in workers and neighboring communities.

3.1.3. Health Concerns:

- Communicable diseases;
- Non-communicable diseases including poisoning from hazardous chemicals and minerals;
- Cardio-vascular and respiratory disease;
- Nutritional problems;
- Injuries such as those that are occupational and traffic-related; and
- Psychosocial disorders.

3.1.4. Appraisal: In-depth assessment of health impacts using available evidence- who were affected, baseline prediction, significance, mitigation. Here consultants used of existing secondary sources of data, key informants and community participation in order to assess the changes in health determinants associated with the project. Principles of equity and community participation would be applied.

3.1.5. Development of health mapping: This HIA has developed health map (both temporal and geographic components).

3.1.6. Reporting: Conclusion and recommendations to mitigate negative impacts on health or to enhance positive

3.1.7. Monitoring: To monitor actual impacts on health to enhance existing evidence base.

3.2. Study Design

It was a descriptive cross-sectional study and data was collected at a single point in a specified time. Considering time period and resource availability, cross-sectional study design was the most feasible for this study.

3.3. Study Area

Proposed Project is going to be constructed at Ward 13 under Khulna City Corporation in Khulna District. With one kilometers radius there are fourteen numbers of villages/Mahallas situated surrounding to the proposed power plant namely *KhalishpurH.e Area Uttar, KhalishpurH.e (purba Block), Khalishpur Housing East Block, KhalishpurH.e (central Block, KhalishpurH.e.(old Colany), Platinum Jublee Mill Gate, Daulatpur Jute Mill, Hardboard Mill Area, Newsprint Mills (project boundary area), Uttar Alamnagar, Charer Hat, Dakshin Alamnagar, Palpara and Chandani Mahal*. Thus, these fourteen villages/mahallas were the study area for this study.

Moreover, Newsprint High School was considered the study area as it is being relocated and restored adjacent to the project site area. Along with the Newsprint High School, a control school (Nurnagar Gov. Primary School) situated 3 km away from the project area was selected based following criteria;

	Experimental Group	Control Group
	Newsprint Mill High School	**Nurnagar Gov. Primary School**
Similarities	Both primary and secondary schooling sections irrespective of gender	Primary schooling irrespective of gender
	Under Khulna City corporation (ward 13)	Under Khulna City corporation (ward 16)
Dissimilarities	50-60-meter distance from the proposed power plant	2.3 km from the proposed project boundary

3.4. Study Population

Based on the scoping report, two categories of populations were included for this Health Impact Assessment (HIA) study. For capturing general health baseline, population was the adult populations both males and females residing within the selected fourteen villages/mahallas.

On the other hand, school children of Newsprint High School both residing either within the selected villages/mahallas or not, were the study population.

3.4.1. Inclusion & Exclusion criteria

Inclusion & Exclusion criteria for general health baseline study are as follows;

Inclusion

- All adults male and female from the selected households; and
- Aged 18 years or older.

Exclusion

- Who were mentally challenged and unwilling to participate;
- Not stay in the study areas or guest; and
- Migrated from other areas for working purpose and duration of stay less than five years.

Inclusion & Exclusion criteria for school children studying at Newsprint High School are as follows;

Inclusion

- Primary school children both boys & girls

Exclusion

- Secondary school children who will finish schooling by 5 years

3.5. Sample Size Calculation

3.5.1. General Health Baseline Study

It was important to determine how large the sample was needed to assess the baseline health status of the population of the project area with desired level of precision and level of confidence. For this purpose, the sample size has been calculated using the following formula-

$$n = \frac{z^2 p(1-p)}{d^2} \text{ X } deeff$$

Where,

n = minimum required sample size
p = anticipated/ known prevalence
z = 1.96 for 95% level of confidence
d = precision level which is usually taken as 0.005
deeff = design effect 1.5 for cluster sampling

For representativeness 14 areas out of 20 situated around 1-km of the project was selected using GPS system then the total 8321 households were identified. Out of 8321 households 262 were selected using probability proportional to size (PPS) sampling technique without replacement.

3.5.2. School Children Baseline Study

20 students from Newsprint Mill High School and 25 students from Nurnagar Gov. Primary School were surveyed who are currently studying between (class i- class iv). Class v students were not available during the survey period for exam purposes; thus, this class was neglected from the survey.

3.6. Sampling Technique

3.6.1. General Health Baseline Study

The sampling technique was clustered random sampling. Out of 8321 households 262 were selected using probability proportional to size (PPS) sampling technique without replacement. In the next stage of sampling, numbers of households were selected within each cluster by systematic random sampling following N/n formula. Thus, the households were taken at a cluster specific interval until the desired sample (calculated) availed for each cluster (see table below). One adult aged 18 years or more was selected from each household for the interview.

Table 2: Calculation of required number of households needed

UNINAME	MAUZA NAME	% within the 1km boundary	total Households (HH)	HH after deduction	Required Proportion (%)	Required HH need to reach
Ward No-11	Khalishpur H.e Area Uttar	0.50	736	368	4	13

UNINAME	MAUZA NAME	% within the 1km boundary	total Households (HH)	HH after deduction	Required Proportion (%)	Required HH need to reach
Ward No-11	Khalishpur H.e (purba Block)	1.00	543	543	7	18
Ward No-12	Khalishpur Housing East Block	1.00	430	430	5	15
Ward No-12	Khalishpur H.e (central Block	0.30	494	148	2	4
Ward No-12	Khalishpur H.e.(old Colany)	0.30	4061	1218	15	40
Ward No-13	Platinum Jublee Mill Gate	1.00	305	305	4	10
Ward No-13	Daulatpur Jute Mill	1.00	184	184	2	5
Ward No-13	Hardboard Mill Area	1.00	141	141	2	4
Ward No-13	Newsprint Mills (project boundary area)	1.00	181	181	2	5
Ward No-13	Uttar Alamnagar	1.00	627	627	8	20
Ward No-13	Charer Hat	1.00	975	975	12	31
Ward No-15(part)	Dakshin Alamnagar	0.50	1089	544.5	7	16
Ward No-15(part)	Palpara	1.00	923	923	11	29
Senhati (Union)	Chandani Mahal	0.40	4333	1733	21	52
Total				**8321**	**100**	**262**

Source: Population & Housing Census, BBS, 2019

3.6.2. School Children Baseline Study

The school students were selected based on random sampling technique. 20 students were surveyed from Newsprint Mill High School (case) and 25 students were surveyed from Nurnagar Gov. Primary School (control).

Lottery method was used for the selection of desired numbers from each school. Before going to lottery methods, number of students from each class was calculated based on Population Proportion Sampling (PPS) methods.

3.7. Data Collection Techniques

For general health baseline study, questionnaire survey technique was adopted where each of the participants was informed about the purpose of the study and written informed consent as well as thumb impression was taken as necessary. Data was collected ensuring the privacy and confidentiality. Each participant was interviewed for approximately 25 to 30 minutes to complete the questionnaire.

For school children baseline study, physical measurements (height, weight, auditory level, visual acuity level) from school children were collected.

Weight: The weighing machine was used for measuring the body weight. Before using the machine every time, the balance was rectified. Body weight was measured in bare foot having light clothes (nearest 0.1 kg).

Height: The Participants' heights were measured in bare foot in standing position with a standard scale to nearest 0.1 cm. At the time of measuring height, the children was instructed to stand straight with eye looking forward, head positioned horizontally, feet together and knee straight.

Weber test: After setting the tuning fork (usually C2 = 128 Hz) in vibration, its stem is placed at the top of the skull, exactly in midline. The role of the school students is to answer whether the tone is heard in the center of head, in the right ear, or in the left ear. In a normal-hearing subject, or in a subject with side-symmetric sensorineural hearing loss, there is no lateralization of the tone to either ear. In a patient with one-sided hearing impairment, the result of the test depends on the type of hearing loss. Where there is conductive hearing loss, the tone strays to the impaired ear, while with sensorineural hearing loss the tone strays to the normal-hearing ear.

Rinne test: After setting the tuning fork (usually C2 = 128 Hz) in vibration, its stem is placed on the mastoid process. The patient is asked to report when s/he can no longer hear the tone. Then, the fork is placed close to the concha on the same side, while ensuring that the prongs are parallel to the axis of the ear canal. The patient is asked whether the tone can still be heard. If so, the result of the test is "positive," indicating that either the patient's hearing on this side is normal, or that the patient has a sensorineural hearing loss. In the latter case both bone conduction and air conduction times are shortened, and the result of the test is described as "small positive." If the patient does not hear the tone, the test should be repeated in reverse order – first, the tuning fork should be placed close to the concha, and once the patient can no longer hear the tone, its position has to be changed to the mastoid process on the same side. If the time of hearing the pure tone emitted by the tuning fork through the bone is longer than through the air, the result is "negative." This indicates a conductive hearing loss in the ear on the tested side. The same procedure is repeated for the opposite ear.

Vision test: Vision test of the students were done using optometry board. This board was place into a wall of the class room and a tool was place 20 meters away from the board. Enough light was ensuring in the room. School students were asked to read the alphabet upward to downward and the letters were arranged larger to the smaller. Who read all the alphabet without any difficulty they got full score 6/6 and who had the difficulty to read the alphabet got less score.

3.8. Statistical Analysis

The data was entered in the pre-designed Microsoft excel format which imported later into the statistical software SPSS version 25.0 for Windows (SPSS, Inc. Chicago. IL.USA). Descriptive measures including mean, standard deviation, median and range, proportion and percentages were generated.

3.9. Ethical Consideration

The following ethical issues were addressed-

- Informed consent (both verbal and written) was taken from each individual prior to interview but ascent was taken for the school students
- The purpose of the study was described properly to the respondents
- All the information collected from the respondents was kept confidential
- Data was not be being used for any other purpose other than the study
- The participant was informed that there will be no physical harm in participating in the study
- They was informed that no remuneration will be provided for participating in the study
- Participant was free to withdraw themselves from the study at any level of data collection as well as to skip any particular question

CHAPTER FOUR: UNDERSTANDING THE TARGETED COMMUNITY

4. Understanding the Targeted Community

4.1. Targeted Villages/Mahallas

Proposed Project is going to be constructed at Ward 13 under Khulna City Corporation in Khulna District. With one kilometers radius there are fourteen numbers of villages/Mahallas situated surrounding to the proposed power plant. Bhairab River flows within the 1-km radius in Eastern side from the proposed plant and separates Chandani Mahal village under Senhati Union. On the other hand, BIDC RD goes through the western side from the project boundary and separates Khalishpur H.e (purba Block), Khalishpur Housing East Block, Khalishpur H.e (central Block and Khalishpur H.e.(old Colany). Along with these in northern side Platinum Jublee Mill Gate, Daulatpur Jute Mill, Hardboard Mill and Newsprint Mills (project area) and in southern side Uttar Alamnagar, Dakshin Alamnagar, Charer Hat and Palpara are situated.

4.2. Population and Demography

Proposed project area underlies within metropolitan city. Studied villages/Mahallas around the project area are also part of metropolitan city. Like other metropolitan city, studied villages/mahallas are densely populated. According to the Population and Housing Census (2011), about 15022 households (HHs) with a total population of 58248 live within the study area. The average sex ratio is 118 against the national figure of 100 which depicts more representation of male population than the female population. Moreover, average household size (3.9) of the study area is lower than that of national figure 4.44.

4.3. Religion

According to the Population and Housing Census (2011), the population of the study areas is dominated by the Muslim community constituting almost 95.3% of the total population. The remaining 4.7% is primarily constituted by Hindus with Christians, Buddhists and others comprising an insignificant percentage.

4.4. Educational Institutions & Literacy

Industrial nature of the study area shapes the infrastructures and utility services. In the study area there are eight secondary schools and five colleges & poly-technique colleges. The concentration of literate people in underlying villages/Mahallas of project area within 1km area is 69.9% which is higher than the national average of 51.8%.

Table 3: List of Educational Institutions

Schools	Colleges
Provati High School	Mohsin College
Zia Secondary High School	Vashani School & College
Bongabashi School	Gov. Poly-Technique College
Platinum Secondary High School	Gov. Girls Poly-Technique College
Peoples Secondary High School	Square Poly-Technique College
Newsprint High School	
Rotary High School	
Satellite Secondary High School	

4.5. Settlement and Housing Structures

As the study area falls within the metropolitan area, modern urban fabric in settlements and structures has been observed. Most settlements and housings are built with Puccha and Semi-pucca structures. Moreover, there are some urban slum areas (Khalishpur housing slum, Railway slum, Alomnagar slum, Khalishpur north slum & khalishpur south slum) within the study area where Kutcha or Jhupri structures are mostly seen.

According to population and housing census (2011), predominant structure of these study areas is Semi-pucca[1] (37.1%) and Pucca[2] (35.6%) followed by Kutcha[3] (26.2%) and Jhupri[4] (1.1%).

Figure 1: Settlement & Housing Structures in the Project Site

[1] "Semi-pucca is defined by the structures whose walls are made of cement and bricks and roof is made of tin, asbestos, wood or bamboo", BBS (2015)
[2] "Pucca is structures whose floor, wall and roof are made of cement, brick and stones", BBS (2015)
[3] "Kutcha is defined by the structures whose walls are made of clay, wood, bamboo, straw or raw bricks and roofs are made of tin, bamboo and straw", BBS (2015)
[4] "Jhupri is very smaller and lower than a general house and made of straw/leaf, polythene, bamboo or tin", BBS (2015)

4.6. Occupations & Livelihood

Wide ranges of industries are available in the study area. Dowlatpur Jute Mills ltd, Platinum Jute Mills ltd, Crescent Jute Mills ltd, Khalishpur Jute Mills ltd, Khulna Hardboard Mills ltd and Khulna Newsprint Mills ltd are the known industries within the project area. A large number of populations thus are engaged with industries. Along with the industries different types of service sectors also have been developed. Consequently, a large number of populations are engaged with service sectors. Being a part of metropolitan city, like other parts of metropolitan cities agricultural activity is barely taken places.

According to the Population Census of Bangladesh (2011), service is the major source of employment in the project study areas. Approximately, 75.2% (67.6% male and 82.8% female) of the total employed populations engage in service sector. Moreover, 24.2% of total employees (31.7% male and 16.8% female) involve in industry sector. On the other hand, only 0.6% employees (0.8% male and 0.4% female) are working in agriculture sector.

4.7. Public Utilities & Infrastructures

4.7.1. Water Supply

Within the influenced village/mahalla areas of proposed project, the major source of drinking water is tube-well where about 93.4% populations use tube-well water. On the other hand, only 6.5% people have access to tap water. Other 0.1% people have access neither tube-well nor tap water and consequently have to rely on nearest surface water sources i.e. river, pond or canal.

4.7.2. Electricity

Electricity is an important indicator for measuring the quality of life. In these study areas, about94.5% of the households have electricity connections.

4.7.3. Sanitation

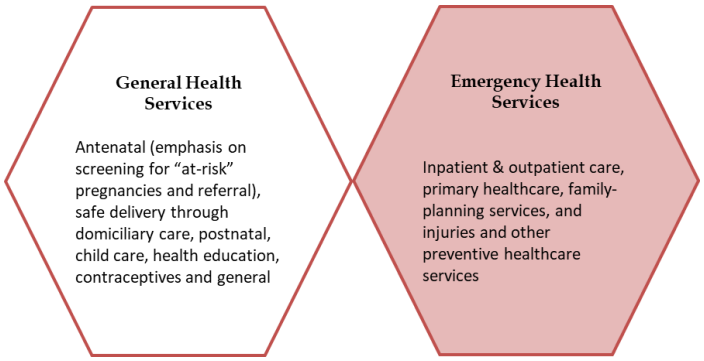
In the study areas, about 93.6% households use sanitary latrine including 42.6% water sealed and 51.0% non-water-sealed facility. Moreover, 5.7% households use non-sanitary facilities. On contrary, 0.7% households have no access to latrine facility and defecate in open places.

4.7.4. Health Care Facilities

Health facilities range from small clinics and doctor's offices for general health services to urgent care centers and large hospitals with elaborate emergency rooms and trauma centers.

