Government of People's Republic of Bangladesh
Ministry of Shipping

Mongla Port Authority
Mongla, Bagerhat

Feasibility Study of Capital Dredging in Pussur River from Mongla Port to Rampal Power Plant

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

August 2015

INSTITUTE OF WATER MODELLING

ACCRONYMS AND ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
BCCI	Barisal Chambers and Commerce Industries
BIWTA	Bangladesh Inland Water Transport Authority
BOD	Biochemical Oxygen Demand
BOQ	Bill of Quantity
BRAC	Bangladesh Rural Advancement Committee
BWDB	Bangladesh Water Development Board
CBOs	Community Based Organizations
CD	Chart Datum
COD	Chemical Oxygen Demand
CPA	Chittagong Port Authority
CSC	Construction Supervision Consultant
DC	Deputy Commissioner
DG	Director General
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Forest
DoS	Department of Shipping
DWT	Dead Weight Tonage
ECA	Environment Conservation Act
ECAs	Environmentally Critical Areas
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
EMMP	Environment Management and Monitoring Plan
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
ESMP	Preparation of an Environmental and Social Management Plan
FAO	Food and Agricultural Organization
FC	Fecal Coliform
FD	Forest Department

FGD	Focus Group Discussion
FRSS	Fisheries Resources Survey System
GDP	Gross Domestic Product
GOB	Government of Bangladesh
ICZMP	Integrated Coastal Zone Management Plan
IECs	Important Environmental Components
IEE	Initial Environmental Examination
IESCs	Identification of Important Environmental and Social Components
IHE	Institute of Hydraulic Engineering
ISSA	Inland Ship Safety Administration
IUCN	International Union for Conservation of Nature
LAP	Land Acquisition Plan
LARP	Land Acquisition and Resettlement Plan
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
MDG	Millennium Development Goal
MEP	Monitoring Environmental Plan
MoEF	Ministry of Environment and Forest
NGO	Non-Government Organizations
O&M	Operation & Maintenance
OPRC	Oil Pollution Preparedness Response and Cooperation
PIANC	Permanent International Association of Navigation Congresses
PPE	Personal Protective Equipment
QS	Questionnaire Survey
RAMSAR	The convention held in the city of Ramsar, Iran to conserve wetlands of international importance, especially waterfowl habitats.
RAP	Resettlement Action Plan
RRA	Rapid Rural Appraisal
RTWs	River Training Works
SP	Sea Port
TC	Total Coliform
TDS	Total Dissolved Solids

ToR	Terms of Reference
TSS	Total Suspended Solids
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
VOCs	Volatile Organic Compounds
WARPO	Water Resources Planning Organization
WQS	Water Quality Standards

Executive Summary

The summary and conclusions that may be drawn for the Environmental Impact Assessment are the following:

In the Dredging Area

1. The actions that require the greatest attention to be avoid negative effects on the environment are the development of activities performed with the dredge and barges, as well as the operation and maintenance thereof.
2. The presence of the dredge and the activities thereof will not cause a negative effect to the water quality, air, or flora and fauna of the area, if the adequate recommended measures are adopted. The most important beneficial effect is to promote the development of socioeconomic activities in the area.
3. The analysis of the physical and chemical characteristics of river water performed in the study area show acceptable values; include low levels of, which satisfy the values established for the criteria of sechedule 3 of water quality guideline of ECR 1997.
4. The results of the metal analyses of bottom sediments in the dredging area, show normal concentrations and, therefore, will not be a limiting factor in the handling and activities performed in the terminal, as well as in the removal resulting from the dredging.

Dredged Material Deposit Area

The area where dredged materials will be discharged from the barges is located northeast of the dredging area. The turbidity concentration will dissipate quickly as it precipitates to the bottom. The volume of sediments discharge will be insignificant in relation to the contribution from the Pussur Rivers.

In the dredged material deposit area, the result of benthos analysis show less biodiversity than in other analyzed areas.

Recommendations

The recommendations that may be drawn for the Environmental Impact Assessment are the following:

1. Periodic monitoring of the aquatic flora, fauna, air quality, noise measurement, turbidity in 3 levels and in 3 sampling locations, during the operations in the project area. Monitoring will be carried out during dredging, in order to determine the existence of changes in the aquatic environment.
2. The dredge must be inspected periodically to evaluate the operation of its equipment and constantly supervised that no change or unevenness occurs in the structure.
3. It is concluded to that the proposed dredging of the Pussur river can be implemented safely in an environmental friendly manner. Therefore, it is recommended that the proposed dredging project can be cleared to proceed with dredging activities.

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1 INTRODUCTION

1.1 Background

Bangladesh has been experiencing acute power shortage for a long time. In order to meet the increasing power demand, Bangladesh Power Development Board (BPDB) has planned to set up a new coal based power plant at the left bank of the Pussur River in Rampal Upzilla. In order to maintain a supply and distribution system of coal for their plant they need to build a jetty in the Pussur River.

On April 2013 an agreement was signed between Bangladesh and India on establishment of coal based thermal power plant. The necessary coal will be transported to the plant site at Rampal through Pussur river route from the sea coast at outer bar. According to the agreement Government of Bangladesh will maintain the safe navigability of the route for the coal bearing 7.5 m draft vessels. Hence, the government will be responsible to carry out capital dredging wherever necessary in Pussur river route from the Bay of Bengal cost to the plant jetty at Rampal. The required maintenance dredging in the future would be carried out under financing from the electricity generation authority. Every day three coal borne vessels having draft of 7.5 m will be plying along the route. In December 2014 Mongla Port Authority (MPA) has accomplished dredging in the harbor area of Pussur river and has ensured safe movement of 7.5 m draft vessels along Pussur river from Outer Bar up to Mongla port. However, at upstream of Mongla port, the river does not have sufficient depth for the vessels of 7.5 m draft. So, safe movement of coal borne vessels between Mongla Port and power plant site at Rampal requires detailed hydrological, morphological, social and environmental studies. This will enable identifying the right dredging alignment in consideration of water depth, dominant current direction, capital and maintenance dredging.

The focus of this Environmental Impact Assessment (EIA) report is the “Capital Dredging in Pussur River from Mongla Port to Rampal” (Figure 1). The main objective of this study is to identify definite alignments for dredging in Pussur River to achieve adequate depth for smooth and safe movement of vessel between Mongla and proposed Rampal coal terminal on the basis of hydrological, morphological, navigational and environmental considerations.

The specific objectives are:

- Selection of approach channel and dredging alignment considering available water depth, dominant current direction, capital and maintenance dredging;
- Carry out mathematical modelling on hydrodynamic and morphological process;
- Environmental Impact Assessment;
- Social Impact Assessment

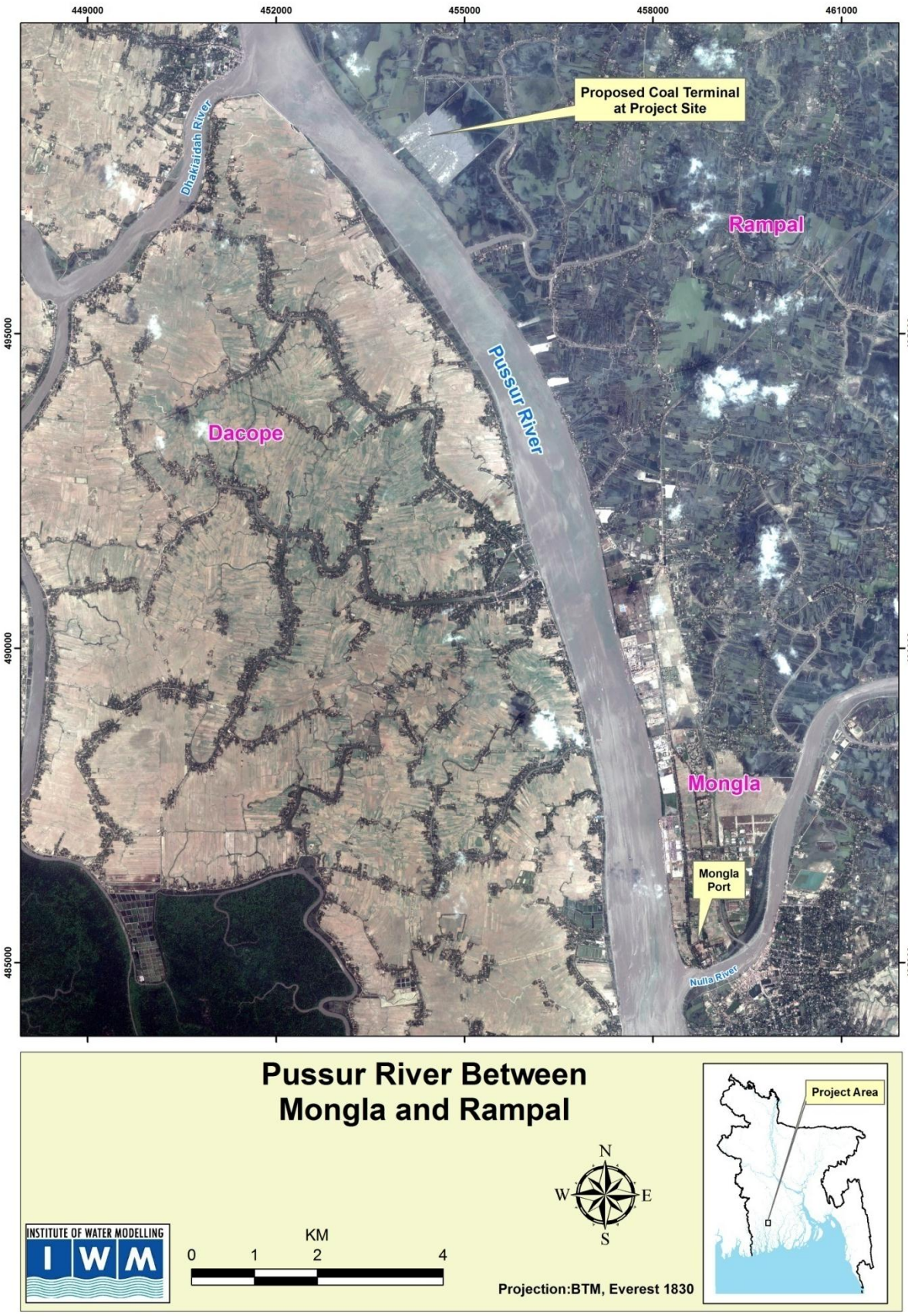


Figure 1: Location Map of the Dredging Project

1.2 Need for Project

In April 2013, an agreement was signed between Bangladesh and India on establishment of coal based thermal power plant in Rampal near Mongla Port. The necessary coal will be transported to the plant site at Rampal through Pussur river route from the sea coast at outer bar. According to the agreement Government of Bangladesh will maintain the safe navigability of the route for the coal borne 7.5 m draft vessels. Hence, the government will be responsible to carry out capital dredging wherever necessary in Pussur river route from the Bay of Bengal coast to the plant jetty at Rampal. Also, the proposed intervention will result in increased earnings of foreign currency for Port authority. There will be increased direct and indirect increased employment opportunities.

1.3 Scope of Environmental Assessment

According to the Terms of Reference (ToR) submitted to Mongla Port Authority in order to forward it to the Department of Environment on 08 June 2015, the following tasks were to be undertaken:

- Conduct field visit, reconnaissance survey and consultation with local stakeholders;
- Collect primary data on water resources, air and noise quality, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic condition through focus group discussion (FGD), rapid rural appraisal (RRA), participatory rural appraisal (PRA), questionnaire survey (QS) and other method for the establishment of baseline conditions of the Project;
- Identify important environmental and social components likely to be impacted by the proposed Project;
- Assess environmental and social impacts of the proposed interventions of the capital dredging in the designated areas of Pussur River;
- Conduct comprehensive public consultations; and
- Include in the environmental assessment report an environmental management plan (EMP) which includes a listing of mitigation table (EMiT) and monitoring table (EMoT) as well timing and responsibility.

1.4 Objectives of the EIA

The overall objective of the EIA is to ensure the implementation of the proposed dredging work in an environmentally sound and sustainable manner ensuing that all negative effects are mitigated as best as practical and positive impacts are enhanced. More specifically, the EIA aims to identify the likely potential impacts likely to be generated by the dredging Project; to quantify and where possible value these, providing Mongla Port Authority (MPA) with a set of actions it needs to implement in order to meet national environmental safeguard standards.

1.5 Methodology

1.5.1 Environmental Quality

Air Quality and Noise

Ambient Air Quality – A total of three air samples were collected from the vicinity of the Project area which is between Mongla Port and proposed Rampal jetty. The parameters were measured in the field using the Environmental Perimeter Air Sampler (EPAS) (model

haz-Scanner). EPAS - portable air quality analyzer - using an automated air sampling sensor array system, measures seven parameters (CO, NO_2, SO_2, O_3, PM_{10}, and $PM_{2.5}$) as well as air temperature, and humidity.

Photo 1: EPAS in Operation, including Sound Meter

Photo 2: Environmental Perimeter Air Sampler

Figure 2 Ambient Air Quality and Noise Level Measurement at the Project Site

Measurements were recorded continuously using a battery-operated instrument, Environmental Perimeter Air Sampler (EPAS) (Figure 2), sampling for one to five minutes repeatedly over a one-hour sample period.

Noise Measurements - Noise level was measured at three locations, same locations of air quality samples, along the corridor during the day time (0600-2100)[1]. Measurements were taken using a SPER Scientific Sound metre[2], connected to the EPAS data recorder Daytime noise was recorded for one hour period. Ambient noise was measured using the EPAS's electronics allowing the selection of the number of sound reading and the readings per interval and measurement duration for this Project. Sampling locations are selected based on the presence of noise sensitive areas. Using these data, average daytime values were generated, and used in this report. The sampling locations of air and noise are shown in Annex 2.

Riverbed Sediment Quality

Riverbed sediment materials (mainly sand) in a significant quantity will be required to be dredged during construction process. Total quantities of dredged materials are estimated over 3.8 Mm^3. Some of the dredged material will be used for filling the nearby low land areas to be used as commercial purpose in future.

Samples of riverbed materials were collected from three locations along probable dredged alignment of the Pussur River in 25 July, 2015 and 27 July, 2015. The riverbed sediment material samples were sent to the BUET for laboratory analysis to know the concentration of heavy metals presents in the proposed dredging locations. The parameters of the heavy metals were zinc (Zn), cupper (Cu), mercury (Hg), lead (Pb), cadmium (Cd), and arsenic (As), Salinity, and electrical conductivity (EC). The sampling locations are shown in Annex 2.

1.5.2 Surface Water Quality

Surface water sampling has not been conducted under this environmental assessment as adequate data was obtained from the literature review. These water quality test results have been analyzed to assess the baseline conditions of the environment. The water quality test

[1] If a night reading exceeded the GoB standard additional readings were taken to identify the dividing line between compliant and non-compliant noise readings

[2] Sper-Scientific Brand, Type 2 (IEC651 Type 2, ANSI s1.4 Type 2); range 30 - 130 dBA sound recording metre

results are mostly collected from the EIA reports of Rampal Power Plant, Dredging on Outer Bar Area of MPA and Dredging of Harbor Area of MPA.

1.5.3 Biological Survey

A brief terrestrial and aquatic ecological survey was conducted in the Project corridor of impact to determine the extent, species composition and living condition of existing vegetation communities, wildlife, threatened and protected flora and fauna, and important habitat for local migratory species. In addition, benthos samples were collected from three locations along probable dredged alignment of the Pussur River on 25 July, 2015 and 27 July, 2015. The samples were sent to the Zoology Department of Dhaka University for counting and also to assess the water quality monitoring requirement during dredging. The benthos of Pussur River (freshwater invertebrates) plays several important roles in aquatic ecosystem of the River. They are instrumental in cleaning excess living and nonliving organic material from River water column, a service that contributes to the overall quality of the Pussur River resources. Water quality degradation of the Pussur River due to any reasons adversely impacts the health of these aquatic communities including fish and invertebrates.

1.5.4 Disposal Area Survey for the Spoil Materials

Field work was carried out during 03-04 July 2015. During the field survey potential sites for dumping dredged spoil were looked into. Informal discussions were held with the local people, Mongla Port Authority, and with the representative of Bangladesh India Friendship Coal Power Company and Orion Group. A number of locations proximate to the dredging alignment have been surveyed to identify suitable spoil materials disposal area. IWM selected three possible disposal areas. These locations were surveyed by the environmental, ecology, and social specialists of IWM to assess the baseline conditions, possible impacts and relevant mitigation measures.

1.5.5 Public Consultation

Public consultation in a form of Focus Group Discussion (FGD) sessions were completed in June and July 2015 at five locations along the corridor. The purpose of the consultation was to disclose the Project and its proposed EMP and take opinion from stakeholders. The comments and suggestions of the stakeholders has been incorporated in the EIA report and its EMP. One-on-one as well as group discussions were held to record the perception of the proposed work by the local communities and to seek their support, cooperation with suggestions on how to reduce any potential impacts to the community, the local landscape, the agriculture, and the environment.

1.6 Environmental Classification of Project

Although the dredging Project is not listed in any categories of Environmental Conservation Rules (1997) of Department of Environment, this Project is classified as red category project in accordance with the requirements of the Department of Environment (DoE), Ministry of Environment and Forests, Government of Bangladesh and requires a full EIA. The 69 types of projects listed as red category in the Environmental Conservation Rules 1997 includes engineering works where the capital investment is more than 1 million Taka. The Project investment is more than 1 million taka, and hence is a red category Project.

1.7 Limitation

This EIA is prepared based on past experience on similar types of activities as well as field investigation and public consultations carried out in connection with the Project. Proposed dredging activity has not yet started. As such all the anticipated impacts could not be fully comprehended at this pre-dredging stage. However, attempts were made to identify most of the potential impacts both positive and negative due to the dredging operation within limited time periods.

1.8 EIA Team

The study team has been formed having their areas of expertise in the related field. The positions are assigned to each team members accordingly in order to accomplish the work smoothly and timely. The team composition is shown in Table 1.

Table 1: Name and Position of the Study Team Members

Sl.	Name of the Study Team Members	Position
1	Zahirul Haque Khan	Team Leader
2	Mehedi Hasan	Environmental Specialist
3	Mustafizur Rahman	Social Specialist
4	Dr. S.M.A. Rashid	Ecology Specialist
5	Tarek Bin Hossain, PEng	Coastal Morphologist
6	Md. Manirul Haque	GIS Specialist

2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 General

The proposed interventions to improve navigability must comply with the relevant legislation and planning requirements of the Government of Bangladesh, as established and/or administered by the Ministry of Environment and Forest (MoEF) and Department of Environment (DoE) and other national and local jurisdictions. The policy, strategy and regulatory issues are extremely important for any project proponent or developer, before they physically go for execution of any program or plan. The proponent is to be well aware about these requirements and is supposed to comply with the provisions as applicable and necessary. The following sections review the relevant national legislative, regulatory and policy instruments and bring out the concerned aspects of these to the notice of the proponent for their awareness, education, cognizance and compliance and also for any reviewer of the document for environmental clearance.

2.1.1 Environmental Policy, Regulations and Guidelines of the Government of Bangladesh (GoB)

National Environmental Policy, 1992

Bangladesh National Environmental Policy 1992 was approved in May, 1992 and sets out the basic framework for environmental action, together with a set of broad sectorial action guidelines. The main Policy requirements related to the water sector are to ensure environmentally sound utilization of resources; so that developments do not create any significant adverse impacts on the environment; and that all water bodies and water resources are kept free from pollution. Key elements of the policy are:

- Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment;
- Protection of the country against natural disasters;
- Identification and regulation of all types of activities, which pollute and degrade the environment;
- Ensuring sustainable utilization of all natural resources, and
- Active association with all environment-related international initiatives.

Policies of fifteen sectors are described in the Environmental Policy and there is an Environmental Action Plan attached to the Policy as an integral part of the Policy. Under ‘Land’ section of the Policy (section 3.6) the relevant clauses, which could be of relevance for the project, are as follows:

- Prevent land erosion, preserve and increase soil fertility, and expand activities for conservation and environmentally sound management of newly accreted land.
- Encourage land use systems compatible with various ecosystems.
- Prevent spread of salinity and alkalinity on land.

Section 3.7 "Forest, Wildlife and Bio diversity" of the same Policy requires:

- Stop shrinkage and depletion of forest land and forest resources;
- Conserve, expand and develop forest to sustain the ecological balance and meet the socioeconomic needs and realities;
- Include tree plantation programs in all relevant development schemes;

- Conserve Wildlife and Bio diversity, strengthen related research and help dissemination and exchange of knowledge in these areas, and
- Conserve and develop wetlands and protection of migratory birds.

Under Environmental Action Plan Section of the Policy, under sub section 'Forest, wildlife and biodiversity', it suggests that:

- Priority will be given to the protection of wildlife, wetlands, birds and animals;
- Steps will be taken to protect present forest resources, prevent deforestation and affect extensive afforestation;
- Growing more trees and enriching forest resources in the rural areas will be given priority through extensive implementation of social forestry and homestead forestry;
- Development projects in all sectors will incorporate and implement the government decision of afforestation, and
- Alternative building materials and fuel sources instead of wood and import of wood will be encouraged.

Section 5 "Institutional arrangement" requires:

- Department of Environment will review and approve all environmental Impact Assessments.

Under Environmental Action Plan Section of the Policy, under sub section 'Legal Framework', it suggests that:

- Concerned ministries will ensure that proposed legislations are environmentally compatible.

The Environmental Policy of 1992, which amongst other policies, seeks to ensure that transport systems, including roads and inland waterways, do not pollute the environment or degrade resources. The Policy states that Environmental Impact Assessments (EIA) should be conducted before projects are undertaken.

National Water Policy

Water resource management is a critical issue for the country because of recurrent floods in the monsoon and drought in the dry season, massive river sedimentation and bank erosion, pollution of surface and ground water and increasing demand of water by the growing economy and population.

The National water policy (2001) was passed to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It has also addressed issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation and water need for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands etc.

The goal of the policy is to provide policy guidance to all the agencies involved in the water sector. There are six specific objectives of the policy which cover a wide range of aspects. The policy puts a lot of emphasis on water resource planning and management and GO-NGO integration. There are separate policy sections on 'Water and industry', 'Water and agriculture', 'Water and river transport', 'Water for recreation and hydro power, 'Water supply

and health '. There are three specific sections on 'Water, fisheries and wildlife', 'Water for environment', 'Conservation and development of haors, baor and Beels'.

The Policy also advocates people's participation in water resource management and People's participation in water development projects is recognized as an essential part of project planning process. This provision of the policy would facilitate the formation of water user groups and community based organizations.

National Environmental Management Action Plan (NEMAP), 1996

The National Environmental Management Action Plan (NEMAP) is a wide-ranging and multi-faceted plan which builds on and extends the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005, and set out of the framework within which the recommendations of the National Environmental Policy were to be implemented. It identified four broad objectives and remains highly relevant today. The four key environmental management directions specified were:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation of the natural environment ;
- Sustainable resource use and the conservation of habitats and biodiversity; and,
- Improvement of the quality of life of the people.

National Water Management Plan 2001 (Approved in 2004)

The National Water Resources Council approved on March 31, 2004 a 25-year National Water Management Plan. The plan provides a framework within which all concerned with the development, management and use of water resources water services in Bangladesh can plan and implement their own activities in a coordinated and integrated manner. The planned activity programs have been presented in the eight sub-sectorial clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of a number of individual programs, with overall a total of 84 sub-sectorial programs identified and presented in the investment portfolio. It will be implemented in three phases. It was approved at the seventh meeting of the National Water Resources Council. It calls for a coordinated approach of concerned ministries and departments to stop water-logging and to incorporate the issues of arsenic mitigation, river administration, and dredging and fisheries resources. To mitigate the environmental risks of water sector project development, the plan suggested for a holistic view, which includes the environment itself as an important water sector stakeholder with an entire cluster of programs devoted to it. Furthermore, programs within the environment cluster are strategically timed in order that public awareness raising, the establishment and enforcement of regulatory mechanisms and long term planning are addressed as priority. Water Resources Planning Organization (WARPO) was assigned to monitor the national water management plan.

Coastal Zone Policy, 2005

Coastal zone policy initiated as a harmonized policy that transcends beyond sectorial perspectives. The policy provides general guidance so that the coastal people can pursue their livelihoods under secured conditions in a sustainable manner without impairing the

integrity of the natural environment. The policy framework underscores sustainable management of natural resources like inland fisheries & shrimp, marine fisheries, marine fisheries, mangrove and other forests, land, livestock, salt, minerals, sources of renewable energy like tide, wind and solar energy. It also emphasis on conservation and enhancement of critical ecosystem- necessary measures will be taken to conserve and develop aquatic and terrestrial including all the ecosystems of importance identified by the Bangladesh National Conservation Strategy (Mangrove, coral reef, tidal wetland, sea grass bed, barrier island, estuary, closed water body, etc.).

Coastal Development Strategy, 2006

Coastal Development Strategy has been approved by the Inter-Ministerial Steering Committee on ICZMP on February 13, 2006. The strategy is based on the Coastal Zone Policy and takes into account the emerging trends: increasing urbanization, changing pattern of land use, declining land and water resources, unemployment and visible climate change impacts. The strategy has 9 strategic priorities and the following 3 are relevant priorities with proposed type of interventions:

- Safety from man-made and natural hazards - i) Strengthening and rehabilitation of sea dykes; and ii) reduction of severe vulnerability in the coastal zone through multi-purpose cyclone shelters-including coping mechanism.
- Sustainable management of natural resources - i) environmentally and socially responsive shrimp farming; ii) introduction of renewable energy in coastal areas; and iii) development of marine fisheries and livelihood.

Environmental conservation – i) Marine and coastal environmental development; ii) strengthening of Coast Guard for improvement of coastal safety and security in coordination with other law enforcing agencies.

National Fisheries Policy, 1996

The National Fisheries Policy, 1996 recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy suggests following actions:

- Shrimp and fish culture will not he expanded to the areas which damage mangrove forest in the coastal region
- Biodiversity will be maintained in all natural water bodies and in marine environment
- Chemicals harmful to the environment will not be used fish shrimp farms
- Environment friendly fish shrimp culture technology will be used
- Control measures will be taken against activities that have a negative impact on fisheries, resources and vice-versa
- Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

The Mongla Port Authority Ordinance 1976 and The Mongla Port Authority (Amendment) Ordinance 1982 & 1987

The Mongla Port Authority Ordinance 1976 and The Mongla Port Authority (Amendment) Ordinance 1982 & 1987 which establishes the role, powers and function of the Port of Mongla as an Authority, but contains no environmental controls.

The Mongla Port Authority (Amendment) Act 1995

Section 41A of this Act states " Penalty for pollution etc.- Any person who throws or allows to fall into the water, shore, bank or land within the limits of the Port any goods, ballast, ashes or any other thing whatsoever causing pollution of the water or environment shall be punishable with fine which may extend to one lakh Taka."

Inland Shipping Ordinance 1976 and Inland Shipping (Amendment) Act 1990

Inland Shipping Ordinance 1976 and Inland Shipping (Amendment) Act 1990 deals with the administration, registration, competency and so on of inland water transport. The parent law will be amended to contain a substituted chapter heading:

- Chapter V: Protection of Vessels and Passengers and Environment with insertion of a new section:
- 57B. Prevention of Pollution

No person shall, by discharge from inland ship or inland-ship facility or inland-ship activity cause pollution of inland water.

The Environment Conservation Act, 1995 (Amended 2010)

Environment Conservation Act 1995 (ECA '95) is currently the main legislation relating to environment protection in Bangladesh. This Act of 1995 is officially the 'Bangladesh Environment Conservation Act 1995' promulgated for environment conservation, environmental standard development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance 1977. The main objectives of ECA '95 are:

- Conservation and improvement of environment, and
- Control and mitigation of pollution of environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operation and process, which can or cannot be carried/initiated in the ecologically critical areas.
- Regulation in respect of vehicles emitting smoke harmful for the environment.
- Environmental clearance.
- Regulation of the industries and other development activities' discharge permit.
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes.
- Promulgation of standard limit for discharging and emitting waste and,
- Formulation and declaration of environmental guidelines.

The Department of Environment (DOE) is executing the Act. A Director General (DG) heads DOE. The power of the DG, as given in the Act, may be outlined as follows:

- Identification of different types and causes of environmental degradation and pollution.
- Instigating the investigation and research into information regarding environment conservation, development and pollution.
- Power to close down the activities considered harmful to human life or the environment. The operator does have the right to appeal and procedures are in place for this. However, if the incident is considered an emergency, there is no opportunity for appeal.
- Power to declare an area affected by pollution as an ecologically critical area. DOE governs the type of work or process, which can take in such an area.

- Similar to an aforementioned clause, if any part of the environment is polluted /damaged by operations, the Director General can request or force the operator to make rectifying arrangements.
- Operators must inform the Director General of any pollution incident.
- Before new project can go ahead as stipulated under the rules, they must obtain an Environment Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance.

Failure to comply with any part of this Act may result in punishment by a maximum of 5 years imprisonment or a maximum fine of Tk.100, 000 or both.

Environment Conservation Rules, 1997 (Amended 2005)

Environment Conservation Rules (ECR) 1997 has provided categorization of industries and projects and identified types of Environment assessments needed against respective category of industries or projects. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) requirement for and procedures to obtain environment clearance (iii) requirement for IEE/EIA according to categories of industrial and other development interventions.

In the ECR 1997, there is a section on ecologically critical area. This is Section 3, 'Declaration of ecologically critical area' and reads, "(1) The Government will take the following into consideration in order to declare any area as Ecologically Critical area vide Section 5(1) of the Act (ECA 1995):

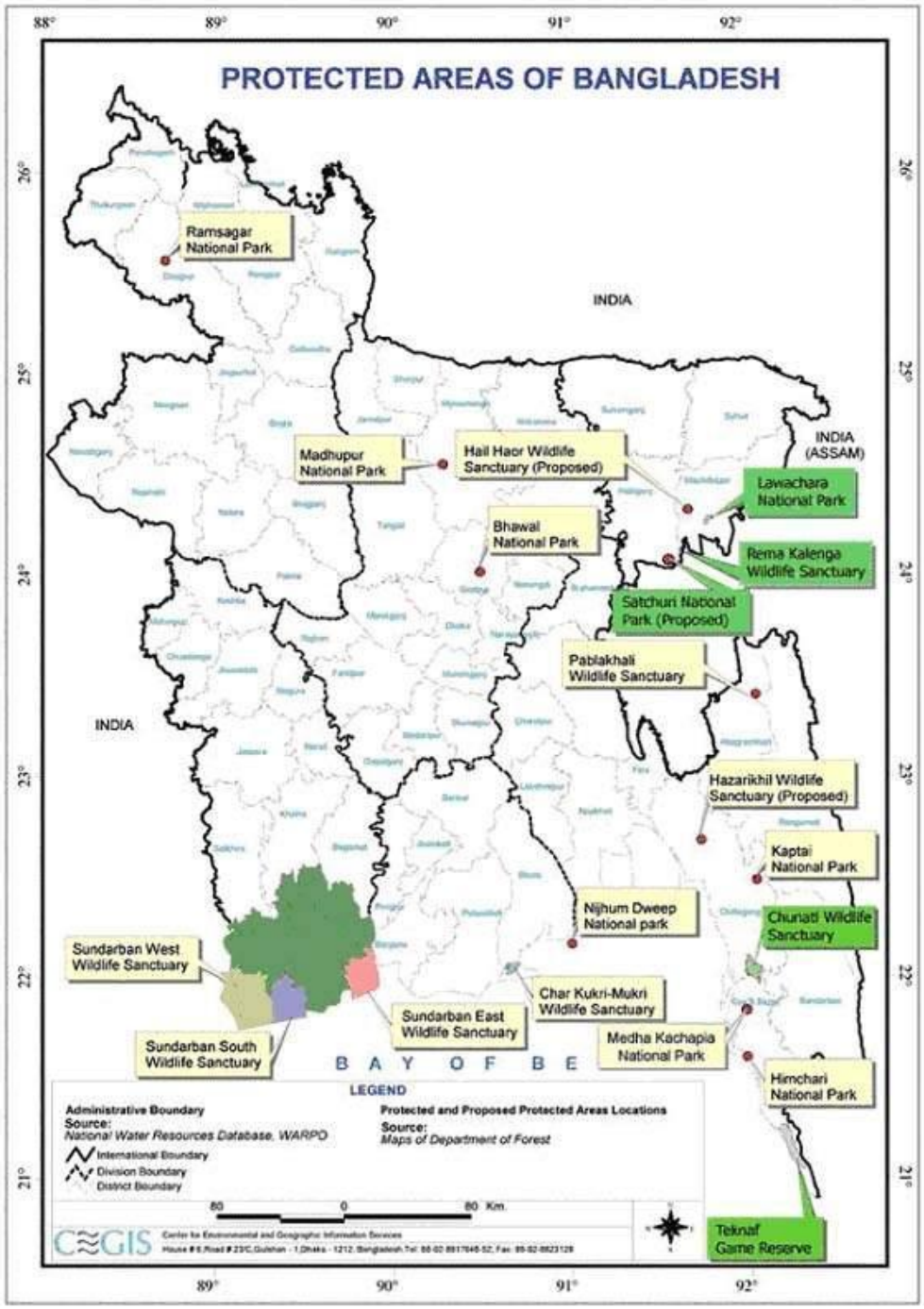
- Human settlement
- Ancient monument
- Archaeological site
- Forest sanctuary
- National Park
- Game reserve
- Wildlife habitat
- Wetland
- Mangrove
- Forest area
- Biodiversity area
- Similar other areas.

