Government of People's Republic of Bangladesh
Ministry of Shipping

Mongla Port Authority

Mongla, Bagerhat

Environmental Impact Assessment (EIA) of the Proposed Dredging Project at the Outer Bar area of Pussur Channel

Revised Final Report

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INSTITUTE OF WATER MODELLING

Executive Summary

E1. Introduction

The Environmental Impact Assessment (EIA) report presents the project interventions, project components, relevant regulations, baseline conditions, likely impacts, mitigation measures, environmental management and monitoring plans. The EIA report for the proposed dredging project at Outer Bar has been prepared following EIA Guidelines of Department of Environment (DoE) and that of Water Resources Planning Organization (WARPO) to fulfill one of the major obligations of Terms of Reference (ToR). The project interventions, dredging plan, dredging volume, potential impacts, mitigation measures and dredged materials disposal plan have been revisited to incorporate comments and suggestions of DOE and other relevant stakeholders.

The overall objective of the EIA study is to ensure that the recommended intervention is implemented in environmentally sound and sustainable manner and that the EMP recommendations are abide by the project authority during all the phases of the project cycle.

E2. Project Description

Mongla port, the second navigational gateway of Bangladesh, is situated at the confluence of Pussur River and Mongla Nulla, approximately 71 nautical miles (about 131 km) upstream from the Fairway buoy in the Bay of Bengal. The navigation channel towards Mongla crosses a wide shallow area known as 'outer bar' at the Pussur river entrance. There are two channels around the outer bar which does not permit vessels with more than 8.5m draft even during high tide conditions. However, 10.5m draft vessels can be anchored at the anchorage area located upstream from the outer bar in the Pussur River. The Outer bar is the only obstacle for the ships of 10.5m drafts to enter into the anchorage area.

To allow bigger ships into the anchorage area, dredging is required for navigation improvement at the Pussur entrance near the outer bar area. In this context, dredging will be carried out at two locations near the outer bar: (1) Dredging Location 1: dredging of 3703 m length of river stretch near Hiron Point light tower; and (2) Dredging Location 2: dredging of 7260m length in the Pussur-Estuary. The total capital dredging volume is estimated as 10.4 Mm^3 with 3.7 Mm^3 at Dredging Location 1 and 7.3 Mm^3 at Dredging Location 2. The maintenance dredging volume is approximately 3.37-3.89 Mm^3. Hopper dredgers will be used for the dredging and dredged materials transportation to the disposal locations. The dredging locations and potential dredged materials disposal locations are presented in ***Figure E.1***.

The project has three major components:

(1) Dredging of the shallow area to improve navigation;

(2) Transportation of the dredged materials; and

(3) Disposal of the dredged materials.