Project area is found having close proximity to the local general health service centers that provide only outpatient services. Average distance between project area and general

Figure 2: Types of Health Services



health service centers is 2.4 km. On the other hand, emergency health service center (Khulna Medical College Hospital & Shaheed Sheikh Abu Naser Specialized Hospital), providing hospital services, is found average 4.6km away from the proposed project area.

Table 4: Available Health Services Around the Project Site

Health Service Providers	Distance km	Service Types
Khalishpur Lal Hospital, Khulna	2.7	General Health Services
NogorSasthoCendro, Khulna	2.6	General Health Services
Sramik Kallan Kendra	1	General Health Services
Platinum Jubilee Hospital	2.7	General Health Services
JB Diagnostic Complex	4	General Health Services
Khalishpur Clinic	2	General Health Services
Fair Health Clinic	2	General Health Services
Shaheed Sheikh Abu Naser Specialized Hospital	4	Both general/emergency health services
Khulna Medical College Hospital	5.3	Both general/emergency health services

4.7.5. Fire Services

Fire Service and Civil Defense works for protecting lives and resources from disasters. Project site is very close (within 1-km) to Khalishpur Fire Service and Civil Defense Station.

Figure 3: Khalishpur Fire Service & Civil Defense

4.7.6. Road and Communication

The project site has good road network connectivity.The project area is located either beside National Highway, Regional Highway, Zilaroad, and rural road etc. The road condition around the project site is satisfactory. In general, in rush hour (at 9:0 to 10:0 AM and in 4:0 to 5:0 PM) of day, low traffic volume was observed. Autos and rickshaws are available for the local residents to go here and there. Rent of the vehicle is also very convenient. Besides, mobile, internet and cable TV network are also available there.

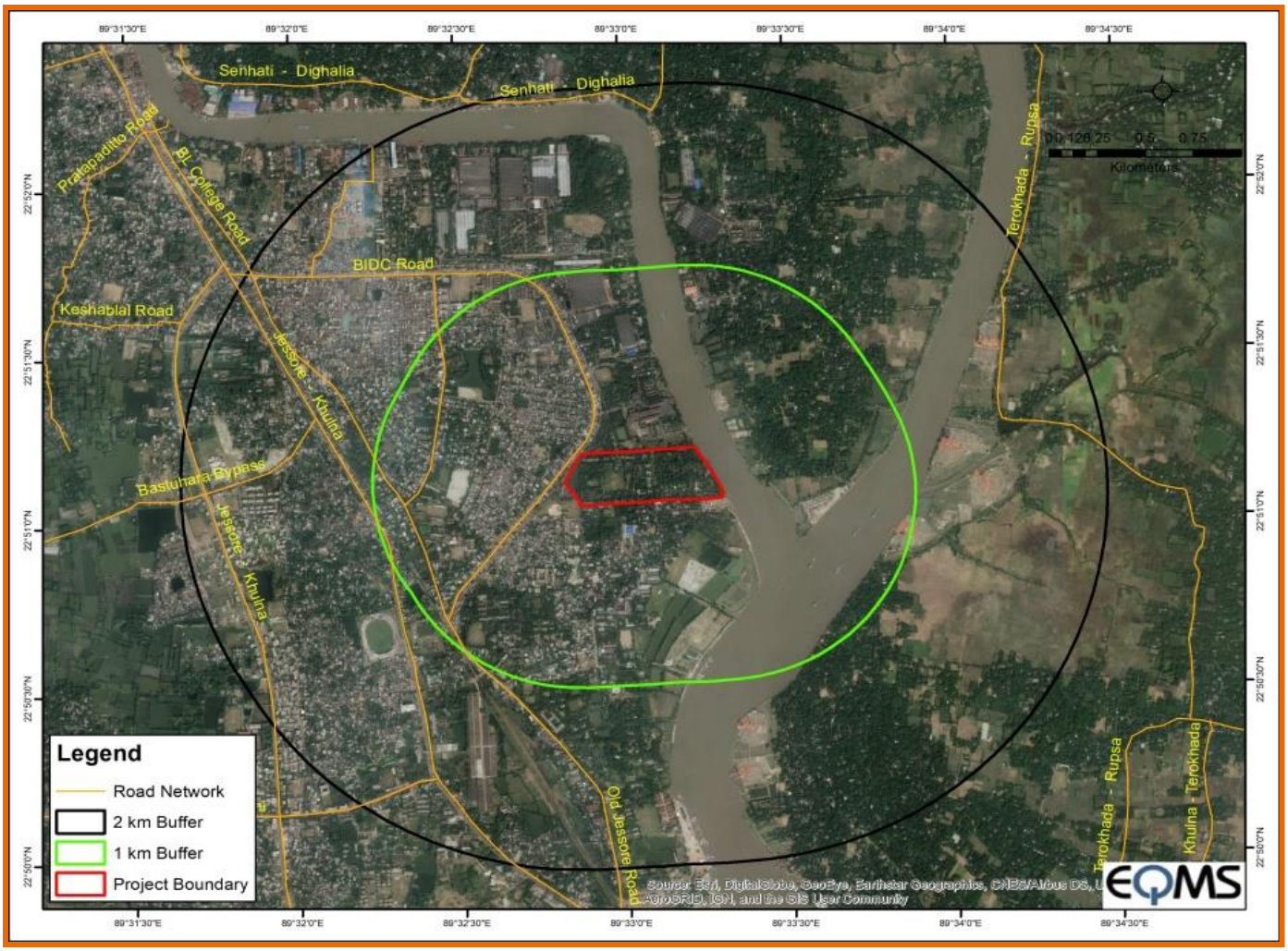


Figure 4: Roads & Communications Around the Project Site

CHAPTER FIVE: STUDY FINDINGS

5. Study Findings

5.1. Quantitative Findings

5.1.1. Socio-demographic Information of the Respondents

Table 5: Socio-demographic characteristics of the respondents

Variables	Category	Respondents	
		n	%
Age in year	*Mean±SD*	36.5±11.9	
Sex	*Male*	122	46.6
	Female	140	53.4
Marital Status	*Married*	215	82.1
	Unmarried	40	15.3
	Others	7	2.7
Education	*Illiterate*	19	7.3
	Primary (incomplete)	31	11.8
	Primary (Completed)	39	14.9
	SSC (Incomplete)	69	26.3
	SSC (Completed)	28	10.7
	HSC	43	16.4
	Graduation	18	6.9
	Postgraduation	15	5.7
Primary Occupation	*Day Laboure*	16	6.1
	Service (monthly salary based)	35	13.4
	Business	42	16
	Student	21	8
	Housewife	113	43.1
	Rickshaw puller	4	1.5
	Unemployed	16	6.1
	Construction worker	5	1.9
	House maid	2	0.8
	Not applicable	8	3.1
Monthly Income	*Median (IQ range)*	12000 (79000)	
Relation to the house hold head	*House hold head*	85	32.4
	husband/wife	105	40.1
	Father	3	1.1

Mother	9	3.4
Sun	29	11.1
Daughter	17	6.5
Brother	7	2.7
Sister	2	0.8
Daughter in law	2	0.8
Relatives	3	1.2

Source: EQMS Survey, 2019

The mean age of the respondents was 36.5 (±11.9) years. More than half (53.4%) of the respondents were female and majority (82.1%) of them were married. 0nly 7.3% of the total respondents were illiterate. Two (43.1%) out of five respondents were housewife. Median income of the respondents was 12000 Bangladeshi takas. Among all the respondents 32.4% were house hold head, 40.1% were husband or wife of the household head, 11.1% was sun for the house hold head, 6.5% were the daughter of the household head. **(Table 4)**

5.1.2. Disability in family of the respondents

Only 2.3% of the respondents reported that they had disabled members in their family. Within this group, 50% of them reported had having mental disabled members, 33.3% reported physical disability, and remaining 16.7% reported multifaceted. Majority of the respondents (66.7%) weren't used to provide any health care service to their disabled family members, whereas only 16.7% were used to provide curative measures and the same proportion reported to provide therapy (not shown in Table).

5.1.3. Behavioral risk factors related information of the respondents

5.1.3.1. Tobacco consumption habits

One-fourth (25.2%) of the respondents reported that they were used to smoke on that time, and their mean duration of use was 9.27±6.49 years. Moreover, more than one in every ten non-smokers (11.3%) was past smoker. In other way, more than three

Table 6: Behavioral Risk Factors Related Information

Variables	Number (%)
Smoking (current)	
Yes	66 (25.2)
Duration of smoking (years)	
Mean±SD (Interquartile range)	9.27±6.49 (4.0-15.0)
Smoking (past, *n*=196)	
Yes	30 (11.3)
Smokeless tobacco use (current)	
Yes	82 (31.3)
Duration of smokeless tobacco use (years)	
Mean±SD (Interquartile range)	3.25±7.52 (0.0-2.0)
Smokeless tobacco use (past, *n*=180)	
Yes	20 (11.1)
Alcohol consumption (ever use)	
Yes	9 (3.4)
Alcohol consumption within last 30 days (*n*= 9)	
Yes	1 (11.1)
Vegetable intake days in a weak (*n*= 260)	
Mean±SD (Interquartile range)	5.93±1.52 (5.0-7.0)
Vegetable intake servings in a typical day (*n*= 259)	
Mean±SD (Interquartile range)	2.70±0.98 (2.0-3.0)
Fruits intake days in a weak (*n*= 258)	
Mean±SD (Interquartile range)	3.03±1.76 (2.0-4.0)
Fruits intake servings in a typical day (*n*= 256)	
Mean±SD (Interquartile range)	1.50±0.79 (1.0-2.0)
Salt intake behavior during meal	
Yes	157 (59.9)
How salt was used (*n*= 154)	
Regular	130 (84.4)
Often	8 (5.2)
Sometimes	16 (10.4)

Source: EQMS Survey, 2019

in every ten respondents (31.3%) were used to use smokeless tobacco on that time, and their mean duration of use was 3.25±7.52 years. Moreover, more than one in every ten non-users (11.1%) was used to use smokeless tobacco previously (Table 5).

5.1.3.2. Alcohol consumption habits

Negligible proportion of the respondents (3.4%) was used to consume alcohol in this survey, whereas very negligible proportion of that group (11.1) reported to consume within last 30 days (Table 5).

5.1.3.3. Diet related habits

The respondents were used to intake vegetables nearly six days in a week (5.93±1.52), and nearly three servings in a typical day (2.70±0.98). They were used to intake fruits around three days in a week (3.03±1.76), and over one serving in a typical day (1.50±0.79). Three in every five respondents (59.9%) were used to use added salt during their meal, among them over four in every five used regularly (Table 5).

5.1.4. Occupation related information of the respondents

Among the respondents, 15.3% were involved in the jobs that related to chemical industry, spinning, dyeing, coal mining, pitching road construction, plastic industry, or any relevant chemical fuming/contacting jobs. Among the farmers, the reported frequency of using pesticides in their land is very negligible. Only one respondent used pesticides by his own hand 4-10 times in every six months (Table 6), who was used to use safety measure & personal protective device during pesticide use and he had no ever history of feeling health problem during pesticide use (not shown in table).

Table 7: Occupation related information of the respondents

Variables		Number (%)
Jobs related to chemical fuming or spinning exposure (*n*= 242)		
	Yes	37 (15.3)
If farmer, frequency of using pesticides by own hand in your land in every six months (*n*= 7)		
	Don't use	5 (71.4)
	Not by own hand	1 (14.3)
	4-10 times	1 (14.3)

Source: EQMS Survey, 2019

5.1.5. Information of the respondents related to public utility and service

5.1.5.1. Sources of drinking water

More than three in every five respondents (63.7%) reported that they consume water for drinking from tubewell and supply water after purification by home based filter and nearly one-third (32.1%) reported to use from shallow tubewell, and remaining others from rainwater, supply water (deep tube well), and river or canal (Table 8).

5.1.5.2. Sources of cooking water

In terms of sources of cooking water, majority of the respondents (55.0%) reported to use water from supply water (deep tube well) followed by shallow tube well (39.3%), and remaining others reported to use from other sources such as home based filter, pond and river or canal (Table 8).

5.1.5.3. Sources of water for washing, bathing and toilet use

In terms of sources of water for washing, bathing and toilet use, majority of the respondents (61.1%) reported to use water from shallow tube well followed by supply water (16.4%) (Table 8).

5.1.5.4. Arsenic contamination in drinking and cooking water from shallow tube well

Almost all of the respondents (98.9%) reported that their drinking and also cooking water from shallow tube well were free from Arsenic contamination (Table 8).

5.1.5.5. Boiling of tube well water before drinking

Almost all of the respondents (99.6%) reported that they weren't used to boil their tube well water before drinking (Table 4). The main reasons of not boiling the water were reported as- their water is Arsenic free, their water is pure, they keep faith on tube well water, they are well using the current water, no time for boiling, and no need to boil (Table 8).

5.1.5.6. Type of household toilet facility

In terms of the type of household toilet facility, majority of the respondents (62.4%) reported their toilet facility as flush or pour-flush to piped sewerage system or septic tank or pit latrine, followed by Pit latrine with slab (20.9%) (Table 8).

5.1.5.7. Sewerage system of house

Most of the respondents (57.5%) reported the sewerage system of their house as average, followed by one-fourth as good (25.0%) (Table 8).

Table 8: Information of the respondents related to public utility and service

Variables		Number (%)
Sources of drinking water		
	River/canal	2 (0.8)
	Shallow tube well	84 (32.1)
	Rainwater	6 (2.3)
	Home based filter	167 (63.7)
	Supply water (deep tube well)	3 (1.1)
Sources of cooking water		
	Pond	1 (0.4)
	River/canal	2 (0.8)
	Shallow tube well	103 (39.3)
	Home based filter	2 (0.8)
	Supply water (deep tube well)	144 (55.0)
	Others	10 (3.8)
Sources of water for washing, bathing and toilet use		
	Pond	1 (0.4)
	River/canal	34 (13.0)
	Shallow tube well	160 (61.1)
	Supply water (deep tube well)	43 (16.4)
	Others	24 (9.2)
Arsenic contamination in drinking and cooking water		
	Yes	3 (1.1)
Boiling of tube well water before drinking		
	Yes	1 (0.4)
Type of household toilet facility (*n*= 258)		
	Flush or pour-flush to piped sewerage system or septic tank or pit latrine	161 (62.4)
	Pit latrine with slab	54 (20.9)
	Flush or pour-flush to open place or elsewhere	25 (9.7)
	Pit latrine without slab or open pit	18 (6.9)
Sewerage system of house (*n*= 40)		
	Good	10 (25.0)
	Average	23 (57.5)
	Poor	7 (17.5)
Sewerage system of locality (*n*= 40)		
	Good	2 (5.0)
	Average	33 (82.5)
	Poor	5 (12.5)

Source: EQMS Survey, 2019

5.1.5.8. Sewerage system of locality

Most of the respondents (82.5%) reported the sewerage system of their locality as average, followed by one-fourth as poor (12.5%), whereas only 5.0% reported as good (Table 8).

5.1.6. Information related to personal hygiene and general health care seeking practice

Taking bath regularly: Almost all of the respondents (97.7%) reported that they were used to take bath regularly (Table 9).

Washing hands before taking meal: Similarly, almost all of the respondents (98.1%) reported that they were used to wash their hands before taking meal (Table 9).

Washing hands after coming back from toilet: In similar way, almost all of the respondents (99.2%) reported that they were used to wash their hands after coming back from toilet.

Keeping nails short and clean regularly: Nearly nine in every ten of the respondents (87.4%) reported that they were used to keep their nails short and clean regularly (Table 9).

Changing clothes after coming back from outside work: In similar way, nearly nine in every ten of the respondents (88.9%) reported that they were used to change their clothes after coming back from outside work (Table 9).