Figure 3 and Table 2 present map and list of protected areas of Bangladesh respectively. The activities or processes which cannot be continued or initiated in Ecologically Critical area shall be specified by the Government as per standards described in following Rules 12 and 13 of the ECR '97)"

According to the rules, any project/development intervention of the Red Category is to obtain environmental clearance in two steps - first to obtain site/location clearance (based on the application along with necessary papers, including the Initial Environmental Examination (IEE) which will contain the scope of work of the proposed EIA, if required, and then to obtain Environmental clearance (by submitting the application along with necessary papers including the EIA). The Department of Environment may take up to sixty days to issue the

site clearance (from the date of receiving the application), sixty days to approve the EIA and thirty more days to issue the Environmental Clearance, provided everything goes well.

This may be quite a lengthy process if DOE uses the full extent of the time limits. The rules however provide the Director General a discretionary authority to grant Environmental Clearance' to an applicant exempting the requirement of site/location clearance, provided he considers it appropriate. [Section 7(4), 2nd Paragraph, Page 3105 of the Bangladesh Gazette of 27 August 1997].



Source: Department of Forest

Figure 3: Protected Areas of Bangladesh

Table 2 Notified & Protected Areas of Bangladesh

Sl	Notified & Protected Area	Location	Area (ha)	Established
A	**National Parks, Reserve Forest**			
1	Bhawal	Gazipur	5,022	1974 / 1982
2	Modhupur	Tangail / Mymensingh	8,436	1962 / 1982
3	Ramsagar	Dinajpur	27.75	2001
4	Himchari	Cox"s Bazar	1,729	1980
5	Lawachara	Moulavibazar	1,250	1996
6	Kaptai	Chittagong Hill Tracts	5,464	1999
7	Nijhum Dweep	Noakhali	16352.23	2001
8	Medha Kassapia	Cox"s Bazar	395.92	2004
B	**Wildlife Sanctuaries**			
9	Rema-Kelenga	Hobiganj	1795.54	1996
10	Char Kukri-Mukri	Bhola	40	1981
11	Sundarban (East)	Bagerhat	31226.94	1960/1996
12	Sundarban (West)	Satkhira	71502.10	1996
13	Sundarban (South)	Khulna	36970.45	1996
14	Pablakhali	Chittagong	42087	1962/1983
15	Chunati	Chittagong	7761	1986
C	**Game Reserve**			
16	Teknaf	Cox"s Bazar	11615	1983

The EIA Guidelines for Industry (1997)

The EIA Guidelines is a handbook defining procedures for preparing EIAs and for reviewing them, prepared for the benefit of the development partners, EIA consultants, reviewers, and academicians. The Guidelines provide a step-by-step methodology for the completion of EIAs, following slightly more general ECR 1997 and its subsequent amendments 2002, 2003, and 2010).

2.1.2 Relevant International Conventions, Treaties and Protocols (ICTPs)

Bangladesh is a party to a large number of international conventions; treaties and protocols (ICTPs) related to the Project and is committed to insuring that these protocols are complied with during all development work. The five applicable ICTPs (**Table 3**) complying with are:

Table 3: International Conventions, Treaties and Protocols Signed by Bangladesh

Conventions	Signed	Ratified/Accessed (AC)/Accepted(AT)	Relevance
International Plant Protection Convention (Rome, 1951) and Plant Protection Agreement for SE Asia and Pacific (1999 Revision)		01.09.1978 04.12.'74 (AC)	Ensuring that Project work or construction materials , do not introduce plant pests
Convention on Wetlands of International Importance ("Ramsar Convention":1971		20.04.1992 (ratified)	Protection of significant wetland and prevention of draining or filling during construction

Conventions	Signed	Ratified/Accessed (AC)/Accepted(AT)	Relevance
Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972)		03.08.1983 (AT) 03.11.83 (ratified)	Prevention of damage or destruction of culturally and/or historically significant sites, monuments, etc.
Convention on Biological Diversity, (Rio de Janeiro, 1992.)	05.06.1992	03.05.1994	Protection of biodiversity during construction and op.
Convention on Persistent Organic Pollutants, Stockholm.	23.05.2001	In process	Restrict use of pesticides and herbicides along rail lines

Source: footnote [3]

World Heritage Sites and Ramsar

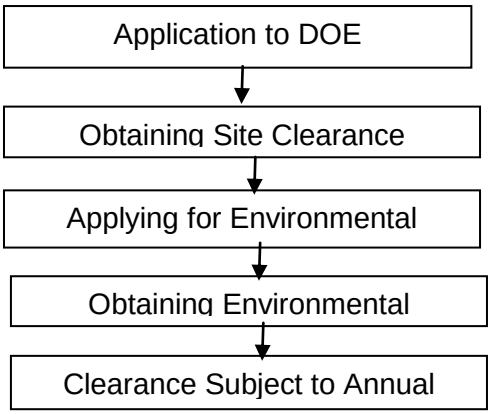
There are sites within the project area that are part of the World Heritage sites within the Sundarbans. The three seaward sanctuaries within the Sundarban form the World Heritage site. These sites are regarded as being of the highest importance for Biodiversity Protection within the Sundarban Reserve Forest despite the concerns raised about their representativeness (Saunders, 2000). RAMSAR signatories agree to protect important wetland systems and their functionality. The Sundarban is recognized as a RAMSAR site and as such the GoB has committed to "the conservation and wise use of wetlands by national action and international co-operation as a means to achieving sustainable development"

2.1.3 GoB Environmental Clearance and Public Consultation Procedure

Legislative bases for EIA in Bangladesh are the ECA 1995 and the ECR 1997. DOE is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an EIA of development proposal, the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) rests on DOE. The improvement of Mongla Port area by dredging will follow the procedures for Red Category, which includes submission of:

- An Initial Environmental Examination (IEE); An Environmental Impact Assessment (EIA) with an Environmental Management Plan (EMP);
- Environment clearance has to be obtained by the MPA from DoE. The environmental clearance procedure can be summarized as follows for Red category projects:

[3] MoEF, 2013. Convention & treaties. [Online] Available at: http://www.moef.gov.bd/html/protocol/protocol_main.html[Accessed 03 12 2014].



Public participation/consultation during the EIA process is not a condition in the Act, the ECR 1997, or EIA Guidelines; it is, however a mandatory requirement of the Terms of Reference of IWM obtained from MPA. Therefore, public consultation programme is considered as a mandatory task and is included in the environmental assessment report.

3 DESCRIPTION OF THE PROJECT ACTIVITIES

3.1 General

According to the objectives, the study area covers about 13 km navigation route of Pussur River from Mongla to coal based Power Plant site at Rampal. The Rampal power station is a proposed 1320 megawatt coal-fired power station located at Rampal Upazila of Bagerhat District and 13 km upstream of Mongla Port. Mongla Port is situated on the east bank of Pussur River about 131 km upstream from the fairway buoy. Figure 4 shows the study area of Pussur River. The improvement proposals at Mongla port include safe movement of vessels of 7.5 m draft in Pussur River from Mongla Port to the proposed coal terminal at Rampal. This requires dredging in around 13 km reach of the river.

3.2 Activities Involved in Dredging

The typical activities involved in dredging are as follows.

- Site Preparation
- Cutting
- Extraction
- Suction
- Transportation
- Disposal

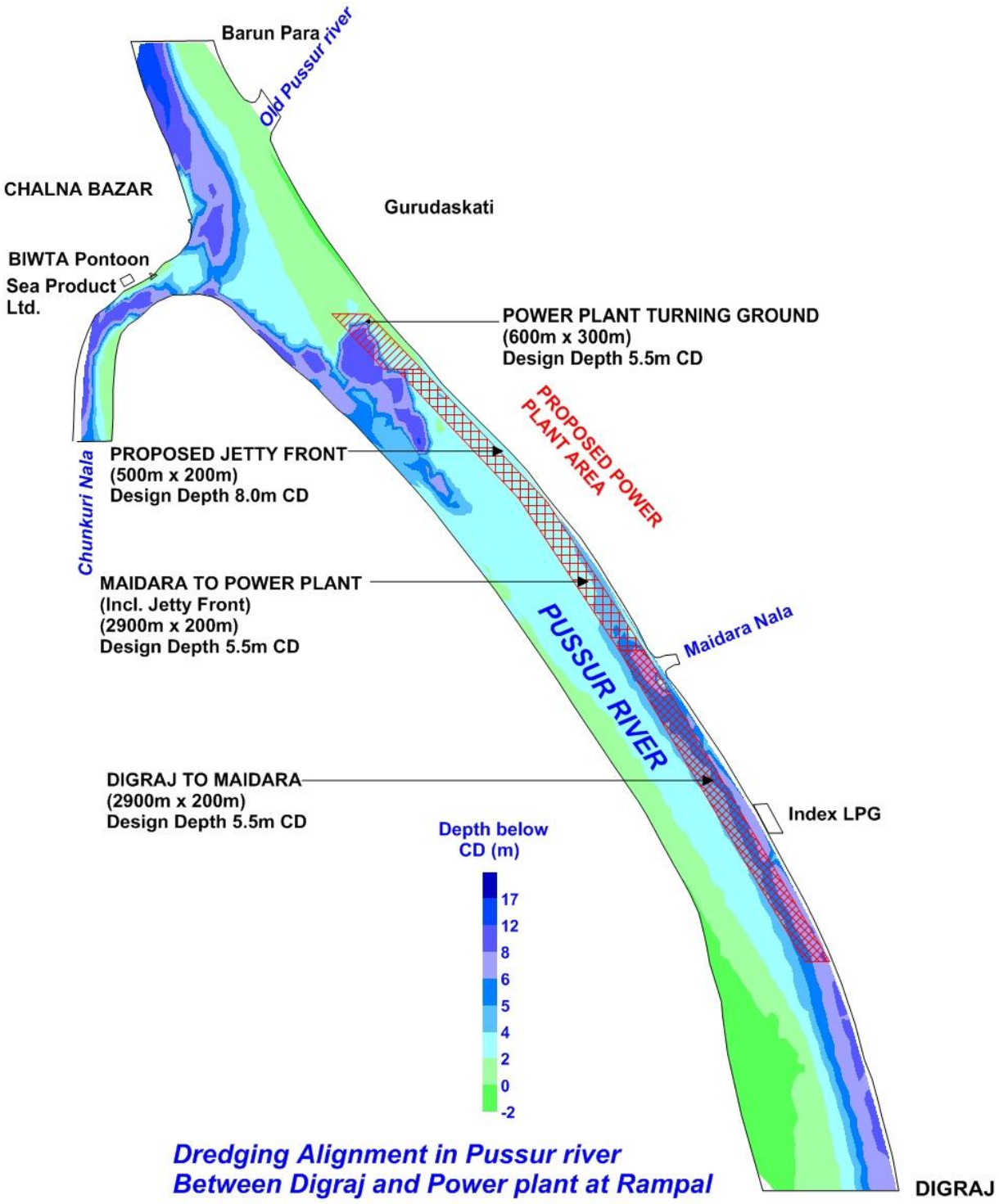


Figure 4 Dredging Location and Alignment

3.3 Project Boundaries

The impact assessment was confined to general legal right of way, which is 100 m either side of the proposed dredging area. However, these distances were adjusted in relation to sensitive receptors where excessive noise was predicted. For these areas the boundary widened to include an examination of possible effects outside the 100 m boundary. Table 4 shows the summary of the EIA boundary condition.

Table 4: Environmental Impact Assessment Boundaries

Component	Definition	Boundary
General Right of Way	Entire width of the Pussur River	Over 2000 m
Air Quality	Along the proposed dredging alignment	100 m
Noise: the boundaries for noise measurements will be a bit more tricky since noise is relevant when it impacts a sensitive receptor	a) the nearest sensitive receptor (record distance);	Distance to be measured from source to receptor, and noise measurement taken
Terrestrial Ecosystem	Can be exceptions if conditions warrant	50 m on either side of the proposed alignment
Aquatic Ecosystem	Can be exceptions if conditions warrant	50 m on either side of the proposed alignment
Sensitive protected Environmental components	E.g. wetlands, special habitat, large river crossings.	1 km on either side of the proposed alignment
Source: Designed by Environment Specialist of IWM		

3.4 Dredging Plan

3.4.1 Selection of Suitable Alignment and Dredging

Dredging in tidal channel of Pussur River with minimum siltation rate is principally based on the ebb and flood flow characteristics and recent bathymetric data. The deepest channel alignment from MPA hydrographic chart of 2013 and flow data are the basis of finalizing the dredging alignment in Pussur River between Digraj and Proposed power plant area. Following the finalized alignment and utilizing the hydrographic survey data of 2013, MPA has quantified the required volume for dredging. However, the proposed dredging alignment and the dredging quantity will be verified and finalized before the dredging is started through hydrographic survey.

Other factors such as current direction, tide, erosion-deposition pattern, navigational depth and width of the channel, required capital and maintenance dredging will also be taken into consideration while finalizing the dredging alignment. The dominant flow direction and available deeper channel are the basis of selecting the best suitable navigational route. If the tidal current is parallel of the dredged channel then backfilling rate is less and the cross current accelerates the sedimentation rate in the dredged channel.

The main principle to maintain deep channel is concentrating tidal energy in the dredged channel to reduce the back filling rate. In order to obtain full benefit of ebb and flood tide energies, velocity field both in high and low tides would be analyzed covering neap and spring period for dry and monsoon seasons using the results of hydrodynamic model of the

Pussur River. To keep the navigational channel sustainable and to minimize maintenance dredging, effectiveness of various dredging alignment would be assessed.

The effectiveness of various options/scenarios will be assessed applying available knowledge and using scientifically based mathematical models. The available models will be applied to assess the tidal characteristics, minimum available navigation depth during lowest spring tide level, the re-siltation or backfilling rate in the dredged channel and over all morphological changes in the Pussur Channel.

From hydro-morphological point of view, the dredged profile needs to be stable with sufficient conveyance capacity. Thus the shape and the dimension of the proposed dredged section would be finalized from model tests with various options. However, the dimensions of dredging alignment as required by MPA are summarized in Table 5.

Table 5 Dimensions of Dredging Alignment

Sl No	Required dredging area	Required Length (m)	Required Width (m)	Design Profile (Below CD in m)
A	Power plant turning Ground	600	300	5.5
B	Jetty Front	500	200	8.0
C	Maidara to Power Plant	2400	200	5.5
D	Digraj to Maidara	2900	200	5.5

The main objective of dredging in the access channel between Mongla port and Power plant site at Rampal is to ensure safe movement of vessels having draft up to 7.5 m during high tide.

3.4.2 Selection of Suitable Location for Disposal of Dredged Spoil

One of the main challenges of dredging program is disposal of dredged spoil, which requires technical, environmental and social considerations. The dredged spoil is, in principle, disposed on the locations where natural sedimentation may not be expected and there is no scope of re-suspension of dredged spoil into the dredged channel. Generally these locations are the inner bends, abandoned channels and along the shoals.

In the proposed dredging project, IWM conducted a detailed site reconnaissance survey around the Project area to identify possible soil disposal locations. The consultants of IWM also discussed this issue with several senior officials of MPA, BIFCL, and Orion Group. The consultants also conducted socio-economic survey around the Project area where local people proposed few suitable spoil dumping areas. All these locations are primarily government acquired land and or private lands interested to fill their sites. These potential areas are near dredging site along both banks of Pussur River. This will provide the baseline status of the existing compartments for dumping dredged spoil. The survey result shows that more than 85 million cubic meter of dredged spoil could be accommodated in the undeveloped areas of Rampal Thermal Power plant and Orion group which is more than sufficient for the expected dredged volume (3.41 Mm^3). It has been evident from the field investigation and key informant interviews that individual land owners along the left bank of the Pussur River are also interested to allow dumping of spoils on their lands for the development of their lands. Figure 5 shows all five possible disposal sites with photos.

Figure 5 Map Showing Locations of Spoil Dumping Areas

3.4.3 Dredging Activities and Soil Erosion

The site for the berths in MP on the left bank of the Pussur River was selected in 1964. At that time the depths of the Pussur River at that location were satisfactory for average 8.5m draft ships. But since 1970 the depths in this area started to deteriorate rapidly. When the construction of the berth was completed in 1978 the depth in the area had already been reduced significantly. Since then regular maintenance dredging has been required to provide sufficient depth alongside the berths in the approaches to the berths and in the Southern Anchorage areas. This deterioration is mainly due to significant reduction of tidal flow in the Pussur River. Thus dredging activities has become a common measure at the Pussur River to bring larger vessels.

It can be seen that the dredging activities had primarily led to the loss of soil stability at the jetty front. Based on previous studies conducted by IWM, it was noted that there is soil slippage at the wharf front resulting in reduction of the draft alongside the jetty. The investigation at the MP site shows the loss of stability of soil arising due to the following reasons:

- Soil Erosion due to flow of the river
- Wave Action
- Propeller action of the ship

GMAPS (2011) has conducted various studies on Mongla port facilities and on navigability of Pussur River where options for improvements in riverbank slopes at the jetty front were included. Both studies stressed the requirement of extensive capital expenditure including dredging. The additional revenue generated from the additional cargo volumes and vessels will balance the capital expenditure.

3.4.4 Use of Dredging Equipment and Capacity

For the proposed dredging operation both Trail Hopper Suction and Cutter Suction type dredger will be used with 750 mm discharge diameter. The dredger will be fitted with accessories such as 750 mm diameter shore pipes and floating pipes made of mild steel. Length of pipe will be about 3000 m to facilitate dumping of spoil materials at the designated locations as shown in Figure 4. Average fuel consumption per cubic meter dredging will be one liter. Capacity of the dredger will be 1000 to 1500 cubic meter dredging per hour. As per document, the dredgers proposed for the work will not be more than 10 years old.

3.4.5 Classification of Dredgers

There are basically three types of Dredges: Mechanical, Hydraulic and Pneumatic. In the proposed Project, MPA will use the hydraulic dredgers. Hydraulic dredges may be of pure suction, are efficient in dredging loose granular material and are characterized because the extraction and transportation process directly depends on inducing a water flow through the use of hydraulic pumps, disintegrating the material on the basis of its erosive capacity. Another type of hydraulic dredges is those equipped with a cutting head adjacent to the suction mouth. In this way, the material is removed or cut, making it fit for hydraulic transportation. MPA will use both trail hopper suction and cutter suction dredger for the proposed Project.

Trail Hopper Suction Dredger

This dredge operates navigating; it has a dredging pump and a suction pipe with an adequate head that moves when it comes in contact with the bottom in the dredging area, aspiring a mixture of water and materials to the pump, from where it is driven to the dredge's hopper. Once it is full, the dredge travels at full speed to the discharge area in deep waters, where the bottom doors of the hopper open and the dredged material is discharged. These dredges are adequate for maintenance and improvement work, in docks and access roads to ports, where the traffic will probably not allow the use of stationary dredges.

Cutter Suction Type Dredger

This dredge basically consists of a centrifugal dredging pump, with a suction pipe that reaches the excavation area where it has been equipped with cutting head (rotary blade). This blade cuts the material which is later aspired by the dredging pump, transported to the stern of the ship and taken to the discharge area through a flow line. This Dredge is the most versatile of all and is the one most widely used.

These Dredges can efficiently excavate and pump any type of alluvial material, such as compact deposits of clay and peat. Large and more powerful equipment is used to dredge coral reefs and softer types of basalt and limestone, without the need of prior blasting.

3.4.6 Volumes and Types of Sediments to be Dredged

In this option the dredging alignment is selected alone the thalweg line to minimize the capital dredging volume and shortening of navigation length. This option requires dredging of 2,900 m of Pussur River along the thalweg from Digraj to Maidara and 2400 m from Midara to Jetty front with dredging level at 5.5m CD. The dredging width is 200 m for both the river stretches. The dredged level is at 8m CD along proposed jetty front for a length of 500 m. The remaining dredging is 500 m length at the turning ground having width 300 m and depth 5.5 m CD. In this option the thalweg line is close to the river bank. The dominant flow direction is along the thalweg alignment. Therefore, in this option re-siltation rate is likely to be less. However, this alignment is close to the river bank. Therefore, there is a chance of erosion of the bank because of proposed dredging since near bank velocity would be very high in the dredged channel. The total dredged volume is 3.881 Mm^3 as shown in Table 6. Re-siltation rate is about 70% to 75% after 1 year. In dredging volume computations, dredging tolerance limit of 0.3 m and side slope of 1:7 are considered.

Table 6 Summary of Volume of Dredging of Option-1

Alignment Reach (m)	Dredging Length (m)	Dredging width (m)	Design depth (m, CD)	Tolerance limit of dredging (m)	Volume of dredged spoil (m^3)
Power Plant TG	500	300	5.5	0.30	6,50,480
Jetty front	500	200	8.0	0.30	6,06,076
Maidara-Jetty front	2400	200	5.5	0.30	14,37,224
Digraj-Maidara	2900	200	5.5	0.30	4,20,936
Sabur beacon TG to Holcim cement factory Jetty	1650	200	5.5	0.30	7,66,071
Total volume of Dredged spoil					**38,80,787**

3.4.7 Facilities Considered to Dispose Oily Wastes, Waste Water and Garbage from Vessels

Activities involving dredging operations will not contaminate water or beaches. The contamination of the surface water by grease, oil and floating bodies resulting from discharges from the vessels' motors may occur. For oily wastes, vessels will have waste storage tanks on board, which will be unloaded upon arrival to the Terminal and taken to a safe place, avoiding contamination of the environment by a poor disposal of these wastes.

Solid wastes from vessels will be collected in plastic bags, and will be unloading at the wharf and disposed of at the designated location of the MP.

3.5 Maintenance Dredging in Mongla Port Area

The Mongla port is maintaining its navigability through dredging since 1980. A summary of their dredging activities and approximate quantity dredged is shown in Table 7.

Table 7 Maintenance dredging in Mongla Port area

Year	Location	Quantity(m^3)
19779-81	Jetty Front	325,000
1983	Jetty Front	345,000
1984	Confluence	127,000
1985	Jetty Front	62,000
1986	Jetty Front	52,000
1987	Jetty Front	109,000
1988-89	Sabur-Beacon+ Jetty Front Confluence	210,000
1990	JettyFront	313,000
1991-92	Sabur Beacon, Jetty Front Confluence, Southern Anchorage	3,591,000
1994-95	Southern Anchorage	98,000
1994-95	Jetty Front	232,000
1995-96	Sabur Turning Basin & Confluence	128,000
1996-97	JettyFront	197,000
1999-00	JettyFront	180,000
2000-01	JettyFront	204,000
2000-04	Southern Anchorage, Sabur Beacon, Jetty Front, Jetty Approach, Confluence	2,790,000
2003-04	Jetty Front	69,000
2004-05	Jetty Front	54,000
2005-06	Jetty Front	69,000
2007-08	Jetty Front	107,000
2009-10	Jetty Front	61,282
	Total	9,323,282

Source: MPA and IWM

3.6 Resources and Utilities

Dredging operation will continue for about 14 (fourteen) months starting from April/May 2016 to May/June 2017. A total of 10 persons including expatriates and locals will operate the Dredger. All solid waste will be collected in container to store and will be dumped in sanitary manner in the shore. Liquid waste will be handled in sanitary manner by observing recommended code of practice/standard.

3.7 Schedule of Dredging Activities – phase and timing for the dredging

A well planned work schedule in the form of bar chart is absolutely essential as a management tool for timely delivery of outputs of activities and milestones. The bar chart is

the most widely and conveniently used schedule for the management of proposed dredging activities. The tentative activity schedule for dredging operation is shown in Figure 5. This schedule will be finalized depending on the field requirements as identified during the course of dredging operation.

3.8 Implementing and Executive Agencies

The Ministry of Shipping, Government of Bangladesh will be the Executing Agency (EA), and Mongla Port Authority will be implementing Agency for the proposed dredging between Mongla Port and proposed coal terminal in the Pussur Channel.

Sl. No.	Activity	Years/ Months																
		2016											2017					
		F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
1.0	Mobilization																	
2.0	Reconnaissance Site Visit																	
3.0	Collection and review of data, maps, and charts																	
4.0	Dredging plan and operation at site																	
4.1	Preparation of dredging plan based on model result																	
4.2	Dredging operation																	
5.0	Completion of dredging operation and demobilization																	
6.0	Reporting																	

Continuous Intermittent

Figure 6 Activity Schedule

4 DESCRIPTION OF THE ENVIRONMENT

4.1 Physical Environment

4.1.1 Climate

Like other parts of the country, the Project area has a tropical monsoon climate with four seasons namely: the dry or winter season (December-February); the pre-monsoon hot season (March-May); the monsoon or rainy season (June-September) and the post–monsoon or autumn season (October-November).

To define meteorological conditions in and around the proposed dredging area of the Project, temperature, rainfall, humidity and wind data were collected from the Khulna and Mongla meteorological weather stations.

Temperature

Temperature reaches the highest in April and drops during winter, generally reaching the lowest in January. In general, temperature in the project area (Mongla) varies between 13.9^{0}C and 34.5^{0}C, with an annual average of 26.7^{0}C, which is slightly higher than the national average of 26^{0}C. Table 8 shows the summary of the average temperature between 1981 and 2002.

Table 8 Mean Monthly and Annual Average Temperature (1981-2002)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Avg.
Temperature (0C)														
Mongla	Max	25.2	28.4	32.5	34.5	34.1	32.6	31.7	31.7	31.8	31.4	29.4	26.5	30.8
	Min	13.9	17.5	21.9	24.7	25.9	26.5	26.2	26.4	25.9	24.5	20.7	15.6	22.5
	Mean	19.6	23.0	27.2	29.6	30.0	29.5	28.9	29.0	28.9	28.0	25.0	21.1	26.7

Source: Bangladesh Meteorological Department (BMD)

Rainfall

Rainfall varies considerably from year to year and month to month. However no rainfall was recorded during the months of November, December and January. The average annual rainfall of the study area (Mongla) is approximately 1894 mm, with about 88% of the mean annual rainfall occurring during the period from May to October, and 36% during June – July (Table 9).

Table 9 Mean Monthly and Annual Rainfall (mm) (1981-2002)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
Mongla	11	39	50	71	190	335	353	319	311	161	50	1	1894

Source: Bangladesh Meteorological Department (BMD)

Relative Humidity

Humidity levels are consistently very high during the monsoon season, and drop significantly for a relatively short period at the end of the dry season. Sunshine levels are low during the monsoon, but from November to May are consistently high. In the project area the relative humidity is the lowest (76% - 73%) during December to March, and from April there is a steady increase till July (Table 10).

Table 10 Mean Monthly and Annual Average Humidity (1981-2002)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Avg.
Relative Humidity (%)														
Khulna	Mean	78	75	73	78	81	86	88	87	88	85	81	79	82
Mongla		74	74	73	77	81	87	89	89	89	86	80	76	81

Source: Bangladesh Meteorological Department (BMD)

Wind Speed and Direction

Historical wind data (wind speed, wind direction) were collected from Mongla substation that provides an overview of prevailing wind conditions within Mongla. The data shows the wind speed is at a maximum in the early part of the monsoon, but drops substantially by the beginning of the dry season and is assumed to reflect the Project corridor conditions. As shown in Table 11 the predominant wind directions in the study area is from south during March to October with minimum magnitude of 2.1 knot in November and maximum of 4.8 knots in May.

Table 11 Mean Monthly and Annual Average Wind Speed and Direction

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Wind Speed (knots)	2.7	2.8	3.2	4.5	4.8	4.1	3.8	3.5	3.4	2.4	2.1	2.3
Wind Direction	NW	NW	S	S	S	S	S	S	S	S	N	N

Source: Bangladesh Meteorological Department (BMD)

4.1.2 Geology and Geomorphology

Geology

The geology of the Project area can be classified into two four geological units; there are marsh clay and peat and Tidal deltaic deposits. The right bank of the Project area is active and nearly level floodplain, located in the marsh clay and peat zone of the geology. The geological profile along the left bank of the dredging alignment is mainly floodplain area placed in tidal deltaic deposits. These deposits include mostly fine sandy, silt and clay materials. Quite a number of incised channels and depressions within the alignment area are lined with recent alluvial deposits comprising Lowland Alluviums. Figure 7 shows the local geology of the Project area.