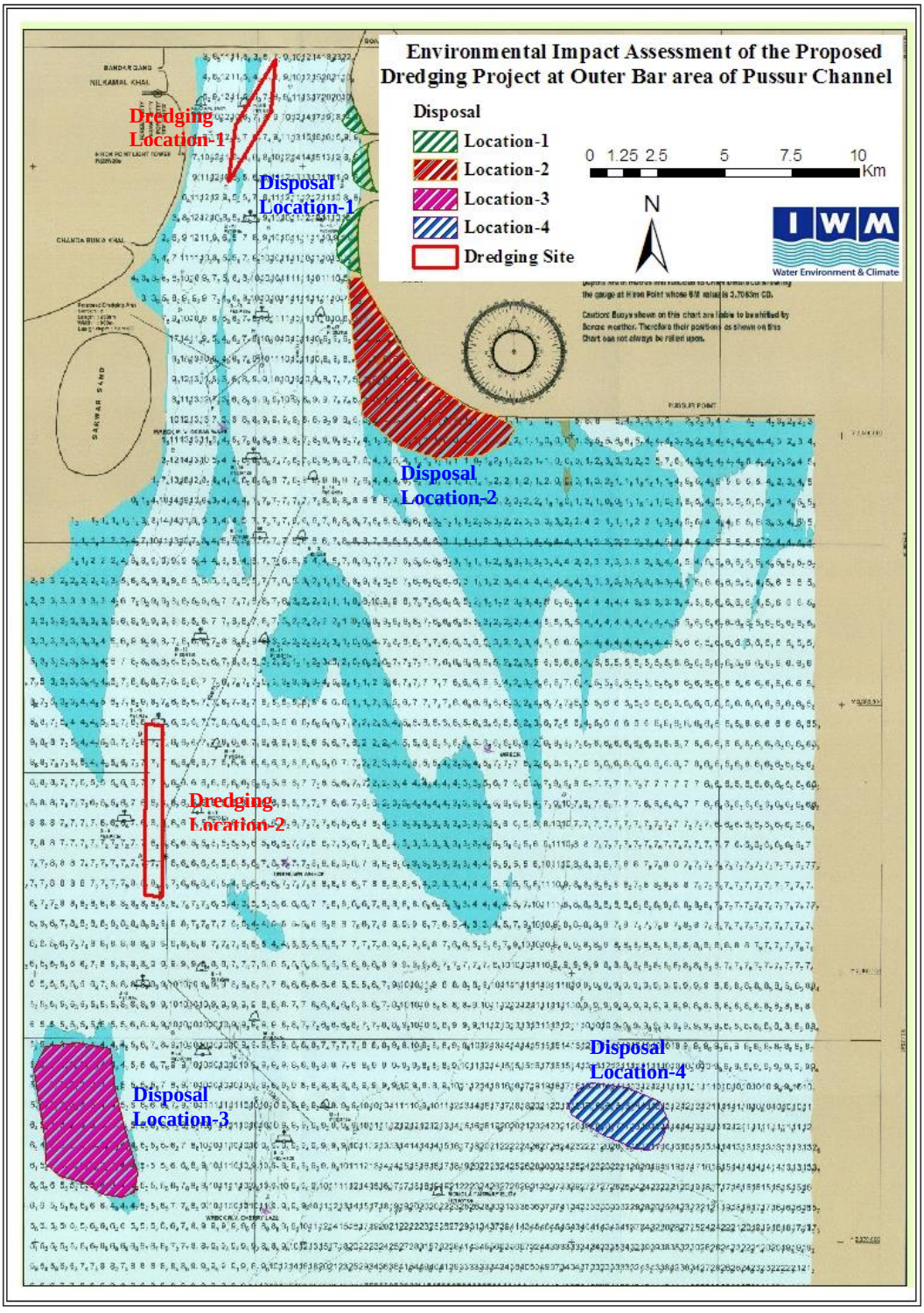

Figure E.1: Potential locations of dredging and dredged material disposal

E3. Baseline Environmental Conditions

The proposed dredging locations at Outer- bar are situated about 45 km seaward of Hiron Point and exposed to the open sea. Zulficar channel crosses the bar along an alignment with a minimum depth of about 6 to 8 m CD. The major physical process controlling the morphology of the Outer bar is the decrease in ebb current speed seaward of Hiron point, where the tidal prism is no longer confined to a distinct channel rather distributed in multiple channels. Towards the mouth of Pussur-Sibsa entrance, where the shores widen, there is a considerable divergence between flood and ebb channel, which leads to sedimentation.

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

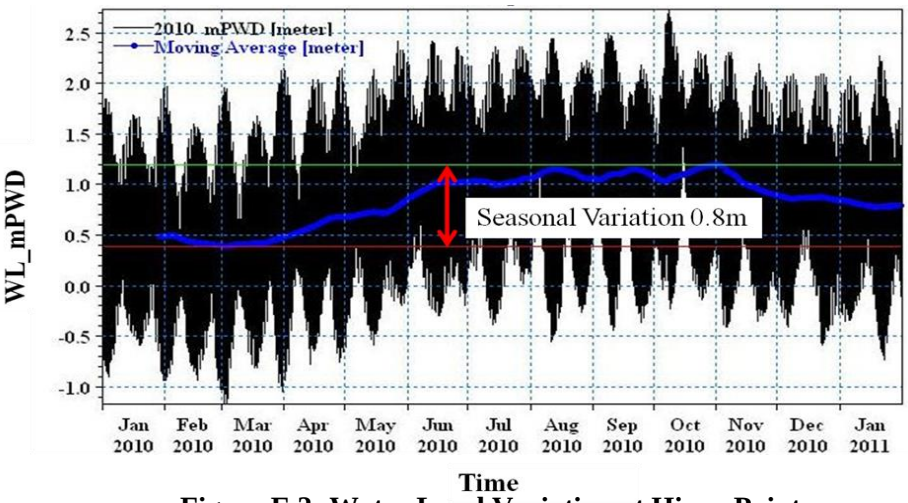

Figure E.2: Water Level Variation at Hiron Point

Biological characteristics, the occurrence of marine species - both plants and animals - has largely been controlled by the physico-chemical properties of ocean water. Water flow 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.

The diversity of cetaceans occupying this relatively small area is remarkable, and rigorous abundance estimates of shushuks/Ganges dolphins (Platanista gangetica), Irrawaddy dolphins and finless porpoises indicate that large populations of these species remain.

The Bangabandhu Island (Sarwar Sand) is occupied by several mangrove tree species like Keora (Sonneratia apetala), Baen (Avicennia officinalis), Gewa (Excoecaria agallocha), Kakra (Bruguiera gymnorrhiza), Dhundul (Xylocarpus granatum), Hargoza (Acanthus ilicifolius) along with different grass species like Malia (Cyperus javanicus) and Nal (Eriochlea procera).