Table 9: Information related to personal hygiene and general health care seeking practice

Variables	Number (%)
Taking bath regularly	
Yes	256 (97.7)
Washing hands before taking meal	
Yes	257 (98.1)
Washing hands after coming back from toilet	
Yes	260 (99.2)
Keeping nails short and clean regularly	
Yes	229 (87.4)
Changing clothes after coming back from outside work	
Yes	233 (88.9)
Washing hands & face or taking bath after coming back from outside work	
Yes	221 (84.4)
From whom treatment is received during illness	
MBBS doctor	175 (66.8)
Others	87 (34.2)
Having hospital/clinic or any health care setting in nearby locality (*n*= 257)	
Yes	257 (100.0)
Visiting that hospital/clinic/health care setting when getting illness	
Yes	185 (72.5)
Ever history of hospital admission in life	
Yes	138 (53.9)
If yes, how many times (n= 135)	
Mean±SD (Interquartile range)	2.04±1.74 (1-2)

Washing hands & face or taking bath after coming back from outside work: Over eight in every ten of the respondents (84.4%) reported that they were used to wash their hands & face or taking bath after coming back from outside work (Table 9).

From whom treatment is received during illness: Two-thirds of the respondents (84.4%) reported that they were used to receive treatment from MBBS doctor during their illness, whereas remaining others reported to receive from other persons such as health assistant, pharmacy, quack, Homeopath/Ayurveda/Unani doctor, and traditional healer locally called kabiraj (Table 9).

Having hospital/clinic or any health care setting in nearby locality: All of

the respondents (100%) reported that they had hospital/clinic or any health care setting in their nearby locality (Table 8).The reported hospitals were Urban Primary Health Care Centre (Nagar Sasthya Kendro), Khalispur clinic, Urban 250-bed Hospital, Lal Hospital, Platinum Jut Mill Hospital, Al-deen, hair clinic, Maitree Modon Clinic, Community Clinic, Mahabubul Alom Clinic, Abu Naser Hospital and so others. Most of the respondents reported that these health care settings are within two kilometers from their home (not shown in table).

Visiting that hospital/clinic/health care setting when getting illness: However, seven in every ten individuals (72.5%) were used to visit that hospital/clinic or any health care setting in their nearby locality when getting illness (Table 9).

Ever history of hospital admission in life: However, more than half of the respondents (53.9%) reported they had ever history of hospital admission in their life. And, the mean frequency of that hospitalization was 2.04±1.74 time in their life (Table 9).

5.1.7. Information related to symptoms of systemic diseases

5.1.7.1. Female Population

Still birth: One woman (0.4%) reported that she gave birth a dead child 3 years before. However, she received treatment from a private clinic namely Rubina Clinic. And, she didn't need to get admitted in hospital for that reason (not shown in table).

Death of infant: One woman (0.4%) reported that she had history of death of infant 3 days before. However, she received treatment from Khalispur. And, she needed to get admitted in hospital for that reason (not shown in table).

Death of under-5 child: No woman reported to have death of under-5 child.

*Abortion:*One woman (0.4%) reported that she had history of abortion before one year. However, she received treatment from a clinic. And, she didn't need to get admitted in hospital for that reason (not shown in table).

Pre-mature delivery: No woman reported to have pre-mature delivery.

*Underweight newborn:*Two women (0.8%) reported that they had history of underweight newborn. However, they received treatment from Khulna Shishu Hospital. One woman needed to get admitted in hospital for that reason (not shown in table).

Delayed child development: No woman reported to have delayed development for her child.

*Uterine prolapse:*One woman (0.4%) reported that she had history of uterine prolapse four years before. However, she received treatment for the reason. And, she didn't need to get admitted in hospital for that reason (not shown in table).

*Low back pain:*Four women (1.5%) reported that they had history of low back pain before ranged from 2-10 years. However, they received treatment from different health care settings such as Urban 250-bed Hospital, Urban Primary Health Care Centre (Nagar

Sasthya Kendro). One woman needed to get admitted in hospital for that reason (not shown in table).

*Mass in lower abdomen:*Two women (0.8%) reported that they had history of mass in lower abdomen before ranged from 2-5 years. However, they received treatment from hospital and pharmacy. One woman needed to get admitted in hospital for that reason (not shown in table).

Leukorrhoea: No woman reported to have leukorrhoea.

*Blood stained vaginal discharge:*Two women (0.8%) reported that they had history of blood stained vaginal discharge before ranged from 2-6 months. However, they received treatment from Khalispur Hospital and Homeopath. And, they didn't need to get admitted in hospital for that reason (not shown in table).

Menorrhagia: No woman reported to have menorrhagia.

*Dismenorrhoea:*No woman reported to have dismenorrhagia.

5.1.7.2. Overall Population

Ear, Nose and Throat (ENT)

Running nose: Three respondents (1.1%) reported that they had history of running nose before ranged from 20 days to 7 years. However, they received treatment from Abu Naser Hospital, clinic and pharmacy. Nobody needed to get admitted in hospital for that reason (not shown in table).

Anosmia: Nobody reported to have anosmia.

Nasal blockage: Eight respondents (3.1%) reported that they had history of nasal blockage before ranged from 1-8 years. However, among them seven respondents received treatment from various health care settings such as Khulna Shishu Hospital, Abu Naser Hospital, clinic, pharmacy and so on, whereas one didn't receive treatment as it wasn't serious anything. No body needed to get admitted in hospital for that reason (not shown in table).

Sneezing: Three respondents (1.1%) reported that they had history of sneezing before ranged from 15 days to 1 year. However, they received treatment Khulna Shishu Hospital and pharmacy. No body needed to get admitted in hospital for that reason (not shown in table).

Difficulty in respiration: Eighteen respondents (3.1%) reported that they had history of difficulty in respiration before ranged from 15 days to 5 years. However, among them sixteen respondents received treatment from various health care settings such as Khulna Shishu Hospital, Khalispur Hospital, 250-bed Hospital, clinic, pharmacy and so on, whereas two didn't receive treatment due to thinking that it will be healed by itself and also without any reason. One respondent needed to get admitted in hospital for that reason (not shown in table).

Nasal ulcer: Two respondents (0.8%) reported that they had history of nasal ulcer before ranged from 15 days to 3 months. However, they received treatment from MBBS doctor and Homeopath doctor. And, they didn't need to get admitted in hospital for that reason (not shown in table).

Other ENT problems: Nine respondents (3.4%) reported that they had history of other ENT problems before ranged from 1 month to 15 years. They received treatment from various health care settings. However, they didn't need to get admitted in hospital for that reason (not shown in table).

Gastro-intestinal tract (GIT) diseases:

Abdominal pain: Thirty-five respondents (13.4%) reported that they had history of abdominal pain before ranged from 7 days to 13 years. They received treatment from various health care settings such as Khulna Shishu Hospital, 250-bed Hospital, Abu Naser Hospital, clinic, chambers, pharmacy and so on, whereas three respondents didn't receive treatment due to thinking as not needed. However, two respondents needed to get admitted in hospital for that reason (not shown in table).

Increased salivation: Nobody reported to have increased salivation.

Blackening of stool: Nobody reported to have blackening of stool.

Alternate costipation and diarhoea: One respondent (0.4%) reported to have had history of alternate costipation and diarhoea before 7 days. However, it was reported to receive treatment from a clinic. And, it wasn't needed to get admitted in hospital for that reason (not shown in table).

Anorexia: Nine respondents (3.4%) reported that they had history of anorexia before ranged from 3 days to 5 years. Among them, eight respondents received treatment from clinics and pharmacies. However, they didn't need to get admitted in hospital for that reason (not shown in table).

Erosion or discoloration of teeth: Two respondents (0.8%) reported that they had history of erosion or discoloration of teeth before ranged from 7 days to 5 years. Among them, one received treatment from pharmacy. However, they didn't need to get admitted in hospital for that reason (not shown in table).

Respiratory diseases

Asthma: Twenty respondents (7.6%) reported that they had history of asthma before ranged from 6 months to 8 years. Among them, nineteen received treatment from various health care settings such as 250-bed Hospital, Abu Naser Hospital, clinics, chambers, pharmacy and so on. However, three respondents needed to get admitted in hospital for that reason (not shown in table).

Chronic obstructive pulmonary disease (COPD): Nine respondents (3.4%) reported that they had history of COPD before ranged from 15 days to 15 years. They received treatment from various health care settings such as Khulna Shishu Hospital, 250-bed Hospital, Khalispur Hospital, and other clinics. However, two respondents needed to get admitted in hospital for that reason (not shown in table).

Chronic bronchitis: Nobody reported to have chronic bronchitis.

Lung cancer: Nobody reported to have Lung cancer.

Cardiac diseases:

Heart attack: Eleven respondents (4.2%) reported that they had history of heart attack before ranged from 3 days to 26 years. They received treatment from various health care settings such as Gazi Medical Hospital, Khulna Hospital, and other clinics. However, six respondents needed to get admitted in hospital for that reason (not shown in table).

Heart failure: One respondent (0.4%) reported to have had history of heart failure before 2 years. However, it was reported to receive treatment from a hospital getting admitted (not shown in table).

Stroke: Twelve respondents (4.6%) reported that they had history of stroke before ranged from 12 days to 10 years. They received treatment from various health care settings such as Abu Naser Hospital, Ad-deen Hospital, and clinics. However, three respondents needed to get admitted in hospital for that reason (not shown in table).

Rheumatic fever: Two respondents (0.8%) reported that they had history of rheumatic fever before ranged from 30-50 days. They received treatment from pharmacy. However, they didn't need to get admitted in hospital for that reason (not shown in table).

Palpitation: Eleven respondents (4.2%) reported that they had history of palpitation before ranged from 45 days to 5 years. Ten of them received treatment from various health care settings such as 250-bed Hospital, Abu Naser Hospital, clinics, and MBBS doctors, whereas one didn't receive due to not having enough money. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Eye diseases

Eye itching: Twenty-three respondents (8.8%) reported that they had history of eye itching before ranged from 10 days to 6 years. Among them eight received treatment from various health care settings such as 250-bed Hospital, Khalispur Hospital, Dhaka Eye Hospital, and other clinics, and remaining didn't receive due to not having money and also not taking as serious anything. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Increased lacrimation: Seven respondents (2.7%) reported that they had history of increased lacrimation before ranged from 3 months to 4 years. They received treatment from various health care settings such as Khalispur Hospital, Ad-deen Hospital, and other clinics. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Conjunctivitis: One respondent (0.4%) reported to have had history of conjunctivitis before 10 years. However, it was reported to receive treatment from 250-bed Hospital. And, it wasn't needed to get admitted in hospital for that reason (not shown in table).

Headache: Thirty-eight respondents (14.5%) reported that they had history of headache before ranged from 8 days to 7 years. Among them twenty nine received treatment from various health

care settings such as Khalispur Hospital, different chambers, Urabn Hospital, and other clinics and pharmacies, and remaining didn't receive due to not having money, unconsciousness and also not taking as serious anything. However, no body needed to get admitted in hospital for that reason (not shown in table).

Cataract: Eleven respondents (4.2%) reported that they had history of cataract before ranged from 1 month to 3 years. Among them ten received treatment from various health care settings such as Badamtola Hospital, different chambers, Dhaka, and other clinics and pharmacies, and remaining one didn't receive without any specific reason. However, three respondents needed to get admitted in hospital for that reason (not shown in table).

Urology

Abnormal urine color: One respondent (0.4%) reported to have had history of abnormal urine color before 1.5 months. However, it was reported to receive treatment from a clinic. And, it wasn't needed to get admitted in hospital for that reason (not shown in table).

Blood in the urine: Nobody reported to have blood in the urine.

Excess urination at night: Nobody reported to have excess urination at night.

Groin pain: One respondent (0.4%) reported to have had history of groin pain before 1 year. However, it was reported to receive treatment from a MBBS doctor. And, it wasn't needed to get admitted in hospital for that reason (not shown in table).

Urgency & frequency of micturition: Two respondents (0.8%) reported to have had history of urgency & frequency of micturition before 1.5 to 3 months. However, it was reported to receive treatment from a clinic. And, no body needed to get admitted in hospital for that reason (not shown in table).

Liver related diseases

Long-termjaundice: Four respondents (1.5%) reported that they had history of long-termjaundice before ranged from 2-6 months. They received treatment from various health care settings such as 250-bed Hospital, Dhaka, and other clinics and pharmacies. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Abdominal pain and swelling: Four respondents (1.5%) reported that they had history of abdominal pain and swelling before ranged from 6 months to 1 year. They received treatment from various health care settings such as 250-bed Hospital and other clinics. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Pale/bloody stool: Three respondents (1.1%) reported that they had history of pale/bloody stool before ranged from 5 months to 2 years. They received treatment from various health care settings such as 250-bed Hospital and pharmacy. However, no body needed to get admitted in hospital for that reason (not shown in table).

Bone &joint related diseases

Pain in joints: Three respondents (1.1%) reported that they had history of pain in joints before ranged from 2-35 years. They received treatment from different clinics and pharmacies. However, no body needed to get admitted in hospital for that reason (not shown in table).

Swelling of joints: One respondent (0.4%) reported to have had history of swelling of joints before 6 months. However, it was reported to receive treatment from a clinic. And, it was reported to need to get admitted in hospital for that reason (not shown in table).

Fragile bone: Twenty-one respondents (8.0%) reported that they had history of fragile bone before ranged from 3 days to 10 years. They received treatment from various health care settings such as hospitals, clinics, MBBS doctors and pharmacies. However, three respondents needed to get admitted in hospital for that reason (not shown in table).

Symptoms of Alzheimer's diseases

Disoriented in time and place: One respondent (0.4%) reported to have had history of disoriented in time and place before 2-3 years. However, it was reported not to receive treatment as well as not needed to get admitted in hospital for that reason (not shown in table).

Confusion: Nobody reported to have had history of confusion.

Forgets names and words recent personal events: One respondent (0.4%) reported to have had history of forgets names and words recent personal events before 2-3 years. However, it was reported not to receive treatment due to unconsciousness as well as not needed to get admitted in hospital for that reason (not shown in table).

Losing things or misplacing them in odd places: Nobody reported to have had history of losing things or misplacing them in odd places.

Repeats questions, phrases or stories: Nobody reported to have had history of repeating questions, phrases or stories.

Poor judgment: Nobody reported to have had history of poor judgment.

Less able to plan, organize, or think logically: One respondent (0.4%) reported to have had history of less able to plan, organize, or think logically before 3-4 years. However, it was reported not to receive treatment not needed to get admitted in hospital for that reason (not shown in table).

Neurological

Numbness: Two respondents (0.8%) reported to have had history of Numbness before 1.5 to 2 years. They received treatment from hospital and clinic. And, no body needed to get admitted in hospital for that reason (not shown in table).

Tingling: Nobody reported to have had history of tingling.

Paresthesia: Six respondents (2.3%) reported that they had history of paresthesia before ranged from 1 month to 8 years. Among them, 4 respondents received treatment from various health care settings such as 250-bed Hospitals, Urban Hospital, and Homeopath clinic, whereas 1 reported

didn't receive due to that it was healed by itself. However, two respondents needed to get admitted in hospital for that reason (not shown in table).

Sexual health and risky sexual behavior related information

Practicing protection against HIV/STDs: In terms of sexual health and risky sexual behavior related information, only one-fourth of the respondents (25.2%) reported to practice protection against HIV/STDs (Table 11).

Table 10: Sexual health and risky sexual behavior related information of the respondents

Variables		Number (%)
Practicing protection against HIV/STDs (*n*= 155)		
	Yes	39 (25.2)
	No	116 (74.8)
Tested ever for HIV/STDs (*n*= 253)		
	Yes	10 (4.0)
	No	243 (96.0)

Source: EQMS Survey, 2019

Tested ever for HIV/STDs: Only 4.0% of the respondents reported to ever testing for HIV/STDs (Table 11).

Tuberculosis (TB) related information

History of TB positive: Among all of the respondents, only 5 respondents had history of TB positive (Table 12).

Table 11: Tuberculosis (TB) related information of the respondents

Variables		Number (%)
History of TB positive (*n*= 253)		
	Yes	5 (1.9)
	No	248 (98.0)
Completion of TB treatment (*n*= 5)		
	Yes	4 (80.0)
	No	1 (20.0)

Source: EQMS Survey, 2019

Completion of TB treatment: Among the 5 respondents, 4 completed the TB treatment regimen (Table 10).

Communicable Diseases

Chronic diarrhoea: Twenty four respondents (9.2%) reported that they had history of chronic diarrhoea before ranged from 4 days to 2 years. Among them, twenty-three received treatment from various health care settings such as 250-bed Hospital, Khalispur Hospital, clinics, MBBS doctors and pharmacies, whereas one didn't receive due to no willingness. However, eight respondents needed to get admitted in hospital for that reason (not shown in table).