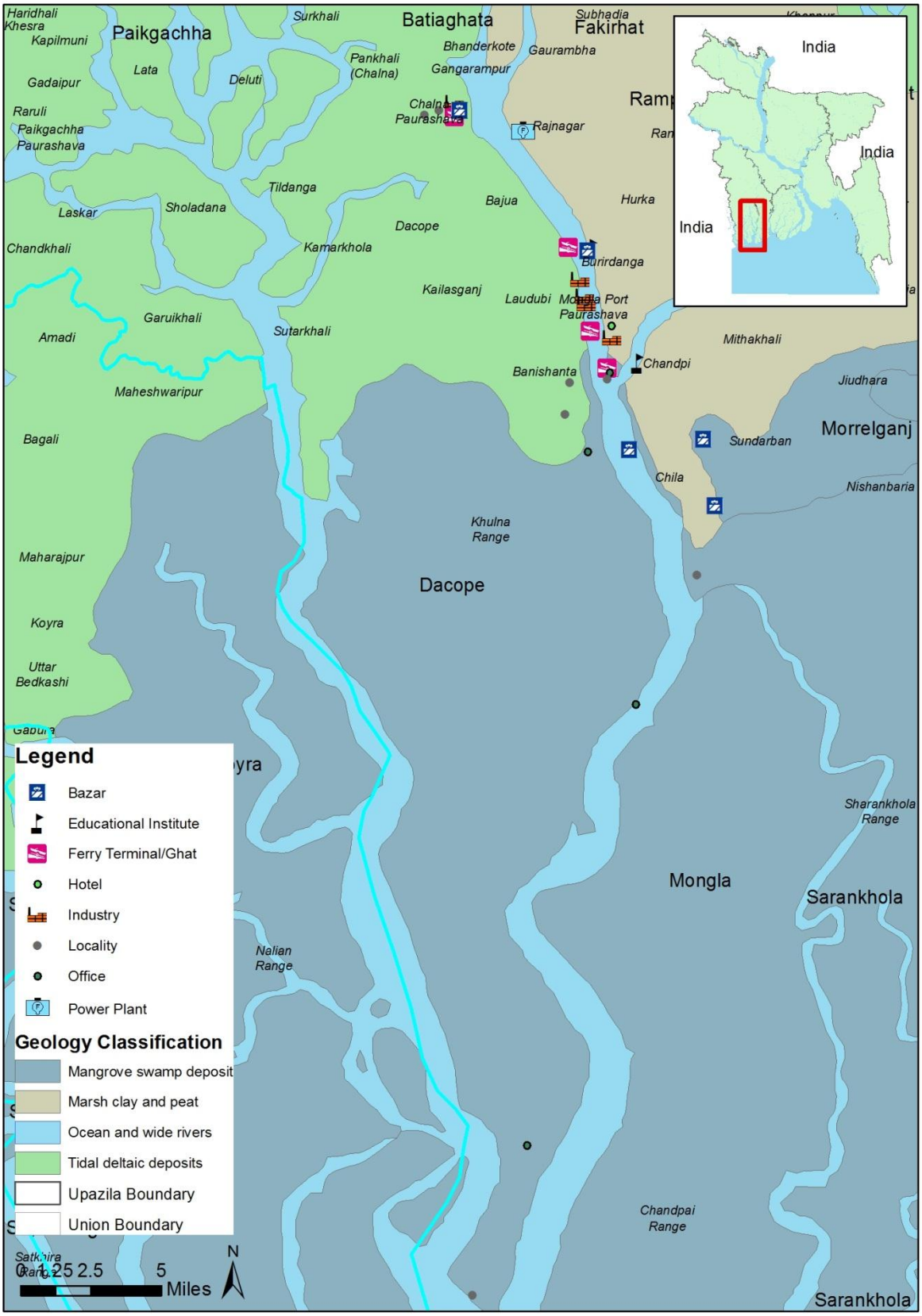


Figure 7 Geological Map of the Project Area

Geomorphology and Bathymetry

In the current study the consultants have analyzed MPA Hydrographic charts for the year 2013 and the recently surveyed IWM hydrographic survey data of July 2015. It may be mentioned that the only hydrographic chart of 2013 was available with MPA for the Digraj–Chalna reach of Pussur River. Assessment has been made of the changes in sedimentation pattern between the overall Sabur Beacon-Chalna reach from March/December 2013 and July 2015. During the 1.5 years period (Mar/Dec 13 to Jul 15) a significant quantity of sediment amounting to 15.53 Mm3 has been deposited in the Sabur beacon-Chalna reach of Pussur River. Figure 8 shows the bathymetric map along the dredging alignment.

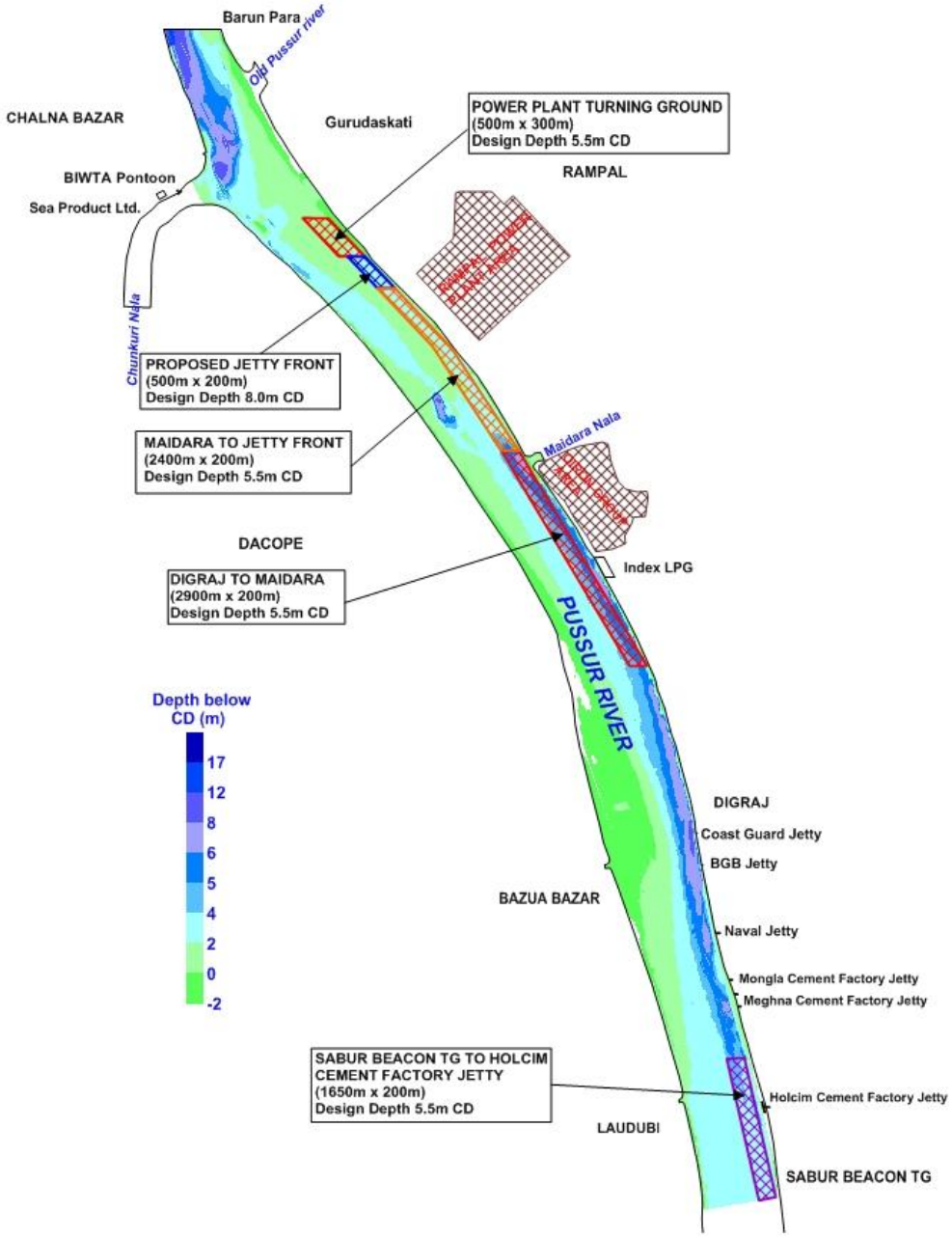


Figure 8 Bathymetry Map of the Study Area

Topography

The topography of the Project area is dominated by the Bay of Bengal. The coastal topography appears to be linked with the presence of a very deep trough in the center of the sea, running in NE-directions, the so-called Swatch of no ground which has its Northern extremity in the immediate vicinity of the Pussur entrance. The outlets of all channels are apparently directed towards this deep trough. The northern tip of Swatch of no ground is right opposite the Pussur outlet. The proximity of this deep trough causes the seaward slopes of the central part of the bar to be extremely steep (Figure 9).

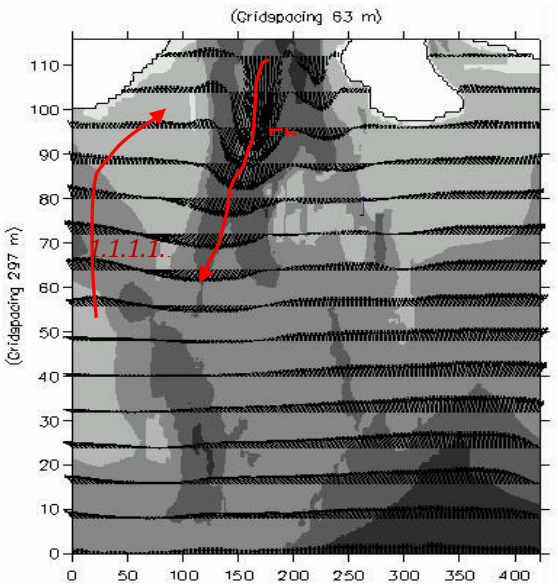


Figure 9 Transition between ebb and flood direction of flow at the Pussur entrance near Outer Bar; Gray color for the water depth, dark color represents deeper area

Soil Quality

Soils are described in terms of general soil type. A general soil type is a group of soil, which are broadly similar in appearance and characteristics because they have developed in response to similar environmental factors such as climate, physiography and drainage. The general soil type is a purely local system, designed to make distinctions, which appear significant for understanding the formation, distribution and use of the soils of Bangladesh. Twenty-one general soil types are recognized over Bangladesh. Project area extends over general soil type 5b non-calcareous floodplain unit (seasonally saline) covering large portion of Khulna and Bagerhat including Mongla. These are seasonally flooded soils, which have either dominantly dark grey or prominent dark grey pressure faces, and calcareous within 125cm from surface. Many basin soils have a neutral to acidic topsoil and a near– neutral sub-soil over a calcareous substratum at 40-60 cm. The pH value varies from 7.0 to 8.0 throughout the Sundarbans. Table 12 shows chemical properties of dredged material at Balir Mat dumping site of MPA. Figure 10 shows the general soil classification of the Project area.

Table 12 Chemical Properties of Topsoil at Mongla

Land Type	Year/Date	PH	Salinity (EC) ds/m	Organic Matter %	Ca	Mg	K	N %	P	B	Zn	Pb
					Milli-equivalent /100 gm soil				µg/g soil			
Dredged Spoil (Recent)	26 Jan. 2012	7.5	4.0	1.21	14.43	1.62	0.18	0.061	7.6	0.53	0.40	Trace
Dredged Spoil (Old)	26 Jan. 2012	6.9	0.73	0.67	14.70	0.54	0.13	0.034	4.1	0.17	0.28	Trace

Source: IWM Field Survey

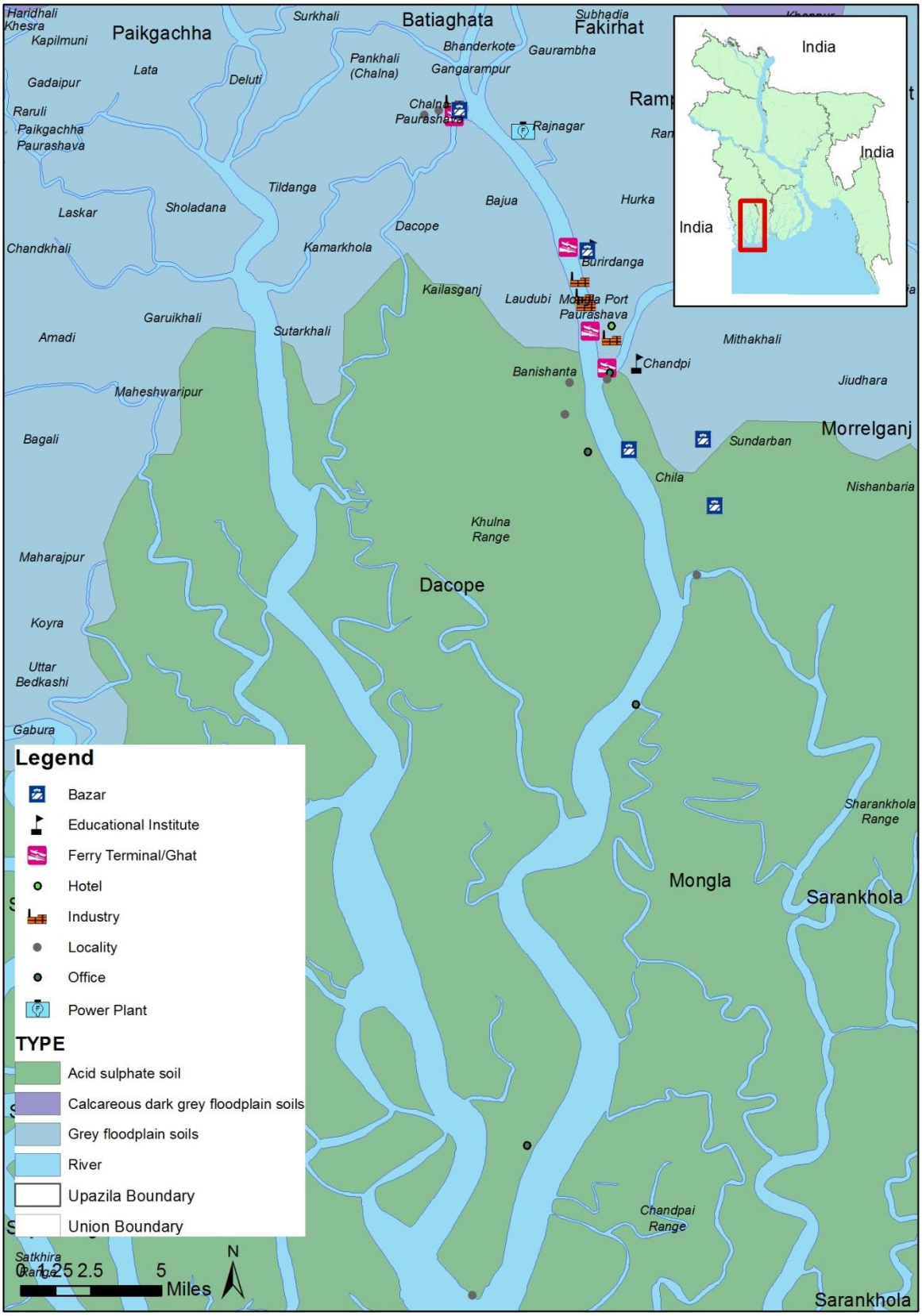


Figure 10 Soil Classification of the Project Area

Erosion and Sedimentation Processes

In the current study the consultants have analyzed MPA Hydrographic charts for the year 2013 and the recently surveyed IWM hydrographic survey data of July 2015. It may be mentioned that the only hydrographic chart of 2013 was available with MPA for the Digraj–Chalna reach of Pussur River. Assessment has been made of the changes in sedimentation pattern between the overall Sabur Beacon-Chalna reach from March/December 2013 and July 2015. Table 13 summarized the overall sedimentation pattern in the river reach.

Table 13 Summarized sedimentation pattern, Sabur Beacon – Chalna Bazar

Sedimentation Pattern	Changes Between years 2013-2015 (Mm^3)
Deposition	15.53
Scouring	0.94
Net Deposition	14.59

Assessments of the changes in sedimentation have also been carried out at the locations within the initially set dredging alignments. Table 14 summarizes the sedimentation pattern.

Table 14 Summarized sedimentation pattern at the initially set Dredging Alignment

Sedimentation Pattern	Changes Between years 2013-2015 (Mm^3)
Power Plant Turning Ground	
Deposition	0.35
Scouring	0.0029
Net Deposition	0.3471
Jetty Front	
Deposition	0.0845
Scouring	0
Net Deposition	0.0845
Maidara - Jetty Front	
Deposition	0.434
Scouring	0.0001
Net Deposition	0.4339
Digraj - Maidara	
Deposition	0.256
Scouring	0.017
Net Deposition	0.239
Sabur Beacon - Digraj	
Deposition	0.252
Scouring	0.0008
Net Deposition	0.2512

The analysis reveals that the overall reach of Pussur River from Sabur beacon to Chalna Bazar has been dominated by sediment deposition and results in accretion of the river bed.

The average accretion of the river bed that has experienced in the reach during the period from March 2013 to July 2015 is 1.14 m.

Here the comparison has been made between the dry season river beds of March 2013 with the wet season river bed of July 2015. During wet season the upland flow in Pussur River remains high and results in low siltation rate in the river bed. In the dry period aggregation of the river bed would be higher than monsoon as the rate of siltation is increased. So the volume of dredged spoil is expected be higher than the volume that has been estimated based on IWM survey (July 2015) if the dredging is done during the upcoming dry period. However, to ascertain the actual volume, pre-dredging hydrographic survey is recommended to be carried out within a short period ahead of the dredging operation.

The change of the river bathymetry is shown in Figure 11.

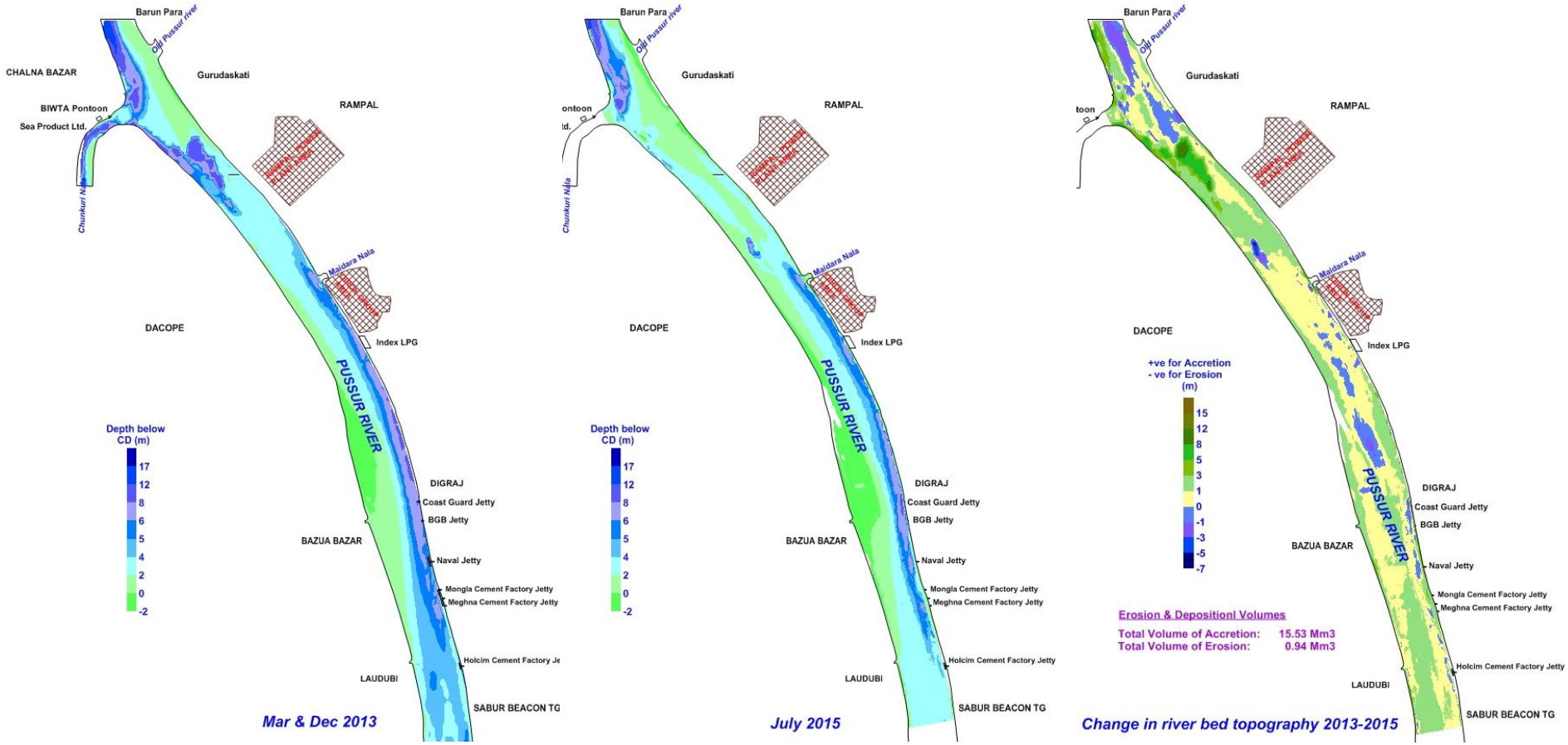


Figure 11 Changes in Bed Topography in Pussur river between Sabur Beacon Turning Ground and Chalna Bazar

4.1.3 Hydrological Characteristics

Surface hydrology of the Pussur River is basically determined by the monsoon winds and to some extent by the hydrological characteristics of the open part of the nearby Bay of Bengal. Fresh water from the rivers largely influences the coastal northern part of the Bay. The rivers of Bangladesh discharge the vast amount of 1,222 million cubic meters of fresh water (excluding evaporation, deep percolation losses and evapotranspiration) into the Bay. The temperature, salinity and density of the water of the southern part of the Bay of Bengal is, almost the same as in the open part of the ocean. In the coastal region of the Bay and in the northeastern part of the Andaman Sea where a significant influence of river water is present, the temperature and salinity are seen to be different from the open part of the Bay. The waves and ripples entering from the southern part of the Bay provide the energy for mixing the water and consequently bring uniformity in its chemical and physical properties. Tidal action is also very great in the shallow coastal zones.

Tides

The importance and study of tides lies in the need to have datum in place in order to calculate the height of hills and valleys and sea depths, besides delimiting riverside land for purposes of fixing boundaries and designing structures in coastal areas, defining the dynamics of the area, basically supported by the range of tides.

The characteristics of ocean tides in the study area have been obtained from the Tide Tables published by the National Bureau of Hydrography and Navigation. Tides are semi-diurnal in nature, that is, there are two high tides and two low tides during each tidal day (24 hours 50 minutes). The mean tidal range is on the order of 0.55 m., while the tidal range during syzygy is on the order of 0.73 m. The common establishment (tidal ports) is 05 hours 36 minutes.

Currents

In the same place where sea current measurements were taken between March 24 and April 2, measurements were taken at three different depth levels in the afternoon of April 12th. The measurement of each level lasted 20 minutes. At 1 m. water depth, the surface current flowed predominantly in a Westerly and Southwesterly direction, with speeds that fluctuated between 25.0 and 7.0 cm/sec., the average value being 15.0 cm/sec. At 7 m. water depth, the current flowed predominantly in a Southeasterly direction, with speeds that fluctuated between 38.0 and 10.0 cm/sec, the average value standing at 18.0 cm/sec. At 14 m. water depth, the sea current showed great variability, reaching speeds that fluctuated between 23.0 and 7.0 c m/sec, the average value being 15.0 cm/sec.

Water Levels and Discharge Rate

Water level data identifies variation in water depth and tidal characteristics over the years. IWM based on 2010 data shows that the maximum tidal range at Hiron Point is about 3.13 m with a seasonal variation of about 0.8m (Figure 12). At Mongla, the maximum tidal range and the seasonal variation are about 4.39 m and 0.87 m respectively (Figure 13).

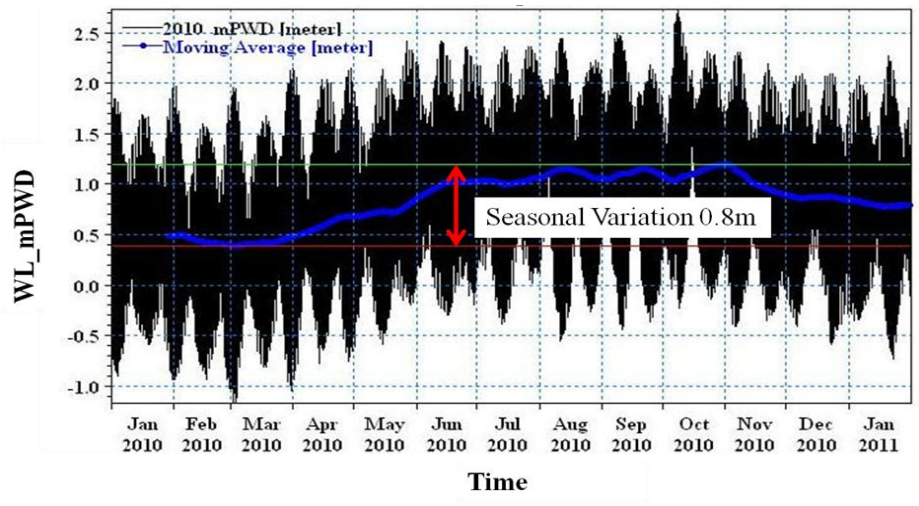


Figure 12 Water Level Variations at Hiron Point

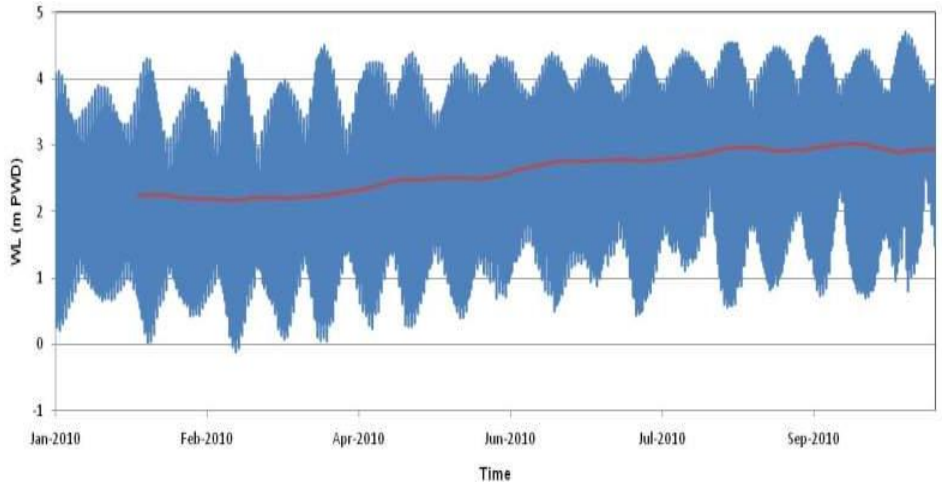


Figure 13 Water Level Variations at Mongla Port

Semi-diurnal tides with a tidal period of about 12 hours 25 minutes are predominant in the Bay of Bengal. The tidal range of the Project area is approximately 3 to 4m between the successive lowest and highest tides. According to the Bangladesh Tide Tables 2012, Mean Tidal Level is 2.310m and 1.70m at Mongla, and Hiron Point along Pussur River, respectively (Table 15). The tidal regime is larger at Mongla than at Hiron Point.

Table 15 Tidal levels at Mongla, and Hiron Point of the Pussur River in 2012 (m CD)

Stations	Lowest tide level	Mean level	Highest tide level
Mongla	-0.261	2.310	4.882
Hiron Point	-0.256	1.700	3.656

Source: Bangladesh Tide Tables 2012

Water level data is important to know the variation of water depth over the year, tidal characteristics and also to calibrate the water flow model. Here, water level observations were made at one location; Dacope (Chunkuri). The observations have been carried out for 24 hours

at ten minutes interval, every day from 1 July to 30 July 2015. Water level data are measured in meter in reference to Public Works Datum (PWD). A sample plot of water level data at the Dacope (Chunkuri) is shown in Figure 14.

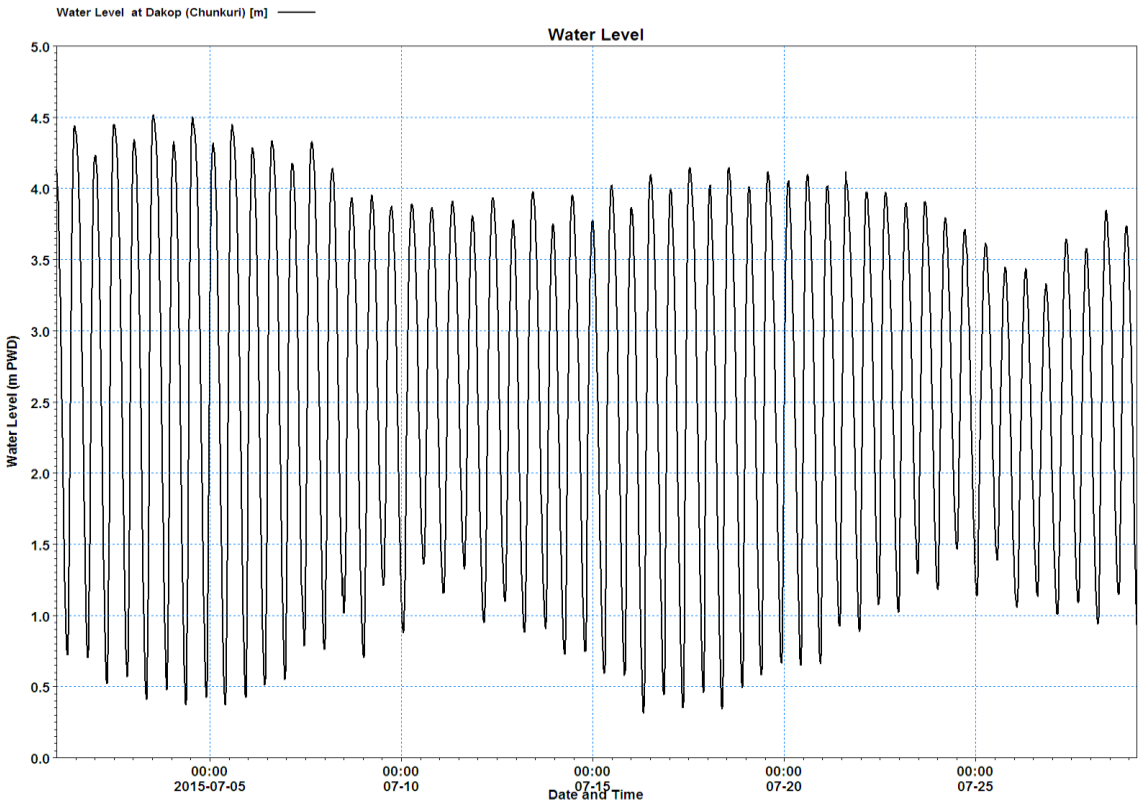


Figure 14 Variation of water level data at Dacope (Chunkuri)

Over the duration of measurement period, maximum, minimum and mean water level, maximum tidal range and measurement period are presented in Table 16.

Table 16 Maximum, Minimum and Mean water level and Maximum Tidal range at different locations

Sl No	Location	Duration	Max WL (mPWD)	Min WL (mPWD)	Mean WL (mPWD)	Max Tidal Range (m)
1	Dacope	01/07/2015 to 30/07/2015	4.518	0.37	2.583	4.93

Here, the mean water level shows the calculated arithmetic average value of all the measured water level during the measuring period. The tidal range was calculated by the algebraic difference of two consecutive high tide and low tide.

Water flow/discharge - IWM in March 2011 measured maximum discharge of 36,987 m^3/sec in Pussur River at Akram Point, during spring flood (high) tide. Near Mongla port in the same month the maximum discharge at Mongla Nulla at spring flood tide was 6,597 m^3/sec. Table 17 summarizes maximum flows in Pussur River during March 2011.

Table 17 Maximum discharge during flood and ebb tide conditions

No	Location	Name of the Channel	Measurement Period	Type of tide	Max flow during flood tide (m^3/sec)	Max flow during ebb tide (m^3/sec)
1	Mongla Nulla (DS of Mongla Nulla)	Pussur	03-30-2011(half hourly)	Neap	4,952	4,386
			03-06-2011(half hourly)	Spring	6,597	8,545
2	Akram Point	Pussur	03-13-2011 (half hourly)	Neap	16,792	17,171
			03-21-2011 (half hourly)	Spring	36,987	31,732

Source: IWM, 2011

The Pussur River is a tidal river. The tidal discharge was measured with the help of Acoustic Doppler Current Profiler (ADCP). The ADCP machine is attached with a boat. The boat travels along the discharge measuring transect. The ADCP machine creates a sound frequency that travels through the water and comes back bouncing from the river bed. The returned frequency deviates from the original. The change of frequency is proportional to the current flow. The time lag of the reflected sound is related to the depth of the river. As the boat moves forward, the ADCP continues its process and calculate the whole discharge along that transect.

The discharge measurement was carried out for 12 hours with half hour interval at two locations namely, Chalna and Mongla Point (Figure 15) during spring tide and neap tide. The purpose of these measurements was to know about the water flow during flood and ebb tides, tidal prism and to calibrate the model. Sample of the measured tidal discharge data at Mongla and Chalna are shown in Figure 15 and Figure 16.