General occupation of the community people of Sundarbans are Goalpata (Nypha fruiticans) harvester, honey collector, shrimp fry collector, fisherman and NTFPs collector. The proposed project intervention has no direct impact to any community as the dredging will be conducted at the Outer Bar area of the Pussur Channel. Local community said that the proposed dredging area is the fishing ground and our survey also

verified it. The consultant observed that two fishing groups were catching fish from the side of the Outer Bar. Mongla Port Authority also reported that sometimes propeller of the ships been affected by the fishermen's fishing net. Dublarchar island is the nearest locality from the project area where more than 3000 fishermen were living on a seasonal basis and they used to catch fish from the deep sea. Forest Department mentioned that community of Dublarchar enters into forest to collect Goalpata to make their temporary houses who also collect their daily firewood. Bangabandhu Island (Sarwar Sand) is a newly accredited land which was found located near the project area. The land is composed of pure sand and already several mangrove floral species been naturally regenerated. During field visit it was observed that fishermen used that land for taking rest during fishing period.

E4. Analysis of Alternatives

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

- Open-water disposal.
- Confined disposal.
- Beneficial use.

Considering all these factors, four dredged materials disposal options (***Figure E.1***) have been selected for multicriteria analysis. *Option-2* and *Option-4* have the highest value according to the multi-criteria analysis and these options are:

Option 2: *Disposal of dredged materials from both dredging locations to disposal location-2;*

Option 4: *Disposal of dredged materials from the dredging location in the Pussur channel to disposal location-2 and disposal of dredged materials from the dredging location in the estuary to disposal location-4.*

In the previous study, the deep sea located around 25km south of the proposed dredging site was selected as the most suitable disposal location but is discarded in the present study since comments were received from environmental experts that the designated location at deep sea would be within the recently gazetted Marine Protected Area - The Swatch of No Ground. The Sarwar Sand (Bangabadhu Island) was discarded in the previous report since this area is already developed and the fishermen community in the area opposed disposal of the dredged materials at the location.

Option-2, disposal of dredging materials in location-2 will enhance accretion process in the area. Initiatives to grow mangroves in this area will increase the Sundarbans mangrove forest. Before disposal, dykes/bunds should be constructed in order to prevent dispersion of disposed sediment at location-2. Erosion frequency of 10 years is evident at location-2 from the time series hydrographic chart analysis. In order to ensure safe disposal of the dredged material it is to be disposed at the designated location during the low tide condition so that the sediment is directed to the deep sea with tidal current and deposit there.

E5. Assessment of Impacts

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. Nearly all the species of the benthic fauna generally recolonize within 6 months from defaunation with a high recolonization rate in spring and summer and low recolonization rate during autumn and winter, according to various studies (Zajac and Whitlatch,1982; Beukema et al., 1999). 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 E.1*** presents impact matrix for dredging. Many of the impacts listed can be mitigated substantially by adopting standard working procedures and ensuring responsible behaviour of the contractor.

Table E.1: 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 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 emission, oil spill from dredging equipments. • Obstacle to navigation traffic. • Occupational health and safety risk.
Post Dredging Works	Impact on Resource System	• Improved waterway traffic. • Biodiversity.	• Hydro-morphological adjustment. • Erosion and sedimentation.
	Impact on User System	• Navigation traffic. • Employment. • Socio-economic development. • Attraction of tourists.	• Erosion and accretion. • Need maintenance dredging.

Impact on the Outstanding Universal Value (OUV) of the Sundarbans

Sundarbans was recognized as UNESCO World Heritage Site in 1997 considering two (2) criteria of the ten (10) criteria set by the World Heritage Center (WHC). In this context, the impact of the dredging and disposal of the dredged materials on the Outstanding Universal Value of the Sundarbans is assessed very carefully.

The potential impact of dredging is localized at the dredging and disposal locations. The project activities will have insignificant impact on on-going ecological and biological processes of Sundarbans (criterion ix) since sediment plume is not dispersed into the Sundarbans and does not increase the turbidity. Again proposed dredging does not affect the Sundarbans' exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Royal Bengal Tiger since impact is localized and dredging and disposal processes are building with nature.

The present dredging of the Pussur River is proposed at the river stretch, which has been experiencing river bed scouring and formation of bars at the outer bar area over the years. The dredging is suggested to deepen the river for improvement of navigability for safe ship movement. This dredging process at this location is building with nature since river deepening is occurring naturally. In order to reduce the sediment dispersion extent and turbidity level of river water, silt curtain is proposed as a mitigation measure. Monitoring is also suggested to control the dredging to limit the increase level and extent of turbidity, i.e. during spring tides at high current speed dredging will remain stopped.

The dredging will be done along the river flow and turbidity of water is very likely to increase along the river not transversely to lead changes inside Sundarban, which implies no impact on the Sundarbans area. Again during spring tides i.e. in full moon and new moon dredging will remain stop since high current, higher tidal range are likely to disperse sediment plume to the Sundarbans. The dredged material disposal plan includes disposing of dredged material on naturally accreting zone, eroding bank to reduce erosion of mangroves.