Typhoid: Ten respondents (3.8%) reported that they had history of typhoid before ranged from 7 to 30 days. They received treatment from various health care settings such hospitals, clinics, MBBS doctors and pharmacies. However, two respondents needed to get admitted in hospital for that reason (not shown in table).

Acne: Ten respondents (3.8%) reported that they had history of acne before ranged from 20 days to 9 years. Among them, only two received treatment from pharmacies, whereas others didn't receive as it was not needed. However, it was not needed to get admitted in hospital for that reason (not shown in table).

Ringworm: Sixteen respondents (6.1%) reported that they had history of ringworm before ranged from 2 days to 10 years. They received treatment from various health care settings such hospitals, clinics, MBBS doctors and pharmacies. However, one respondent needed to get admitted in hospital for that reason (not shown in table).

Food poisoning: Three respondents (1.1%) reported that they had history of food poisoning before ranged from 13 days to 2 years. They received treatment from clinic, urban hospital and Ayurveda. However, it was not needed to get admitted in hospital for that reason (not shown in table).

Noncommunicable Diseases

Diabetes mellitus

Type-I diabetes: Three respondents (1.1%) reported that they had history of type-I diabetes before ranged from 1-2 years. They received treatment from Abu Naser Hospital and a clinic. However, it was not needed to get admitted in hospital for that reason (not shown in table).

Type-II diabetes: Seventy-two respondents (27.5%) reported that they had history of type-II diabetes before ranged from 15 days to 30 years. Among them, 68 received treatment from various health care settings such 250-bed Hospitals, Abu Naser Hospital, Ad-deen Hospital, diabetic hospital, Khalispur Hospital, Urban Hospital, different clinics etc, whereas remaining two didn't receive treatment due to they had no complication and already under control. However, two respondents needed to get admitted in hospital for that reason (not shown in table).

Liver diseases:

Liver cirrhosis: One respondent (0.4%) reported to have had history of liver cirrhosis before 1 year. It was reported to receive treatment from Khulna Diabetes Hospital. However, it was not needed to get admitted in hospital for that reason (not shown in table).

Hepatitis: Four respondents (1.5%) reported to have had history of hepatitis before ranged from 1 month to 4 year. Among them, 3 receive treatment from Filtola Hospital and other clinics. However, they didn't need to get admitted in hospital for that reason (not shown in table).

Liver failure: Nobody reported to have had history of liver failure.

Liver cancer: One respondent (0.4%) reported to have had history of liver cancer before 5 years. It was reported to receive treatment from Khalispur Hospital after getting admitted (not shown in table).

Other cancers related information:

Breast cancer: Nobody reported to have had history of breast cancer.

Cervical cancer: Nobody reported to have had history of cervical cancer.

Prostate cancer: Nobody reported to have had history of prostate cancer.

Stomach cancer: Nobody reported to have had history of stomach cancer.

Cancer in other parts of the body: Nobody reported to have had any history of cancer in other parts of his/her body.

Psycho-social or psychiatric disorders:

Anxiety disorder: Nobody reported to have had history of anxiety disorder.

Depression disorder: Nobody reported to have had history of depression disorder.

Mood disorder: Nobody reported to have had history of mood disorder.

Information related to injury, snake bite, and mosquito caused diseases:

Road traffic accident faced by respondents or any of their family members: One in every five (20.4%) respondents or any of their family members faced road traffic accident during commute to/from workplace. And, majority went to hospital for seeking treatment in this regard.

Burn injury in last 2 years faced by respondents or any of their family members: Around 6% of the respondents or any of their family members faced burn injury in last 2 years in their work place and home. And, majority went to clinic and pharmacy for seeking treatment in this regard.

Mosquito-caused disease: Five respondents (1.9%) reported to face mosquito-caused disease by him/her or any of their family members or individuals in their locality but the transmission could not be identified. Dengue and chikungunya were reported as more prevalent.

Measures to control mosquito: The respondents reported that they were used to take various sorts of measures in order to control mosquito in their house, such as using mosquito net, residential spray, cleaning blocked water, mosquito coil, insect curtain, and also electric zapper (not shown in table). But limited measures have been taken by the workplace authority.

5.2. Qualitative Findings

5.2.1. Findings from Key Informant Interview (KII)

Key informant interviewers play the vital role in gaining information for such type of community-based survey especially health services facilities, health & safety status and health care seeking behavior of the community. Considering their role and views, the current study also took an

attempt to have Key informant's view regarding the capacities of current health services, health & safety status and health care seeking behavior of the community.

A total 11 key informant personnel from different health care facilities, Fire Service Department and school teachers were included in this study. The key informants also expressed their opinion towards the necessary steps for strengthening the health services. Establishment of one stop health care center with emergency crisis management facility and deployment of specialty trained care service provider were desired by more than two third key informants.

5.2.1.1. Health Care Facilities

The managers of health services of Khulna informed from the record that there are 281 health facilities in Khulna districts including a 500-bed medical college and community clinics. These facilities are providing health care services with approximately, 1100 beds and 439 doctors 580 nurses. In addition, 184 private medical facilities are also available here with Medical College Hospital, General Hospitals, Clinics and NGOs facilities also available with 2300 beds for the patients. No trauma center is present in Khulna. Khulna Medical College Hospital is a tertiary level hospital running with 80 doctors and 246 nurses.

It is noted that around the project site in Khalishpur, there are six State-Owned Jute mills (Eastern Jute Mills Limited, the Crescent Jute Mills Limited, Platinum Jubilee Jute Mills Limited, Star Jute Mills Limited and Khalishpur Jute Mills Limited. Each Jute mills have one Medical Center mostly outpatient department services are offered here and some have indoor services (6 – 8 beds are available) for short time duration medical problems. Besides these there are two government outpatient medical facilities near the project sites (Lal Hospital and Labor Welfare Center). HIA team also visited two key personnel from Lal Hospital and Labor Welfare Center.

According to Khulna Civil Surgeon, approximately 2 million patients receive OPD services from government facilities. More than 150000 patients have to treat emergency care from government facilities and 46116 patients got admitted from OPD in these hospitals in last year.

According to Civil Surgeon, the leading under five child morbidities were 10.4% Diarrhea and gastroenteritis of presumed infectious, origin; 5.7% Pneumonia, organism unspecific; 4.5% unspecific acute lower respiratory infection; and 3.7% fever. Whereas, adults' morbidities were, 11.4% Diarrhea and gastroenteritis of presumed infectious; 5.1% asthma; 4.7% Salpingitis and oophoritis; 3.9% cardiovascular diseases; and 2.6% Traffic accident of specified type but victim's mode of transport unknown.

In case of mortality, 14.3% under five mortality occurred due to bronchopneumonia; 9.5% due to septicemia; acute lymphoblastic leukaemia; and 2.4% due to epilepsy. In addition, 22.6% maternal deaths were occurring due to eclampsia; 16.1% due to ectopic pregnancy; 12.9% due to obstructive labour. In addition, 2.8% people aged 30 to 70 years were death due to stroke; 16.8% due to bronchiectasis.

85% Coverage of households having access to safe drinking water and 95% Coverage of households having access to sanitary latrines.

According to Civil Surgeon, most of the people of Khalispur area receive their treatment facility from Khulna medical college hospital and Khulna district hospital. He added that only Khulna Medical College Hospital have the capacity for the casualty management if any accident occurs. They need a trauma center immediately. Burn management service is not sufficient in the existing facilities.

He is also recommended for the reopening of the existing health center situated in the project area, so that the workers get immediate services.

According to Director, Khulna Medical College Hospital, 242686 patients received treatment in last year, among them 7468 were for emergency care. Bed occupancy rate is 129%. 5.3% hospital death rate has been reported among the emergency patients. However, he felt that the existing manpower is not enough for them, it will be better if government appointed rest of the doctors and nurses in the vacant posts. He is working for one stop services for the patients. Drugs are available but some important drugs like antibiotics are lacking. He also opined that the bed capacity of the hospital should be increased to double for the benefit of the patients.

Regarding installation of Power Plant, he is expecting it will be highly modernized power plant, so the health hazard also will be less as ADB financing it. He ensures it that his hospital is always ready for any disaster, incidence and accidents though they are always over burden.

The HIA team visited one Doctor of one Jute mill Medical Center f. According to his statement the jute mills workers and their relatives usually are entitled to get the medical care from these centers. Approximately 20 to 30 patients mostly male receive treatment from this center daily from his center. Arthralgia is mostly reported health problem as sought by the treatment seekers in last months. He also added that these centers are not so equipped to provide major injuries and accidents. Only primary management for minor injuries can be provided from here. It will be helpful for the resident, if a medical center can be established in the New Newsprint mill area as it is very populous area. Beside this, it will be helpful, if the abandoned medical centers can be restarted again with medical graduates. It will be better if one medicine specialist can be appointed. There should be low cost pathological test facilities along with X-ray diagnostic services.

On an average 120 patients at Lal Hospital usually received consultation and at Labor Welfare Center around 30 patients visit every working day. Most of the patients attending the facilities are female.

Most of the patients at Lal Hospital are coming with skin diseases. Diarrhea and amoebiasis also reported very frequently. On the other hand at Labor Welfare Center patients mostly visit with asthma, gastritis, joint pain, tuberculosis and skin diseases. According to them poor hygiene and water quality are the cause of more skin diseases.

5.2.1.2. Water Supply and Sanitation

Key Informant from Department of Public Health Engineering reported that, the project site is under Khalishpur area of Khulna City. The water supply and Sewerage facilities are now

implementing through Khulna WASA (Water and Sewerage Authority) since announcement of the Khulna City Corporation by the Government. At this moment the residents of the Khalishpur are receiving water from deep tube well. There is no arsenic problem in this area but there has been chance to get arsenic contamination in near future.

Key Informant from Khulna WASA informed that at this moment they are supplying 24 crore liters water in Khulna city including the Khalishpur where the Power plant is going to install. Out of these 11 crore liters coming from Deep tube well and this water supply around the News Print Mill areas. Khulna WASA is going to implement another project for proper management of sewerage. Safety tank is only present in to the government office but a sewerage system project will be developed using drainage system within next 5 years. Khulna WASA will arrange 35 thousand new sewerage connections under this project. At present all the wastage of sewerage are disposing in to the river.

5.2.1.3. Fire Service

The HIA team also visited local Fire Service department. According to key personnel of the fire service and rescue department, accident rate is less in the Khalishpur mill areas. So far, he mentioned that only one accident occurred in last year at Jamuna Oil Depo where five workers died due to fire and it is about 3-kilometer distance from the fire station. He mentioned that people are still unaware about the services the department provided beside the fire management like emergency ambulance services, CPR (cardiopulmonary recitation) to the victim if needed.

5.2.1.4. School Children and Health Issue

At present there is a school with 1.84-acres land but the new allocated school area is only on 0.5 acres. A total of 20 teachers are working in this school. Approximately 400 students are studying in this school now which was more than 800 in the year of 2015. Almost 60 to 70% students are attending the classes regularly but during examinations the rate becomes 95%.

According to one school teacher, they are very unaware about the establishment of power plant in the place of school land and shifting of the school very nearby to the project wall. He is little bit confused, about the health effect of power plant among the school students. He feels only noise may be the problem for them.

Another teacher added that guardians of the most of the students are day laborer. The reasons for school missing are involvement in to the work and long distance from home to school. No transportation system is available in their school. Other reasons for decreasing number of the students in this school is shutdown of the newsprint mills and workers already left the area with their family members for searching or arranging their earnings for living. Most of the students of the school could not pay their tuition fee due to the poverty. Only 30% paid their tuition fee 100 to 150 taka only. He added that he has no idea about the health risk of power plant but he thought that noise would be the one of the major causes of health problem. He also thought about the air pollution from the power plant as natural gas will be used as fuel.

He is little bit worried about the distance between the power plant and school. However, he wants to see the successful establishment of power plant. He also recommends, all types of vehicles of

power plants should be stops for around 1 hour during school start and close. It is his perception, that the power plant should be established as far as possible from the school, though the school is very close to the project wall.

They mentioned that noise pollution may be the causes of different health problems among the school children. They suggested the sound proof glasses for the school building so that the students can to feel any additional sound. It seems to them that the shifting of the school will be beneficial for them. Most of the teachers staying around 1 kilometer of the school.

Both the teachers opined for arranging mid-day meal for the students from the donor side of the power plant and re-installing of medical center with modern treatment facilities (though no formal request have been submitted from their end to any authority).

5.2.2. Findings from Focus Group Discussion

Focus-group discussion aimed to elicit existing health problems among the community people and their health care seeking pattern. Two focus group discussions (FGDs) were conducted with male and female separately for understanding and learning about their experience on health status along with care seeking behavior and opinion and suggestions on future expectation from Combined Cycle Power Plant. Important findings are presented below in the narratives. Among the male participants, almost all were workers working in different industries around the project sites and mostly poor by economic status. On the other hand, among the female participants about 70 percent were housewife and rests were house maid by occupation. Almost all were married came from very poor family. Their husband was found working as mostly daily labours and some were working at different industries nearby. A total 22 females within the range of 15 – 50 years age and 10 males within the range of 35 – 60 years age participated in these focus group discussions. Each FGD was facilitated by the research team. Data were short-noted and tape-recorded.

5.2.2.1. KEY FINDINGS

According to male participants the most frequent health problems prevailing among the local population are:

- Joint pain
- Injury
- Itching
- Headache
- High blood pressure
- Gastritis
- Breathlessness
- TB

While the female participants mentioned as:

- Back pain
- Allergy
- Itching

- Headache
- Pain in lower abdomen
- Low pressure
- Gastritis
- Piles
- Breathlessness
- Displacement of uterus
- Pain in to the joints
- Complication in the menstruation (irregular)
- Fever with epilepsy
- Leukorrhea

Low back pain and allergy problem was present among 17 women out of 22. Itching was the common problem for all of the respondents. Most of them used to take medicine from the pharmacy and they were not used to go to the doctor. Sometimes, they visited the Sromik Kalyan Kendra (Workers Welfare Center) for their health problem and they received consultation from Dr. Chand Mohammad but they do not receive any medicine except vitamin from there.

Four out of twenty-two participants were suffering from uterus problem. Among them one got operated in a private clinic on five months ago but she felt that the uterus displaced again. She visited 250 beds hospital and received consultation from a gynecologist and she advised for operation again. Ultrasonography also done there and they told that infection got back there.

Most of the respondents collected their medicine from the pharmacy and Alamnagar Pharmacy where they can go by walking was the most visited one. Beside this, only 5-taka rickshaw rent is needed to reach in the Alamnagar Pharmacy. They usually do not visit Lal hospital as the hospital is very far from them and travel cost is more.

Painful menstruation was present among the 3 respondents age ranged between 15 to 18 years and they visited JB Medical center for their ultrasound.

All of the respondents want a medical center nearby their mill area where a good skilled gynecologist should be appointed, so that they can visit there in any time. They feel ashamed to go Dr. Chand Mohammad with their gynae problem. Beside this low-cost ultrasound, blood test facility, X-ray facility should be arranged and it will be helpful for them. They want to see the existing hospital inside the newsprint in operation again.