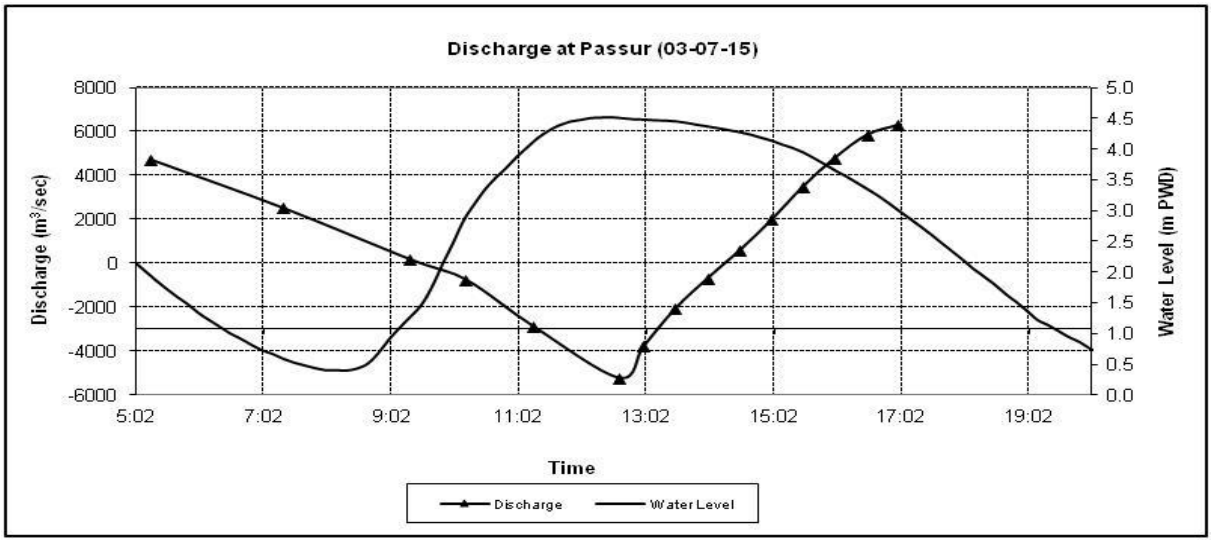


Figure 15 Discharge plot during spring tide in July 2015 at Mongla point

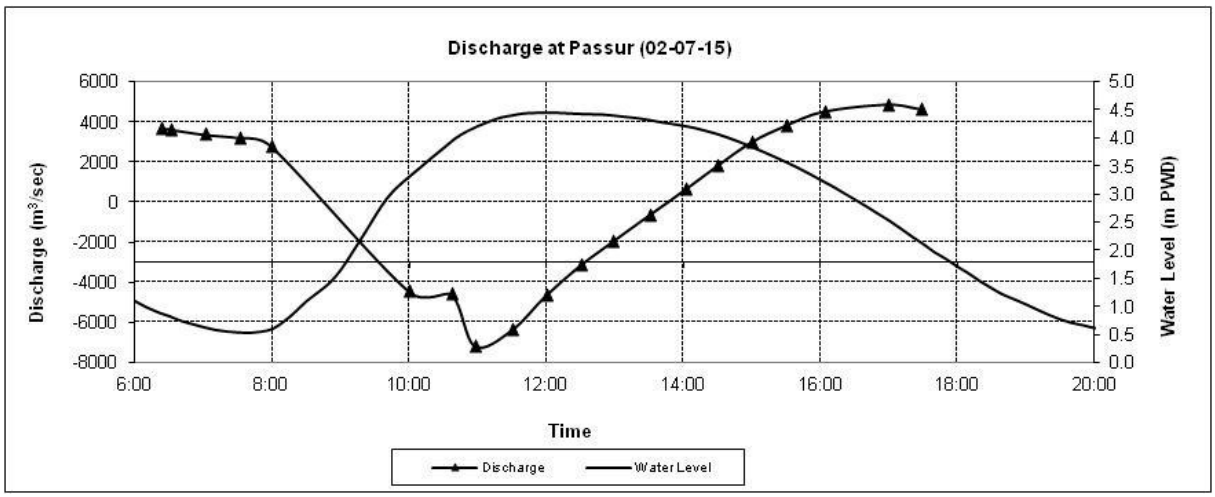


Figure 16 Discharge plot during spring tide in July 2015 at Chalna point

It is observed that maximum discharge during the measurement at Mongla point is 6272 m^3/sec during spring at ebb (low) tide and at Chalna is 7162 m^3/sec during spring tide at flood tide (high) tide (Table 18). The discharge measurement during neap tide is completed and data is under process.

Table 18 Maximum measured discharge during spring tide at two locations

No	Location	Name of the Channel	Measurement Period	Type of tide	Max flow during flood tide (m^3/sec)	Max flow during ebb tide (m^3/sec)
1	Mongla Point	Pussur	03-07-2015 (half hourly)	Spring	5227	6272
2	Chalna	Pussur	02-07-2015 (half hourly)	Spring	7162	4866

4.2 Biological Environment

The section mainly describes the preliminary assessment of the floral and faunal diversity of Project area. A wide variety of wildlife, fish, as well as plant species are available in the project area. The area is one of the most important bio-habitats of Bangladesh. As the project area is within the Pussur River, only aquatic ecosystem has been studied further for impact assessment.

4.2.1 Terrestrial Ecosystem

Terrestrial Flora

The nearby settlement and river side area is enriched with diversified terrestrial flora, mainly coconut (Cocos nucifera), betel, nut/supari (Areca catechu), mango (Mangifera indica), black berry/jam (Syzygium cumini), babla (Acacia nilotica), koroi (Albizia procera), chattim (Alstonia scholaris), kadam (Anthocephallus chinensis), nim (Azadirechta indica), sishoo kath (Dalbergia sisoo), krishnachura (Delonix regia), mandar (Erythrina varigata), simul (Bombax ceiba), banyan/bot (Ficus benghalensis), assawath (Ficus religiosa), banana (Musa sapiantum), rain

tree (Samanea saman), mehagoni (Swietania mehagoni), arjun (Terminalia arjunai) and pitali (Trewia polycarpa) are commonly found terrestrial flora.

Some local varieties of rice have been cultivated in freshwater shrimp culture regions. Other species like chilli (Capsicum frutescens), brinjal (Solanum melongena), potato (Solanum tuberosum), tomato (Lycopersicon lycopersicum), ladies finger/dheros (Abelmoschus esculentus), puishak (Basella alba), sugarcane (Saccharum officinarum), jute (Corchorus capsularis) and sesame/til (Sesamum indicum) are also commonly grown crops in this block. Some grasses like Cynodon dactylon, Axonopus compressus, Dactyloctenium aegipticum, Eragrostis tenella, Cyperus kyllinga etc. are commonly found in cultivated field and on the divider land of cultivated fields. Figure 17 shows the typical mangrove in the project area.

Figure 17 Terrestrial Flora (Mangrove) in the Project Area

Terrestrial Fauna

Northern parts of project area have villages that support varieties of terrestrial wildlife. Common wildlife in the area is black drongo- Dicrurus macrocercus, red-vented bulbul - Pycnonotus cafer, tailor bird- Orthotomus sutorius, small Indian mongoose- Hervested auropunctatus et4. Central parts of project area have been degraded due to shrimp culture, and as a result wildlife diversity in this region is not significant. It appears that species such as little cormorant - Phalacrocorax niger, pond heron- Ardeola grayii, skipper frog- Euphlyctis cyanophlyctis have managed to adjust with this altered habitat. The southern part of project area is very rich in faunal diversity.

Burrowing animals used dry areas of Project area as a nesting and breeding ground. Homestead bio-habitat of Project area is rich and able to produce plenty of food that invites wildlife to visit and stay in the area for shelter, food, nesting and breeding. Agricultural habitat is preferred by paddy-field pipit- Anthus rufulus, black drongo- Dicrurus macrocercus, lesser bandicoot- Bandicota bengalensis et4.

Fantail Snipe- Gallinago gallinago, Little Ringed Plover- Charadrius dubius etc. are local migratory birds and they prefer the shore areas to stay, feed and breed. Monitor Lizard, mongoose, snakes, frogs etc. prefer marginal aquatic areas of Project area.

4.2.2 Aquatic Ecosystem

Aquatic Flora

Project area has a vast area of wetland habitats (i.e. ponds, canals, ditches, low cultivated lands), which have rich diversified aquatic flora. Common aquatic flora of the study area are Kacuri pana (Eichhornia crassipes), malancha (Enhydra flactuans), dholkalmi (Ipomoea fistulosa), khdipana (Lemna perpusilla), bunolang (Ludwigia suffruticosa), sushni shak (Mersilea quadrifolia), baranukha (Monochoria hastata), shada shapla (Nymphaea pubescens), nil shapla (Nymphae anouchali), lalshapla (Nymphaea rubra), pnachuli (Nymphoides indica), topa pana (Pistia starteotes) helencha (Alternanthera philoxeroides), kalmi lata (Ipomoea aquatica), kessardam (Jussiaea repens), sachi shak (Amaranthus sessilis), hogla (Typha angustat) and paniphal (Trapa bispinosa) are commonly found wetland flora in this area.

Aquatic Fauna

Project area has vast areas that sustain different types of wetland habitats with diversified fauna. Freshwater ponds, ditches, small reservoir support several species of wildlife whereas rivers, canals, and big water reservoirs provide habitats for other species of wildlife. Coastal and brackish water areas offer habitat for some wildlife species whereas mangrove forests provide habitat for several other types of wildlife species.

Human intervention for development activities creates alteration of an ecosystem that severely affects water dependent reptile, birds and other wildlife. The degraded bio-habitat, due to extensive shrimp culture, in the project area has left virtually no sheltered place for waterfowl to roost or nest. The reproduction and breeding of aquatic fauna is very finely tuned and adjusted to the rhythm and amplitude of monsoon flooding in project area.

Three general types of fish habitats are found in Project area. These are (i) fresh water such as pond, ditches, canals etc. (ii) brackish water and (iii) marine water. These habitats provide shelter, feeding and spawning grounds for different types of fish species. These habitats are under great threat due to the selective monoculture of Catfish like Pangus and African Magur. Over exploitation of fish resources in all the mentioned habitats is a threat to certain fish species.

Fisheries

Fishery is an important renewable resource in Bangladesh. Bangladesh is endowed with vast marine, brackish and inland waters having fisheries potentials. It has a land area of 1,47,570 sq. km. and has declared an Exclusive Economic Zone (EEZ) from her base line to 200 nautical miles seaward in 1974. As a result along with 710 km. (coast line) an area of about 1,66,000 sq. km., which is greater than actual land of Bangladesh, is now under the economic jurisdiction of the country for exploitation, exploration, conservation, and management of its living and non-living resources (DOF, 1999). Contribution of fisheries sector in the national economy of Bangladesh is substantial, particularly with reference to food consumption, nutrition, employment and export. The sector contributes about 6% to GDP and about 5% to foreign exchange earnings through export. The sector provides full time employment for 1.2 million professional fishermen and 11 million part time fisher folk, which is about 10% of the total population (BBS, 2010).

At present the marine fisheries sector contributes about 22% of the country's total fish production. Bangladesh Marine fishery has two sub sectors, such as artisanal fishery and industrial (trawl) fishery. Trawl shrimp fishing is one of the most important sub sectors in marine fishing in Bangladesh. Bangladesh started with a fleet of 10 trawlers after liberation i.e. 1972-1973. The numbers of trawlers more than doubled to 21 in a year and then jumped to 26 two years later. The current number of trawlers is 119 of which 41 are shrimp trawlers and the remaining are fish trawlers (BBS, 1999; MFSMUC, 2007). The trawlers operate in the shelf area beyond the depth of 40 meters in the EEZ. Because of an unplanned and irrational increase in fishing efforts, many species of the marine fish and shrimp stocks have already been declined. As a result, coastal fishing has become non-remunerative and fisher folk are becoming poorer. Their fruitless endeavor for survival is thus putting more and more damaging pressure on the resources. Different studies identified that overfishing is the main reason of declining CPUE of trawl shrimp fishery (Khan and Hoque, 2000; Khan, 2000). CPUE of trawl shrimp fishery in Bangladesh along with annual effort and annual harvest during the period 1981-82 to 2005-2006 are shown in Table 19. Figure 18 shows the fishing activities in the project area.

Table 19 Actual Annual Values of Stock, Harvest, Effort and CPU (catch per unit)

Year	Actual Stock (tons)	Actual Harvest (tons)	Actual Effort (Standardized Fishing days)	CPUE
1981-1982	4592	1697	3782	0.448704
1982-1983	4545	3120	7024	0.444191
1983-1984	5784	5461	9662	0.565204
1984-1985	6921	5518	8159	0.676308
1985-1986	6406	4034	6444	0.626009
1986-1987	6629	4488	6928	0.647806
1987-1988	5476	3523	6583	0.535166
1988-1989	7210	4893	6945	0.704536
1989-1990	5783	3134	5546	0.565092
1990-1991	7802	3430	4499	0.762392
1991-1992	4851	2902	6122	0.474028
1992-1993	6066	4188	7065	0.592781
1993-1994	4967	3480	7169	0.485423
1994-1995	3657	2416	6761	0.357344
1995-1996	4966	3588	7394	0.485258
1996-1997	5091	3536	7107	0.497538
1997-1998	3338	2444	7491	0.326258
1998-1999	4666	3764	8255	0.455966
1999-2000	3795	2919	7871	0.370855

Year	Actual Stock (tons)	Actual Harvest (tons)	Actual Effort (Standardized Fishing days)	CPUE
2000-2001	3855	3162	8395	0.376653
2001-2002	4675	3168	6935	0.456813
2002-2003	3120	2487	8158	0.304854
2003-2004	3767	3076	8357	0.368075
2004-2005	3941	3310	8595	0.385108
2005-2006	4259	3444	8276	0.416143

Source: BBS, 1999; Ray and Khan, 2003, MFSMUC, 2007

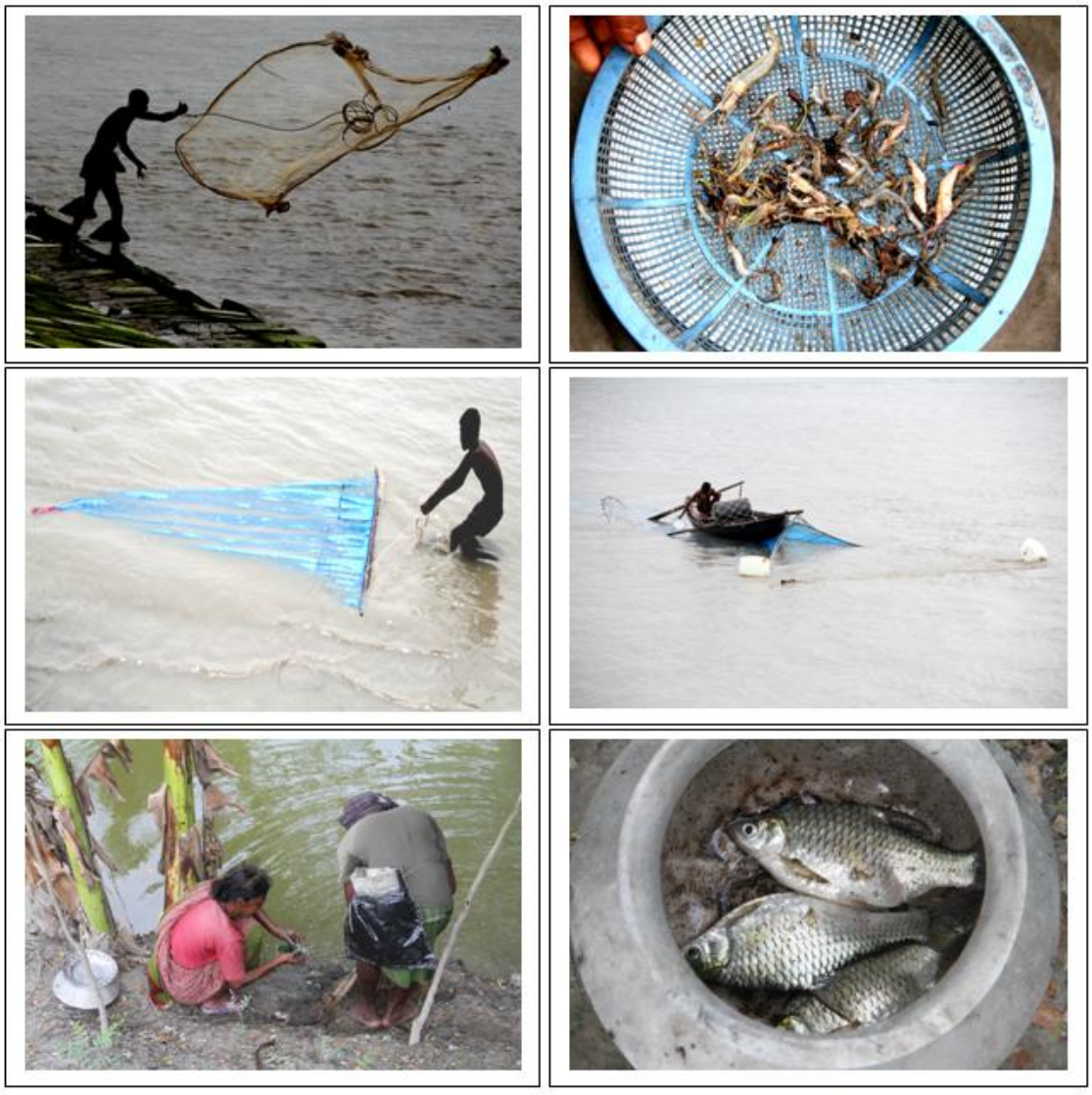


Figure 18 Various fishing activities – capture and culture fisheries along the Pussur and within the Polder.

Fifteen kilometers south of the proposed dredge site is the northern boundary of the 'Swatch of No Ground' – and important habitat for the marine fisheries and mammals (cetaceans – dolphins, porpoises and whales). Waters of the Bay of Bengal are included in the Indian Ocean Cetacean Sanctuary established according to Article V (1) (c) of the International Convention on the Regulation of Whaling (IWC, 1980) [although Bangladesh is not a member of the Convention] and were prioritized as part of a proposed marine mammal initiative for South Asia endorsed at the 11th Meeting of the Scientific Council of the Convention on the Conservation of Migratory Species of Wild Animals (CMS, 2002).

The results of survey conducted in the Sundarbans mangrove forest (Smith et al. 2006) and near-shore cetaceans indicate that Bangladesh serves a regionally vital role as a reservoir of cetacean abundance and diversity supporting relatively large populations of at least two species (Irrawaddy dolphins and finless porpoises) known to be at risk in other areas of their ranges. However, declines in population sizes are expected unless threats, particularly gillnet entanglement, are reduced.

Artisanal coastal fisheries include both commercial and subsistence fishing. The last survey (1988) showed that of the total of 67,300 artisanal fishing boats, only 6,000 were mechanized. Most people living in coastal communities make their livelihood from fishing, and – unlike inland fishing communities – are almost totally dependent on fishing. Fisheries in Bangladesh, and in particular marine and brackish-water fisheries, are faced with a dilemma. On the one hand, fisheries provide the people of Bangladesh with protein at a reasonable price, and generate employment, income and foreign exchange. On the other hand, fisheries – particularly the in-shore marine and estuarine fisheries – are under stress due to overfishing, environmental and habitat degradation, and competing uses of water systems.

Detritus, generated mainly by phyto- and zoo-plankton, is one of the important groups in the ecosystem and major energy flows connect it to other groups (Table 20).

Table 20 Omnivory index, efficiency and flow to detritus of each ecological group

Ecological group	Omnivory index	Net efficiency	Flow to detritus (t·km-2·year-1)
Large sharks	0.15	0.33	2.98
Medium pelagics	0.18	0.42	1.34
Medium mesopelagics	0.24	0.40	0.72
Medium demersal	0.46	0.46	1.45
Small demersal	0.31	0.48	2.26
Small mesopelagic	0.00	0.09	6.12
Small pelagic	0.00	0.28	0.73
Small discards	0.02	0.13	3.67
Rays	0.03	0.23	0.45
Penaeidae	0.07	0.07	0.21
Other crustaceans	0.21	0.58	3.45
Cephalopoda	0.00	0.09	4.53
Zooplankton	0.00	0.29	606.49

Source: Mustafa, M. G. 2003

Tropical sandy beaches and sand flats are dominated by crustaceans, mainly crabs, and bivalve mollusks and tropical mudflats have a high proportion of polychaetes and micro-crustaceans as they are motile and possess more rapid escape mechanisms to avoid high temperatures, salinity and desiccation as revealed by behavioral studies (Ansell & Trevallion 1969, McLusky et al. 1975, Jones 1979).

Identified Fishing Zones in the Bay of Bengal - Biological characteristics the occurrence of marine species - both plants and animals - has largely been controlled by the physico-chemical properties of ocean water. Water discharges from the surrounding river catchments carry huge influx of sediments full of nutrients to the Bay, particularly along the near shore region. This has turned the Bay into a fertile marine fishing ground of the region. The near-shore up-welling zone not only has a high yield of nutrients, but also is a high primary production area for the phytoplankton and related zooplankton zones.

Fishing the hydrological conditions of the Bay of Bengal is favorable for a variety of shrimps and fishes. Although fishes remain scattered in the Bay in some places they get concentrated and constitute important fishing grounds. Four fishing grounds (Figure 19) have been identified so far. They are south patches, south of south patches, middle ground and Swatch of no Ground.

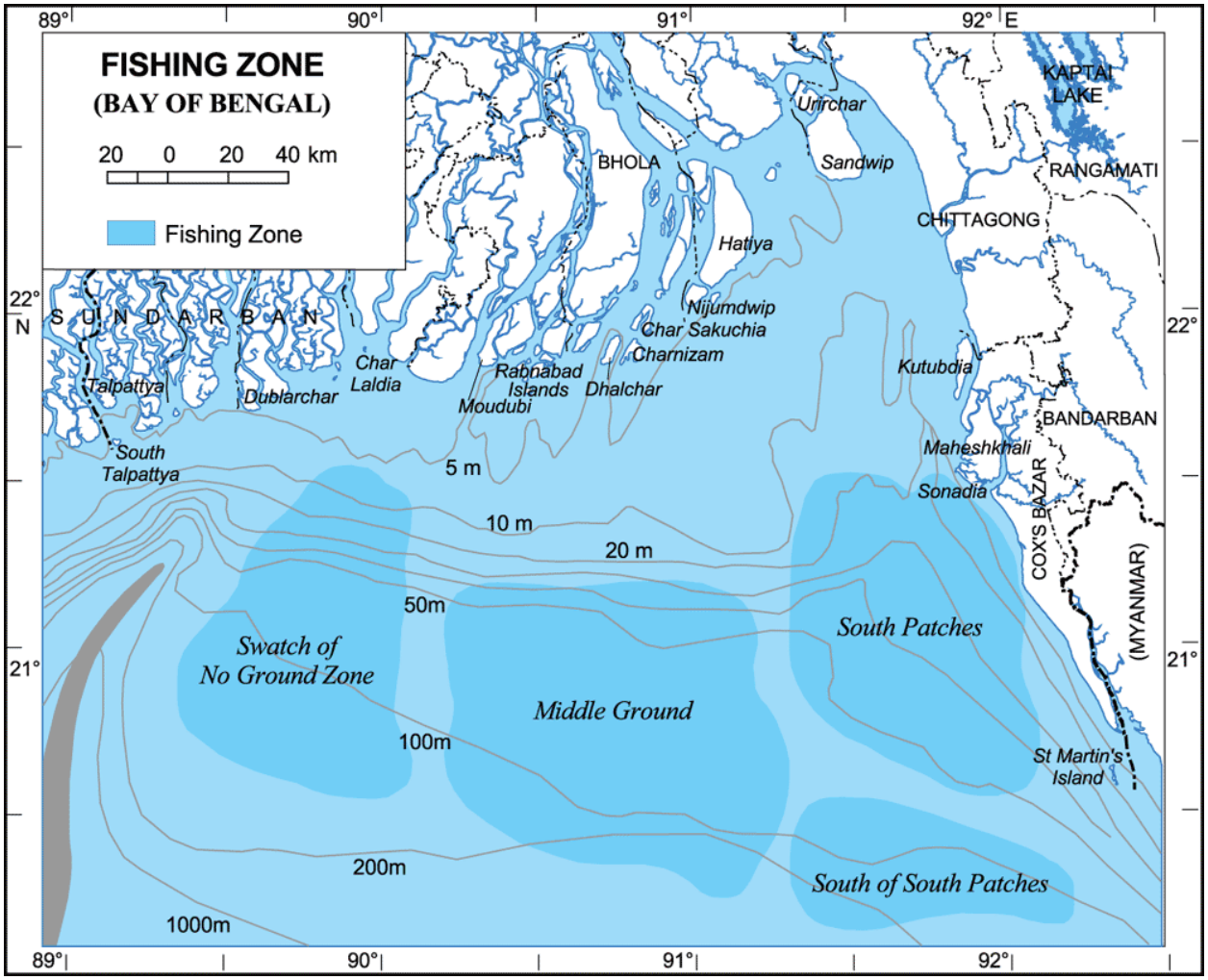


Figure 19 Identified Fishing Grounds in the Bay of Bengal

Swatch of no Ground located at 89.35ºE to 90.10ºE and 20.55ºS to 21.55ºS, about 30 km away from Dublarchar and 40 km from Sunarchar. Total area is about 3,800 sq. km, of which 70% is more than 40m deep. Overall depth of the area ranges from 10m to 100m. Bottom sediment consists of muddy sand. Surface salinity is 28% to 34%, while the bottom salinity is 30% to 35%.

All these fishing grounds are potential reserves for fish and shrimp. Most of the known commercial species of shrimps and fishes are harvested from these areas by trawlers or mechanized fishing boats. Commercially important shrimp and fish species include tiger shrimp, karuma shrimp, cat fish, Bombay duck, snapper, flounder, Indian salmon, crocker, sea bream, jewfish, mullet, pomfret, ribbon fish, anchovy, hilsa, oil sardine, tuna, mackerel and skipjack.

4.3 Environmental Quality

In order to assess the environmental quality of the Project area, air quality, noise level, riverbed sediment materials, and benthos samples have been collected from three locations in July 2015. An environmental sampling map has been developed and shown in Annex 2.

4.3.1 Air Quality

The air shed dimensions for assessment possible impacts were 50 m centered over the dredging area. Air quality samples were taken at three sampling stations. Tests were completed for carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), large particulate matter (PM_{10}), and small particulate matter ($PM_{2.5}$) (Table 21).

Table 21: Ambient Air Quality Condition along Project Corridor

Sampling ID	Sampling Location	CO µg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	Air Temp °C
AAQ_01	Proposed Jetty Area	319.74	60.29	0	9.12	51.33	24.01	26
AAQ_02	Settlement Area	509.33	73.27	0	14.76	61.99	29.06	26
AAQ_03	Shalobunia	199.28	54.01	0	7.33	30.49	17.66	25
DoE Standard (2006)		**40,000**	**100**	**365**	**235**	**150**	**65**	**-**

Carbon monoxide ranged from 199 µg/m^3 to 509 µg/m^3 and nitrogen dioxide ranged from 54 µg/m^3 to 73 µg/m^3. Ground ozone ranges from 7 µg/m^3 to 14 µg/m^3. However, no sulphur dioxide was detected in any of the three samples. Particulate matters PM_{10} and $PM_{2.5}$ ranges from 30 µg/m^3 to 62 µg/m^3 and 17 µg/m^3 to 29 µg/m^3 respectively. All parameters shown in Table 21 were within the acceptable limits specified by DoE[4].

4.3.2 Noise Level Measurements

There are no major noise pollution sources in the Project areas. Noise measurements were recorded at three locations and the existing ambient noise level at averaged between 49 and 54 dBA during the daytime which is within the DoE standard for residential land use zones except location 2 (NM_02) that is found 54. The reason of this slight increase may be due to the presence of people around the testing site and also the interference of background noise e.g., adhan from mosque, human chatting close to machine, and insect sound. Table 22 shows the level of noise measurement in the project area.

Table 22: Noise Level in Pre-monsoon Season (within 100 m of RoW)

Sampling ID	Sampling Location	Sampling Date	Noise level (Laeq) dB (Daytime)
NM_01	Proposed Jetty Area	26 July 2015	50.67
NM_02	Settlement Area	26 July 2015	54.39
NM_03	Shalobunia	27 July 2015	49.87
DoE Noise Standard (2006)			**Day**
		Silent areas	45
		Residential	50
		Mixed	60
		Commercial	70
		Industrial	70

Note: Cells shaded in light grey show readings taken as a train passed the sampling

[4] DoE, 2005. Amended by notification SRO 220-Law/2005, Dhaka: Department of Environment, Ministry of Environment and Forests, GoB.

4.3.3 Surface Water Quality

Industrial and fecal pollution are serious environmental problems in the area particularly in the rivers near Khulna and Mongla towns. A survey in the mid-1990s showed that the Khulna district had about 200 industrial units, most of which were located along the Bhairab River and discharging untreated effluent into it. Shrimp farming is another major polluter in the area. There are about 2365 Singri Gher (Prawn farm) in Mongla covering 9787 hectors. This causes environmental degradation to water and soil resources of the project area. Due to reduction in upland flow of the Ganges, the salinity level within the area has increased, which has caused adverse impact on social and biological environments in the Project area. The situation is becoming worse due to the increased discharged of untreated industrial effluent into the rivers and other water bodies. Population pressure is aggravating the situation.

High salinity in the surface water in the area has restricted their use in agricultural and for industrial purposes. In addition, salinity also inhibits use of water for domestic purpose. Despite these limitations, surface water in the area is used for navigation, gher fishing, and agricultural, industrial, recreational and domestic purposes.

The effect of the salinity zone varies greatly between the monsoon season and the dry season due mostly to the strong influence of the Meghna freshwater discharge, which in the monsoon season creates a huge plume of freshwater into the Bay of Bengal influencing salinities over 120km from the mouth (OGDA, 2001). In dry season the saline front intrudes past Khulna. Maximum salinity data covering the periods from 1980 to 1995 shows that it varies from 4 ppt[1] to 18 ppt at Khulna, 9 ppt to 25 ppt at Chalna and 10 ppt to 20 ppt at Bagerhat (EGIS, 2000). Table 23 shows the water quality data at Mongla Ferry Ghat. Table 24 shows the maximum level of salinity in the project area for dry periods of the years 1968, 1976, 2009 and 2011.

The consultants have collected water sample of Pussur River from two locations and analyzed for pH, Electrical conductivity (EC), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), TDS, Chloride and Turbidity. The results indicate that river water has high dissolved solids, turbidity, EC and chloride. Chemical contamination is also quite high.

Table 23 Surface Water Quality Analysis of the Pussur River in the Study Area

Location	pH	EC	Turbidity	TDS	DO	COD	Chloride	Date of sample collection
		µS/cm	NTU	mg/l				
Mongla Ferry Ghat	7.53	2050	823	1849	3.49	17	1150	26.02.12
Koromjal Forest office	7.47	3200	813	1951	3.22	20	1250	26.02.12
Drinking water standard	6.5-8.5	-	10	1000	6	4	600	

Source: Field Survey

[1] 1 ppt = 1000 ppm ; ppt = one part per thousand; ppm = one part per million

Table 24 Highest Monthly Water Salinity at Khulna and Mongla (ppt)

Stations	Year	March	April	May
Khulna	1968	0.34	0.45	1.0
	1976	7.2	13.5	13.6
	2009	10.43	13.69	13.50
	2011	12.20	16.20	16.80
Mongla	1968	7.5	NA	NA
	1976	12.5	16.5	18.5
	2009	12.65	15.43	15.46
	2011	14.40	19.40	20.70

4.3.4 Ground Water Quality and Availability

The project area is in proximate to Sundarban Reserve Forest, which is gradually extended to the Bay of Bengal. In the northern portion of the project area, groundwater is used for industrial, domestic and irrigation purposes. But at the port area there is hardly any potable ground water.