The Project will not remove or have on effects on habitats required to maintain the diversity of fauna and flora in the Sundarbans WHA (Criterion x) since chance of change of physical environment is very insignificant such as change of turbidity and other water quality parameter. In relation to retaining the Integrity of the World Heritage Area (Sundarbans), the proposed dredging Project does not cause loss to any whole OUV element (Wholeness Criterion), there will be no reduction in the size of the WHA property.

None of the proposed disposal locations is within the WHA area of the Sundarbans and there is no scope of loss of the mangrove forest due to dredging and dredged materials disposal locations. Rather, there is a huge potential of growth of mangroves on the land reclaimed by the disposal of the dredged materials at location-2. It is also likely to increase the area of the Sundarbans and enhance the natural environment.

The growth of the mangroves at location-2 is expected to provide a unique, irreplaceable habitat making significant contributions that benefit the coastal ecology. In general, mangroves preserve

water quality and reduce pollution by filtering suspended material and assimilating dissolved nutrients and serve as a diverse habitat for many species including insects, crustaceans, mollusks, fish, amphibians, reptiles, birds, and many other invertebrates. Up to 80% of the global fish catches are directly or indirectly dependent on mangroves (Fujimoto 2000). Mangroves are essential to maintain coastal fisheries, protect property and coastlines from the effects of cyclones and storms and protect coral reefs from sediments and pollutants.

The dredged materials cannot be disposed at the Sarwar Sand or Bangabandhu Island since it is within the World Heritage Area of the Sundarbans. Disposing the dredged materials at the Bangabadhu Island and resulted increase of turbidity may disturb the aquatic ecology within the WHA.

E6. Environmental Management Plan and Monitoring Plan

A comprehensive EMP is developed with mitigation measures, monitoring plans, , institutional arrangement, capacity building and EMP cost. Some of the mitigation measures for likely adverse impacts due to the project interventions are presented in ***Table E.2*** and the all the measures are discussed in details in ***Chapter 9***.

Table E2: Summary of negative impacts and mitigation measures

Activity/ Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
Pre-dredging activities			
Safety of navigating vessels	Dredging location and activities in the waterways may result in traffic congestion or accidents or disturbance to fishermen boats and navigating ships/vessels.	Installation of navigation signs and aids in the dredging and disposal sites to alert the vessels passing the area.	MPA and the Contractor
Dredging Operation			
Dredging: excavation	• Increased sediment concentration in water, increased turbidity of water, loss of transparency, impacts on marine and benthic habitats.	• Select dredging equipment with low risk of sediment dispersal. The Contractor should select the dredging methods to minimize suspension of sediments, minimize destruction of benthic habitat, and increase the accuracy of the operation. Suspended sediment concentrations due to	MPA and the Contractor

Activity/ Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
	• Impacts on morphology and bathymetric changes	dredging activities should not exceed 4,000 mg/l near the dredger; • Monitor the dredging operation and, if necessary, change the dredging plan to minimize amount of material being dredged (or the number of dredgers allowed to operate) at any one time; • Suspend dredging works during new moon and full moon for one cycle to reduce the extent of dispersion of sediment plume; • Inspection and monitoring of dredging activities should be conducted to evaluate the effectiveness of impact prevention strategies, and re-adjusted where necessary; • An ongoing ecological monitoring will be in place to evaluate the impacts of the dredging and develop additional mitigation measures as required; • Ensure adequate measure to protect channel bed and banks through proper design and construction of training works; • Use of silt curtain in order to control sediment dispersion within the dredging area.	
Noise from dredging activities	• Noise and vibration under water: Disruption to fish migration and disturbance to dolphins • Noise and vibration above water: disturbance to the	• Reduce the dredger noise at source by isolation of exhaust systems and by keeping engine room doors shut; • Limit the noisy dredging to daylight hours, where possible, rather than at sunrise or sunset (significant for	MPA and the Contractor

Activity/ Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
	animals and birds of the Sundarbans	wildlife) or during night time hours. Where unavoidable, the contractor should ramp up the levels of engines or other noise producing sources, so that the noise slowly increases. This will encourage marine and terrestrial fauna to move away from the source area prior to significant noise emissions.	
Oil spills	• Oil spill will cover large area from a specific point location through tidal and wave action in the Pussur estuary and the bay	• Refueling of barges and boats with a proper care to avoid any spills; • Make available spill kits and other absorbent material at refueling points on the barges; • Monitoring of oil spill and use of spill kits.	MPA and the Contractor
Post-dredging activities			
Placement of dredged materials	Dispersion of sediments and release of high sediment laden runoff from the placement sites.	• Prior to filling commencing, the disposal areas at location-2 where the water depth is less and there is a delta building process, should be enclosed by sand-filled geo-tubes and subdivided into compartments; • Use of silt curtain to prevent dispersion of sediment plume.	MPA and the Contractor
Drainage Congestion	• There are khal outlets near disposal location-1; which can be blocked by disposed sediment at his location and hamper drainage. If these khals are blocked drainage congestion will occur;	• Remove sediment accumulation at the outfalls of the natural khals; • Before disposal, dykes/bunds should be constructed in order to prevent blockage of drainage canals near location-2;	MPA and the Contractor

Activity/ Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
	• Drainage congestion may occur if the dredged materials block drainage of the reclaimed area at disposal location-2; • If the drainage is hampered water logging in the catchments will affect ecology of the area.	• Use of silt curtains will prevent sediment dispersion and khal blockage.	