5.3. School Children's Baseline Study Findings

Mean age of the school children was 8.5 years. The mean BMI of the school children was 15.0 kg/m2. The mean height was 124.8 cm. The mean weight of the school children is 23.6 kg. Almost similar findings have been observed between two schools. (Table 13)

Almost six (57.8%) out of ten respondents were female. One (33.3%) in every three students were in the class IV. More than one (35.6%) in every three students were underweight whereas, four out of ten students of school 2 were under weight. (Table 14)

One in every three school children had hearing problem whereas, 15.6% school children had eye problem. (Table 15)

Table 12: Age and physical measures of the school children

Variables	Group 1	Group 2	Mean	SD
Age *in year*	Both Schools	Overall	8.5	1.7
		Male	8.4	1.8
		Female	8.5	1.7
	School 1	Overall	8.5	1.4
		Male	8.5	1.4
		Female	8.2	1.4
	School 2	Overall	8.5	1.9
		Male	8.3	2.1
		Female	8.5	1.9
BMI, *Kg/m2*	Both Schools	Overall	15.0	2.3
		Male	15.3	2.3
		Female	15.0	2.3
	School 1	Overall	15.5	2.8
		Male	15.5	2.8
		Female	15.2	2.8
	School 2	Overall	14.6	2.3
		Male	15.1	1.6
		Female	14.6	1.7
Height*in cm*	Both Schools	Overall	124.8	9.9
		Male	124.2	10.2
		Female	124.7	10.0
	School 1	Overall	124.5	9.3
		Male	124.5	9.3
		Female	122.8	9.0
	School 2	Overall	125.0	10.3
		Male	123.3	10.9
		Female	125.0	10.3
Weight *in Kg*	Both Schools	Overall	23.6	6.1
		Male	24.0	6.5
		Female	23.6	6.1
	School 1	Overall	24.5	7.1
		Male	24.5	7.1
		Female	23.4	6.7
	School 2	Overall	23.0	5.0
		Male	23.3	5.8
		Female	23.0	5.0

School 1= Newsprint Mill High School; School 2=Nurnagar Gov Primary School; BMI= Body Mass Index

Source: EQMS Survey, 2019

Table 13: Distribution of the respondents according to their classes, sex and BMI

Group	Variables	Category	Number	percentage (%)
Both schools	Class	I	10	22.2
		II	10	22.2
		III	10	22.2
		IV	15	33.3
	Sex	Male	19	42.2
		Female	26	57.8
	BMI	Underweight	16	35.6
		Healthy weight	25	55.6
		Overweight	3	6.7
		Obese	1	2.2
School 1	Class	I	4	20
		II	4	20
		III	4	20
		IV	8	40
	Sex	Male	9	45
		Female	11	55
	BMI	Underweight	6	30
		Healthy weight	11	55
		Overweight	2	10
		Obese	1	5
School 2	Class	I	6	24
		II	6	24
		III	6	24
		IV	7	28
	Sex	Male	10	40
		Female	15	60
	BMI	Underweight	10	40
		Healthy weight	14	56
		Overweight	1	4
		Obese	0	0

School 1= Newsprint Mill High School; School 2=Nurnagar Gov Primary School;
2019BMI has been classified according to CDC guideline
Source: EQMS Survey

Table 14: Results of vision and hearing test of the school children

Groupe	Variables	Categories	Number	Percentage (%)
Both school	Weber test	Conductive hearing loss in left ear	4	8.9
		conductive hearing loss in right ear	4	8.9
		Normal	31	68.9
		Slight conductive hearing loss in left ear	3	6.7
		Slight conductive hearing loss in right ear	3	6.7
	Eye sight	Normal	38	84.4
		Problem present	7	15.6
School 1	Weber test	Conductive hearing loss in left ear	3	15
		conductive hearing loss in right ear	3	15
		Normal	11	55
		Slight conductive hearing loss in left ear	1	5
		Slight conductive hearing loss in right ear	2	10
	Eye sight	Normal	16	80
		Problem present	4	20
School 2	Weber test	Conductive hearing loss in left ear	1	4
		conductive hearing loss in right ear	1	4
		Normal	20	80
		Slight conductive hearing loss in left ear	2	8
		Slight conductive hearing loss in right ear	1	4
	Eye sight	Normal	22	88
		Problem present	3	12

Source: EQMS Survey

CHAPTER SIX: KEY DISCUSSIONS

6. Discussion

Health impact assessment (HIA) is a planning tool that helps evaluate the potential health effects of a plan, project or policy before it is adopted, built or implemented. HIAs bring potential public health impacts and considerations to the decision-making process for proposals that fall outside the traditional public health arenas, such as transportation and land use. It is a "health lens" that can increase positive health outcomes and minimize adverse health impacts. Like other people in Bangladesh It is obvious that community living around the proposed Rupsha 800 megawatt (MW) Combined Cycle Power Plant are suffering from physical, mental, or social health problems. The study presents the Health Impacts of natural gas combined cycle power plant along with its mitigation measures of Rupsha 800-Megawatt Combined Cycle Power Plant and transmission line (both gas and power line) Project. A descriptive cross-sectional study among adult population in located 1 kilometer radius of the project sites was conducted. This Health impact assessment was conducted with the objective to develop a health baseline profile for project-affected communities; assessing the capabilities and capacity of the current health services; assess the health and safety impacts/risks of the project to the existing communities within the project's area of influence; and to identify appropriate and feasible community health indicators to monitor community health impacts, especially among vulnerable populations. Both qualitative (key informants interview, focus group discussions) and quantitative (community survey and school children's health assessment) approaches were adopted in this HIA.

6.1. Socio-demographic Characteristics

A total of 262 households were included through simple random sampling techniques for community survey. The mean age of the respondents was 36.5 (±11.9) years. More than half of the respondents were female, 82.1% of them were married and only 7.3% of the total respondents were illiterate. Two (43.1%) out of five respondents were housewife. Median income of the respondents was 12000 Bangladeshi takas. Among all the respondents 32.4% were house hold head, 40.1% were husband or wife of the house hold head, 11.1% was son for the house hold head, 6.5% were the daughter of the house hold head. According to, Bangladesh Demographic and Health Survey (BDHS) 2014 the sex ratio is 95 males per 100 females and almost 70% respondent's age ranged from 15 to 64 years old. And almost 27% respondents were illiterate which is four times higher than the present study. 79.8% respondents were married which is almost similar to the present study.

6.2. Physical Health

HIA team tried to find out the prevalence of diseases among the study population. Females and mothers are always vulnerable to any construction project or any disaster. It was reported that among the study population, still birth (0.4%), death of infant (0.4%) and abortion (0.4%) are common maternal health problems. Though no under-five child death and premature delivery was reported but 0.8% women reported that they had history of underweight newborn baby. According to BDHS 2014, Under-5 mortality for the five-year period is 46 deaths per 1,000 live

births. The infant mortality rate for the five years preceding the survey is 38 deaths per 1,000 live births. The situation in the study area is very good compare to the country situation. According to Bangladesh Maternal Mortality and Child Care Survey (BMMS) 2016, ante and postpartum hemorrhage (31%) and eclampsia and preeclampsia (24%) are the most common causes of maternal death, followed by indirect causes (20%), abortions (7%), and obstructed or prolonged labor (3%) which is also very high compare to the present study. Other reproductive health problems like uterine prolapse (0.4%), Low back pain (1.5%), Mass in lower abdomen (0.8%) and blood-stained vaginal discharge (0.8%) were also reported. No woman reported to have leucorrhoea, menorrhagia and dysmenorrhea. Focus Group Discussion also provides similar opinion in addition to allergy and itching. Among the school going children of the project area 35.6% were underweight, more than 30% have hearing impairment and 15.6% school children had eye problem.

6.3. Gaps between EIA Report and HIA

Before starting the community survey, HIA team tried to understand the EIA report thoroughly and find some gaps which are also should be addressed.

Environmental health impact and effects (Based on EIA)

Environmental Determinant as EIA	Environmental Determinant as HIA	Health Impact (population)	Health Effect (individual)
Impairment of ambient air quality (CO, CO_2, SO_X)	Impairment of ambient air Quality (CO, CO_2, SO_X)	Increased cases of asthma	• Respiratory diseases/infection • Selected cardiopulmonary disease • Lung cancer
Impairment of ambient air Quality (dust PM10 and PM2.5)	Impairment of ambient air Quality (dust PM10 and PM2.5)	Increased cases of asthma Increased case of allergic reaction	• Respiratory diseases/infection • Selected cardiopulmonary disease Lung cancer
Potential increase in ambient noise level	Potential increase in ambient noise level	Increase/decrease in noise levels	• Hearing damage • Stress • Sleep disturbance • Mental health
Degradation of water quality due to construction works	Degradation of water quality due to construction works	• Water-borne and water-washed disease outbreaks • Poor personal and household hygiene • Decline/improved lifestyle	• Incidence of diarrhea • Skin and eye disease

Environmental Determinant as EIA	Environmental Determinant as HIA	Health Impact (population)	Health Effect (individual)
	Exposure to vibration	• Neurological Disorders • Musculoskeletal disorders	• Persistent numbness • Reduced sensory perception • Headache • musculoskeletal disorders
Improper disposal of used mineral oil	Improper disposal of mineral oil	• Liver damage • Skin irritation • Respiratory problems • Cancer	• Liver damage • Skin irritation • Respiratory problems • Cancer
	Waste management	• Health problems due to improper waste management • Increase rodent borne diseases	• Diarrheal incidence • Typhoid incidence • Rabies incidence • Plague
Vegetation	Vegetation and improper drainage	• Vectors and pests borne disease	• Malaria • Dengue • Chikungunya
Transmission line posing hazards	Transmission line hazards including EMF radiation	• Increased the case of Cancer (long term) • stimulation of nerves and muscles or affect other biological processes • Increased case of generalized weakness, headaches • fatigue • anxiety • insomnia • prickling and/or burning skin • rashes • muscle pain (immediate)	• Electrocution • Lightning strike, etc • Cancer • Excitability of nervous tissue in the central nervous system which may affect memory, cognition and other brain functions
	Transmission line hazards specially EMF radiation	• Damage human cells and tissues leading to cancer	• Skin lesion • Tumor • Cancer (lung cancer)

Environmental Determinant as EIA	Environmental Determinant as HIA	Health Impact (population)	Health Effect (individual)
	Increase Road Traffic	• Injury, disability and death from road traffic accident • Hospital admission with respiratory problems	• Injury, disability and death • Asthma, bronchitis, chronic obstructive pulmonary disease, pneumonia, upper respiratory tract infection

6.3.1. Health Problems Due to Impairment of Ambient Air Quality

The health risks of air pollution are extremely serious. Poor air quality increases respiratory ailments like asthma and bronchitis, heightens the risk of life-threatening conditions like cancer, and burdens our health care system with substantial medical costs. Suspended particulate matter from excavation works and land clearing including vehicular emissions may affect workers and community. Based on EIA findings, the air pollutants of concern in this power plant project are PM10 and PM2.5 in addition to CO, CO2, SOX. Pervasive air pollutant, the fine particulate matter known as PM2.5 is a mixture of emissions from diesel engines, power plants, refineries and other sources of combustion. According to EIA the movement of vehicles and vessels will increase and ambient air quality will also impair due to vehicle exhaust. Motor vehicles emit PM2.5 along with a variety of other pollutants such as nitrogen oxides, carbon monoxide. Neighborhoods along busy roads have more nitrates from vehicle exhaust. The microscopic particles PM10 and PM2.5 include inhalable particles that are small enough to penetrate the thoracic region of the respiratory system. Health research shows that exposure to PM2.5 has a significant effect on admission rates for a subset of respiratory diagnoses (asthma, bronchitis, chronic obstructive pulmonary disease, pneumonia, upper respiratory tract infection). Particulate matter irritates the eyes, nose, throat, and lungs, contributing to respiratory and cardiovascular illnesses and even premature death in long term (months, years) exposure. Aggravation of asthma, respiratory symptoms and an increase in hospital admissions; mortality from cardiovascular and respiratory diseases and from lung cancer are also reported. One research also found that those residing near high traffic flows (measured at the nearest street) were more likely than those residing near lower traffic flows to have two or more medical care visits for asthma. Particulate matter is singlehandedly responsible for up to 30,000 premature deaths each year. In India, 26.45% premature annual deaths (among people above 25) result from thermal power plant pollution. HIA indicates from key informant interviewers that in Khulna 5.1% of admitted patients in different hospitals are due asthma and 3.9% from cardiovascular diseases. According to Bangladesh Health bulletin 2018, overall mortality from cardiovascular diseases, cancers, diabetes or chronic respiratory diseases was 67% which was 59% in the year 2010. And may be these are the reasons for increasing non-communicable diseases burden.

6.3.2. Health Problems Due to Impairment of Ambient Noise

EIA mentioned that noise is generated in this area due to the movement of vehicles and vessels like bus, micro, auto, van, motorbike, trawler, engine boat, launch and other local machines which ply all day long. Though EIA ambient noise level measurements indicated that daytime noise limits are within the Noise Pollution Control Rules 2006 level. Mobilization of heavy equipment and machineries, use of construction vehicles, transport of materials, and construction activities may increase ambient noise level. Exposure to high level ambient noise may cause anxiety and disturbance to workers and community. Results of ambient noise level measurements indicated that daytime noise limits are met. HIA conducted one small survey among school going children of the project site. It was found that more than 30% children have hearing impairment. According to Disability survey Bangladesh 2015, 0.23% people have hearing disability where the present study shows more than thirty time higher than the national study.

6.3.3. Health Problems Due To Vibration

During the walk-through visit of the project sites HIA members from their experience found some important health hazards like vibration during operation of power plant and EMF radiation from transmission line. Neurological Disorders, Musculoskeletal disorders are reported health problems from researches from some power plant sites in different countries. As in Bangladesh such research are very unavailable further research on this issue is also suggested.

6.3.4. Transmission Line Posing Hazards and Health Problems

Transmission lines are the main source of electrical transportation. EIA report emphasized on Electrocution and Lightning strike health problem as Transmission line posing hazards. But we know that high voltage lines transmit radiation called the "electro-magnetic field" or shortly EMF. Whenever a current passes through a conductor, an EMF is always associated with it. EMF contains an electric and magnetic field component oscillating at 180 degrees. The phase difference between the electric and magnetic fields is 90 degrees. Researches showed that Transmission lines may poses nerve stimulation, at very high exposure levels. Exposure at lower levels induces changes in the excitability of nervous tissue in the central nervous system which may affect memory, cognition and other brain functions. Some study also mentioned about prevalence of leukaemias and brain tumours in children living nearer to transmission line. Some researches indicated that this radiation could possibly lead to cancer in human body. High-power EMF can damage human cells and tissues leading to cancer. Skin is directly exposed to these radiations, it can be badly damaged. From the experience of Chernobyl accident, WHO commented that as human beings are continually exposed to ionizing radiation from many natural sources, from power plant additional radiation may increase the suffering from cancer. As research on relation between EMF field strength and the possible risk associated with it or the mechanisms that can trigger processes like cancer and the creation of tumor is very scarce full-fledged research on this specific issue is also recommended under this project. Use of "Gauss meter" to measure the intensity of EMF is also recommended.

6.3.5. Accident and Injury Due to Heavy Road Traffic

As EIA mentioned that the proposed project sites the movement of vehicles and vessels like bus, micro, auto, van, motorbike, trawler, engine boat, launch and other local machines which ply all day long which during project operation period will be increased. HIA finding indicates that among the study population, road traffic accident was 20.4%. Considering this issue, proper road traffic management through adequate traffic police deployment is also suggested.

6.3.6. Health Problems Due to Impairment Surface Water Quality

EIA also conducted water quality test around the project area for both surface and ground water during pre-monsoon and monsoon period. The measured values of pH, DO, EC, TDS and Salinity are within the limit of ECR 1997, Schedule 3. HIA indicates that 13.0% surrounding community people use river/canal water for washing, bathing and toilet purpose. This is one important reason of suffering from skin problems like itching and eczema among the study population.

6.3.7. Health Problems Due to Impairment Groundwater Quality

The groundwater quality has been tested by EIA in and around the project area. Results of analyses indicated that all the parameters are within the ECR 1997 (Schedule 3) (drinking water standards) values. EIA also mentioned that about 97.3% of the population gets drinking water from tube wells. HIA finding is also more or less similar to this statement. Diarrhea, gastroenteritis, enteric fever (Typhoid) and hepatitis are mostly common health problem due to polluted drinking water consumption. According to the Bangladesh Health Bulletin 2018, similar picture also reported regarding these communicable diseases.

6.3.8. Employment and Drug Abuse

EIA report mentioned about the main occupation of the local people as service (47.8%), agriculture (27.1%) and about 25.1% in industrial work. While HIA indicated 15.3% were involved in the jobs that related to chemical industry, spinning, dyeing, coal mining, pitching road construction, plastic industry, or any relevant chemical fuming/contacting jobs. As it has been learned that community people are not well aware about the installation of gas-fired power plant, however, they appreciated the project hoping that this will address the growing demand for electricity in Bangladesh and make community economy better.