The general land elevation of the area is generally low; with an average elevation is 3 meters. The fluctuation of groundwater table in the study area, which is influenced by the tide, is insignificant. The use of groundwater for irrigation and industrial purposes is not significant. The upper clay and silt layer is thick, which extends up to 100-m meter depth.

It is observed from groundwater table data that the groundwater fluctuation of Bagerhat and Khulna Sadar are insignificant and the depth to groundwater tables are shallow, which indicate that the groundwater use is limited. BWDB have a limited number of monitoring wells in the area from which groundwater samples are collected for water quality analysis. Available data on groundwater quality suggest that in Khulna city, the TDS values are high, around 1000 mg/l. The chloride and iron contents are also high. Presence of high levels of arsenic has also been detected in the area. Groundwater salinity in the southwest region varies significantly both spatially and with depth. Fresh water lenses of variable thickness occur, which are underlain by brackish/saline horizons. Fresh water occurs in a deep aquifer where this aquifer is separated from the overlying aquifer by low permeable clay layers. There is concern about possible intrusion of saline groundwater in the coastal region due to large-scale groundwater abstraction that may affect the dynamic balance. Table 24 presents groundwater quality data of existing shallow Tube well in the project area.

Most of the villagers in the project area use ground water for drinking and others purposes which is mostly extracted from the shallow depth aquifer. However few deep tube wells have been sunk for accessing the deeper aquifers. The ground water has negligible salinity and it is not an arsenic affected area. In Mongla port area and surroundings ground water quality is saline. As part of this assignment the Consultants have generated primary data through collection of ground water samples from two locations at the port location. The parameters of ground water monitoring were pH, Arsenic, Chlorides, Iron, Chlorides as residual Chlorine, Coliform, etc. All the parameters except TDS, EC, iron and chloride have been found well within limits specified for Drinking Water in Environment Conservation Rules, 1997.

Table 25 Ground Water Quality Analysis in the Study Area

Sample Location	PH	EC	Cl	TDS	N2	Fe	As	Collection Date
		µS/cm	mg/L					
Mongla Port Jame Mosque HTW, Depth 60 feet	6.87	-	65	380	7.0	5.5	ND	Oct., 2003
Balir Mat Mosjid STW, Mongla	7.1	4410	1500	2573	0.3	1.7	0.001	26 Jan., 2012
Drinking water Standard	6.5-8.5	-	600	1000	10	0.3-1	0.05	

Source: IWM report 2011

4.3.5 Riverbed Sediment Quality

Analyses of Riverbed sediments of Pussur River are important. This has implication on the safe disposal of dredged material on land and its use as filling material. Riverbed materials (mainly sand) in a significant quantity will be required to be dredged. Total quantities of dredged materials preferred option is estimated as 3.8 Mm3. Some of the dredged material will be used for filling of low land areas around the project site. Samples of Riverbed materials were collected using Eckman Dredger Sampler from three locations of the Pussur River during July 2015 to identify the heavy metals presents in the dredge materials and determine their concentration. Test results are given in Table 26. Bangladesh has not established any standards for riverbed materials. Therefore, test results were compare with US EPA guideline. The results show no significant level of heavy metals in the sediments and the test results of these locations satisfy the guideline of Prediction of Sediment Toxicity using Consensus-based Freshwater Sediment Quality Guidelines, US EPA, 2000. The technique used to collect riverbed sediment quality materials is shown in Figure 20.

Table 26 Analytical Test Results of Riverbed Sediments Quality, July 2015

Parameter	Unit	RBM- 1	RBM- 2	RBM- 3	PEC**
Chloride	%	0.11	0.02	0.01	-
Electrical Conductivity	µS/cm	410	916	463	-
Cadmium (Cd)	mg/kg	0	0	0	4.98
Copper (Cu)	mg/kg	23	28	91	144
Zinc (Zn)	mg/kg	49	54	64	459
Mercury (Hg)	mg/kg	0	0	0	1.06
Lead (Pb)	mg/kg	9.4	9.4	7.7	128
Arsenic (As)	mg/kg	29	35	30	33
** PEC: Probable Effect Concentration, Prediction of Sediment Toxicity using Consensus-based Freshwater Sediment Quality Guidelines, US EPA, 2000					
- no guidelines					

Sampling of RBM_01 and Ben_01 using Eckman Dredger near the Power Plant site dated 25/07/2015 at 12:40 PM

Sampling of RBM_03 and Ben_03 using Eckman Dredger at Shalobunia dated 25/07/2015 at 10:15 AM

Figure 20 Riverbed Sediment Materials Sampling at Project Area

4.3.6 Benthos

Three sediment samples were collected using an Eckman Dredger Sampler and the samples were stored in the icebox after sample collection. Identification of the benthic fauna to the nearest taxon, and density was determined at the Department of Zoology, University of Dhaka. Benthic communities act as indicators of long-term changes and provide useful information during monitoring. Benthic fauna, by virtue of their intimate association with the sedimentary matrix, relatively sedentary habits, and role as a forage base for higher trophic levels, comprise the most likely component in which cumulative impacts of dredging and disposal might appear.

The soil sample is dominated by sand. In total eight specimens of animals were observed. They are all Polychaetes (Phylum Annelida). The identification is done up to family level (Table 27). Figure 21 shows the field methodology of benthic sampling.

Table 27 Benthic (sediment) Fauna Identified in the Pussur River Channel between MP and Rampal

Sl.	Name/ Group	Number (Density/225cm²)		
		Location 1	Location 2	Location 3
1	Neanthes sp.			2
2	Peloscolex sp.	1	2	
3	Pristina schmienderi			1
4	Aeolosoma sp.	2		
5	Lumbriculus sp.	1		
6	Neanthes minicola		1	
7	Limnodrilus sp.	2	1	
8	Unidentified oligochaete		1	3
	TOTAL	**6**	**5**	**6**

Collection of Benthos using the Sieve at the project site

Completion of Sieve Analysis for Benthos Samples

Figure 21 Benthos Sampling at Project Area

Comments:

- All species identified in the three locations are common in all rivers of Bangladesh.
- None of these species are fall any threatened species list.
- The dominance of polychaete number indicates the abundance of organic materials in the sampling area.
- Polychaetes are the good source of food for animals, especially bottom feeder fish and shrimps. As a food, naturally these animals serve as a source of lipids for fish and shrimp to get mature.

4.4 Socio-economic Environment

4.4.1 Socio Profile

The general purposes of social impact assessment (SIA) is to define the present socio-economic conditions of the people of the project area which will provide sound reference and assess probable socio-economic impact of the proposed interventions. This will enable us to compare the changes and impacts of the project interventions in future.

The socio-economic baseline scenario describes the socio-economic characteristics project area on the basis of primary and secondary data. The socio-economic characteristics include administrative area, demographic, household size, education, occupation, housing, employment opportunity, health, housing, access to water and sanitation status, etc. The findings of baseline survey in respect of socio-economic conditions are given below. A details land use map has been provided for the Project area in Annex 2.

Administrative area and location

The project area lies within the administrative area Rampal upazila of Bagerhat district. The Rampal became a police station in 1892 and was upgraded as upazila 1983. This upazila consist of 10 union, 118 Mauza, and 134 villages. The proposed dumping area for the dredge

material is under Rajnagar union. Figure 22 shows the administrative units consists within the project area.

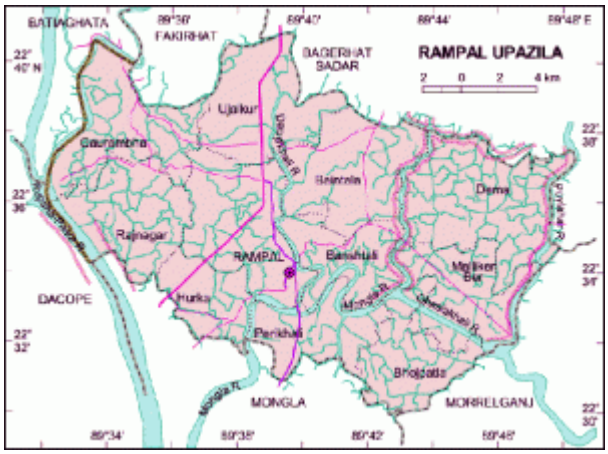


Figure 22 Administrative Units of the Study Area

The Passur River flows beside the union. This is costal area and very close to Sundarban, mangrove forest and world heritage. Crop intensity is very low, only one crop is produced. Shrimp is the main cash crop and more than 80% land is used for the shrimp cultivation.

Demographic Features

The demographic characteristics of Rampal show the proportion of the male and female is fifty-fifty. According to 2011 BBS census report, Rampal had a population of 154,965. Among them, 77,504 are male and 77,504 are female. The population of Rajnagar union is only 13,593. The growth rate is -1.38 which is far below the average rate in Bangladesh (1.47). It is very rare to have a decadal trend of population growth in Bangladesh. We are assuming that these might happen due to climate change effect in the coastal area. People are migrating to other region. The livelihood became difficult for poor people. Shrimp cultivation was dominating economic activities for the last decade and this activity is capital intensive. Rice production was more labor intensive sector which replace by shrimp cultivation.

The average family size is 4.04 which is little below the national figure 4.44. The population density per sq. km 1003 in Rampal Upazila which is very close to national figure is 976 (Source Census 2011, BBS).

The marital statuses show an interesting finding; 9.3% female are widow whereas male are only 0.9. It means female widow are 10 times higher than counterpart. This may be due to “age at marriage”, female are getting marriage at very early age compare to male.

The rate of disability (a physical or mental condition that limits a person's movements, senses, or activities) is 2%.

The percent of people up to the age 14 is 29.2 % and 10.3% People are above 60 year old. The majority people belong to working age i.e. (15- 59). The age heaping found abnormally in the 30-49 year age group, almost one third of the people constitutes this group (Table 28).

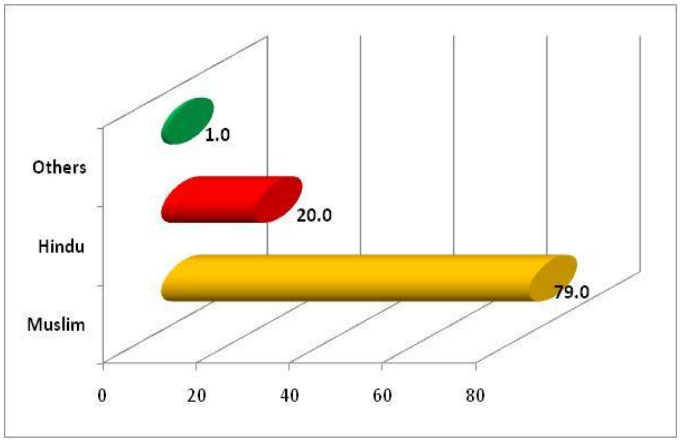
Table 28 Population Distribution by Age and Ethnicity

Age group	0-4	5-9	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
% of population	8.1	10.1	11.0	7.7	8.0	8.9	28.1	7.8	3.3	7.0

Some Ethnic people have been living here and their number is 3327 among them Barmon (657), Khiyang (24), Chakma (10) and others (2636), but it is interesting that there is ethnic living in Rampal Upazila.

Religion and ethnicity

The Muslim community (79%) dominates in terms of faith. The second group goes to Hindu who is 20% and other groups (Christian and Buddhist) are very negligible in percentage. Previously it was dominated area of Hindu community.



Education

The literacy rate in the project area around 58 percent (Male 59.6, Female 56.4) whereas national figure is 51.8 percent. Male are the slightly ahead in literacy rate. School Attendance (5 to 24 years) around 56.8 percent in the project area and the national figure is 52.7and the school attendance rate is improving quite satisfactorily; it was only 42.8% in 2001. Male female discrimination is found in higher education, female representation is very minimal. The literacy rate is increasing very slowly. It was estimated at 57.3% in 2001.

Employment

Agriculture is the main profession of project area and as a rural area it very common in Bangladesh. The livelihood of 66.1% people depends on agriculture activities. The second sector goes to service which is 30.0%. Very few numbers (3.9%) of people engaged in Industry sector. The table is constructed based on 102713 number of people and it does not mean there is no unemployed rather it consider only the people who are age of 7 plus and who have employment. The national figure for agriculture and non-agriculture is 46.4% and 53.6% respectively (Table 29).

Table 29 Main Profession by Gender

Sector	Agriculture		Industry		Service	
Gender	Male	Female	Male	Female	Male	Female
%	63.8	2.3	3.3	0.6	26.1	3.9
Sector %	66.1		3.9		30.0	

The labor force (age between 15 to 59 year) is the actual number of people available for work is 61.5%. The labor force includes both the employed and the unemployed. The percent of people

up to the age 14 is 29.2%. People above 60 years old are 10.3%. So the 39.5% people depend on the 61.5%. The dependency ratio is quite high.

Sanitation and Waste Management

The sanitation system is improving in the project area, only 19.5 percent of household have non-sanitary latrine which is much lower than national figure (35.1%) and the majority people (43.3%) use non water sealed toilet. 35.4% HH use sanitary (water sealed) latrines which is second dominant group. Only 1.8% HHs have no toilet facilities (Source: Census, 2011, BBS). It is observed Khulna division has 15.1% morbidity and female (15.5%) were reported more morbidity compared to male (14.7%).

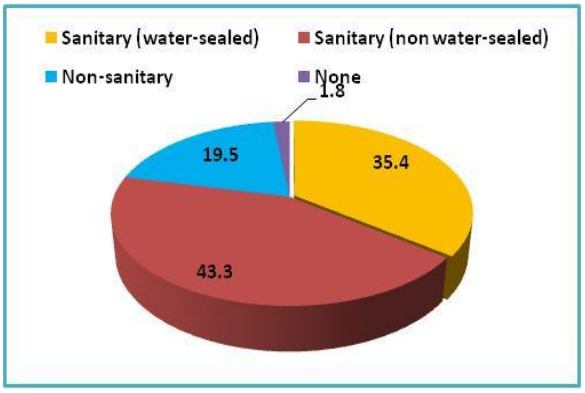


Figure 23 : Distribution of percentage by Sanitation

Health and Social Services

Socio-economic conditions affect the health status of people by causing differential access to such determinants of health such as adequate food and nutrition, sanitation, a safe water supply, housing, education, and health care. There is a direct correlation between the socio-economic status of households and their access to health care. In many parts of the Khulna Division, an inadequate road system also influences access, which is true in the case of Mongla as a whole. Though it is very likely to expect the improved health and sanitation condition of the Mongla Port and Municipality area but in practice it is far below the expectation. Table 29 summarizes key indicators of the health status of the region over the period from 1996 to 1998. There has been a decrease in the birth rate over the last decade due to the impact of family planning efforts; however, infant mortality rates remain high and the life expectancy is relatively low at around 60 years (Table 30).

Table 30 Health Indicators of Khulna Division

Health Indicators	1996	1997	1998
Crude birth rate (per 1,000)	25.6	21.0	19.9
Crude death rate (per 1,000)	8.1	5.5	4.8
Infant mortality rate (per 1,000 live births)	67	60	57
Maternal mortality rate (per 1,000 live births)	4.4	3.5	3.0
Life expectancy (years)	58.9	60.3	60.8

Source: Country Profile 2000: Bangladesh, E.I.U

Around 90% of the rural people in Khulna division have access to water from tube wells, ring wells or taps, compared to 97% of the urban population (Progotir Pathey, Unicef, 1999). However, salinity and arsenic contamination are persistent problems with the drinking water in the region. About 20 million (17%) of the total population of Bangladesh is potentially at risk of

arsenic, and Khulna division contains some of the most severely affected areas. Sanitation in rural areas is also precarious. In rural Khulna, only 10% use water seal latrines, and about half use pit latrines. According to UNICEF, only 18% of births take place with the help of a trained person, while the rest occur with untrained midwives. Virtually all births (95%) occur at home.

Acute Respiratory Infection (ARI) is very common in this area. There are also high rates of skin disease, such as scabies and fungal infection, particularly among women. Water borne disease is prevalent in areas where stagnant water is found. Women who process snail meat have been found to be particularly vulnerable to skin disease.

Data presented in Table 31 clearly indicates the health facilities available in these districts. In early 1960's most of the people living in these districts hardly had any access to the qualified physicians despite having lot of health hazards. People mostly suffered from the snakebites, wild animals' attack, stomach diseases and so on. But those could not be addressed well due to non-availability of adequate medical facilities and of qualified physicians. Even in late 1970's people often faced those types of problems on a wider scale resulting harm to their economic life considerably.

The data presented in Table 31 give the picture of a number of physical facilities available in the districts Khulna and Bagerhat. Under present system people from one area can easily have access to the main medical centers of another area. Nonetheless, it would be pertinent to mention here the health services rendered by different NGOs, as many NGOs working in these districts are engaged in rendering health services. But enumeration of such number of NGOs is not there, neither have their record of extent of services, nor have data on their numerical or of area coverage.

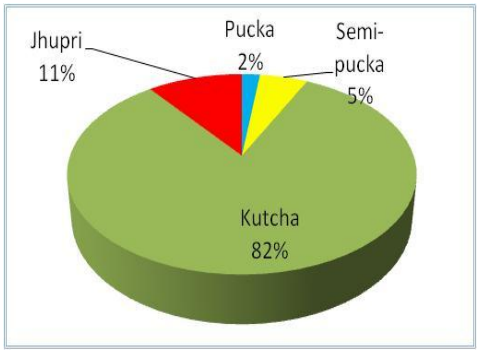
Table 31 Health Facilities at Different Districts

Sl. No.	District	District Hospital & No. of Bed	Other Hospital		Upazila Health Complex	Union Sub Center Rural Disp.	Other outdoor facilities
			Health Division	Private			
1	**Bagherhat**	1 (100)	-	3	8	8	1
2	**Khulna**	1 (150)	3	9	10	14	2

Source: Country Profile 2000: Bangladesh, E.I.U

Human Settlement in the Project Area

According to the Population and housing census 2011, Kutcha (82.1%) is the major among dwelling house structure followed by Jhupri (10.5%), semi-pucca (5.3%) and pucca only 2.0%. Kutcha and Jhupri are structures uses by poor people using locally available trees.



Housing Tenancy

Very few dweller of this area resides in rented house and they are only 1.4%. The majority 96.1% people live in own house or flat and some people (2.5%) found who dwell as rent free.

Electricity

According to population census and housing survey (BBS 2011), 31.4 percent household enjoyed electricity facilities in the project area. All the 10 union of the upazila have been brought under the rural electrification programs but many household have no access. More than 15% people use solar energy though it is expensive. Government is promoting this energy and the costal is the potential market. Very few people use Kerosene.

Source of Drinking Water

In Rampal upazila, 78.6% general household get the facilities of drinking water from tube-well, only 0.3% from tap and the remaining 21.1% household get water from other source. Rain water drinking becomes popular. People are not habituated to drink the rain water couple decade ago. This is a phenomenon change in water drinking behavior.

Transportation

Road is main communication in this district as well as the upazila now and all the upazila are well connected with the district head quarter. In the past, the main transport system was based on the water path. This area is going to enjoy rail communication with Dhaka very soon. An airport is under construction. The second largest port Mongla is very close and once the area was under the jurisdiction of this upazila.

NGOs in the Project Area

The major NGOs are working in the project area ASA, BRAC, Grameen Bank and Proshika. The major programs of those NGOs are Micro Credit, health, education and awareness and governance.

4.4.2 Economic Activities

The regional economy of Khulna, like the rest of the country, though is based on agriculture and fishing but shrimp culture and its related activities considered an important sector, which employ majority of the population. Land is cultivated intensively, with an average of two rice crops in normal course but land under shrimp culture is cultivate only one rice crop per year. The rainy season rice crops, Aman, Aush are flooded varieties planted during the monsoons and usually intercropped with fish and prawn. Fishing is a widespread household activity and is done in rivers, beels, public waterways, and ponds. Fishing is particularly important to village households since it constitutes the major source of protein of local diets. Fish are also marketed widely, and the region contributes a significant proportion of the national supply of dried and fresh fish. In the past, Khulna was also the primary center of jute production, although levels have dropped off in recent years. Farmers also grow betel nuts, betel leaves, fruits and vegetables, mustard seed and oilseeds, coconut, sugarcane, and Khejur date palm and the Tal palm trees. In the southern districts of Khulna, many people earn their livelihoods from extractive activities in the SRF. Many families diversify their income with various service and commercial activities such as small-scale trading, shop keeping, handicraft production, rickshaw and van pulling, and a range of skilled and unskilled labor occupations.

The major economic trend in Khulna has been the emergence of aquaculture, particularly of prawn and tiger shrimp farming. Over the last twenty years, the export of shrimp and prawn has grown into a $350 million export industry, and the capacity for growth has not yet been

Figure 24 Local Economy and Livelihood

exhausted. The tiger shrimp (Penaeus monodon), known as bagda, is grown in large saltwater enclosures. The owners of these farms tend to be wealthier families, who have invested in shrimp farming as a business opportunity. There is a considerable debate regarding the environmental and social impacts of bagda aquaculture. The freshwater prawn (golda), on the other hand, has become the economic mainstay of small-scale farmers, who grow the prawn in small enclosures (ghers). Due to highly positive returns, the construction of freshwater ghers has increased by 10-20 per cent per annum as reported by the CARE Bangladesh studies. Gher farming is now the primary livelihood strategy for more than 100,000 rural households in the southwest. However, day labors are also a common and one of the major income source for the people of the project area (Figure 24).

Gher Firming

The rise of gher farming in southwest Bangladesh is very much a part of the history of human intervention in a fragile and biologically diverse environment. During the 1960-80 period, major public works were undertaken to manage river flow and to prevent saltwater intrusion onto cultivable fields. The system of embankments and polders constructed for this purpose dramatically altered the natural ebb and flow of river and tidal waters. One of the unanticipated effects of this effort was to, and other problems. In response to increasing degrees of waterlogging, farmers in Fakirhat Upazila (Bagerhat district) introduced the freshwater prawn (Macrobrachium rosenbergii) into a pond with very favorable results. These innovators consequently devised a land management technology for prawn production on very small-scale holdings, building dike enclosures (ghers) around a field, and then excavating a trench inside perimeter of the field to retain water year round. During the 1980s, this technology, with its highly positive economic results, became widely known and was rapidly adopted throughout the region. Attracted by potentially high returns, increasing number of farmers has adopted

freshwater gher farming as their primary livelihood strategy. Table 32 shows the estimated numbers of freshwater ghers in Bagerhat, Khulna, and Satkhira Districts.

Table 32 Estimated Numbers of Freshwater Ghers in Khulna Region

District	Households with ghers	Ghers (number)	Survey (Year)
Bagerhat	31,073	35,098	1997
Khulna	23,514	30,245	1998
Satkhira	1316	1397	1998

Source: GOLDA Project surveys, CARE-Bangladesh.

In 1994, according to the Prawn Association based in Fakirhat, there were some 3500 gher farmers in Fakirhat Chitalmari and Mollarhat Upazila. This figure surpassed to 64,000 by 1998 and now exceeds 100,000 farmers. As shown in the Table 31 Khulna and Bagerhat districts have experienced the most dramatic growth in this technology.

Freshwater gher farmers tend to be small-scale landowners. In the largest producing district, Bagerhat, all of the landholdings for gher households are less than 250 decimals (about one hectare). The size of a gher itself averages around one bigha, roughly 0.5 acre (0.2 ha), and most households have only one gher. In some villages, several unrelated households in the community, in fact manage many ghers by sibling families cooperatively or even collectively. Thus, the gher technology is well adapted to the pattern of smallholdings found in the region (Table 33).

Table 33 Total Landholdings for Gher Households in Khulna Region

Total land (including ghers) in decimals	<50	50-100	101-150	151-200	201-250	>250
	% HH	% HH	% HH	% HH	% HH	% HH
Bagerhat	19.6	27.0	21.8	13.6	18.0	0.0
Khulna	14.2	12.6	12.4	11.4	9.3	40.1
Satkhira	0.0	40.0	0.0	20.0	20.0	20.0

Source: Greater Options for Development through Aquaculture (GOLDA) Project, CARE- Bangladesh.

Environmental and Social Concerns with Gher Farming

In the areas where it has developed, freshwater prawn farming has had a dramatic effect on the rural landscape. In some parts of the region, significant areas of low-lying floodplain have been converted into ghers, and there is concern about possible adverse environmental effects. In some cases, unplanned gher expansion has reduced the beel area and blocked fish migration routes, caused or increased drainage problems and reduced the grazing areas available for livestock. Good quality hatchery golda seed (post-larvae or PL) meets only a very small proportion of the existing demand, and during the last decade the capture of wild PL in the coastal and riverine regions has intensified dramatically, raising concerns about the threat to both the stocks of wild prawns and the other fish species that are caught in the nets.

Gher farmers have traditionally used the meat from the freshwater apple snail (Pila globosa) as the preferred prawn feed. As gher farming has expanded, the demand for snail meat has grown and the harvest of snails has intensified so much that they have now disappeared from many local wetlands. Collection areas now extend to remote districts and snails are transported long distances by boat and truck, even airplane, to satisfy the demand. Snails are now imported from as far away as Gopalgonj, Faridpur, Madapur, Jalokathi and Barisal because they have become

virtually extinct in Bagerhat, Khulna, Gopalgonj and Jessore. The processing of snails (the extraction of the snail meat from the shells, primarily by women) has also been identified as a source of skin and respiratory disease, and the discarding of shells into waterways has been cited as a cause of localized solid waste problem and water pollution.

Project documents have identified concerns regarding a number of socio-economic issues. The conversion of rice land to gher development has reportedly reduced opportunities for sharecropping among landless families, although gher sharecropping has been documented and labor opportunities for day labor and gher guarding have increased.

Heritage, Archaeological, Historical Treasures and Scenic Areas

With regards to the aesthetics of Khulna region, the Sundarbans the world heritage and the largest mangrove forest of the world is located there. It is surrounded by the southern part of Khulna Division and is the major attraction of tourists from all over the world. The Sundarbans also protect the region from the tidal surge, storms and cyclones from the adjacent Bay of Bengal. The Mongla Port and its surroundings also enrich the aesthetical character of this region.

Besides these, the Khulna region is being historically older than many parts of Bangladesh, characterizes by different historical and architectural attractions. Among different monuments, a list of nationally and internationally known historical and cultural properties in the area is as follows.

1. Khan Jahan Ali's tomb, Bagerhat, erected in 1459 A.D.
2. Saith Gumbad Mosque, Bagerhat (exterior view).
3. Saith Gumbad Mosque, Bagerhat (interior view)
4. Kodla Math, Bagerhat, 16th Century A.D.
5. Masjedd Kur Mosque, Khulna (4. 15th century A.D.)
6. Bibi Begni's Mosque, Bagerhat (Khan Jahan Aki style. 4. 15th Century
7. An image of Mahishmardini in black basalt, 11th Century A.D.
8. Tenga Mosque, Shyamnagar
9. Ranbijoypur Mosque, Bagerhat
10. Mr. Morrell's monument, Morrellganj.
11. Nine-domed Mosque, Bagerhat (Khan Jahan Ali style, 4. 15th Century AD)

However, no heritage, archaeological, historical treasures are recorded within 2km from the project site.

5 Analysis of Alternatives

Consideration of suitable site selection for dredging as well as safe disposal of dredged spoils is essential to arrive at feasible and environmentally sound option. For the present project several alternatives were considered by the Consultants by using modelling tool and analyzing hydro-morphological characteristics of the offshore Outer Bar area of Pussur Channel. One of the main challenges of dredging program is disposal of dredged spoil, which requires technical, environmental and social considerations. The dredged spoil is, in principle, disposed on the locations where natural sedimentation may not be expected and there is no scope of re-suspension of dredged spoil into the dredged channel. These locations are the inner bends, abandoned channels, deeper channel with strong currents, along the shoals and on slope of swatch of no ground.

In the present dredging project, IWM has conducted detailed field survey at two alternative locations around proposed dredging site at Pussur River channel between Mongla port and Rampal Power Plant in July 2015. The bathymetric survey result shows that approximately 3.881 million cubic meter of dredged spoil will be required to handle in an environmentally safe and sound manner. Figure 26 shows the locations of alternative dumping sites in the offshore area of Pussur Channel.

5.1 Disposal of Dredged Materials

The extent to which dredging as well as disposal of dredged materials might affect river ecosystem which is highly varied and site specific. Factors influencing the potential effects of dredging and disposal are:

- Magnitude and frequency of dredging activity;
- Method of dredging and disposal;
- Channel size and depth;
- The size, density and quality of the material;
- Intertidal area;
- Background levels of water and sediment quality, suspended sediment and turbidity;
- Tidal range;
- Current direction and speed;
- Rate of mixing;
- Seasonal variability and meteorological conditions, affecting wave conditions and freshwater discharges;
- Proximity of the marine feature to the dredging or disposal activity, and
- Presence and sensitivity of animal and plant communities (including birds, sensitive benthic communities, fish and shellfish).

5.2 Without the Project Alternative

As the implementation of this project is directly connected to the operation of the proposed power plant at Rampal, the significance of this Project is high as it is directly related to the economic development of country through power generation. Without the implementation of the project, the proposed power plant will not able to commence the operation of their plant which will causes no additional power supply to national grid. As Bangladesh has severe shortage of

power during peak hours, the operation of the power plant will significantly contribute to the additional 660 MW power to national grid by 2019. Additional 660 MW power will also be added in 2025. Without the project, the development growth of Bangladesh will slow down or become constraint.

5.3 Alternative to the Project

5.3.1 Alternative Disposal Options

River disposal of dredged material constitutes one of the most important problems in river zone management and in some areas represents the major anthropogenic disturbance to the benthos. Macro-faunal communities typical of environmentally stressed or high energy habitats are more resilient than those of more environmentally stable habitats. Invertebrate recovery following dredged material disposal in relatively unstressed fresh water environments generally takes between 1 and 4 years, while in more naturally stressed areas, recovery is generally achieved within 9 months, although deeper polyhaline habitats can take up to 2 years to recover. Differences in recovery times are attributed to the number of succession stages required to regain the original community composition and that species typical of naturally unstressed assemblages do not possess life-history traits to allow rapid decolonization of disturbances. Since the natural disturbance regime appears to be very important in determining the response of a benthic community following dredged material disposal, it is recommended that when predicting the potential environmental impact of an operation, the nature of the physical environment in combination with the status and role of associated aquatic benthic communities should be considered.

Selection of proper dredging and transport equipment and techniques must be compatible with disposal site and management requirements. Three major alternatives are available:

- On-land disposal (Beneficial use).
- Confined disposal.
- Open-water disposal.

Each of the major alternatives involves its own set of unique considerations, and selection of a management alternative should be made based on environmental, technical, and economic considerations.

Promising areas for dumping dredged material may be: (1) areas with high natural sediment concentrations; (2) areas with erodible material; (3) areas with a potentially high current velocity, either natural or artificial; (4) areas in the vicinity of deep troughs; (5) areas with material of low level contamination.

One of the objectives of the study is to identify a potential disposal site for the dredged material. To search for a suitable disposal site, multidisciplinary Consultants visited few locations within close proximate to the Project area. Phase II of proposed Rampal Power Plant (RPP) is located approximately 13 km north from Mongla port and close to the end of the project area. IWM team met the representative of the RPP discuss their interest on spoil disposal issue. Mr. Dev of RPP confirmed the IWM team that they will be happy to take the dredge materials which will help them to develop the site faster. Second location was about 6km from the Mongla port on the

right bank of the Pussur River which owns by the Orion Group. Representative of Orion Group also has shown their interest to take dredge materials at their land.