The environmental monitoring plan will be executed by the contractor and third party will monitor the execution of the EMP to assist MPA. The longer term monitoring of the project will be carried out to address any change in socio-economic condition, change in benthic community, water quality, fishery, etc. A management feedback system is required so that information from the monitoring can be fed back into decision taking and corrective action if required. Cost of monitoring including required resource personnel shall be included in the project budget.

To assess impacts of dredging and disposal material, benthic grabs may be obtained in the vicinity of a dredge area and disposal area when the operation is in progress. The objectives of sampling will be:

1. to define the impacts of dredging and disposal on the benthos;
2. determine the spatial extent of dredged material dispersion from the discharge point;
3. follow the rate of recovery of the benthos; and
4. a seasonal survey, sampling to ascertain benthic conditions may be conducted to yield a background against which the short-term impacts of dredging and disposal could be used to assess the potential for long-term impacts.

A format of the monitoring report is incorporated in the EIA Report. Moreover, an Emergency Response Plan is also incorporated illustrating the emergency procedures to be followed in case of cyclones and accidental oil spill.

E7. Findings

I. The proposed dredging activities for improvement of navigability at the Outer Bar area of Mongla Port does not make any long term irreversible impact on the ambient environment. In most cases, the implementation of the dredging operation will cause short term environmental impacts;

II. The implementation of project will improve navigability of deep draft vessels, thereby increasing foreign trade of the country and overall socio-economic development;
III. Mitigation and monitoring measures have been developed in the EMP. The EMP will be implemented by the Port Authority and the authority will engage monitoring Consultant for supervision and monitoring of dredging activities;
IV. The key stakeholders including port users, inhabitants, etc. are in favour of the project;
V. Handling of dredge materials does not require any land acquisition for the project;
VI. Disposal of dredged materials will not affect the Outstanding Universal Value of the Sundarbans and there will be no reduction in the size of the WHA property. Rather, it will be utilized in beneficial purposes such as erosion protection and land reclamation;
VII. Silt curtain is proposed as a mitigation measure for reducing the sediment dispersion extent and turbidity level of river water. Monitoring is also suggested to control the dredging to limit the increase level and extent of turbidity, i.e. dredging will remain paused during spring tides at high current speed; and
VIII. The disposal locations will be enclosed by sand filled geo-tubes/geo-bags before disposal. As a result, the potential impact is localized and will have no impact on on-going ecological and biological processes of Sundarbans.

E8. Recommendations

Followings recommendations are made based on baseline conditions, impacts, mitigations measures and importance of the project:

- The implementation of the project is suggested to follow the recommended mitigation measures as outlined in the Environmental Management Plan (EMP). The EMP shall be included in the bid document of civil works and need to become part of the civil works contracts. Civil Works Contractor shall execute the EMP. The timely implementation of EMP will reduce negative impacts;
- Both MPA and the contractor shall abide by relevant environmental rules, regulations including workers' health and safety aspect, prevention of air and water pollution, protection of aquatic fauna and flora, etc.;
- Dredge material shall be disposed in designated location following environmental code of practice;
- MPA shall engage a third party to supervise and quality control of monitoring plan to assist MPA.

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1 INTRODUCTION

1.1 General

This Environmental Impact Assessment (EIA) report is prepared to comply with the reporting requirement as stipulated in the Terms of Reference (ToR) for the consultancy services entitled "Feasibility Study for Dredging at Outer Bar". The report presents the main project interventions, relevant regulations, impact identifications, mitigations, environmental management plans and conclusions and recommendations carried out during the study period for Mongla Port Authority (MPA). The EIA Report has been prepared following EIA Guidelines of Department of Environment (DoE) and that of Water Resources Planning Organization (WARPO) to fulfill one of the major obligations of Terms of Reference (ToR). This EIA report is the updating of the earlier EIA report integrating changed project interventions i.e. the new alignment of dredging at the Outer Bar.

EIA is mandatory study process to assess the environmental consequences of an existing or proposed project and to delineate any environmental management measures that must be integrated into the plan to ensure that the project is technically, economically, socially and environmentally acceptable. Flood Action Plan (FAP) promotes EIA as an early planning tool with the inclusion of peoples' participation as an integral part. The EIA preparation led to the identification of potential environmental impacts due to proposed dredging activities and feasible remedial measures as included in the Environmental Management Plan (EMP). The proposed dredging programme at Outer Bar of Pussur Channel to improve navigability may have some adverse impacts on various components of environment during construction and operation phases. In order to mitigate these adverse impacts and to comply with the regulatory requirements of DoE the EIA has been taken up to integrate environmental mitigation measures in the project design.