Unemployment Rate in Bangladesh is 4.30 percent in 2018 according to BBS. The total labour force of the country is 56.7 million. Most of the female labour force employed in household work, number of days labour is 10.6 million, unpaid family helpers are 11.8 million, and rate of under employment is 20.3 percent. Employment opportunities have not increased as we need. So, in any construction project, people try to get a job. This problem may cause some negative social health effects like crime and alcohol consumption and drug abuse. HIA also found that among the study population 3.4% are habituated with alcohol consumption. In this regard, it may be noted here that 25.2% study population have smoking habit and 31.3% have smokeless tobacco habit.

6.3.9. Community Health

According to EIA study, the most prevalent diseases in the study area are diarrhea, typhoid, pneumonia, jaundice, skin diseases, etc. Children are mostly affected by water-borne diseases. Instant health facility is inadequate in nearby areas except the city corporation area. Hyper tension/high blood pressure is also increasing among the people. Disability is also found in the study area. Total disability is about 1.5%. Key informants of HIA also opined the similar comments. Diarrhea and gastroenteritis (11.4%), abdominal pain (13.4%), asthma (5.1%), Salpingitis and oophoritis (4.7%), cardiovascular diseases (3.9%) and Traffic accident (2.6%) are the common causes of hospital admission among the adult and Diarrhea and gastroenteritis (10.4%), Pneumonia (5.7%), unspecific acute lower respiratory infection (4.5%) and fever (3.7%) are among the infant and children. According to WHO, lack of safe water, inadequate excreta disposal facilities, poor hygiene, poor living conditions and unsafe food can all cause increase prevalence of enteric fever and diarrhoeal diseases. Flooding after heavy rains can result in sewage overflow and widespread water contamination. Among the community 3.4% had history of chronic obstructive pulmonary disease, 4.2% had history of heart attack, 4.6% had history of stroke, 8.8% reported that they had history of eye problem, 1.5% had history of long-term jaundice, 1.1% reported that they had history of pain in joints and 0.8% had some sorts of neurological problem.

6.3.10. School Children's Health

Special attempt was undertaken to assess the health status among the school going children as there is one school is operating and there is a plan to shift the school from existing site to nearby another site of this proposed project. HIA finding indicates that the mean BMI of the school children was 15.0 kg/m2 with mean height -124.8 cm. and mean weight 23.6 kg. Among the school children 35.6% were underweighted and 8.9% were over weighted and obsessed. Of them 31.2% had hearing problem and 15.6% had vision problem. As vulnerable group school children need to draw special attention in this project. It was learned from the project personnel that one new school will be installed within 60 meters of the main power plant site instead of existing old (vulnerable) school building. Appropriate measures against sound and vibration must be considered while installing the new school building.

6.3.11. Cancer Prevalence

Cancer is a disease caused by the acquisition of an unfortunate combination gene mutations in a single cell of the body over one's lifetime. During the period of early mutation, the cell is not called a cancer cell because it has not acquired the appearance and behavior of a cancer cell. It might look normal, or it might be called "dysplastic" if it looks abnormal but is still not a full-blown cancer. From EIA and HIA team's experience it was learned that some carcinogenic agents like PM10, PM2.5, CO, CO2, SOX. Nitrates and EMF may emit during installation and operation of the power plant and transmission line. HIA findings indicated that among the community people only 0.4% reported about liver cancer. No other cancer was reported. Whereas there are 13 to 15 lakh cancer patients in Bangladesh, with about two lakh patients newly diagnosed with cancer each year. HIA team's observation regarding this specific issue is that the mean age of the

respondents was 36.5 (±11.9) years. It indicates that as the study area is a industrial area, most of the residents of this area are involved in occupation and after ending of the job they return back to their home or migrate to other areas for job.

6.3.12. Health Care Seeking Behavior

According to health managers in Khulna, there are 281 health facilities in Khulna districts including a 500-bed medical college and community clinics. These facilities are providing health care services with approximately, 1100 beds and 439 doctors 580 nurses. In addition, 184 private medical facilities are also available here with Medical College Hospital, General Hospitals, Clinics and NGOs facilities also available with 2300 beds for the patients. No trauma center is present in Khulna. Khulna Medical College Hospital is a tertiary level hospital running with 80 doctors and 246 nurses. It is noted that around the project site in Khalishpur, there are six state-owned Jute mills operating Medical Center mostly outpatient department services are offered here and some have indoor services (6 – 8 beds are available) for short time duration medical problems. Besides these there are two government outpatient medical facilities near the project sites.

EIA report mentioned that about 48% of patients go to trained physician as people have easy access to the trained physician in Khulna city. About 25% people in the study area go to paramedic doctor and about 22% patients go to quack doctors. Local people are nowadays much more aware about their health. They have eagerness to receive health treatment from trained physicians but all of them are not able to do that due to inadequate financial capability and availability of health facility. HIA scenario is also similar. Community survey also indicates that 84.4% of them were used to receive treatment from MBBS doctor during their illness, whereas remaining others reported to receive from other persons such as health assistant, pharmacy, quack, Homeopath/Ayurveda/Unani doctor, and traditional healer locally called kabiraj.

CHAPTER SEVEN: PUBLIC HEALTH MANAGEMENT PLAN

7. Public Health Management Plan (PHMP)

Public health is concerned with the health of populations as a whole, rather than specific care for individual patients. The goal of public health management is to identify and control threats to public health, and to create policy which supports public health and the development of healthy populations. The Public Health Management Plan (PHMP) covers measures that will be conducted in every phase of implementing to ensure that adverse impacts are minimized and positive impacts enhanced. Aside from the mitigation measures, the PHMP also includes the required monitoring and implementation arrangements.

The objective of this plan is to set up a program of preventive health care aimed at the surrounding communities. The program of information, education and communication will focus on issues like personal health, sanitation, food and nutrition, vaccination, malaria prevention and HIV/Aids/STI prevention. Also, curative health facilities and services will be set up in the project site. These centers will provide medical services to surrounding community people, the general public as well as to the work force in the project. This facility will also have the capacity to treat emergency cases including trauma patients.

Table: Public Health Management Plan

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Ambient air quality	Air pollutants • PM10 and PM2.5 • CO, CO2, SO2.	• 5.1% asthma; • 3.9% cardiovascular diseases	• Prevalence of Cardiovascular Diseases • Prevalence of chronic respiratory diseases • Air pollutant indicators SPM – 200 µgm/m3 NO2 – 80 µgm/m3 SO2 -80 µgm/m3	• Spraying water twice or thrice in every working day surrounding the project areas to ensure dust control inside the project sites • Ensuring use of N95 (PM2.5 protection) mask by the workers and others related persons at the projects • Ensuring use of N95 mask for the school children during to/from school regularly • Lung function test among the local residents at least once in	Health Safety and Environment Unit of NWPGCL, DoE (Department of Environment)

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Ambient noise level	Daytime noise within limits (Noise is generated in this area due to the movement of vehicles and vessels like bus, micro, auto, van, motorbike, trawler, engine boat, launch and other local machines which ply all day long)	• 31.1% School going children had hearing impairment	• Prevalence of hearing impairment among school children	• Ambient noise level monitoring • Provide temporary enclosure of noise-generating activities and equipment • Construction works will be limited to daytime only • Drivers will be instructed to avoid unnecessary use of horn	Health Safety and Environment Unit of NWPGCL DoE (Department of Environment)
Transmission line posing hazards	Electrocution and Lightning strike health	• As we know that high voltage lines transmit radiation called the "electro-magnetic field (EMF)" • EMF causes cancer and tumor and cell damage, excitability of nervous tissue which may affect memory, cognition and other brain functions, leukaemias and brain tumours in children	• Prevalence of Electrocution and Lightning strike • Prevalence of EMF impaired memory, cognition, leukaemias and brain tumours in children	• Full-fledged research on EMF induced health problems • Use of "Gauss meter" to measure the intensity of EMF • No living structures/houses will be allowed within the RoW • Keep EMF in permissible limits according to EHS guidelines	Health Safety and Environment Unit of NWPGCL

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Surface Water Quality	The measured values of pH, DO, EC, TDS and Salinity are within the limit of ECR 1997, Schedule 3.	• 9.2% reported diarrhea • 3.8% reported typhoid • 1.1% reported food poisoning • 1.5% reported jaundice • 4.2% reported heart attack	• Prevalence of diarrhea among the local residents • Prevalence of typhoid • Prevalence of food poisoning • Prevalence of jaundice • Prevalence of hypertension	• Water quality should be tested regularly • Salinity level should be check on regular basis	WASA NWPGCL
Groundwater quality	All the parameters are within the ECR 1997 (Schedule 3) (drinking water standards) values.	No arsenicosis case has been reported but it should be under monitoring.	• No of cases reported with arsenicosis • Presence of iron in the tub well • Prevalence of hypertension	• Arsenic level should be measure regular basis • Salinity level also should be check regular basis	Health Safety and Environment Unit of NWPGCL

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Drinking Water Source	About 97.3% of the population gets drinking water from tube wells, 1.4% is dependent on tap water, and 1.3% depends on other sources such as pond, river and canal	• About 32.1% population gets drinking water from tube wells, 1.1% from supply water • 63.7% use home-based filter	• Prevalence of diarrhea among the local residents • Prevalence of typhoid • Prevalence of food poisoning • Prevalence of jaundice • Prevalence of hypertension	• Water quality (all parameters) should tested regular basis according to WHO drinking water standards	WASA Health Safety and Environment Unit of NWPGCL
Toilet Facility		• Flush to piped sewerage system or septic tank or pit latrine 62.4% • Pit latrine with slab 20.9% • Flush to open place 9.7% • Pit latrine without slab or open pit 6.9%	• Use of sanitary latrine among the community people	• Installation of 100% sanitary latrine among the residents • Awareness raising for practicing proper hand washing technique among the residents through appropriate communication system	WASA Health Safety and Environment Unit of NWPGCL Local health facility

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Disability	Disability rate is about 1.5%.	• Disability rate is about 2.3%.	• Prevalence of disability	• Ramp should be built in all facility so that a disable can move freely • Availability of assistive device should be ensuring for the disable. • Disable should be employed with modification as per their qualification and skill.	NWPGCL JPUF (JatyoPotibondhiUnnyan Foundation), Ministry of Social Welfare
HIV/STD/TB		• HIV/STDs protection Practice 25.2% • Test for HIV/STDs - 4.0% • History of TB – 1.9%	• Prevalence of HIV/STD • Prevalence of TB	• Facilities for HIV/STD test should be available • Contraceptive materials should be available • A TB corner can be established in the proposed medical center • Free consultation regarding HIV/STD should be arranged within the center	NWPGCL Proposed Health Center Local Health Facility

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Communicable diseases	Most prevalent diseases in the study area are diarrhea, typhoid, pneumonia, jaundice, skin diseases, etc.	• Chronic diarrhea- 9.2% • Typhoid- 3.8% • Ringworm -6.1% • 11.4% Diarrhea and gastroenteritis;	• Prevalence of diarrhea • Prevalence of typhoid • Prevalence of skin diseases • Prevalence of pneumonia	• Awareness raising for practicing proper hand washing technique among the residents through appropriate communication system • Awareness raising for practicing proper hygiene among the residents through appropriate communication system	Local health facility NWPGCL
Non-communicable diseases	Hypertension/high blood pressure is also increasing among the people.	Diabetes mellitus- 25.7% Liver diseases- 0.4%	• Prevalence of hypertension • Prevalence of liver diseases • Prevalence of diabetes mellitus • Prevalence of cardiovascular diseases • Prevalence of cancer • Prevalence of chronic obstructive pulmonary diseases (COPD)	• Screening program for hypertension, Diabetes, Cancer (cancer cervices, breast cancer), COPD, Dyslipidemia can be done. • NCD corner should be established in the proposed health center. • Awareness raising for preventing Non-communicable diseases among the residents through appropriate communication system	Local health authority NWPGCL NCDC, DGHS

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Cancer		Liver cancer- 0.4% No other cancer reported	• Prevalence of Breast cancer among female • Prevalence of cervical cancer among female • Prevalence of prostate cancer among male • Prevalence of lung cancer • Prevalence of oral cancer	• Though no other cancer case were detected except liver cancer, yet we have to monitor the breast and cervical cancer as both of the cancers are preventable in case of early detection. So, screening program should be launched and vaccine for cervical cancer should be given to the reproductive women.	Local health authority NWPGCL NCDC, DGHS
Accident and injury		• Road traffic accident -20.4% • Burn injury – 6.2% • Snake bite- 0.4%	• Prevalence of morbidity and mortality from road traffic accident • Prevalence of disability due to road traffic accident • Prevalence of work place accident • Prevalence of burn injury • Prevalence of morbidity and mortality from snake bite	• Fire safety should be ensured in the project site as per standard guideline. • At least two fire drill should be arranged in a month • Appropriate safety signage's should be installed in around the project sites • Speed breaker should be placed in front of public facilities like school, hospitals etc. • Appropriate measures should be taken against snake bite, like should be avoid jangle, carbolic acid can be supplied among the local residents. • A burn unit can be established in the proposed health center	Fire Services and civil defenses RHD City corporation NWPGCL Local health authority

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Vector, rodent and pest borne disease		• Dengue - 40.0% • Malaria - 20.0% • Chikungunya - 40.0%	• Prevalence of morbidity and mortality from dengue dengue, malaria, chikungunya • Prevalence of rodent and pest borne disease	• Regular cleaning of drains including vegetation in around the project sites to prevent breeding of mosquito • Need based regular spraying or fogging anti mosquito chemicals at project sites • Promotion of using mosquito net among the surround community (Community	Health Safety and Environment unit of NWPGCL City corporation Local health authority
Children Health	Children are mostly affected by water-borne diseases.	• Diarrhea and gastroenteritis - 10.4% • Pneumonia -5.7% • Acute lower respiratory infection - 4.5% • Fever -3.7%	• Prevalence of diarrhea in children • Prevalence of Pneumonia in children • Prevalence of underweight children • Prevalence of overweight and obese children	• Awareness program through the school on personal hygiene can be initiated • Appropriate handwashing technique and personal hygiene should be teaching among the residents through campaign and leaflet.	• School authority • Proposed Health Center • NWPGCL

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Tobacco consumption habits		• Smoking habit - 25.2% • Smokeless tobacco habit -31.3%	• Prevalence of tobacco (smoking and non-smoking) users	• Though it is lower consumption then the national data but it might me increased when the power plant will be launched. So, WHO FCTC guideline MPOWER should be implemented. • An NCD risk factors survey using WHO STEPs questionnaire can be done periodically in order to understand the trend. • As tobacco is the leading cause of NCD mortality.	NCTC Law enforcement authority

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Alcohol consumption habits		3.4% are habituated with alcohol consumption is supported by national data.	• Prevalence of alcohol consumption • Prevalence of narcotic drug consumption	• It should be under strict monitoring • An NCD risk factors survey can be done periodically in order to understand the trend.	NCTC NWPGCL

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Diet related habits and physical inactivity		• Vegetables intake nearly six days a week (5.93±1.52), and three servings in a typical day (2.70±0.98). • Fruits intake around three days in a week (3.03±1.76), and over one serving in a typical day (1.50±0.79). • 59.9% population use added salt during their meal	• Prevalence of recommended (>5 servings per day) amount of fruits and vegetables intake • Mean servings of fruits consumptions • Mean servings of vegetables consumptions • Mean number of days in a week consumption of fruits and vegetables • Prevalence of respondents using extra salt during meal • Number of respondents do not follow the recommended (more than 150 min physical activity per week) level of physical activity	• The WHO recommended amount (more than five servings or 400 gm) of fruits and vegetables in a week intake should be ensure among the residents, as we know fruits and vegetables protects our health against all diseases especially NCDs. • An NCD risk factors survey can be done periodically in order to understand the trend. •	City corporation School authority NWPGCL

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Health services	250-bed capacity health complex at Boyra. Number of private clinics in Khulna city	• There are 281 health facilities in Khulna districts including a 500-bed medical college and community clinics. • In addition, 184 private medical facilities are also available here with Medical College Hospital, General Hospitals, Clinics and NGOs facilities • Health care settings are within two kilometers from their home except indoor hospitals • No trauma center is present in Khulna.	• Establishment of health center nearby the project area with trauma care facility with adequate manpower • The referral system within the health care facility • Ambulance facility • Number of private health care facility nearby the project area	• Establishment of health center nearby the project area with trauma care facility with adequate manpower • Health insurance program can be launched but premium should be very low (not more than 20 taka in a month) some time it should be bear by the company.	NWPGCL Civil Surgeon Office, DGHS

Issue	EIA Findings	HIA Base Line findings	Monitoring Indicator	Mitigation/Monitoring	Responsible Unit
Health care Seeking pattern	• About 48% of patients visit trained physician • About 25% people visit paramedic doctor and about 22% patients go to quack doctors.	• 72.5% population visit hospital/clinic or any health care setting in their nearby locality when getting illness • 84.4% visit MBBS doctor during their illness, • Rest population visit health assistant, pharmacy, quack, Homeopath/Ayurveda/Unani health care provider, and traditional healer (kabiraj)	• Prevalence of visit graduate health provider during any illness • Prevalence of attending health care facilities during any ambulatory health problems	• Raising awareness related to utilization of approved health care provider and health care facilities among the community	Civil Surgeon Office, DGHS

CHAPTER EIGHT: CONCLUSION & RECOMMENDATION

8. Conclusion and Recommendation

The construction of Rupsha 800 MW CCPP is an economical important project for the country through enhancing power generation capacity in addressing the increasing demand for electricity. Prevalence of diseases among the community people surrounding the project was found lower than the Bangladesh diseases prevalence profile. Diseases caused by environmental degradation like ambient air quality is found low but water quality degradation and noise pollution are found at higher level. School going children are found most vulnerable as they already suffering from noise pollution related health problem such as hearing impairment. Besides these the particular group was found malnourished and suffering from vision problem. Special consideration should provide to address them. As school is officially silent zone, vehicles plying with horn near to the school area should be strictly avoided. Water spraying twice or thrice in a working day and providing dust mask (preventing PM 2.5) among the workers and school children are recommended. Yearly Lung function test among the local residents including students along with installation of Polludrone (an ambient air quality monitoring solution to automate the Pure Skies purifiers) within the power plant are also suggested to reduce the release of pollutants into the environment.