Therefore, following sections of this Chapter discusses the potential on-land disposal issues as this option found the most convenient and economical solution to dispose dredges materials. Deep Sea (open-water) option has not studied as the nearest and possible sea disposal site that is the swart of no ground located around 100 km south of the proposed dredging location. Confined option is not a suitable option as well.

5.3.2 Disposal Site Selection

Disposal of dredged spoil is the main concern of the project. The project area lies in the channel of Pussur River and there are limited fallow lands. Though crop intensity is low and salinity is high, that's why people became interested in shrimp farming. Most of land is occupied for agriculture and fishing. It is difficult to find dumping area in the project area. The disposal of dredged spoil requires technical, environmental and social considerations. In the proposed dredging project, IWM conducted a detailed site reconnaissance survey around the Project area to identify possible soil disposal locations.

The consultants also discussed this issue with several senior officials of MPA, BIFCL, and Orion Group. Socio-economic survey conducted around the Project area where local people proposed few suitable spoil dumping areas. Key informant interview (KII) with local elite like Union Parishad member, chairman, mayor, expert are conducted. Through the discussion and consultation with local people, local elected bodies, expect, some the possible areas have been identifies and these are shows in Figure 25 below.

Figure 25 Potential sites on the right bank of the Pussur River for dumping dredged spoil

Specific Criteria for Site Selection

In the selection of disposal sites, in addition to other necessary or appropriate factors, the following factors will be considered:

1. Geographical position, depth of water, bottom topography and distance from dredging site and the river bank;
2. Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;
3. Location in relation to other amenity areas;
4. Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any;
5. Feasibility of surveillance and monitoring;
6. Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;
7. Existence and effects of current and previous discharges and dumping in the area (including cumulative -effects);
8. Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shell-fish culture, areas of special scientific importance and other legitimate uses of the disposal area;
9. The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;
10. Potentiality for the development or recruitment of nuisance species in the disposal site;
11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

Location-1: Northern part of the Proposed Power Plant

The Rampal Power plant site located at Rajnagor union of Rampal upazila. The Pussur River passes by west part of the union and it can be reached through a 10 km Upazila road directing to the west from the Khulna-Mongla highway at Bagerhat of Rampal.

It was learnt from the Power plant authority that the total 1834 acres has been acquired and out of which 485 acres of land has been filled with earth. The remaining 1349 acres of land is the first possible option for the dumping. This is huge area and most potential for the dumping of dredge soil. The crucial issue is the land is already acquired. Land acquisition is a complicated and expensive task. Sometime it takes huge time and has to face legal hazard. Here the project is fortunate that the land is ready to dump.

Location-2: Existing Developed Area of Proposed Power Plant

The Rampal power plant authority raised 485 acre land and the work is continuing. This area can be filled for further development. This is the adjacent area of location 1 describe above. The areas also located at Rajnagor union. At the moment there is scope to dump but if it is delayed the opportunity will be missed.

Location 3: Land of Orion Group

The Orion group has a plan to build another coal-based power plant adjacent to the Rampal power plant site. This area is located at Burirdanga union of Mongla upazila. The Orion group already acquired land and raise land by sand filling. But most of the land remains undeveloped. They are very much interested to collect dredge material. As per notice board of Orion group, the amount of land will about 200 acre. They acquired land by purchasing from local owner and this process is continuing. Some other entrepreneurs are coming in his area. During the field visit we found many areas are under developing by sand. This area (Burirdanga union) is low lying area which is considered the industry area. Land use is changing quickly and turn to non-agriculture.

The Banisanta union is opposite the Mongla port, or situated right bank of the Pussur River. This is under Dacope upazila of Khulna district. There are some pockets areas exist here where dredged spoil can be dumped. According to MPA officials they have acquired land lies this area. According to local people it is informed that two plot amounted 90 Bigha and 84 bigha lands are disputed where spoil can be dumped. This land may khas. Local people said that some influential people are occupied the land. We visit the areas and one GPS coordinate is (N-2227301, E- 8934913).

The MPA also claim that around 60 acres low lying land in Baniashanta area may be considered as another potential site for dredged spoil dumping. But local people don't certify the claim rather two above mention land (90 and 84 Bigha) can be easily use for dumping.

Location 4: Land of Individual Entrepreneurs

Another area (N: 2246829, E: 8958332) where entrepreneurs are developing land requires spoil but amount is not huge.

Location 5: Right Bank of Pussur River Inside Polder 33

The Banisanta and Bajua unions are under Dacope upazila. Parallel to the proposed dredging alignment which inside the polder 33 can be last option for spoil management. These are all agricultural land and land need to be acquired. We have talked with local union Parishad chairman and found that land can be acquired and they will cooperate to purchase land.

All above-mentioned locations are shown in Figure 26.

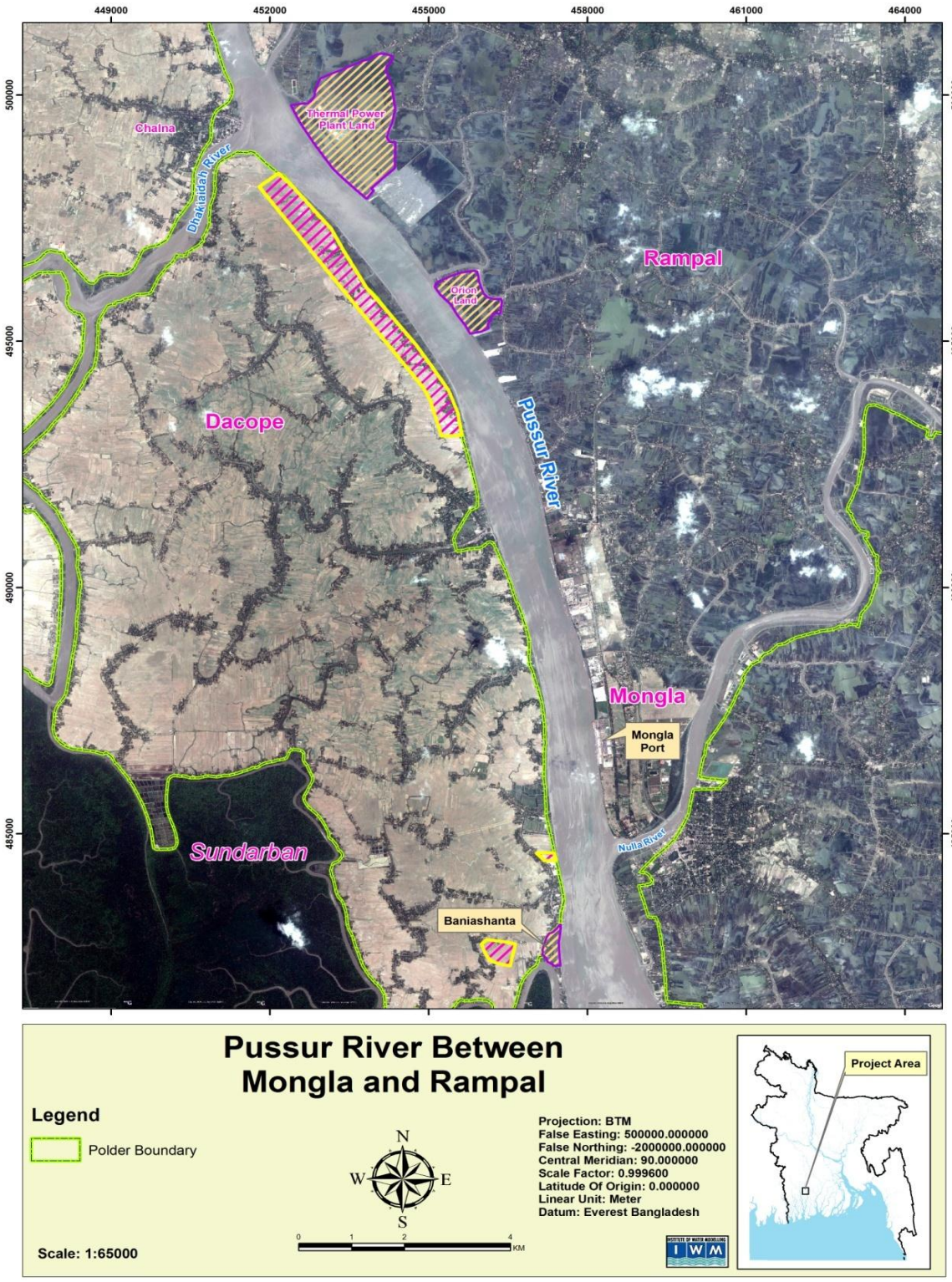


Figure 26 Possible Disposal Sites of Dredged Spoil Materials

All these locations except location 5, are primarily government acquired land and or private lands interested to fill their sites. These potential areas are near dredging site along both banks of Pussur River. This will provide the baseline status of the existing compartments for dumping dredged spoil. The hydrographic survey result shows that approximately 4.64 million cubic meter of dredged spoil could be accommodated in the surveyed dumping compartments which is sufficient for the expected dredged volume (4.196 Mm^3).

5.4 Alternative Channel for Dredging

Recently in December 2014 MPA has accomplished dredging in the harbor area of Pussur channel and has ensured safe movement of 7.5 m draft vessels along Pussur River from Outer Bar up to Mongla port. It is evident from the Navigable chart that for 7.5 m draft vessel required depth (5.5m CD) is available from Mongla port to the immediate downstream of Sabour Beacon. However, dredging is only required from Sabour Beacon to proposed jetty at Rampal based on bathymetry data of July 2015.

Based on bathymetric data (survey done by IWM July 2015), tidal characteristics, setback distance, sedimentation pattern and requirement of navigability (for 7.5 m draft vessels) in the Pussur river, two potential options have been considered in the study for capital dredging with the aim to improve the navigability of the river from Mongla port to Rampal as shown in Figure 8 and Figure 27. The details of the potential options are described in the following section.

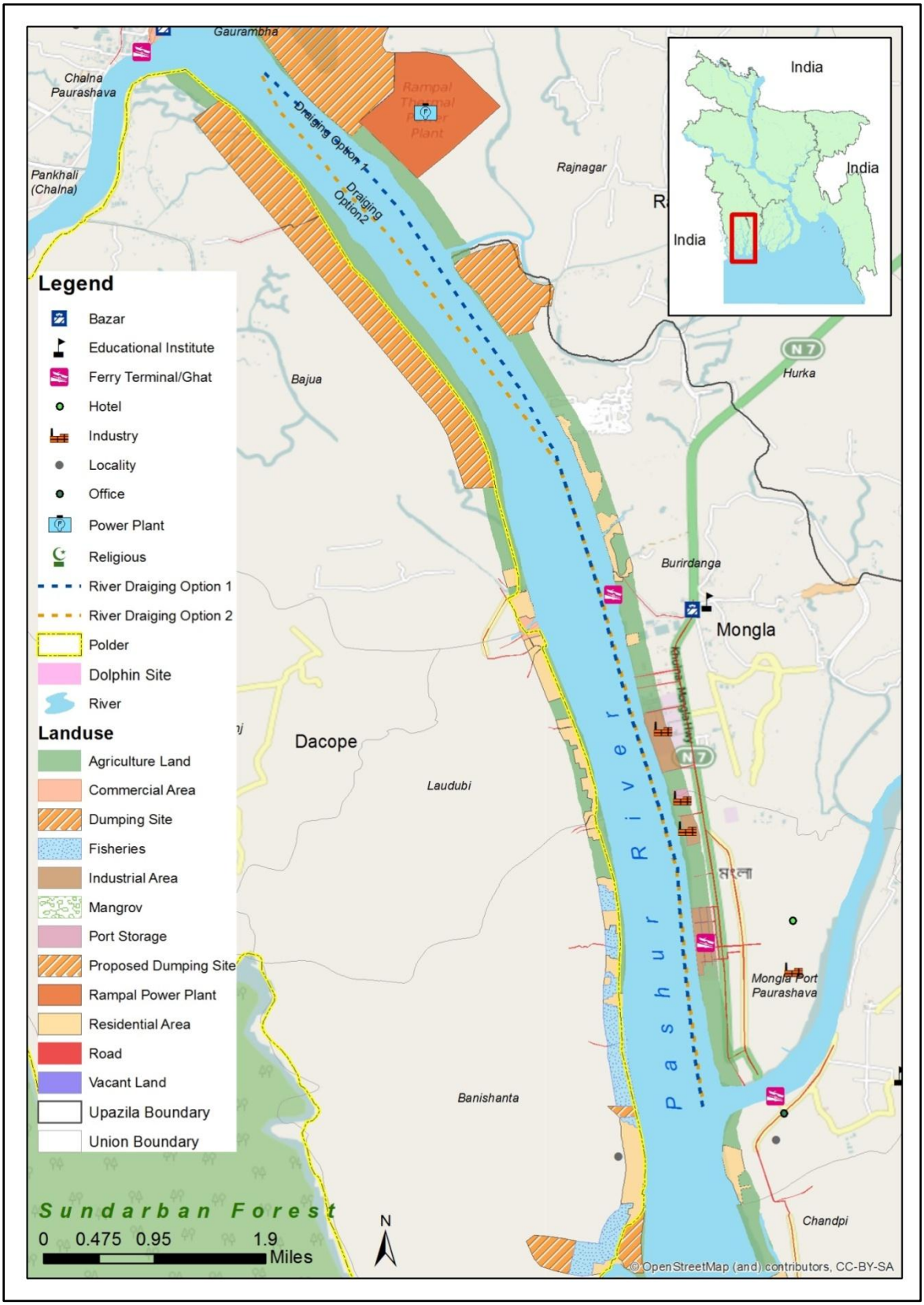


Figure 27 Proposed dredging Alignment of Option-1 and Option-2

Option 1 - In this option the dredging alignment is selected alone the thalweg line to minimize the capital dredging volume and shortening of navigation length. This option requires dredging of 2,900 m of Pussur River along the thalweg from Digraj to Maidara and 2400 m from Midara to Jetty front with dredging level at 5.5m CD. The dredging width is 200 m for both the river stretches. The dredged level is at 8m CD along proposed jetty front for a length of 500 m. The remaining dredging is 500 m length at the turning ground having width 300 m and depth 5.5 m CD. In this option the thalweg line is close to the river bank. The dominant flow direction is along the thalweg alignment. Therefore, in this option re-siltation rate is likely to be less. However, this alignment is close to the river bank. Therefore, there is a chance of erosion of the bank because of proposed dredging since near bank velocity would be very high in the dredged channel. The total dredged volume is 3.881 Mm^3 as shown in Table 33. Resiltration rate is about 70% to 75% after 1 year, which is illustrated in Table 34. In dredging volume computations, dredging tolerance limit of 0.3 m and side slope of 1:7 are considered.

Table 34 Summary of Volume of Dredging of Option-1

Alignment Reach (m)	Dredging Length (m)	Dredging width (m)	Design depth (m, CD)	Tolerance limit of dredging (m)	Volume of dredged spoil (m^3)
Power Plant TG	500	300	5.5	0.30	6,50,480
Jetty front	500	200	8.0	0.30	6,06,076
Jetty front- Maidara	2400	200	5.5	0.30	14,37,224
Maidara -Digraj	2900	200	5.5	0.30	4,20,936
TG Holcim cement factory Jetty to Sabur beacon	1650	200	5.5	0.30	7,66,071
Total volume of Dredged spoil					**38,80,787**

Option 2 - This option is same as Option- 1. Only difference is the alignment from Maidara to Jetty front. In this option from Maidara to proposed Jetty point the alignment is proposed far from river bank and deeper channel for more safety and avoiding likely river erosion. In option 2, the total length and dredged volume is slightly increased and sedimentation rate is more than that of Option- 1. In this option total dredged volume is 4.46 Mm^3 as shown in the Table 34. Capital dredging volume is increased by 15% in this option because of increased length and dredging depth. Resiltration rate is about 80% to 85% in this option, which is more than the Option-1 as shown in Table 35. In addition, volume of capital and annual maintenance dredging of option 1 and option 2 is shown in Table 36.

Table 35 Summary of Volume of Dredging of Option-2

Alignment Reach	Dredging Length	Dredging width	Design depth	Tolerance limit of dredging	Volume of dredged spoil
(m)	(m)	(m)	(m, CD)	(m)	(m^3)
Power Plant TG	500	300	5.5	0.3	650480
Jetty front	500	200	8	0.3	606076
Jetty front- Maidara	2600	200	5.5	0.3	2019342.05
Maidara -Digraj	2900	200	5.5	0.3	420936
TG Holcim cement factory Jetty to Sabur beacon	1850	200	5.5	0.3	766071
Total volume of Dredged spoil					**44,62,905**

Table 36 Capital and Annual Maintenance Dredging Volume of Option-1 and Option-2

Event	Capital Dredging (Mm^3)	Backfilling (Mm^3)			% of Backfilling Rate(One Year)
		Dry (after 6 month)	Monsoon (after 6 month)	Annual Maintenance Dredging	
Option-1	3.88	1.71	1	2.71	70
Option-2	4.46	2	1.35	3.56	80

Multi-criteria analysis of two potential options considering salient socio-economic and environmental parameters has been carried out to obtain the best possible dredged spoil disposal site is shown in Table 37. The number used in the table varies from 0 to 5 where '0' (zero) means no impact and 5 means maximum impact while '+' indicates beneficial and '–' indicates harmful impacts.

Table 37 Multi-criteria Analysis of Option- 1 and Option- 2

SL No.	Criteria	Option 1	Option 2
1	Capital Dredging volume	+4	+3
2	Maintenance Dredging volume	+4	+3
3	Resiltration/Back filling Rate	-1	-2
4	Distance from dredging alignment to dredge earth locations	+2	+1
5	Length of the channel and Travel Time	+2	+1
5	River bank erosion	-2	-1
6	Dominant Flow Direction	+3	+2
7	Costing of dredging	+3	+2
	Total	**+17**	**+9**

Note: - The impact assessment scoring was done within the following points score scale ranging from –1to -5 for negative impact and from +1 to +5 for positive impact

5.5 Selection of Best Suited Option

In Option 1 and Option -2 the dredging alignment is almost same except from Maidara to Jetty point. In Option 2 the alignment is far from the existing river bank than in the Option 1.

The multi-criteria analysis has been carried out to evaluate the different options on the basis of hydrological and navigation considerations. Table 36 illustrates the results of the analysis. It is expected with this type of analysis, that the units of measurement cannot be same for each criterion; however the relative importance can be assessed and can be used in selecting the best option. By comparing the two potential options considering the physical criteria given in the Table, it appears that the Option-1 is the most suitable dredging alignment for implementation. However, it is suggested to carry out physical and environmental monitoring and evaluation for proper operation and maintenance of navigation route.

6 Potential Environmental Impact and Mitigation Measures

6.1 The Boundaries

The primary requirement of any EIA study is to delineate the geographical boundary of the "project area" and the "impact area". The "project location" is the physical location of the project, which mainly covers Pussur river system. "Impact area" encompasses the geographic extent of the significant environmental and socio-economic impacts resulting from implementation of the proposed project activities of Mongla Port. All environmental features around the Project area are shown in Figure 28.

6.2 Identification of Important Environmental Components (IECs)

For maintaining navigation depths in waterways, dredging operation causes disturbance in the natural condition of the waterway and its surroundings. Fauna and flora are likely to be affected, particularly where recurrent dredging is carried out year after year.

6.3 Scoping

The scoping process has identified 19 project area impacts and direct construction impacts of land acquisition/requisition, public nuisance (noise, vibration, dust, air pollution, etc.), and traffic disturbance. These include both positive and negative impacts and these are summarized in Table 38.

Table 38 Important Environmental Components (IECs)

A. PROJECT AREA IMPACT	B. DREDGING IMPACT
Physical Environment	**Physical Environment**
Water Quality	River Hydrology
Turbidity	River Morphology
Soil contamination (salinity)	Public Nuisance (Air and Noise pollution)
Drainage Congestion	
Erosion of River	
Sedimentation	
Tidal Volume	
Biological Environment	**Biological Environment**
Aquatic Flora and fauna	Aquatic Flora
Socio-economic Environment	Aquatic Fauna
Economic Livelihood	Fisheries
Crop Damage	
Human Nutrition	
Common Resource Rights	
River transport	
Wage paid Employment	
Sanitation	
Road Transport	
Capture Fishery	
Culture Fishery	

Figure 28 Environmental Features around the Project Area

6.4 Assessment of Impact on Important Environmental Components (IECs)

Using the field investigation data, the IECs have been identified and shown in Table 39. The IECs have been rated with positive and negative trends under future without project and with project scenarios. They have been valued prior to drawing up suitable mitigation and compensation programs.

Table 39 Impact Identification Matrix on IECs

Important Environmental Components	Future Without Project	Future with Project (No Mitigation)
PROJECT AREA IMPACTS		
Navigation		
River Transport	-	+
River Sedimentation	-	+
Erosion of River	0	0*
Drainage Congestion	0	-
Salinity	-	-
Surface Water Quality	-	-
Soil contamination (salinity)	-	+
Turbidity	0	-
Economic Livelihoods:		
Women	0	+
Port Labourer	-	+
Fishing HH	0	+
Business HH	-	+
Boatmen HH	-	+
Land less HH	0	+
Land Acquisition HH	0	-
Common Resource Rights:		
Aquatic flora and fauna	0	-
Agricultural Output		
Capture Fisheries (including flood plain)	-	+
Culture Fisheries	0	-
Crop production	-	+
Wage Paid Employment		
Agriculture	-	+
Dredging operation	-	+
Land development	-	+
Social Management	-	+
Human Nutrition	-	+
Navigability	-	+
DIRECT IMPACTS DUE TO INTERVENTION		
Land Acquisition		
Permanent	0	-

Important Environmental Components	Future Without Project	Future with Project (No Mitigation)
Temporary	0	-
Public Nuisance	0	-

Rating of Impacts:

+	Positive trend	0	Present baseline status
-	Negative trend	0*	Taken care in the project design

6.5 Impacts Matrix of the Proposed Intervention (Dredging)

In describing the impacts related to the engineering interventions for the project one can distinguish between the temporary impacts directly related to the dredging operation and the long-term impacts associated with the modified physical environment and a consequence of the works. In addition, a systematic distinction can be made for the components of the environment, affected by various measures or activities, i.e. between impacts on the resources system and impacts on the user system. Table 40 present impact matrices for dredging. Many of the impacts listed can be mitigated substantially by adopting standard working procedures and ensuring responsible behavior of the contractor.

Table 40 Impact Matrix for the Dredging Works

Phase	System affected	Potential positive impact	Potential neutral or negative impact
During dredging Works	Impact on Resource System (physical, biological and ecological)	-	• Disturbance of aquatic (plankton & benthos) organisms in the river bed. • Risk of pollution of surface water from oil spills and leaks. • Deterioration of water quality by disposal of liquid and solid waste. • Disturbance of fish and mammals in the river. • Increased water turbidity. • Loss of aquatic vegetation. • Risk of pollution of soil, surface water and ground water. • Nuisance from dredger • Change of landscape
	Impact on User System (socio-economic and cultural aspects)	• Employment opportunities • Availability of dredged materials for land development • Use of spoils for settlement • Improved navigable depth.	• Noise, dust, exhaust gas emissions from dredging equipment. • Land for disposal of dredged spoil. • Obstacle to river traffic. • Nuisance from stockpiling of spoils. • Local drainage congestion. • Occupational health and safety risk. • Obstruction to fishing.
Post Dredging Works	Impact on Resource System	• Improved river traffic. • Biodiversity.	• Hydro-morphological adjustment. • Erosion and sedimentation.
	Impact on User System	• River traffic.	• Erosion and accretion.

Phase	System affected	Potential positive impact	Potential neutral or negative impact
		• Employment. • Socio-economic development. • Attraction of tourists.	• Need maintenance dredging.
Dredged Material Disposal Area	Impact on Resource System (physical, biological and ecological)	• Uses of dredged materials for filling low lying areas	•

6.6 Impacts and Proposed Mitigation Measure during Dredging Period

6.6.1 Dredging

Excavation

Aquatic Flora and Fauna - The flora and fauna of the area will be affected to the extent the dredging activities cause the spill of organic and inorganic substances to the environment. This effect is related to the effect on the water quality that may be caused by dredging activities.

The dredge, the overflow period has been suppressed, which has practically eliminated the problem of turbidity generation with this equipment and the resulting dispersion of materials, which in the case in question has been determined to be found in natural concentrations. This avoids as much as possible the increase in the concentration of sediments in suspension affecting the flora and fauna of the area, also reducing the photosynthesis processes.

It should be taken into account that concentrations of over 200.0 mg/l of solids in suspension notably affect the fauna and flora; therefore it is recommended to avoid exceeding said concentration in the smallest area possible.

Dredging activities in the Passur River and limited navigational activities (in the existing navigation routes) may have minor impact on Dolphin community of the Passur River and Maidara River. MPA, fishermen, and local communities confirmed that Dolphin usually do not use this route but can be seen rarely once or twice a year. EIA suggests Environmental Management Plan to avoid/limit the disturbance on the swimming, surfacing and migration of Dolphin during dredging and navigational activities that shall be followed by the implementing agency. Thence, the impact on dolphin community may be insignificant.

Alteration of existing shrimp farming and agricultural area only within the project boundary may cause loss of feeding ground of different local aquatic birds mostly Heron, Egrets, waterfowl, and etc.

In case of dredging activities in the Passur River may affect the benthic community of the river only within the dredging area. Dredging activities may cause short term alteration of habitat and death of benthos like some Mollusks and Arthropods, living in the river bed sediments. The regeneration rate of benthic community is high and therefore, the impact on benthic community may be insignificant.

The flora and fauna of the area will be affected to the extend the discharge of dredged materials cause the spill of organic or inorganic substances in Pussur River channel. Rationalizing the

discharge within the deposit area, limits the increase in the concentration of sediments in suspension that affects the flora and fauna of the area, thus reduces the photosynthesis processes.

It should be taken into account that concentrations of over 200.0 mg/l of solids in suspension notably affect the fauna and flora; therefore it is recommended to avoid exceeding said concentration in the smallest area possible.

The proposed disposal site (Option 1) is currently a low laying area covering mostly shrimp farming pond. These ponds might require clearing the aquatic weeds, reeds, and floating plants growing in the shrimp farming pond and agricultural pond. However, these impacts will be limited within the project boundary.

The periodic monitoring of the deposit area will allow verifying if the activities performed have a negative impact on the River water and taking corrective measures such as temporarily stopping dredging operations.

Gangetic dolphins are essentially blind and navigate using sound and echo-location. Dredgers generated noise has the potential to impact dolphin populations as this noise is capable of masking the dolphin's vocalization. The threshold peak impulse source pressure for direct physical trauma in marine mammals is generally considered to be >200 dBA and hence dolphins would not be expected to experience permanent hearing impairment from sound pressures generated by dredgers. It is assumed that dredging activities will have temporary impact to the gangetic dolphins. Effects on behavior are more likely. The behavioral reaction of the Ganges dolphin to dredging is not fully known. Therefore, precautionary measures will be taken to minimize potential effects.

Geo-morphology and Bathymetry - In the dredging area the bathymetry will change until finding a desired depth. Thereafter, nature will again raise the bottom due to the natural sedimentation process, to again carry out dredging activities, until finding another solution to maintain the bottom stable. However, this foreseen activity should not be considered as an undesired effect.

Unloading activities at the Jetty area of proposed power plant will cause a very imperceptible change on the bathymetry, since the currents will be in charge of distributing the sediment in a large area, avoiding the formation of sand banks that could restrict navigation in the area.

Sediment Dispersal - The rotary action of the cutter head in the case of a cutter suction dredge, and the dragging of the suction pipe along the bottom in the case of a hopper dredge, will disturb the substrate and place sediments into suspension. These suspended sediments may then smother nearby bottom-living flora and fauna as and when they settle. The effect will be greatest in those areas with fine sediments, which are more easily placed into suspension. The suspension of sediments would be minimized to the extent that the powerful suction pumps on the dredgers are able to suck up these materials out of the water column.

The potential impacts of sediment dispersal are considered to be of moderately high significance at the entrance to the approach channel where the suspended sediments may get caught up in the westerly currents flowing through the channel. These currents could carry suspended sediments to downstream along the sides of the channel. Hence, the direct impacts

of sedimentation, although limited in duration could be moderate to severe on the benthic communities close to the dredging site. Furthermore, the dredging activities in the channel should not exceed one day, thus limiting the amount of material placed in suspension.

This impact will be acute in dredging of the soft mud since this type of material has a low specific gravity and is easily placed into suspension. There is very little biota living in these muds that would be affected by sediment settlement. The transport of these suspended materials is not likely to be extensive due to weak currents in Pussur River.

Drainage Congestion - Drainage will be disturbed in the flood plain from land disposal in the areas using dredge material. Land disposal of the dredge material in designated power plant area will entail land disposal; a preliminary estimate indicates a land requirement of 1,133ha with a 5m height above existing ground level for the dredge material management. Such large land disposal is likely to result in significant drainage problem in the filled area.

Fishing Hindrance - The Passur, Chunkuri and Maidara rivers are the main channels for open water fish migration. All the migratory fishes move inward and seaward for their biological needs (e.g. spawning, feeding).

Navigational activities for transporting construction materials for proposed power plant through existing navigation route and dredging activities may result minor disturbance to fish migration. Only during the dredging operation, fish migration may be disturbed within the dredging operation area. This impact may be very limited due to adoption of Environmental Management Plan during dredging period. However, dredging activities may also cause migration of some bottom feeder fish species from the dredging operation zone. On the other hand, increased turbidity in water column may attract some fish species for food sourcing. In general, there may be a minor change in fish composition only during dredging operation but it would not affect the local fish diversity.

Apart from incidental recreational-type hand fishing done from the shoreline, all commercial fishing activities currently taking place in the project area will be disturbed during dredging. In that case, dredging operations could have an impact on local fishery activities through the generation of turbidity and dispersed sediments which prevent fishermen being able to see and find their fish pots, clog gill nets, and cause suffocation of fish caught in traps. However, all the fishermen interviewed have indicated their support for the dredging project and the brevity of the proposed dredging operations would militate against such events.

In considering the consequences of capital dredging it is important to distinguish between the direct and indirect effects of the activity. Direct effects can be summarized as follows:

- Mortality - Population mortality occurs either as part of the catch (landings plus discards) or incidentally either by killing benthic and demersal species or making them more vulnerable to scavengers and other predators.
- Increased food availability - Discarded fish, fish offal, and dead benthic organisms become food for scavenging species.
- Loss of habitat - Some fishing gears cause the disturbance or destruction of benthic habitat.

Indirect effects are the downstream consequences of a direct effect. Reductions in the total biomass of target fish, along with the direct effects noted above, could be expected to affect predators, prey, competitors of a target species, and overall seafloor community structure. Indirect effects also encompass potential changes in the flow of materials and energy through ecosystems and shifts in the balance among the processes of primary production, primary consumption, and secondary production.

Dredge Spillage and Leakage

Deliberate Spillages - The working system in the dredge is one of the most important actions to consider in order to prevent negative effects upon the environment.

Mongla Port Authority will adopt every preventive measure to avoid the spill of fuel or lubricants into the Pussur River that may result from a poor maneuver of the dredge or a bad operation of dredging equipment in an undesired area, although as it was seen earlier, the sediment analyses results under the bottom of river bed, in the area to be dredged, have not shown any contaminating element.

The personnel must be trained to perform optimum work in the dredge and barges, and must have the required contingency equipment. This is one of the most important actions that MPA must take into account in the dredge operation, in order to prevent contamination of the environment.