1.2 Background

Mongla Port is situated at the confluence of Pussur River and Mongla Nulla, approximately 71 nautical miles (about 131 km) upstream from the Fairway buoy (approaches to the Pussur River) of the Bay of Bengal. It is the second gateway of Bangladesh and the most eco-friendly seaport of the country. The Port is well protected by the largest mangrove forest known as the Sundarbans, part of which has been declared as "World Heritage" in 1997 by UNESCO. Since 1950, Chalna Port continued to function as a Government Directorate under Ministry of Communication and in May 1977 the Directorate was converted to an autonomous organization named "Port of Chalna Authority" which is again renamed "Mongla Port Authority" on 08 March 1987. The Port provides facilities and services to the international Shipping lines and other concerned agencies providing shore based facilities like 5 (five) Jetty berths (total length 914m), have a capacity of about 6.5 million tones general cargo/break bulk and 30,000 TEUS. The midstream berth (7 buoys & 14 anchorages) have a capacity of about 6.00 million tonnes. Total 33 ships can take berth in the Port (in the Jetties, buoys & anchorage) at a time. However, alike other modern port of the world Mongla Port is keen to provide highest port facilities, so that bigger draft ships can enter in to the port channel safely.

The Pussur River forms part of a very big and complex river system. Numerous tributaries and channels connect the Pussur River with other rivers like Sibsa, the Gorai and Ganges rivers. Tide from the Bay and water flow conditions in all these rivers determined the current and morphological condition in the Pussur River. The navigation channel at the Pussur River entrance crosses a wide bar known as outer bar. With the existing depth in the outer bar, maximum 8.5 m draft vessel can cross the outer bar and enter the port at

normal high tide. But the depths over the anchorage area of the channel permit anchoring of more than 9 m draft vessels. Outer bar area is only obstacle for the ships of 9 m and above to enter into the anchorage area. If the depth of the outer bar would be increased to make safe passage of 10.5 m draft vessels in normal high tide, Mongla port could handle more ships means handling of more cargoes.

ECNEC approved the dredging project on 27 September 2006 and was originally scheduled for implementation from 2006-07 to 2008-09. However, due to non-allocation of fund in the ADP, non-receipt of tenders, re- tendering owing to high quoted price, justification of technical viability as suggested by the ministry, and finally revision of the project as decided by ECNEC, the implementation of the project has been delayed and re-scheduled from 2007-08 to 2012-2013.

From various studies of the past it has been evident that the morphological behavior of the river system, sedimentation and erosion pattern of the Pussur River is frequently changing. The continuous and high siltation in the channel poses extreme threat of uncertainty to safe maneuvering including economic handling of the ocean going vessels. Therefore, to ensure safe navigation route, intelligent dredging at proper location, alignment and timing for optimum dredging volume (Capital and maintenance) is a need of the day.

Prior to implementation of the proposed dredging project, it is imperative to conduct a thorough study on Environmental Impact Assessment (EIA) and assess adverse biophysical and socio environmental impact, if any, with recommendation of appropriate mitigation plan. Department of Environment provided the environmental clearance on 25 August 2013 and later on extended the validity of clearance till 24 August 2015.

The last PEC meeting on recast DPP held on 6th August 2015 at Planning Commission suggested to carry out a new feasibility study of Pussur Channel, which has to be included in the recast DPP. EIA study is also carried out as an integral part of the feasibility study. The present EIA study is the updating of earlier detailed EIA study.

1.3 Type of Project

In Bangladesh all development projects are categorized into three categories namely Category Red (projects with significant adverse environmental impacts), Orange/Amber (projects with some adverse environmental impacts, but of lesser degree than those of Red category projects) and Green category (projects with minimal/insignificant adverse impact). As per National Environment Policy 1992 all developmental activities need to ensure environmental impact assessment. The environmental clearance certificate is required from the DoE. As per ECA 1995 and ECR 1997, the project falls in Red category. Accordingly the EIA report has been prepared.

1.4 Project Rationale

The proposed intervention will allow 10.5meter draft vessel to ply at the Outer Bar area which will lead to increase traffic and more cargo handling at Mongla port. This will allow faster transport of goods and increased export. This will result in increased earnings of foreign exchange. There will be increased direct and indirect employment opportunities. At Mongla port there is main import of automobile vehicles (luxury cars), food/grain commodities and other value added products. The foreign investors will be more attracted to Mongla Export Processing Zone due to arrival of more cargo vessel with desired draft facility to the port.

1.5 Objectives

The overall objective of the EIA study is to ensure that the recommended intervention is carried out in environmentally sound and sustainable manner and that the EMP recommendations are abide by the project authority during all the phases of the project cycle.