It has been experienced that power plant use some vibrating machines and tools those produce noise. A vibration-exposed worker is likely to be exposed to noise at the same time. Some researches revealed that, for equal noise exposure, those with vibration-induced white finger (VWF) had greater hearing loss than those without VWF. Further study related to threshold value or the amount of vibration exposure that results in no adverse health effects and dose-response relationship (how the severity of the ill health effects is related to the amount of exposure and in this proposed project is highly recommended. As one new school building will be installed immediate outside the project boundary instead of existing old (vulnerable) school building, appropriate measures against sound and vibration (complying national standard for silent zone) are also strongly recommended.

As in this project high voltage transmission lines will be installed where there is possibilities of EMF (Elector Magnetic Field) radiation hazards, Exposure at lower levels induces changes in the excitability of nervous tissue in the central nervous system which may affect memory, cognition and other brain functions. Studies have shown a higher incidence of leukaemias and brain tumours in children living near overhead power lines. Therefore, it is recommended that houses will not be allowed within the RoW of the line and during design transmission line and substation equipment will be rated to ensure electromagnetic field is within the permissible limits specified in the EHS guidelines.

As Road traffic accident was found a severe health problem (20.4%) among the community people, proper road traffic management through adequate traffic police deployment is also suggested.

Organizing regular Fire drill among the project personnel with the support of local Civil Defense and Fire Service department also recommended.

Prevalence of vector borne (mosquito) diseases like Malaria, Dengue and Chikunguniya also found marked. HIA is recommending proper solid waste management facilities including drainage system with regular cleaning of vegetation in and around the project area. Anti-mosquito and anti-rodent program according to new approach formulated by Ministry of health should also be conducted time to time along with local health department and local government department.

Development of proper hazardous waste system is recommended also including construction waste management system to prevent any spillage of mineral oil.

Awareness related to HIV and STD is also found better that other areas of Bangladesh. Still as in any new project areas migrant workers rush for employment and as it is reported the increase prevalence of HIV and STD in ongoing development activities where migrant workers work, HIV and STD related awareness program should be continue in project sites.

Community survey also indicates that 84.4% people were used to receive treatment from MBBS doctor during their illness and from hospital for ambulatory problems. Health care services capacity was found better than other cities in Bangladesh, though they have on shortcoming regarding emergency trauma management. The Rupsha 800 MW CCPP may consider in improving this issue through installing one trauma center near the project site in addition to outpatient facilities. Key discussion has been briefly annexed in **Summary of Recommendations**.

ANNEX

Health Impact Assessment Questionnaire

SECTION-1: IDENTIFICATION

Respondent ID	
Cluster No.	
Household No.	
Date of Interview:	

Name of the Respondent: _____

Address of the Respondent:

Village	**:**
Union	**:**
Upazila	**:**
District	**:**

Name of the Interviewer : _____Signature: _____

Informed consent/ Ascent

Assalamaliakum/Adab,

My name is ..... . I am representing EQMS. We are conducting a research for assessing the health impact of Rupsha 800-Megawatt Combined Cycle Power Plant Project. In this regard I would like to ask you some questions about your experiences.

There is no risk if you agree to participate in this interview, although some of the questions are personal and may make you feel uncomfortable. However, all the information that you give to me will be kept strictly confidential. Your name will not be used and you will not be identified in any way. This interview may take approximately 20 to 30 minutes to complete. Your participation is absolutely voluntary and there is no compulsion for refusing to take part. You are free to ask any questions; you may refuse to answer any question in the interview; and you may stop the interview at any point.

Do you have any questions? Do I have your agreement to take your interview now?

Yes 1 No 2

Interviewer's Signature: _____ Date: _____

(Please read to respondent before asking any question for the interview)

1.1.1.1.1 SECTION-2: HOUSEHOLD RELATED DATA

(Please put the name of the household head at first, in the serial number 1. Then put other names as per age of each member sequentially)

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		Q9
Sl	Name of the HHH and other members	Relationship with HHH Code: 1= HHH 2= Husband/ Wife 3= Children aged 5-16 years 4= Children aged 0-59 months 5= Father 6= Mother 7= Son 8= Daughter 9= Brother 10= Sister 11= Son-in-law 12= Daughter-in law 13= Relatives/Friends 14= Other dependants	Sex Code: 1=Male 2=Female	Age (Years/month)	Marital Status Code: 1= Married 2= Unmarried 3= Widow/Widower 4= Separated 5= Divorced 6= Not applicable	Education Code: 0.Illiterate 1.Incomplete primary 2.Primary school passed 3.Incomplete secondary 4.SSC passed 5.HSC passed 6.Graduation and above 7.Other (please specify…….)	Still in Study Code: 1=Yes 2=No [If any child continues study in school even before 6 years age, please put code- 1]	***1.1.1.1.1.1.1 Reasons of drop outs from schools (if any, during last one year)*** **Code:** 1= poverty 2= Household work pressure 3= Income 4= Physical ailments 5= Accidents of parents 6= Distance of schools 7= Early marriage 8= Teasing 9= others (specify)	***1.1.1.1.1.1.2 Occupation*** **Code:** 1= Agriculture 2 = Labour 3= Service 4 = Small Business 5 = Student 6 = Housewife 7 = Rickshaw/ Van 8 = Unemployed 9 = Handicrafts 10= Tailoring 11= Mechanic/Mason 12= Housemaid 13= Bonded labourer (Rakhal) 14= Begging 15= Household Work 16= Student 17= Unemployed 18= Not applicable 19= Others (specify)		Whether any member of this family is disable 1= Yes 2= No
									Primary	Secondary	
01											
02											
03											
04											
05											
06											
07											
08											
09											
10											

Information on People with disability (Please check question 213. If there is no PWD, please go to section 3)

Code	Question & filters section and number	Answer in number, values or specified value ranges	Value or codes

Q10	If there is anybody with disability in this family, please mention the type of disability	1= Physically Challenged, 2= Visually Impaired, 3= Hearing and Speech Impaired 4= Mentally Challenged, 5= Multifaceted	
Q11	What services and healthcare you are providing to her/him?	1= Preventive measures, 2= Curative measures, 3= Therapy, 4= No treatment is provided	

SECTION 4: BEHAVIORAL RISK FACTORS RELATED INFORMATION

Sl.	Questions	Responses	Code
	Tobacco use behavior		
Q12	a. Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes? ***(If no, go to c)***	0. No 1. Yes	
	b. For how long you are smoking?	Years …….	
	c. In the past, did you ever smoke any tobacco products?	0. No 1. Yes	
	d. Do you currently use any smokeless tobacco products such as snuff, chewing tobacco, betel? ***(If no, go to f)***	0. No 1. Yes	
	e. For how long you are using smokeless tobacco?	Years …….	
	f. In the past, did you ever use smokeless tobacco products?	0. No 1. Yes	
Q13	**Alcohol consumption**		
	a. Have you ever consumed any alcohol such as beer, wine, spirits, Bengali alcohol etc.?	0. No 1. Yes	
	b. Have you consumed any alcohol within the past 30 days?	0. No 1. Yes	
Q14	**Diet**		
	a. In a typical week, on how many days do you eat vegetables?	No. of days……	
	b. How many servings of vegetables do you eat on one of those days? (Use WHO showcard)	No. of servings….	
	c. In a typical week, on how many days do you eat fruit?	No. of days……	
	d. How many servings of fruit do you eat on one of those days? (Use WHO showcard)	No. of servings……	
Q15	**Added salt intake behavior**		
	a. Do you use added salt during meal?	0. No 1. Yes	
	b. ***If yes then***, how do you use?	0. Regular 1. Often 2. Sometimes	

	c. What is the amount of that salt you use in 24 hours?	0. 0.5 tea spoon 1. 1 tea spoon 2. 1.5 tea spoon 3. 2 tea spoon 4. 2.5 tea spoon 5. 3 tea spoon and more	
	Occupation related behavior practices		
Q16	If employed or service holder, are you involved in any job related to chemical industry, spinning, dyeing, coal mining, pitching road construction, plastic industry, or any relevant chemical fuming/contacting jobs?	0. No 1. Yes	
Q17	If farmer, how frequently do you own use pesticides in your land usually in every six months?	0. Don't use 1. Not by own hand 2. 1-3 times	
Q18	If use pesticide, do you use any safety measure & personal protective device during the use of pesticide?	0. No 1. Yes	
Q19	If use pesticide, do you feel any problem when you use the pesticides?	0. No 1. Yes	

SECTION 5: BASIC INFORMATION ABOUT UTILITIES AND SERVICES

Sl.	Questions	Responses	code
Q20	What is the source of your drinking water?	0. Pond 1. River/canal 2. Shallow tube well 3. Rainwater 4. Home based filter 5. Supply water (deep tube well) 6. Others (please specify…….)	
Q21	What is the source of your cooking water?	0. Pond 1. River/canal 2. Shallow tube well 3. Rainwater 4. Home based filter 5. Supply water (deep tube well) 6. Others (please specify……..)	
Q22	What is the source of your washing/bathing/toilet using water?	0. Pond 1. River/canal	

		2. Shallow tube well 3. Rainwater 4. Home based filter 5. Supply water (deep tube well) 6. Others (please specify……)	
Q23	If you are using water from shallow tube well for drinking/cooking purpose, does the water have arsenic contamination?	0. No 1. Yes	
Q23a	Do you boil water from tube well before drinking?	0. No 1. Yes	
Q23b	*If not, what are the reasons of not boiling water before drinking?*		
Q24	What is the type of toilet facility used by your household?	0. Flush or pour-flush to piped sewerage system or septic tank or pit latrine 1. Pit latrine with slab 2. Flush or pour-flush to open place or elsewhere 3. Pit latrine without slab or open pit 4. Hanging toilet/latrine 5. Public or shared sanitation facilities 6. No facilities or bush or field (open defecation)	
Q25	How will you describe the sewerage system of your house?	0. Good 1. Average 2. Poor	
Q26	How will you describe the sewerage system of your locality?	0. Good 1. Average 2. Poor	

SECTION 6: PERSONAL HYGIENE AND GENERAL HEALTH SEEKING PRACTICE RELATED INFORMATION

Sl.	Questions	Responses	code
Q27	Do you take bath regularly?	0. No 1. Yes	
Q28	Do you wash your hands before taking meal?	0. No 1. Yes	
Q29	Do you wash your hands after coming back from toileting?	0. No 1. Yes	
Q30	Do you keep your nails short and clean regularly?	0. No 1. Yes	

Q31	Do you change your clothes after coming back from outside work?	0. No 1. Yes	
Q32	Do you wash your hands & face or take bath after coming back from outside work?	0. No 1. Yes	
Q33	When you get illness, usually from whom do you receive treatment?	0. MBBS doctor 1. Health assistant 2. Pharmacy 3. Quack 4. Homeopath/Ayurveda/Unani doctor 5. Traditional healer (kabiraj) 6. Others (specify……...)	
Q34	Do you have hospital/clinic or any health care setting in your nearby locality?	0. No 1. Yes	
Q35	If yes, how far from your house?	…….km	
Q36	Do you visit that hospital/clinic/health care setting when you get illness?	0. No 1. Yes	
Q36a	Do you have ever history of hospital admission in your life?	0. No 1. Yes	
Q36b	*If yes, how many times?*		

SECTION 7: INFORMATION RELATED TO SYMPTOMS OF SYSTEMIC DISEASES

Symptoms		How long you are suffering	Taken treatment	From whom	If not, why	Ever admitted in hospital
Q37. Female	1. Still birth					
	2. Death of infant					
	3. Death of under-5 child					
	4. Abortion					
	5. Pre-mature delivery					
	6. Underweight newborn					

	7. Delayed child development					
	8. Uterine prolapse					
	9. Low back pain					
	10. Mass in lower abdomen					
	11. Leukorrhoea					
	12. Blood stained vaginal discharge					
	13. Menorrhagia					
	14. Dismenorrhoea					
Q38. ENT	1. Running nose					
	2. Anosmia					
	3. Nasal blockage					
	4. Sneezing					
	5. Difficulty in respiration					
	6. Nasal ulcer					
	7. Others (please specify)					
Q39. GIT	1. Abdominal pain					
	2. Increased salivation					
	3. Blackening of stool					
	4. Alternate costipation and diarhoea					
	5. Anorexia					
	6. Erosion or discoloration of teeth					
		How long you are suffering	Taken treatment	From whom	If not, why	Ever admitted in hospital
Q40. Respiratory	1. Chronic cough					
	2. Blood stained cough/sputum					
	3. Chest pain					

	4. Wheezing					
	5. Difficulty in breathing					
	6. Chest tightness					
Q41. Cardiac	1. Chest pain					
	2. Exertional dyspnea					
	3. Hot flash					
	4. Palpitation					
	5. Ankle edema					
	6. Fainting					
Q42. EYE	1. Eye itching					
	2. Increased lacrimation					
	3. Conjunctivitis					
	4. Headache					
	5. Cataract					
Q43. Urology	1. Abnormal urine color					
	2. Blood in the urine					
	3. Excess urination at night					
	4. Groin pain					
	5. Urgency & frequency of micturition					
Q44. Liver	1. Long-termjaundice					
	2. Abdominal pain and swelling					
	3. Pale/bloody stool					
		How long you are suffering	Taken treatment	From whom	If not, why	Ever admitted in hospital

Q45. Bone &	1. Pain in joints					
	2. Swelling of joints					
	3. Fragile bone					
Q46. Dermatology	1. Itching					
	2. Red sores					
	3. Bumps					
	4. Cracked rash					
Q47. Cancer	1. Chronic pain					
	2. Prolonged low grade fever					
	3. Rapid weight loss					
	4. Rapidly increasing tumour/ mass					
Q48. Alzheimer's Diseases	1. Disoriented in time and place					
	2. Confusion					
	3. Forgets names and words recent personal events					
	4. Losing things or misplacing them in odd places					
	5. Repeats questions, phrases or stories, *in the same conversation*					
	6. Poor judgment					
	7. Less able to plan, organize, or think logically					
Q49. Neurological	1. Numbness					
	2. Tingling					
	3. Paresthesia					

I am going to ask you a few questions about your sexual health and sexual practices. I understand that these questions are very personal, but they are important for your overall health. Just so you know, I ask these questions to all of my adult patients, regardless of age, gender, or marital status. These questions are as important as the questions about other areas of your physical and mental health. Like the rest of our visits, this information is kept in strict confidence.			
Q50. Risky sex behaves		**Yes**	**No**
	1. What is your sexual behave?		
	2. Do you use any protection against HIV/STDs?		
	3. Have you ever been diagnosed with an STD?		
	4. Has your current partner or any former partners ever been diagnosed or treated for an STD?		
Q51. TB related	1. Have been diagnosed with verified TB ?		
	2. If yes, were you treated?		
	3. Have you completed your TB treatment regime?		