Working with the dredge should not cause any disturbance to the surrounding environment, in the river or air, and special care will be taken in handling lube oil of the absorbing pump motor, as well as in handling the fuel.

In order to prevent leaks in the discharge line, the sediment suction pipe must be fully welded, with safety valves in the ends that allow sealing the pipes. Similarly, no water should filter from the pipe connections, for which purpose they will be secured with packing and bolted flanges or adjusted with other means.

Petroleum and oily wastes will be periodically taken to the Mongla port in drums for disposal. Solids wastes produced by activities carried out in vessels will be adequately collected and taken later to the Mongla port for final disposal.

Accidental Spillages - The amount of material leaking from the bottom gates of a hopper dredge (or hopper barge) would normally be insignificant. However, if a hard object or rock becomes lodged between the gates, then material will steadily spill out of the ship's hold into the water column. As applies above, the resulting impacts of turbidity and sedimentation would be most severe in the vicinity of inshore fringing.

Surface Water Quality and Hydrology

Water Quality (Turbidity) - The original condition of surface water of Pussur River may be altered by two mechanisms:

- Confinement in a given floatation area due to the geometry of infrastructures or natural morphology;
- Contribution of certain components to the water by the activities carried out in the Project area.

This alteration can give rise to two types of contamination:

- Contamination of the water body by chemical, biological components and materials in suspension;
- Contamination of the surface water by greases, oils and floating bodies.

Bacteriological contamination, both of the water bodies and of the bottom may be caused by:

- Turbulence, greases and oils that inhibit self-purging.
- Removal of the bottom.

All these causes can be eliminated or mitigated with the corresponding preventive or corrective methods based on elimination. The biological contamination of the water body is more clearly evidenced by the eutrophication phenomenon or excessive fertilization of the aquatic ecosystem, which causes an excessive growth of floating and suspended vegetative life, the trophic state of which depends on the quantity of nutrients that the water may contain.

The most appropriate measures are the suppression of these discharged elements and the removal of grease and oil with the use of special recovery devices that cause a depression in the surface water sheet. Then, the effect on the water quality will be determined by the conditions under which activities are carried out in the vessels, of the accidental final disposal of residual liquids outside the port, of hydrocarbons and oils, which must be destined to be used on land, and on the final disposal of the solid wastes that must be sent to a designated place.

The adequate management of substances or products used or produced by the vessels (dredge), the training of personnel and the education of the users, will avoid the contamination of river water in the project area.

The adequate management of lubricants (motor oil), fuel and solid wastes will avoid the contamination of river water with these substances.

Dredging operation may increase turbidity of water at dredging locations. If the dredgers cannot be managed properly, water quality of river may be contaminated by spillage of oil, grease and effluent from dumping site. Dumping of dredged material and seepage from dumped dredged material may also increase the turbidity of river water at project site.

Nevertheless, the dredging may improve navigability of the Passur River. The implementing agency shall be responsible for taking necessary measures suggested environmental management plan for mitigation of impact. Thereby, it is expected that impact during dredging may be minimum.

Public Nuisance (Air pollution and Noise)

Emission of greenhouse gases carbon dioxide and nitrogen oxides may be emitted from combustion of the petroleum products in project related vehicles, machinery, generators, and vessels/barges etc. during dredging period. Their impact on air quality will not be significant as the pollutant emission activities (point and area sources) will be limited within the project boundary and the activities will be short term (only for preparation and dredging periods). However, this impact may further be minimized by adopting Environmental Management Plan.

Impact on ambient noise operation of different machineries and equipment for hauling, running of heavy load traffic for construction materials transportation, and regular traffic movement may generate noise during construction period. The produced noise may have impact on existing acoustic environment of rural category defined in ECR, 1997. Local inhabitants may feel disturbed due to noise from line sources (traffic movement). However, it is very unlikely that the local people will be affected by the noise which might be produced from vehicular movements as the nearest village is located more than 2 km away from the dredging sources.

Given the proximity of the 24/7 dredging operation to few residential areas, the noise generated by the dredging vessels may cause a level of auditory discomfort, especially at night, which is difficult to evaluate in the absence of any noise measurements for dredging operations. However, given the very short-term nature of the dredging works, it is not expected that these sounds would be intolerable. Furthermore, the dredging vessels being employed to carry out the dredging works are very modern vessels fitted out with noise abatement equipment.

Employment and Livelihood

There will be twofold impacts: affected people (indirect: fishermen) may lose their income opportunity; on the other hand, locals to be employed by the project will get income opportunity. If local people get access to project employment, then income level of the locals will increase.

6.6.2 Spoil Disposal

Dredging works will be carried out during consecutive dry seasons along river banks up to a depth of 7.5 m PWD to achieve the require depth for safe navigational movement of coal transportation and construction materials for the proposed power plant. Disposal of the materials on the land, for disposal purposes or filling of project sites for 100 year flood level, generates a huge outflow of wet materials that contain very high turbidity and impact the soil fertility of nearby agricultural lands. In addition, the dredging activities will generate local turbidity around the cutter heads of the dredges, but this turbidity will not significantly spread beyond the dredging tranches and channels because the bulk of the dredging takes place below the surrounding riverbed.

The settling rate is primarily dependent on the density of the suspension and the grain size distribution of the suspended material, assuming a two-layer fluid system around the dredger or fill area outflow: an upper layer of water and a lower layer of suspension (water plus sediment). Sand-size particles may settle within the hour, but clay-size particles (<2 micron) may take many hours (sometimes even days), if the density of the suspension is high. The influence of strong currents is indirect: they cause high turbulence that disturbs the boundary between the two layers and thereby causes mixing/dilution, leading to quick removal of part of the suspended sediment from the area with the water current.

All disposal sites will be designed as of industry best practices. Adequate filtration system should be developed for the spoil disposal sites. If EMP is followed during the disposal of the spoil materials, impacts will be reduced to an acceptable level.

Method of Disposal/Disposal - The wording “disposal area” is used whenever the dredged material is considered as useful fill material; the disposal area may be either the final destination or a stockpile area. In principle, both bunded/closed and open disposal areas are possible, but

mostly they are expected to be bunded/closed, with a water outlet weir box at its downstream end. Bunding is under taken then with hydraulic excavators using nearby surface material. Bund heights can be raised as necessary using dredged material.

The weir box can be used to control the water level in the disposal area. Adjusting the weir allows control of the setting process in the disposal area. Both fill quality requirements (density, grading and fines content, homogeneity) and turbidity requirements to the surrounding waters can be managed.

If the disposal area is isolated from surrounding waters, then the outflow from the disposal area can either be directed to the surrounding waters by a ditch, or be pumped back from a small collecting basin at the weir box.

The proposed approach in the dry season for dredged material is to pump it to a disposal area. This area could be split into two bunded areas: the sand (disposal) area and the silt (disposal) area/pond, placed in tandem in the downstream direction. The dredged material would be pumped first to the sand area where segregation would ensure only fines would pass into the silt pond, from which virtually clean water would flow. During the next monsoon these filled areas might either remain or be scoured away, similarly to any riverbank section. Figure 29 below gives an example of a sand (disposal) area with silt (disposal) area/pond below.

Image Courtesy: www.google.com/image

Figure 29 Disposal Area with Silt Pond

6.7 Impact during Post-Dredging Period

Maintenance dredging for maintaining navigability of the Pussur River for coal transportation may be required. The dredging works shall be executed by the relevant authorities (MPA, BIWTA or BWDB). The relevant authorities shall keep close communication with DoE for necessary clearances. Dredging activities may have impacts on river water quality. During dredging operation, water column may be contaminated due to spillage of oil, grease, machine oil, etc. Unplanned dredging may also cause erosion in some places. Therefore, adequate EMP should be developed based on the movement of the vessels and its materials.

6.7.1 River Morphology

In certain points, through different mechanisms or paths, whether natural or artificial, part of the sediments leave the riverine system. The balance between sand contribution or losses that the different physiographic units that make up the river border are what determines the trend towards erosion, progression or balance in the evolution of each one of them.

The usual sedimentation sources are: fluvial beds of a continuous or intermittent regime such as rivers, torrents, etc., and other calcareous elements, materials in suspension dragged by the wind, artificially produced by regeneration works, quarries, and etc.

The dredged material deposit area is distant from the Bay of Bengal, where the direction of currents prevails towards the south; that is, parallel to the coastline. Due to the little amount of material to be discharged and the effect of the currents, this sediment will be distributed over a large area without relevant changes in bathymetry and in the morphology.

6.7.2 Aquatic Flora and Fauna

Due to dredging, existing aquatic flora and fauna including benthic communities will be removed permanently from the dredging alignment. Therefore, during post-dredging period, there will be a little aquatic flora and fauna that will impact on the ecosystem that is dependent on aquatic flora and fauna. However, this impact is considered temporary as floating aquatic flora and fauna will be returned to the dredged area over time as the Pussur River is tidal.

6.7.3 Surface Water Quality

Surface water pollution during the post-dredging period comes primarily from untreated sewage effluent discharged by vessels, which then washes into local surface waters. There is also some risk of spillage of fuel and other chemicals from the vessels moving between Mongla Port and Rampal; however this latter pollution has not been an issue. There is of course the issue of accidental spillage of oil and other noxious chemicals, after an accident, and the leakage of materials into Pussur River and canals. A spill contingency plan and good maintenance of safety protocol will help reduce the risk of such accidental spills, and permit rapid action if an accident does occur.

6.7.4 Accidental Spillage

The amount of material leaking from the bottom gates of a hopper dredge (or hopper barge) would normally be insignificant. However, if a hard object or rock becomes lodged between the gates, then material will steadily spill out of the ship's hold into the water column. As applies

above, the resulting impacts of turbidity and sedimentation would be most severe in the vicinity of inshore fringing. Moreover, possible accidental spillage may potentially impact on aquatic habitats within the Project area through the accidental release of waste or hazardous substances. A spill contingency plan and good maintenance of safety protocol will help reduce the risk of such accidental spills, and permit rapid action if an accident does occur.

6.7.5 Environmental Completion Report

If there is failure to adopt the measures and continue the mitigation actions defined in the Environmental Completion Report, MPA or its Contractor will assign environmental expertise to obtain, examine and take the necessary actions defined in the Environmental Completion Report.

6.8 Summary of Potential Impacts

Those potential impacts relevant to the proposed project are summarized in Table 41.

Table 41 Summary of Potential Impacts

Phase	System Affected	Potential Positive Impact	Potential Neutral or Negative Impact
During dredging Works	Impact on Resource System (physical, biological and ecological)	Monitoring and timely response may assist in mitigating negative impacts	▪ Disturbance of aquatic (plankton & benthos) organisms in the river bed. ▪ Risk of pollution of surface water from oil spills and leaks. ▪ Deterioration of water quality by disposal of liquid and solid waste. ▪ Disturbance of fish and mammals in the river. ▪ Increased water turbidity. ▪ Risk of pollution of air, surface water and contamination of disposal site.
	Impact on User System (socio-economic and cultural aspects)	▪ Employment opportunities ▪ Improved navigable depth.	▪ Noise, dust, exhaust gas emissions from dredging equipment. ▪ Obstacle to navigation traffic. ▪ Occupational health and safety risk. ▪ Obstruction to fishing.
Post Dredging Works	Impact on Resource System	▪ Improved waterway traffic. ▪ Opportunistic species.	▪ Hydro-morphological adjustment. ▪ Erosion and sedimentation. ▪ Loss of aquatic biodiversity ▪ Possible changes in aquatic species abundance and composition
	Impact on User System	▪ Navigation traffic. ▪ Employment. ▪ Socio-economic development. ▪ Attraction of tourists.	▪ Erosion and accretion. ▪ Need maintenance dredging.

7 ENVIRONMENTAL MANAGEMENT PLAN AND COSTS

7.1 Environmental Management Plan

EMP aims at providing specific environmental friendly action plan which will be carried out during the project cycle for sustainable development to achieve project objectives. The action plan is intended to avoid/mitigate the negative impacts to an acceptable level and make the project environmentally sound. The plan also includes monitoring to ascertain whether the measures taken are adequate, and to verify whether any unanticipated impacts occur.

EMP recommendations should be fully integrated with the project design, since many features depend closely on this. MPA should engage experienced Consultant to monitor the performance of dredging in connection with hydrological, morphological and environmental impacts of dredging. However, the port authority shall address adequately the following environmental issues during the project planning, dredging and post-dredging phases of the project.

7.1.1 Dredging Period

MPA identified 12 mitigative and monitoring actions that will need to be implemented if significant dredging-related effects are to be minimized (see EMP Table 41 and Table 42). The following dredging activities are likely to trigger negative effects which have been addressed in the EMP:

- Site preparation including unrestricted movement of machinery and vehicles;
- Cutting of the dredge spoil;
- Extraction of the dredge spoil;
- Transportation of the dredge spoil through pipe or hopper;
- Disposal of the spoil materials in the designated land disposal areas; and
- Poor good housekeeping practices by the contractor and failure to properly implement an occupational health and safety programme.

Of these, the most important will be the effects stemming from the cutting of the 3.881 Mm3 dredge materials in Pussur River channel between port and Rampal. The extraction and pumping of these dredged sand, generating noise and dust as well as traffic bottlenecks, will need to be properly managed. Dust suppression, and limits to truck traffic during low noise periods, as well as care with fleet maintenance will be important. Insuring the dredge, tugboats, trucks and other associated dredging machinery do not idle for more than three minutes if not in use will markedly reduce the emissions and provide considerable fuel savings.

7.1.2 Post-Dredging Period

Four mitigative and monitoring actions will need to be implemented during post-dredging period. Three important impacts that MPA will address are:

- Possible inadequate clean up and rehabilitation of contractors camps and yards;
- Possible changes of river morphology due to dredging; and
- Losses of aquatic flora and fauna due to vessel movements
- Increase surface water pollution from vessels due to release of hazardous materials
- Increase solid waste

- Accidental spillage from vessel running between MPA and Rampal

7.2 Environmental Management Plan - Mitigation Measure

The following two Tables (Table 42 and 43) show the proposed environmental management plan (Mitigation and Monitoring) of the dredging project. Implementation of this EMP will substantially reduce the environmental impact in the Project area.

Table 42 Summary of Environmental Management Plan - Mitigation Measures

Project Period and Environmental Parameters	Negative Impacts on IECs	Mitigation Measures	Location	Timing/Duration	Who will Implement	Who will Supervise
Dredging Period						
1.0 Excavation						
1.1 Ecological Resources						
1.1.1 Aquatic Flora including Benthos	Disturbance to riverbed and benthos. Loss of aquatic communities especially benthic biota	Restrict dredging only to the area where required. Minimize habitat loss by applying careful control of cutter head, restrict digging to specified boundaries.	Throughout the dredging area	Everyday	Contractor	Engineer
1.1.2 Aquatic Fauna	Disturbance to aquatic mammals and permanent impairment	Dredging area should be checked every day prior to commencement of dredging work. All dredging activities should be stopped at sight of aquatic mammals.	Throughout the dredging area	Everyday	Contractor	Engineer
1.1.3 Fisheries	Disturbance of fish and damage of aquatic vegetation. Loss of fish species by bagda larva hunters.	No mitigation is required as operation will not be long lasting and due to dynamic nature of riverbed the system will regain soon. Ensure measures to prevent bagda larva collection and killing other species by traditional fishers. Enhance culture and capture fishery in planned manner.	Throughout the dredging area	Everyday	Contractor	Engineer
1.2 Geo-morphology and Bathymetry	Erosion and accretion of the river bank.	Ensure adequate measure through proper design and construction of training works	Throughout the dredging area	Monthly	Contractor	Engineer
1.3 Sediment Dispersal	Settlement of suspended solids Attenuation of	Apply good control of ladder swing speed and cutter head	Throughout the dredging	Everyday	Contractor	Engineer

Project Period and Environmental Parameters	Negative Impacts on IECs	Mitigation Measures	Location	Timing/Duration	Who will Implement	Who will Supervise
	light in water column Dispersion of contaminated sediments Degradation of pelagic habitat	rotation speed to minimize sediment dispersion. - Do not allow overfilling of hopper and resultant spillage. - Deploy silt screens in front of drainage pipes to prevent sedimentation on surrounding lands of the disposal areas. Do not exceed DoE turbidity standards. Apply measures to minimize sediment dispersion.	area			
1.4 Drainage Congestion	Drainage will be disturbed in the flood plain from land disposal in the areas using dredge material	Deploy silt screens in front of drainage pipes to prevent sedimentation on surrounding lands of the disposal areas. Do not exceed DoE turbidity standards. Apply measures to minimize sediment dispersion.	Throughout the dredging area	Everyday	Contractor	Engineer
1.5 River Traffic	Obstruction to river traffic. Hindrance of other ship traffic.	Adequate precautionary measures, prior announcement and proper workmanship. Coordinate location of dredging activity with vessel operators and MPA to reduce shipping delays.	Throughout the dredging area	Everyday	Contractor	Engineer
2. Dredge Spillage and Leakage						
2.1 Deliberate Spillage	spill of fuel or lubricants into the Pussur River that may result from a poor maneuver of the dredge or a bad operation of dredging equipment	Personnel must be trained to perform optimum work in the dredge and barges, and must have the required contingency equipment. Observe proper maintenance of equipment and vehicles	Throughout the dredging area	Everyday	Contractor	Engineer
2.2 Accidental Spillage	a hard object or rock becomes lodged between	Observe proper maintenance of equipment and	Throughout the dredging	Everyday	Contractor	Engineer

Project Period and Environmental Parameters	Negative Impacts on IECs	Mitigation Measures	Location	Timing/Duration	Who will Implement	Who will Supervise
	the gates, and then material will steadily spill out of the ship's hold into the water column.	vehicles	area			
3. Surface Water Quality and Hydrology	Deterioration of water quality. Increase of turbidity of water. Change in salinity level of water.	Ensure proper site management and good monitoring. Ensure proper monitoring.	Throughout the dredging area	Monthly	Contractor	Engineer
4. Public Nuisance						
4.1 Air Pollution	Impact due to operation of the dredge, trucks, tugboats, generators, and other associated machineries and equipment.	Control rampant movement of vehicle and equipment	Throughout the dredging area	Everyday visual inspection but sampling quarterly of the parameters (CO, NOx, Sox, PM2.5, PM10, VOC, O3)	Contractor	Engineer
4.2 Noise Pollution	Nuisance from stockpiling of pipes and accessories. Increased ambient noise level	Proper site management and construction plan shall be in place. Ensure that the site is kept orderly and tidy with good working conditions and first-aid units in working areas.	Throughout the dredging area	Everyday visual inspection but sampling quarterly	Contractor	Engineer
5. Employment and Livelihood	Damage to fishing gear	Apply to minimize sediment dispersion. Advise local residents before commencement of dredging works.	Throughout the dredging area	Everyday	Contractor	Engineer
6. Occupational health & safety	Conduct monthly check to review PSE compliance. Random check of 10% of the labor force, and check that laborers have contract letters and check age, working conditions and documentation	Provide sufficient training for pollution control safety measures, first aid, and fire-fighting. Establish effective on-site safety procedures and control systems	Workers camp	Monthly	Contractor	Engineer

Project Period and Environmental Parameters	Negative Impacts on IECs	Mitigation Measures	Location	Timing/Duration	Who will Implement	Who will Supervise
7. Spoil Disposal						
7.1 Leakage of sediment during transport to disposal site	Increased turbidity over sensitive inshore habitats	Independently monitor vessel logs and records for each disposal trip. Employ appropriate electronic monitoring equipment.	Throughout the dredging area	Everyday	Contractor	Engineer
7.2 Sediment disposal	Sedimentation of deep-water benthic habitat Degradation of pelagic habitat	N/A	Throughout the dredging area	Everyday	Contractor	Engineer
Post-Dredging Period						
1. River Morphology	Erosion and accretion of the river.	Ensure adequate measure through proper design and construction of training works.	Throughout the dredging area	Monthly	Contractor	Engineer
2. Aquatic Flora and Fauna	Depletion of fish due to land development by dredged spoil.	Enhance culture and capture fishery in planned way. Creation of sanctuary at suitable location.	Throughout the dredging area	Monthly	Contractor	Engineer
3. Surface Water Quality	Change in salinity level of water and soil	Augment upstream flow. Raise land elevation to above flood level by dredged spoils to reduce soil salinity.	Throughout the dredging area	Monthly	Contractor	Engineer
4. Accidental Spillage	Accident may occur in the dredging area	MPA should have adequate skill personnel, spill recovery kits, and a team to handle any accidental case	Throughout the dredging area	Monthly	Contractor	Engineer

7.3 Environmental Management Plan – Monitoring Measures

The impact monitoring measure is presented below in outline form. It should be detailed and completed when the final dredging action plan has been determined.

The purpose of the monitoring measure is to monitor or control the environmental effects of the dredging process. It should be based on compliance, verification, feedback, and know-how. It should be able to provide responses to the following three questions:

1. Why is monitoring being conducted?
2. What specifically is being carried out?
3. How are the data and information to be used in planning and decision-making?

In the case of the proposed dredging works, environmental monitoring is particularly necessary to ensure that suspended sediments generated during excavation and during disposal of the dredged materials, do not adversely affect the health of the aquatic ecosystems within the Project area. This could be achieved by:

1. ensuring that the deliberate disturbance and removal of bottom sediments during dredging are done technically in a manner (i.e. appropriate dredge type and operational procedures) that minimizes the degree and extent of fugitive sediment suspension;
2. ensuring that the fine sediments generated from Areas S1 and S2 are only released at the approved deep sea disposal site.

The monitoring programme should therefore focus on;

1. use of appropriate and specified dredging equipment for maintenance and capital dredging;
2. confinement of dredging to the specified dredging areas;
3. frequent measurements (twice daily) of water turbidity at the active dredging areas;
4. constant surveillance of the operations of the cutter suction dredger during transit to and sediment release at the approved disposal site;
5. constant surveillance of the operations of the hopper dredger during deposition of coarse dredged materials.

The results of the turbidity measurements, which should be taken independently with in situ instrumentation, should immediately be recorded formally and made available to the dredging supervisor so that any corrections and adjustments to dredging operations can be made quickly. The environmental monitor must have the authority to halt dredging and/or sediment disposal operations should this become necessary to protect the aquatic ecosystems at risk.

Table 43 Summary of Environmental Management Plan – Monitoring Measures

Monitoring Parameters	Details of Monitoring Action to be Undertaken	When/Frequency/Duration	Output to be Provided	Who will Implement	Who will Supervise
Dredging Period					
1.0 Excavation					
1.1 Ecological Resources					
1.1.1 Aquatic Flora including Benthos	As part of the daily/weekly inspection, examine the benthic communities and examine the level of turbidity in excavation area and also in the outlet of the disposal area. Confirm turbidity is not exceeding the DoE guideline.	Take samples every three months from the dredged area.	Checklist to be provided monthly	Contractor	Engineer
1.1.2 Aquatic Fauna	As part of the daily/weekly inspection, observe dolphin near to the dredging areas and confirm dredger are stopped working if sighted.	Daily throughout the dredging period	Checklist to be provided monthly	Contractor	Engineer
1.2 Geo-morphology and Bathymetry	Avoid the formation of sand banks	Daily during dredging period	Observation checklist to be provided	Contractor	Engineer

Monitoring Parameters	Details of Monitoring Action to be Undertaken	When/Frequency/Duration	Output to be Provided	Who will Implement	Who will Supervise
1.3 Sediment Dispersal	Ensure powerful suction pumps on the dredgers are able to suck up suspended sediment out of the water column	Throughout the dredging area	Checklist to be provided	Contractor	Engineer
1.4 Drainage Congestion	Confirm the drainage outlets in the disposal area are functional and adequate to discharge water as of DoE standards.	Take three samples for turbidity testing.	Test results and analysis	Contractor	Engineer
1.5 River Traffic	Make sure river traffic has not been disturbed due to dredging activities or prepare a detour plan if necessary	During dredging period	Checklist to be provided	Contractor	Engineer
2. Dredge Spillage and Leakage					
2.1 Deliberate Spillage	personnel must be trained to perform optimum work in the dredge and barges, and must have the required contingency equipment	Throughout the dredging area	Checklist to be provided	Contractor	Engineer
2.2 Accidental Spillage	Regular inspection is necessary to check all equipment and machineries	Throughout the dredging area	Checklist to be provided	Contractor	Engineer
3. Surface Water Quality and Hydrology	Deterioration of water quality. Increase of turbidity of water. Change in salinity level of water.	Ensure proper site management and good monitoring. Ensure proper monitoring.	Throughout the dredging area	Contractor	Engineer
4. Public Nuisance					
4.1 Air Pollution	Record that report in the hands those responsible for maintaining existing measures and completing those required	Control rampant movement of vehicle and equipment. Sample two times during dredging period	Ambient air quality testing, analysis and report	Contractor	Engineer
4.2 Noise Pollution	Noise measurements to be continued at noise sensitive sites as defined during in this EIA report 2 times during dredging period	Throughout the dredging area	Noise measurement , analysis and report	Contractor	Engineer
5. Employment and Livelihood	Damage to fishing gear	Apply measures as mentioned in mitigation. Advise local residents before commencement of dredging works.	Throughout the dredging area	Contractor	Engineer
6. Occupational health & safety	Provide sufficient training for pollution control safety measures, first aid, and fire-fighting. Establish effective on-site safety procedures and control systems	Periodic inspection	Throughout the dredging area	Contractor	Engineer
7. Spoil Disposal					
7.1 Leakage of sediment	Independently monitor vessel	Throughout the dredging	Checklist and	Contractor	Engineer

Monitoring Parameters	Details of Monitoring Action to be Undertaken	When/Frequency/Duration	Output to be Provided	Who will Implement	Who will Supervise
during transport to disposal site	logs and records for each disposal trip. Employ appropriate electronic monitoring equipment.	area	report		
7.2 Sediment disposal	Sedimentation of deep-water benthic habitat Degradation of pelagic habitat	N/A	Checklist and report		
Post-Dredging Period					
1. River Morphology	Ensure adequate measure through proper design and construction of training works.	Throughout the dredging area	Checklist and report	Contractor	Engineer
2. Aquatic Flora and Fauna	Enhance culture and capture fishery in planned way. Creation of sanctuary at suitable location.	Throughout the dredging area	Checklist and report	Contractor	Engineer
3. Surface Water Quality	Augment upstream flow. Raise land elevation to above flood level by dredged spoils to reduce soil salinity.	Throughout the dredging area	Checklist and report	Contractor	Engineer
4. Accidental Spillage	MPA should have adequate skill personnel, spill recovery kits, and a team to handle any accidental case	Throughout the dredging area	Checklist and report	Contractor	Engineer

7.4 EMP Implementation Arrangements

The approved EIA and the certificate from DoE will trigger the implementation phase for the EIA, i.e. the actions to mitigate and monitor the predicted impacts resulting from the activities of the Project. MPA is committed to implement this above mentioned EMP.

Quarterly progress reports on EMP implementation shall be prepared by the Contractor in cooperation with the Engineer appointed by MPA. All reports to be submitted to MPA via the Engineer. The quarterly reports will include a compliance monitoring checklist reporting on the progress of all dredging period actions. Incidents of significant contamination/pollution caused by the Contractor's activities shall be reported. Recommendation shall be made for mitigation of environmental damage and for prevention of any recurrences.

7.5 EMP Implementation Costs

The mitigation measures associated with significant costs, beyond those of dredge equipment rental and deployment and good dredging practice, are identified below along with the major cost elements.

1. **Control of suspended sediment dispersal**
   - Silt screen purchase and repairs
   - Deployment of turbidity meters over reef
2. **Monitoring of on-land disposal**
   - Employment of environmental persons to monitor dredging during dredged material disposal

The Cost of implementing the EMP mitigation and monitoring measures was estimated at BDT 500,000. Once all engineering costs and other normal expenditures associated with the dredging work are better identified, a recalculation of the costs will be undertaken and a revised figure applied to the work.

7.6 Impact Timing

A 14 months period has been proposed for assessment of the likely impacts of the interventions. For medium term and long term impacts a baseline data collection and a monitoring program is needed.

8 INFORMATION DISCLOSURE, CONSULTATION AND PUBLIC PARTICIPATION

8.1 General

The purpose of public consultation meetings was to invite comments and detailed suggestions on any environmental and social issues considered relevant by the people living in the area of the Project corridor. The public consultation programme is an essential part of the environmental assessment process and has been undertaken both formally and informally throughout the study to ensure that the knowledge, experience and views of stakeholders and the general public are taken into account during the EIA work. The information shared and recorded has, where relevant, been applied to justify planning, dredging, alignment, and timing changes, in order to reduce predicted negative effects. This approach satisfies statutory consultation requirements of DoE.

In order to carry out SIA, stakeholder consultation was conducted to assess opinion of local people who will be impacted due to project intervention. Consultations were conducted arranging several sessions of Focus Group Discussions (FGDs) with local people for assessing their opinion and to share their experiences. Key Informant Interviews (KIIs) were conducted to explore the views of the informants. Consultations were carried out with different stakeholders like Land owners, Local Government Representatives; Local elite chairman, mayor, expert etc. The consultants also discussed this issue with several senior officials of MPA, BIFCL, and Orion Group. Socio-economic survey conducted around the Project area where local people proposed few suitable spoil dumping areas.

8.1.1 Stakeholders Identification Process

As part of EIA, in connection with the monitoring of dredging activity in the Mongla Port area, in-depth consultations were carried out at the proposed disposal sites and other key locations of the project area. Consultations were also held with the Mongla port officials, and other Key stakeholders of the port users. The IWM consultant team members in collaboration with the MPA officials conducted the consultation meetings. These consultation meetings with different stakeholders and community groups were conducted focusing on the proposed dredging of Mongla Port. During consultation, land owners, local villagers, senior officials of MPA, BIFCL, and Orion Group, beneficiaries and other stakeholders were involved.

The community level consultation program was conducted using different qualitative research techniques such as Group Discussions, Key Informants Consultation and Participatory Observations following checklist. During consultation process collection of qualitative data and information were gathered from the people regarding the likely impacts due to dredging activities and choice of alternatives to mitigate likely impacts. All attempts have been made to cover different category of participants including farmers / Gher owners. During discussions, feedback was obtained about the perceived benefits and issues of concern raised by the participants.

8.1.2 Objective of Public Consultation

- build up awareness among the local people and community members about the project, its nature and implementation process.
- facilitate the stakeholder to identify the problems and prospects of the project and conflict of interest among the groups.
- learn about the present socio-economic conditions of the study area
- learn about people's participation on the impact of proposed interventions.
- obtain people's suggestions on the enhancement measures of the positive impact; and
- identify solutions to the apparent problems related to the project and ideas on mitigating the negative impacts.

A total of ten consultation meetings in a form of FGD were conducted in the project area.

8.2 Consultation Methodology

The consultation methods adopted for these public meetings were a mixture of short presentations, using graphics, photos and maps and posters, accompanied with a hand-out folder followed by discussions and Q/A sessions. The use of these materials enabled the participants to comprehend the issues easily, encouraging them to participate in the discussions more effectively and provide informed comments and opinions.

8.2.1 Consultation Delivery

A range of stakeholder consultation and engagement methods have been used depending on the stakeholder type and the level of interest or concern. The key methods used during these consultation sessions were:

- Group discussions - stakeholders were provided with a Project briefing, given a chance to view posters and a PowerPoint presentation, followed by a question and answer period;
- Face-to-face individual interview with sector specific experts including Mongla Port Authority, Bangladesh India Friendship Company Limited, and Orion Group; and
- Letters/correspondence via regular mail and email.