The EIA aims to identify the likely potential impacts of the proposed interventions to quantify and where possible, value these so that they can be used in a multi-criteria analysis for rational decision making by the project authority and policy makers. The specific objective of the study is to:

- Conduct "Environmental Impact Assessment (EIA) study for the proposed dredging project at the Outer Bar area of the Pussur Channel" to increase navigability to facilitate easy entrance and maneuvering of 10.5meter draft in the anchorage area of Mongla Port;
- Assess biophysical and socio environmental impact, if any, with recommendation of appropriate mitigation plan in the project area; and
- Prepare report on EIA to obtain Environmental clearance from DOE.

1.6 Scope of Works

As spelled out in TOR (Annex-4), the studies need to be carried out in support of EIA are:

- An inventory of the marine species and habitats in the areas to be dredged and surrounding impact areas including Sundarban;
- A hydrodynamic model to evaluate the potential for the proposed dredging of the Outer Bar area and its impact on hydraulic conditions on morphology of the upstream navigation channels like Pussur and Sibsa rivers;
- Sediment sampling and laboratory testing to determine the quality of the potential for release of contaminants during dredging;
- Water quality sampling at the dredging area to provide baseline water quality condition.
- Selection of suitable location for disposal of dredged materials;
- Assess the environmental impact of the proposed dredging activities;
- Prepare an outline environmental management plan (EMP);
- Conduct public consultations; and
- Impact on the Outstanding Universal Value (OUV) of the property of World Heritage

1.7 Study Team Composition

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 1.1**.

Table 1.1: Name and position of the study team members

Sl. No.	Name of the Study Team Members	Position
1	Md. Shamsuddin, PEng	Team Leader
2	Zahirul Haque Khan	Environmental Engineer/Dredging Specialist
3	Dr. Khurshid Alam	Sociologist/ Water Management Institutional Specialist
4	Dr. S.M.A. Rashid	Ecologist
5	Tarek Bin Hossain, PEng	Coastal Morphologist
6	Md. Manirul Haque	GIS Specialist
7	Md. Ziaur Rahman	Data Analyst/Field Researcher (1)
8	Shume Akhter	Data Analyst/Field Researcher (2)

1.8 Structure of the Report

The EIA report primarily includes the following Chapters and annexes as described below:

Executive Summary: Presents precisely the salient environmental project features including baseline conditions, study methodology, major impacts, findings and recommendations.

Chapter 1: **Introduction** - This chapter gives background information of the project together with the description of methodology, study team composition, study limitations and references.

Chapter 2: **Policy and Legislative Requirement** - It attempts to address salient environmental Acts, Rules, Policies and Laws relevant to the present study.

Chapter 3: **Description of Project Activities**- This chapter describes briefly the project area, major activities involved in dredging operation including type of dredger to be used and a tentative wok schedule in the form of bar-charts.

Chapter 4: **Description of Baseline Condition** - Baseline information on physical Environment, biological environment and environmental quality of the project area. This includes among others the water quality data and benthic organism in the bed materials at the proposed intervention area.

Chapter 5: **Social Impact Assessment** - This chapter presents precise description on SIA methodology, consultation with key stake holders, findings of social assessment and recommendations.

Chapter 6: **Analysis of Alternative Sites**- This chapter considers different sites for disposal of dredged materialss and compares each site against certain parameters to decide the most suitable one.

Chapter 7: **Identification of Impacts** - This chapter describes project scoping, project bounding, identification, prediction and assessment of impacts likely to result from the proposed dredging project.

Chapter 8: **Impact Mitigation and Environmental Management Plan (EMP)** - This chapter includes significant major impact on project implementation together with the mitigation measures

and the environmental management plan.

Chapter 9: **Findings, Conclusions and Recommendations** - This chapter presents study findings, conclusions and recommendations in precise form.

Annex-A: Revised Terms of Reference (ToR).

Annex-B: Environmental Monitoring Report Format

Annex-C: Comments and Responses on the Final EIA Report

1.9 Study Approach and Methodology

The approach consisted of review of available literature on the project related reports like "Monitoring the Performance of Dredging in/c Hydrological & Morphological Impacts by Mathematical Modeling & Assessment of Effectiveness of Dredging in the Harbour Area of Pussur River of Mongla Port" prepared in March, 2012, Final Report (TA 7389-BAN) on "Port and Logistics Efficiency Improvement" prepared on 13th July 2011, DoE's Guide Lines for EIA of Industries, WARPO's Guidelines for EIA of Water Management (FCDI) Projects (2005) and other related studies and data sources.