SECTION 8: INFORMATION RELATED TO DIAGNOSED DISEASES

		How long you are suffering	Taken treatment	From whom	If not, why	Ever admitted in hospital
Q50. Communicable diseases						
1. Chronic diarrhoea						
2. Typhoid						
3. Hepatitis-B						
4. Acne						
5. Psoriasis						
6. Scabies						
7. Eczema						
8. Contact dermatitis						
9. Ringworm						
10. Tuberculosis						
Systemic noncommunicable diseases						
Q52. Poisoning symptoms	1. Breathing difficulty					
	2. Chest pain					
	3. Vomiting					
	4. Swelling					
	5. Burning					
	6. Bleeding					
	7. Severe abdominal pain					
	8. Severe diarrhea and melena					
	9. Bloody urine					
Q 53	1. Asthma					

	2. Chronic obstructive pulmonary disease (COPD)					
	3. Chronic bronchitis					
	4. Lung cancer					
		How long you are suffering	Taken treatment	From whom	If not, why	Ever admitted in hospital
Q54. Cardiovascular	1. Heart attack					
	2. Heart failure					
	3. Stroke					
	4. Rheumatic fever					
Q55. Diabetes	Type-I diabetes					
	Type-II diabetes					
Q56. Liver	1. Liver Cirrhosis					
	2. Hepatitis					
	3. Liver failure					
	4. Liver cancer					
	5. Liver abscess					
Q57. Other cancers	1. Breast cancer					
	2. Cervical cancer					
	3. Prostate cancer					
	4. Stomach cancer					
	5. Cancer in other parts of the body					
Q58. Neurologic	1. Drowsiness					
	2. Dizziness					
	3. Confusion					

	4. Chronic headache					
	5. Alzheimer's disease					
Q59. Psycho-	1. Anxiety					
	2. Depression					
	3. Mood disorder					

SECTION 9: INFORMATION RELATED TO INJURY AND SNAKE BITE

Sl.	Questions	Responses	code
Q60	Do you or your family members faced any road traffic accident?	1. Yes 2. No	
Q61	If yes, where you were going for seeking the treatment?	1. In hospital 2. In clinic 3. In medical college hospital 4. In pharmacy 5. In doctor 6. In other health care professionals 7. Others Pls specify……..	
Q62	Do you or any of your family members faced any burn injury in last 2 years?	1. Yes 2. No	
Q63	If yes, where you were going for seeking the treatment?	1. In hospital 2. In clinic 3. In medical college hospital 4. In pharmacy 5. In doctor 6. In other health care professionals 7. Others Pls specify……..	
Q64	Do you or any of your family members faced any snake bite in last 2 years?	1. Yes 2. No	
Q65	If yes, where you were going for seeking the treatment?	1. In hospital 2. In clinic 3. In medical college hospital 4. In pharmacy 5. In doctor 6. In other health care professionals 7. Others Pls specify……..	

Q66	Have you or your family member or any member of your community suffered from any of following diseases in recent past	1. Dengue 2. Malaria 3. Chikungunya	
Q67	Which measures do you take to reduce the number of mosquitoes present on your property?	1. Residual spray 2. Eliminate stagnant water 3. Mosquito coils 4. Repellent 5. Clothing 6. Stay indoors 7. Insect screens 8. Operate fans 9. Electronic zapper 10. Automatic spray 11. Mosquito netting 12. Other 13. None of the above	

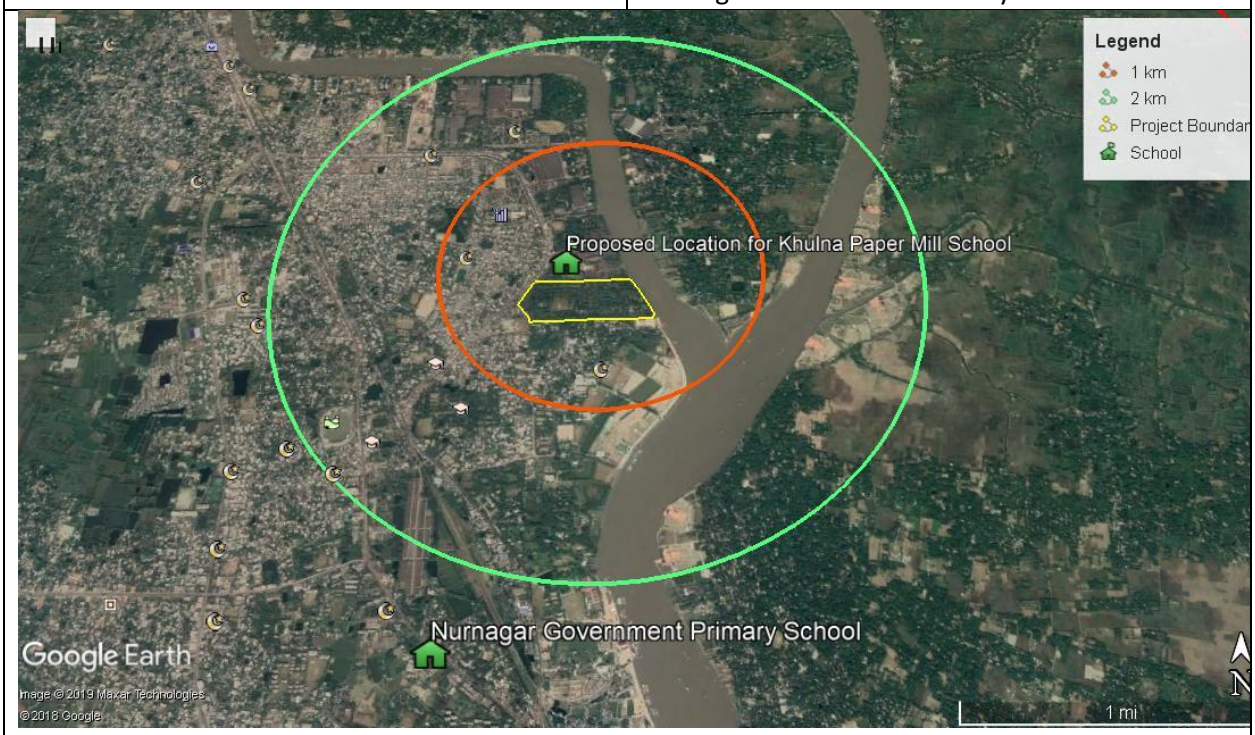
KII Photographs

Dr Kabir Medical Officer, Contact No: 01731927183 Platinum Jute Mill, Medical Support Center	Md Golam Sarwar Senior Station Officer, Contact No: 01726184288 Fire Service & Civil Defense Station, Khalishpur
Denied to take photographs	
F. M. Ismail Hossain Assistant Engineer, Contact No: 01726184288 Department of Public Health Engineering	Eng. Md. Kamaluddin Ahmed , Contact No: 01711398784 Khulna Water Supply & Sewerage Authority

Consultation Meeting with the School Authority

Khulna News Print Mill School

Nurnagar Government Primary School



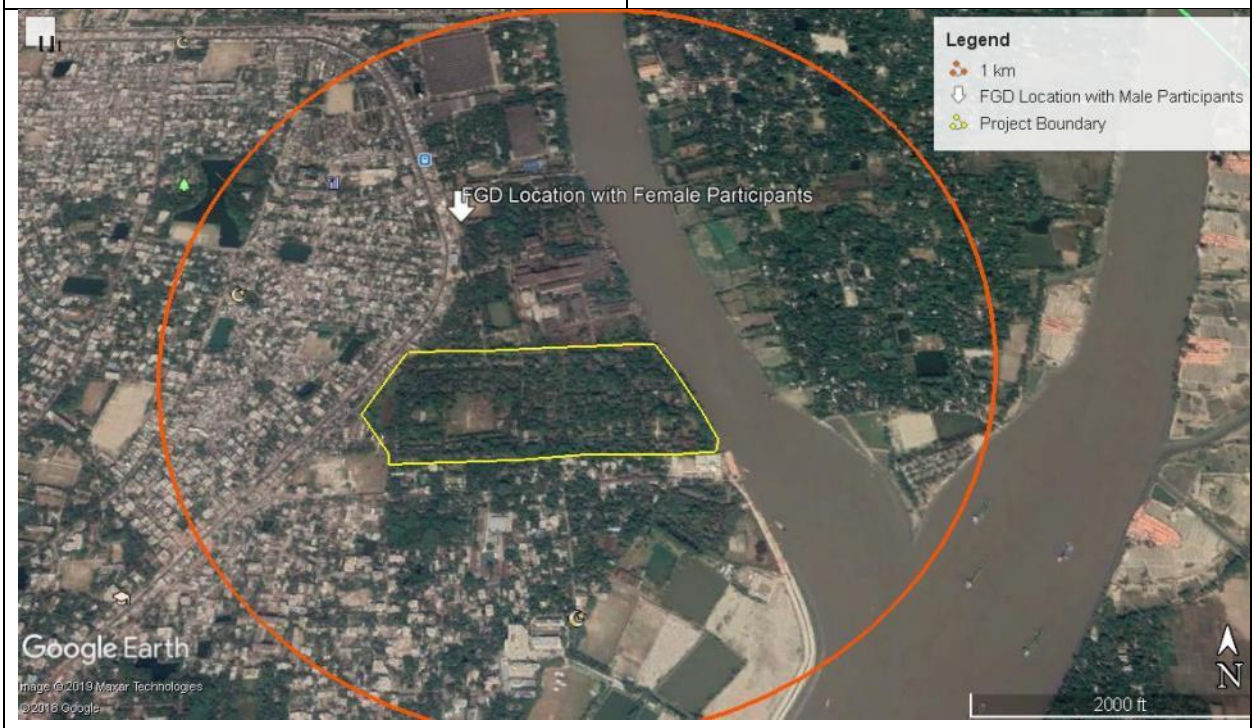
Control Group	Experimental Group
School Name: **Nurnagar Government Primary School** **Address:** **Nurnagar, Jessore Road, Boyra, Khulna** **Location:** **Lat 22°49'55.76"N Long 89°32'37.99"E**	**School Name:** **Khulna Newsprint Mill School** **Address:** **Khulna Newsprint Mill Area, Ward 13, Khulna City Corporation, Khalishpur** **Location:** **Lat 22°51'13.91"N Long 89°32'58.78"E**

Baseline Health Survey Photographs with The School Children

Health Survey with the primary Students of Khulna Newsprint Mill High School

Health Survey with the Primary Students of Nurnagar Government Primary School

FGD Photographs with Female Participants



Lat: 22°51'24.14"N Long: 89°32'55.48"E
Area Name: Hard Board Mill Area
Ward 13, Khalishpur, Khulna

FGD Photographs with Male Participants

Lat: 22°51'29.63"N Long: 89°33'5.09"E
Area Name: Daulatpur Jute Mill Area
Ward 13, Khalishpur, Khulna

Female FGD Attendance Sheet

Health Impact Assessment (HIA)for Rupsha 800-Megawatt Combined Cycle Power Plant, Khulna, Bangladesh

Female Group

FGD Participant List

Location: Hardboard Grate Date: 28/08/19 Time: 5:30

Sl.	Name of Participant	Sex Female	Address	Occupation	Phone Number	Signature
1	Hazara Begum	"	Hard board Area	—	—	
2	Shakia	"	"	Home Service	01966015036	
3	Shefali	"	"	"	—	
4	Tani	"	"	"	—	
5	Rashida	"	"	—		
6	Halima	"	"	House wife	01774934090	
7	Lacki	"	"	"	01752263540	
8	Sufia Begum	"	"	Home service		
9	Moyna	"	"	House wife	01939658466	
10	Morjina	"	"	Service-Mill	01922716914	
11	Piara	"	"	Home Service	01679502042	
12	Rashid	"	"	"	01677455146	
13	Minara	"	"	"		
14	Rabeya	"	"	"	01995924665	
15	Kakoli	"	"	"	01787506940	
16	Komela Begum	"	"	Housewife		
17	Jesmin	"	"	"		
18	Shahanaz	"	"	H. Service	01949208132	
19	Monjika	"	"	House wife		
20	Ratna		"	H. Service	01983122640	
21	Moriam	"	"	"	01985297160	
22	Nargis		"	House wife		
23						

Male FGD Attendance Sheet

Health Impact Assessment (HIA)for Rupsha 800 Megawatt Combined Cycle Power Plant, Khulna, Bangladesh

FGD Participant List

Location: Daulatpur Jute Mill Nouka Ghat Date: 25/08/2019 Time:- 3:30

Sl.	Name of Participant	Sex	Address	Occupation	Phone Number	Signature
1	Md. Tusar	M	Chandani Mahal	Mechanical Worker	01873-859601	Tusar
2	Md. Amin Hossain	M	Daulatpur Jute Mill quarter	Labor Leader	01934-757521	[illegible]
3	Sultan Mahmud	M	Karkipur, 7 No ward	Labor	—	[illegible]
4	Md Lutfor Rahman	M	Daulatpur Jute Mill quarter	Labor	01724-822349	
5	Abdullah	M	Daulatpur Jute Mill quarter	Labor	0199-578095	[illegible]
6	Zalal Uddin	M	Shimonomi	Labor	01961-639335	[illegible]
7	Monsur Ali	M	Dorm Colony	Labor	01736-523278	
8	Md Delwar Hossain	M	Daulatpur Jute Mill area	Labor	01753-737248	Delwar
9	Md. Akhter Hossain	M	Daulatpur Jute Mill quarter	Labor leader	01735-859724	
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						

Rupsha 800-Megawatt Combined Cycle Power Plant
Health Impact Assessment

Summary of Recommendations

No.	Issues	Actions to be Taken
1	Provision of healthcare facility, including a trauma unit, within or very near the project site	Re-installation of healthcare facility, including a trauma unit to improve the healthcare readily available to the local community.
2	Air Pollution reduction	Installation of Polludrone within the power plant to reduce the release of pollutants into the environment and regular water spray nearer construction areas
3	Mitigation for the noise and vibration impacts	For new school building adjacent to the project site, necessary measures should be taken to comply national standard for silent zone
4	Transmission Line Posing Hazards	Houses will not be allowed within the RoW of the line. Moreover, during design, transmission line and substation equipment will be rated to ensure electromagnetic field is within the permissible limits specified in the EHS guidelines.
5	Education and information dissemination (EID) about the project to the local community	Education and information dissemination (EID) including health and safety awareness should be ongoing, considering the upcoming construction works. Progress on this should be included in the safeguard monitoring reports
6	Provision for HIV testing and availability of treatment options	Contractor should ensure the provision for HIV testing and availability of treatment options for laborers
7	Regular monitoring of water sources for domestic use and EID on water, sanitation, and hygiene (WASH)	Regular monitoring of the water sources for domestic use should be done consistently, together with EID on WASH along with proper waste and wastewater management at the project site during construction and operation.
8	Hazardous waste management	Installation of waterproof floor at oil storage site and use wood dust to prevent any spillage of mineral oil.
9	Consistent traffic management during construction works	traffic management especially during construction works should be strictly implemented
10	Fire prevention and response	The contractor should ensure all required firefighting equipment and emergency communication plans are readily available and conduction of regular Fire Drill in accordance and support of Civil Defense and Fire Services of local unit.