8.3 Information Provided

Project Disclosure Meetings - Part of the consultation process involved disseminating factual information regarding the Project, with the aim of developing positive and constructive relationships with stakeholders and decreasing the likelihood of incorrect perceptions. A variety of methods and materials were utilized, including:

- Technical meetings with key government stakeholders; and
- Written and visual information, including maps, drawings and diagrams, detailing the Project staging

Figure 25 shows photographs of FGDs and KII at Various locations in the Project area

Group Discussion with Local Villagers near to Port

Discussion with Dr Abdullah Harun, Khulna University

Discussion with Local People at Rampal Upazila

Potential Site for Dredge Material Disposal (top left)

Discussion with Union Parishad Chairman, Baniasanta

Discussion with Union Parishad Chairman, Rajnagar

	
Discussion with Mr. Dev, BIFCL on Possible Disposal Areas and Environmental Concerns Due to Dredging Activity	**Discussion with Local Day Labor, Site Engineer of Proposed Power Plant**

Figure 30: Focus Group Discussions with Key Informant at Various Locations of Project

8.4 Consultation Outcomes

For the purpose of conducting community consultation meetings, the Consultants' team visited the area of dredging and proposed location of spoil dumping points several time between May and July 2015. Followings are the major findings and observations of the community consultations:

- People do not appreciate to dump dredge spoil in agricultural land as sand (dredge material) makes the land barren. In many case it is observed dredge material are dumped open agricultural land where people cannot perform agricultural activities.
- We have asked The Mayor of Mongla City Corporation whether there is scope to dump spoil in his jurisdiction area. He replied that this area does not need so much dredge material. Private developers already developed most of the land. The huge quantity of dredge material supposed to produce by this project is unmanageable for the Mongla city corporation.
- Local people as well as expert requested to make chamber properly to dump so that spoil can stay permanently. One informant informed that the dredge spoil of Ghasiakhali channel very close to the project area is an unbearable burden for the local people.
- One Key informant suggested that if it is possible to dump the spoil in ocean areas (Bay of Bengal) then do it. It might be expensive but they believe that it will produce least negative impact.
- Right bank of Pussur River is potential area to dredge. Banisanta and Bajua union of Dacope upazila constitute the areas. These are all agricultural land and land need to be acquired. Land price is comparatively low than other area of Bangladesh. Local elected bodies will cooperate to purchase land.
- Most of the local people think no social imbalance would be if Pussur River is dredged. The proposed dumping area has few human settlements. They also mentioned that water flow in the river/canal will be increased.

- Dredging spoil could be dumped at the left bank of River. This area is becoming industrial area. Land use pattern is changing, sand filling is going on. If they are requested to collect the spoil they will happy to collect since it will be free of cost. Project should pursue them.
- The project already acquired huge land for the Rampal power plant, local people think if the dredge spoil is dumped here then there will be no need to acquire additional land.
- Only 7 Households/Families were displaced due land acquisition for Rampal power plant but many have lost their land. Some people claimed that they did not get compensation so far from the project.
- Participants welcomed the dredging for restoration and improvement of navigability of the port;
- The local people can provide labor and necessary cooperation to the people of interventions implementation by providing labor, equipment and moral- all types.
- The stakeholders unanimously agreed with the socio-economic importance of the port for the country and felt need for proposed dredging/improvement to increase port activities.
- Project will play vital role to enhance port activities as well as socio-economic development of the country.
- Regular dredging for maintenance of port navigability is required;
- Sustainable capital dredging is needed to maintain the navigability of the port;
- Dredging in the proposed locations will bring no adverse environmental and socioeconomic impact in the area
- Dredging will bring positive impact through increased income of people through increasing port activities;

8.5 Beneficial Impacts

8.5.1 Generation of Employment

The significant potential positive impact is employment generation during dredging work in Pussur River. In the dredging works employment will be generated both for skilled and unskilled professionals at different levels directly. Indirectly, it will generate employment for the peoples in the project area and beyond within and outside the country those related to dredge operation. During dredging period there will be positive impacts in the employment and livelihood.

8.5.2 Use of Dredge Materials

The dredge materials will be used to fill-up low land areas (up to five areas) close to the Project area. The owners of the private land already vow to allow disposal of spoil materials in their selected land. This sand filling will help to raise the platform of the lands for industrialization in future and the filling will consider 100-year flood return period.

8.5.3 Economic Development

The dredging project will provide a vital work to progress the construction of the proposed Rampal power plant. This project indirectly will support development in an area that has to date been poorly utilized. After commencement of the power plant operation, economic development in the area as well as Bangladesh will be noticed.

9 Conclusions and Recommendations

9.1 Conclusions

The Conclusions that may be drawn for the Environmental Impact Assessment are the following:

In the Dredging Area

1. The actions that require the greatest attention to be avoid negative effects on the environment are the development of activities performed with the dredge and barges, as well as the operation and maintenance thereof.
2. The presence of the dredge and the activities thereof will not cause a negative effect to the water quality, air, or flora and fauna of the area, if the adequate recommended measures are adopted. The most important beneficial effect is to promote the development of socioeconomic activities in the area.
3. The analysis of the physical and chemical characteristics of river water performed in the study area show acceptable values; include low levels of, which satisfy the values established for the criteria of Schedule 3 of water quality guideline of ECR 1997.
4. The results of the metal analyses of bottom sediments in the dredging area, show normal concentrations and, therefore, will not be a limiting factor in the handling and activities performed in the terminal, as well as in the removal resulting from the dredging.

Dredged Material Deposit Area

The area where dredged materials will be discharged from the barges is located northeast of the dredging area. The turbidity concentration will dissipate quickly as it precipitates to the bottom. The volume of sediments discharged will be insignificant in relation to the contribution from the Pussur Rivers.

In the dredged material deposit area, the result of benthos analysis show less biodiversity than in other analyzed areas.

9.2 Recommendations

The recommendations that may be drawn for the Environmental Impact Assessment are the following:

1. Periodic monitoring of the aquatic flora, fauna, air quality, noise measurement, turbidity in 3 levels and in 3 sampling locations, during the operations in the project area. Monitoring will be carried out during dredging, in order to determine the existence of changes in the aquatic environment.
2. The dredge must be inspected periodically to evaluate the operation of its equipment and constantly supervised that no change or unevenness occurs in the structure.
3. It is concluded to that the proposed dredging of the Pussur river can be implemented safely in an environmental friendly manner. Therefore, it is recommended that the proposed dredging project can be cleared to proceed with dredging activities.

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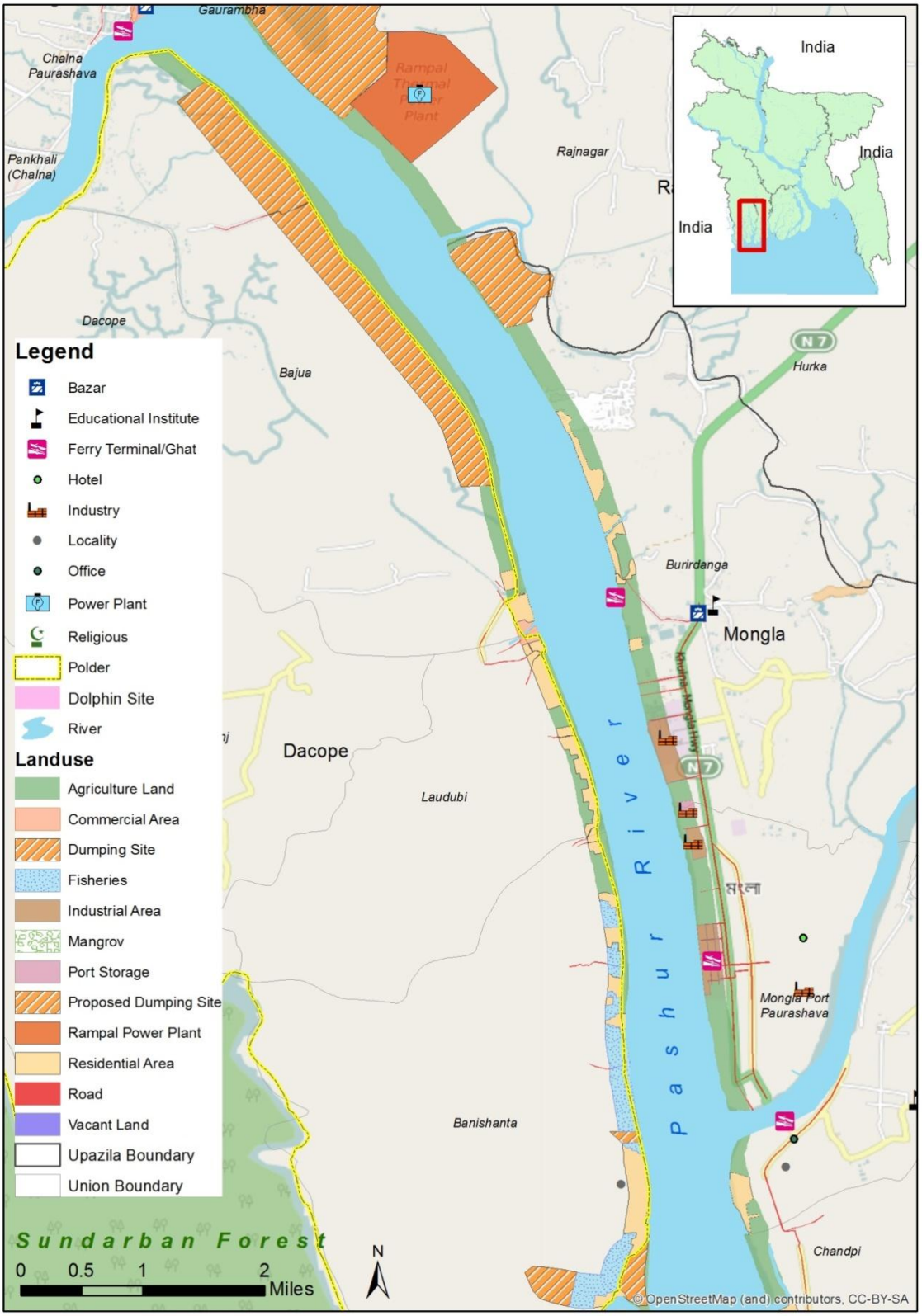
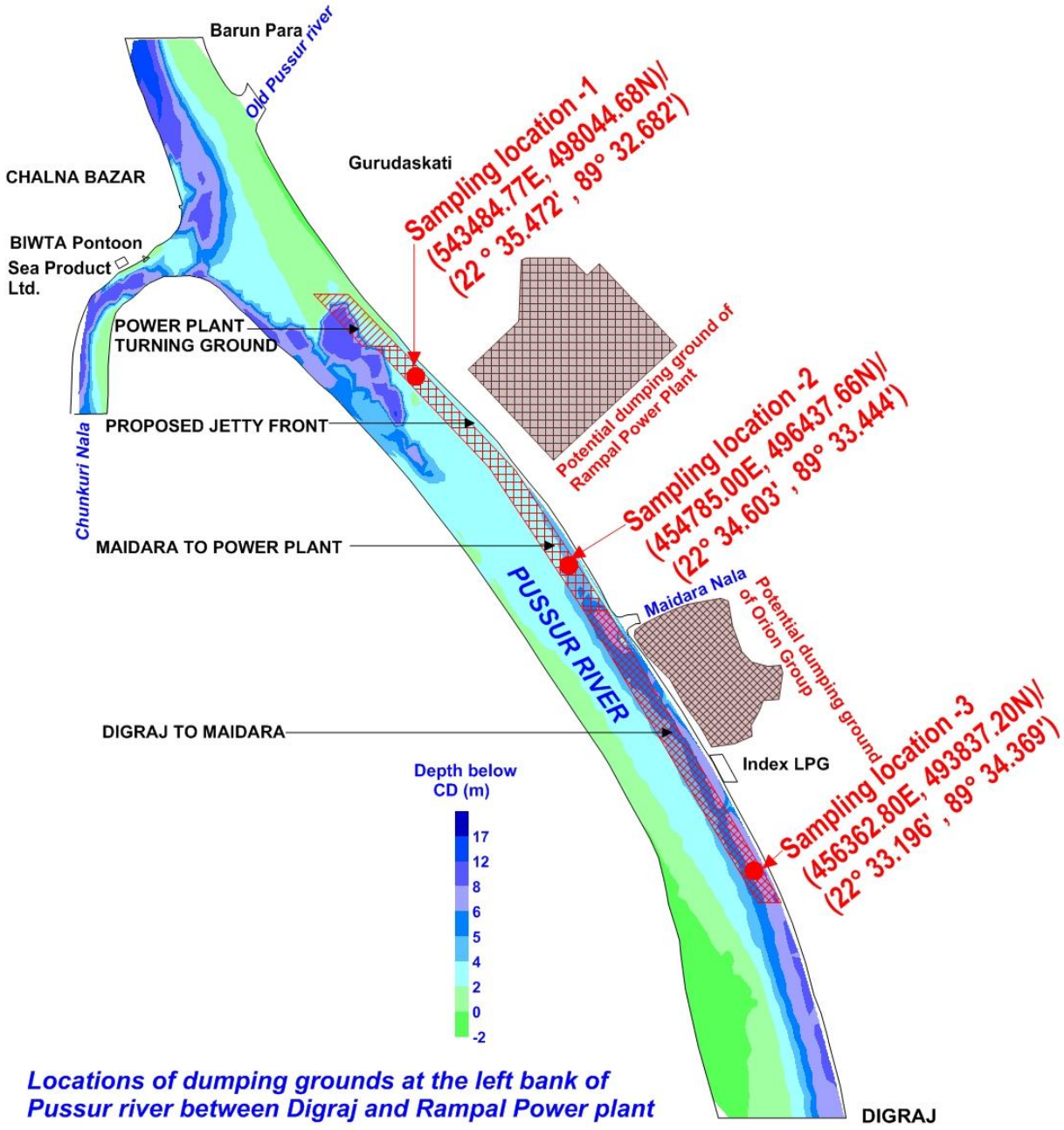
ANNEXES

Annex 1 Land Use Map of the Project Area



Annex 2 Location of Environmental Sampling



Locations of dumping grounds at the left bank of Pussur river between Digraj and Rampal Power plant

Annex 3 Analytical Test Results of Ambient Air Quality and Noise Measurement

ENRAC

AMBIENT AIR QUALITY AND NOISE LEVEL MEASUREMENT REPORT

COMPANY NAME : Institute of Water Modelling (IWM)
PROJECT NAME : Environmental Sampling and Testing for EIA Studies under "Feasibility Study of Capital Dredging in Pashur River from Mongla Port to Rampal Power Plant"
CLIENT REF. : N/A
CLIENT ADDRESS : House No.496, Road No. 32, New DOHS, Mohakhali, Dhaka- 1206, Bangladesh
SAMPLE COUNT : 60 (1 hour)
SAMPLING DATE : 26/07/2015, 11:44 AM
ANALYSIS DATE : 04/08/2015
SAMPLING ID : AAQ_01 (Proposed Jetty Site)
GPS COORDINATES : 22°35.313' N 89°32.969' E

Ambient Air Quality (AAQ) Test Results

Sampling Site Description	Description of Parameters	Unit	Concentration of Ambient Air Quality Parameters			GoB Air Quality Standards*
			Minimum	Maximum	Average	
• Environmental Perimeter Air Station (EPAS) was set at the proposed jetty site which was 2 m east from the river bank. • Passur river is the main navigational route between Mongla port and Chalna bazar. Troller boat, marine ship, speed boats were observed to ply through this river channel. However, a dredger was also found there but was not active during sampling. • Vegetation was high and no wildlife except some birds was found around the sampling site.	Carbon Monoxide (CO)	$\mu g/m^3$	78	693	319.74	40000 (1 hour)
	Nitric Oxide (NO)	$\mu g/m^3$	35	149	88.41	100 (Annual)
	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	26	93	60.29	
	Sulphur Dioxide (SO_2)	$\mu g/m^3$	0	0	0.00	365 (24 hour)
	Ozone (O_3)	$\mu g/m^3$	0	28	9.12	235 (1 hour)
	Particulate Matter (PM_{10})	$\mu g/m^3$	5	79	51.33	150 (24 hour)
	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	2	45	24.01	65 (24 hour)
	Air Temperature	°C	25	29	26.40	NSE**
	Relative Humidity	%	53	74	69.21	NSE**

Noise Measurement (NM) Results

Sampling ID	Time (No of Measurement)	Unit	Noise Measurement Data		
			Minimum	Maximum	L_{eq}
NM_01	11:44 AM (60)	dBA	43	61	50.67

	Zone	Day	Night
GoB Noise Standard***	Silent area	50	40
	Residential area	55	45
	Mixed area	60	50
	Commercial area	70	60
	Industrial area	75	70

* The amended Schedule-2, 2005, of (Air Quality Standard) Environmental Conservation Rules, 1997
** NSE- No standards established yet
*** The amended schedule-4, 2006, of (Noise Measurement Standard) Environmental Conservation Rules, 1997

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ENRAC

AMBIENT AIR QUALITY AND NOISE LEVEL MEASUREMENT REPORT

COMPANY NAME	: Institute of Water Modelling (IWM)
PROJECT NAME	: Environmental Sampling and Testing for EIA Studies under "Feasibility Study of Capital Dredging in Pashur River from Mongla Port to Rampal Power Plant"
CLIENT REF.	: N/A
CLIENT ADDRESS	: House No.496, Road No. 32, New DOHS, Mohakhali, Dhaka- 1206, Bangladesh
SAMPLE COUNT	: 60 (1 hour)
SAMPLING DATE	: 26/07/2015, 01:52 PM
ANALYSIS DATE	: 04/08/2015
SAMPLING ID	: AAQ_02 (Settlement Site, Bidderbaor)
GPS COORDINATES	: 22°32.336' N 89°34.765' E

Ambient Air Quality (AAQ) Test Results

Sampling Site Description	Description of Parameters	Unit	Concentration of Ambient Air Quality Parameters			GoB Air Quality Standards*
			Minimum	Maximum	Average	
• Environmental Perimeter Air Station (EPAS) was set about 30 m west from the community settlement at Bidderbaor which was adjacent to the river bank. • Different type of water transports were plying through the river channel from Mongla port to Chalna bazar. Troller boat, marine ship, speed boats were observed during sampling. • Vegetation was high and no wildlife except some domestic animal and birds were found around the sampling site.	Carbon Monoxide (CO)	µg/m^3	62	931	509.33	40000 (1 hour)
	Nitric Oxide (NO)	µg/m^3	52	288	102.08	100 (Annual)
	Nitrogen Dioxide (NO_2)	µg/m^3	35	163	73.27	
	Sulphur Dioxide (SO_2)	µg/m^3	0	0	0.00	365 (24 hour)
	Ozone (O_3)	µg/m^3	0	31	14.76	235 (1 hour)
	Particulate Matter (PM_{10})	µg/m^3	12	108	61.99	150 (24 hour)
	Particulate Matter ($PM_{2.5}$)	µg/m^3	8	52	29.06	65 (24 hour)
	Air Temperature	°C	25	28	26.18	NSE**
	Relative Humidity	%	56	78	75.65	NSE**

Noise Measurement (NM) Results

Sampling ID	Time (No of Measurement)	Unit	Noise Measurement Data		
			Minimum	Maximum	L_{eq}
NM_02	01:52 PM (60)	dBA	46	65	54.39

GoB Noise Standard***	Zone	Day	Night
	Silent area	50	40
	Residential area	55	45
	Mixed area	60	50
	Commercial area	70	60
	Industrial area	75	70

* The amended Schedule-2, 2005, of (Air Quality Standard) Environmental Conservation Rules, 1997
** NSE- No standards established yet
*** The amended schedule-4, 2006, of (Noise Measurement Standard) Environmental Conservation Rules, 1997

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ENRAC

AMBIENT AIR QUALITY AND NOISE LEVEL MEASUREMENT REPORT

COMPANY NAME	: Institute of Water Modelling (IWM)
PROJECT NAME	: Environmental Sampling and Testing for EIA Studies under "Feasibility Study of Capital Dredging in Pashur River from Mongla Port to Rampal Power Plant"
CLIENT REF.	: N/A
CLIENT ADDRESS	: House No.496, Road No. 32, New DOHS, Mohakhali, Dhaka- 1206, Bangladesh
SAMPLE COUNT	: 60 (1 hour)
SAMPLING DATE	: 27/07/2015, 10:20 AM
ANALYSIS DATE	: 04/08/2015
SAMPLING ID	: AAQ_03 (Shalobunia)
GPS COORDINATES	: 22°33.406' N 89°34.329' E

Ambient Air Quality (AAQ) Test Results

Sampling Site Description	Description of Parameters	Unit	Concentration of Ambient Air Quality Parameters			GoB Air Quality Standards*
			Minimum	Maximum	Average	
• Environmental Perimeter Air Station (EPAS) was set on the bank of Pashur river at Shalobunia. • Pashur river is the main water communication system between Mongla port to Chalna bazar. Troller boat, marine ship, speed boats were observed to ply through this river channel. • Vegetation was moderate especillay mangrove species found there and some birds were also observed around the sampling site.	Carbon Monoxide (CO)	$\mu g/m^3$	51	487	199.28	40000 (1 hour)
	Nitric Oxide (NO)	$\mu g/m^3$	30	112	78.52	100 (Annual)
	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	19	76	54.01	
	Sulphur Dioxide (SO_2)	$\mu g/m^3$	0	0	0.00	365 (24 hour)
	Ozone (O_3)	$\mu g/m^3$	0	21	7.33	235 (1 hour)
	Particulate Matter (PM_{10})	$\mu g/m^3$	3	55	30.49	150 (24 hour)
	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	1	29	17.66	65 (24 hour)
	Air Temperature	°C	24	26	24.82	NSE**
	Relative Humidity	%	59	74	70.34	NSE**

Noise Measurement (NM) Results

Sampling ID	Time (No of Measurement)	Unit	Noise Measurement Data		
			Minimum	Maximum	L_{eq}
NM_03	10:20 AM (60)	dBA	41	57	49.87

	Zone	Day	Night
GoB Noise Standard***	Silent area	50	40
	Residential area	55	45
	Mixed area	60	50
	Commercial area	70	60
	Industrial area	75	70

* The amended Schedule-2, 2005, of (Air Quality Standard) Environmental Conservation Rules, 1997
** NSE- No standards established yet
*** The amended schedule-4, 2006, of (Noise Measurement Standard) Environmental Conservation Rules, 1997

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Annex 4 Analytical Test Results of Benthos

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ঢাকা-১০০০, বাংলাদেশ
পিএবিএক্স ঃ ৯৬৬১৯২০-৭৩/৭৫৮০, ৭৫৮১
ফ্যাক্স ঃ ৮৮০-২-৯৬৬৭২২২ (উপাচার্যের অফিস)

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তারিখ.....

Table 1. Composition and abundance of benthic (sediment) fauna of proposed jetty areas near Mongla Port .

Name/group	Location 1		Location 2		Location 3		Average	
	Density/ 225cm^2	Relative (%) abundance	Density/ 225cm^2	Relative(%) abundance	Density/ 225cm^2	Relative (%) abundance	Density/ 225cm^2	Relative (%) abundance
Neanthes sp.					2	33.33	0.67	11.81
Peloscolex sp.	1	16.67	2	40			1.00	17.57
Pristina schmienderi					1	16.67	0.34	6.00
Aeolosoma sp	2	33.33					0.67	11.81
Lumbriculus sp.	1	16.67					0.34	6.00
Neanthes minicola			1	20			0.34	6.00
Limnodrillus sp.	2	33.33	1	20			1.0	17.58
Unidentified oligochaete			1	20	3	50%	1.33	23.46
							5.67	100%

Analysed and prepared by

Md. Abdur Rob Mollah 26.8.15
Professor

Annex 5 Analytical Test Results of Riverbed Materials

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ENVIRONMENTAL ENGINEERING LABORATORY

BRTC Bureau of Research, Testing & Consultation

BRTC No. : **110089930/15-16/CE; Dt: 29/7/2015** Ref. No. : Letter; Dt: 29/7/2015
Sent by : Mr. Md.Saiful Islam, Asst. Environmnetal Professional, Environmnetal & Resource Analysis Centre (ENRAC)
Project : Environmnetal Sampling & Testing of Samples for EIA Studies under feasibility study of Capital Dredging in Poshur river
Company Address : 484/D Ground Floor, Khilgaon, Dhaka
Sample Id : RBM-1 Source : Poshur River
Date of Test : 29/7/2015 - 25/8/2015 Location : ---

TEST REPORT (TOTAL EXTRACTION OF Soil SAMPLES : TOTAL EXTRACTION DONE BY AQUA-REGIA)

Sl. No.	Parameter	Unit	Concentration Present	EU Directive 86/278/EEC for Land Application	Method of analysis	Minimum Detection Limit (MDL)
1	Chloride (Cl)	%	**0.11**	---	USEPA 325.6; SM 4500-Cl-	---
2	Electrical Conductivity (EC)	µS/cm	**410**	---	USEPA 120.1; SM 2510 B	---
3	Cadmium (Cd)	mg/kg	**0**	40	USEPA 213.2 ; SM 3113 B	---
4	Copper (Cu)	mg/kg	**23**	1750	---	---
5	Zinc (Zn)	mg/kg	**49**	4000	USEPA 200.9 ; SM 3111 B	---
6	Mercury (Hg)	mg/kg	**0**	25	USEPA 245.1 Rev. 3.0; SM 3112 B	---
7	Lead (Pb)	mg/kg	**9.4**	1200	---	---
8	Arsenic (As)	mg/kg	**29**	---	USEPA 206.2; SM 3113 B	---
9	---	---	---	---	---	---
10	---	---	---	---	---	---

Comments : 1. Sample was supplied by CLIENT
2. Sample was received in unsealed condition.

Note :

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed cover/pack

Countersigned by:
Dr. Abu Siddique
Professor, Dept. of Civil Engg.

DEPARTMENT OF CIVIL ENGINEERING

Test Performed by:
Dr. Rowshan Mamtaz 25/8/15
Professor, Dept. of Civil Engineering

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)
DEPARTMENT OF CIVIL ENGINEERING
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ENVIRONMENTAL ENGINEERING LABORATORY

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Project : Environmnetal Sampling & Testing of Samples for EIA Studies under feasibility study of Capital Dredging in Poshur river
Company Address : 484/D Ground Floor, Khilgaon, Dhaka
Sample Id : RBM-2 Source : Poshur River
Date of Test : 29/7/2015 - 25/8/2015 Location : ---

TEST REPORT (TOTAL EXTRACTION OF Soil SAMPLES : TOTAL EXTRACTION DONE BY AQUA-REGIA)

Sl. No.	Parameter	Unit	Concentration Present	EU Directive 86/278/EEC for Land Application	Method of analysis	Minimum Detection Limit (MDL)
1	Chloride (Cl)	%	**0.02**	---	USEPA 325.6; SM 4500-Cl-	---
2	Electrical Conductivity (EC)	µS/cm	**916**	---	USEPA 120.1; SM 2510 B	---
3	Cadmium (Cd)	mg/kg	**0**	40	USEPA 213.2 ; SM 3113 B	---
4	Copper (Cu)	mg/kg	**28**	1750	---	---
5	Zinc (Zn)	mg/kg	**54**	4000	USEPA 200.9 ; SM 3111 B	---
6	Mercury (Hg)	mg/kg	**0**	25	USEPA 245.1 Rev. 3.0; SM 3112 B	---
7	Lead (Pb)	mg/kg	**9.4**	1200	---	---
8	Arsenic (As)	mg/kg	**35**	---	USEPA 206.2; SM 3113 B	---
9	---	---	**---**	---	---	---
10	---	---	**---**	---	---	---

Comments : 1. Sample was supplied by CLIENT
2. Sample was received in unsealed condition.

Note :

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed cover/pack

Countersigned *by*:
Dr. Abu Siddique
Professor, Dept. of Civil Engg.

DEPARTMENT OF CIVIL ENGINEERING * BUET *

Test Performed *by*:
Dr. Rowshan Mamtaz 25/8/15
Professor, Dept. of Civil Engineering

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Project : Environmnetal Sampling & Testing of Samples for EIA Studies under feasibility study of Capital Dredging in Poshur river
Company Address : 484/D Ground Floor, Khilgaon, Dhaka
Sample Id : RBM-3 Source : Poshur River
Date of Test : 29/7/2015 - 25/8/2015 Location : ---

TEST REPORT (TOTAL EXTRACTION OF Soil SAMPLES : TOTAL EXTRACTION DONE BY AQUA-REGIA)

Sl. No.	Parameter	Unit	Concentration Present	EU Directive 86/278/EEC for Land Application	Method of analysis	Minimum Detection Limit (MDL)
1	Chloride (Cl)	%	**0.01**	---	USEPA 325.6; SM 4500-Cl-	---
2	Electrical Conductivity (EC)	µS/cm	**463**	---	USEPA 120.1; SM 2510 B	---
3	Cadmium (Cd)	mg/kg	**0**	40	USEPA 213.2 ; SM 3113 B	---
4	Copper (Cu)	mg/kg	**91**	1750	---	---
5	Zinc (Zn)	mg/kg	**64**	4000	USEPA 200.9 ; SM 3111 B	---
6	Mercury (Hg)	mg/kg	**0**	25	USEPA 245.1 Rev. 3.0; SM 3112 B	---
7	Lead (Pb)	mg/kg	**7.7**	1200	---	---
8	Arsenic (As)	mg/kg	**30**	---	USEPA 206.2; SM 3113 B	---
9	---	---	---	---	---	---
10	---	---	---	---	---	---

Comments : 1. Sample was supplied by CLIENT
2. Sample was received in unsealed condition.

Note :

Important Notes: Samples as supplied to us have been tested in our laboratory. BRTC does not have any responsibility as to the representative character of the samples required to be tested. It is recommended that samples are sent in a secure and sealed cover/pack

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DEPARTMENT OF CIVIL ENGINEERING * BUET *

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Dr. Rowshan Mamtaz 25/8/15
Professor, Dept. of Civil Engineering

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Annex 6 Photographs Taken During Environmental Quality Sampling at the Project Site

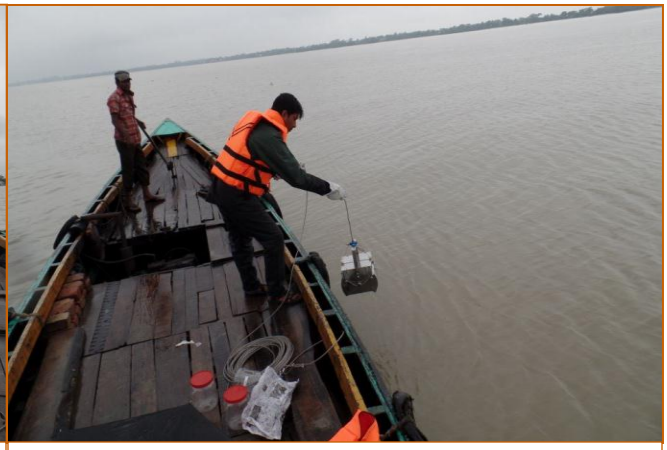
Rampal Power Plant Area

Sampling of AAQ_01 and NM_01 at Proposed Jetty Area for the Power Plant Dated 26/07/2015 at 11:44 AM

Sampling of AAQ_02 and NM_02 near the closest settlement at Bidder Baor Dated 26/07/2015 at 1:52 PM

Sampling of AAQ_03 and NM_03 at Shalobunia on the Riverbank of Pussur Dated 27/07/2015 at 10:20 AM

Sampling of RBM_01 and Ben_01 using Eckman Dredger near the Power Plant site dated 25/07/2015 at 12:40 PM



Sampling of RBM_02 and Ben_02 using Eckman Dredger close to Maidara Nala dated 25/07/2015 at 11:32 AM

Sampling of RBM_03 and Ben_03 using Eckman Dredger at Shalobunia dated 25/07/2015 at 10:15 AM

Collection of Benthos using the Sieve at the project site