Consultations were carried through a multidisciplinary team consisting ecologist, sociologist, morphologist and environmentalist covering various aspects including technical, social and environmental dimensions. An exclusive field visit was undertaken from February 2-7, 2013 to the proposed dredging site[1] (**Figure 1.1**) and to hold meeting and discussions with relevant government officials including Forest Department, Department of Fisheries, DoE, local community representative and people as part of scoping process. Consultations were held with the Project Director and Chief Engineer, Mongla Port Authority (MPA), Port users (Shipping Agents) and other key stakeholders. Participatory Rapid Rural Appraisals (PRRAs) adopting Focus Group Discussions (FGDs) and other techniques were conducted in the project area.

After field data collection on different aspects of environment, an environmental baseline description has been developed. This was followed by the initial screening and scoping, bounding and assessment. The impact assessment began with the establishment of scenario 'future without project' assuming that the past trend will continue in future and this was followed by the scenario 'future with project' after implementation of study findings. The impact was predicted by assuming the difference between the scenarios. The methodology compares the present situation to that in the future both with and without the proposed intervention. The impacts of project intervention on identified environmental components are presented in the matrix where the column shows the IECs and the rows project activity (impact factors) indicating their respective linkages in the matrix cells by indication of positive and negative trends. Mitigation measures for addressing potential negative impact and indicative plan to enhance positive impact has been indicated in this EIA report.

[1] The proposed dredge site is roughly between the Fairway Buoy and Hiron Point lighthouse in the shallow continental shelf, largely affected by the tide, wind, water flow current from upstream. A GARMIN 60SfX GPS was used to mark transect and sample location sites. The continental shelf ends about seven km south of the Sampling Site No. 2 (N 21°35′46.6″; E 89°27′46.5″) and about 15km to the northern end of the Swatch of No Ground.

1.10 Limitations of the Study

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. The study took place without recruitment of the contractor to execute the dredging operation in question. Details of equipment and accessories could not be specified.

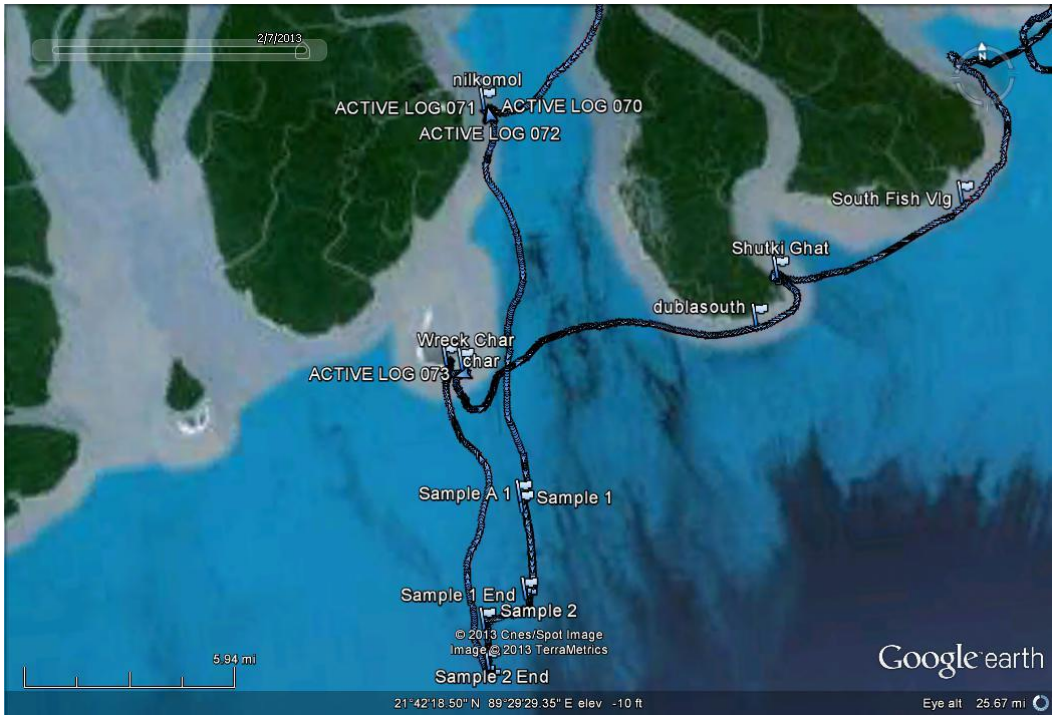


Figure 1.1: Map showing route taken during field visit to the proposed dredging site and sampling locations.

2 POLICY AND LEGISLATIVE REQUIREMENT

2.1 General

The proposed interventions to improve navigability of Pussur Channel at the outer bar area must comply with the relevant legislation and planning requirements of the Government of Bangladesh 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 the 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.

2.2 National Environment 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 sectoral 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.

2.3 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 1999 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 haor, 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.

2.4 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-sectoral 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-sectoral 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, 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.

2.5 Coastal Zone Policy, 2005

Coastal zone policy initiated as a harmonized policy that transcends beyond sectoral 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.).

2.6 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.

2.7 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.

2.8 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.

2.9 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."

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

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

2.11 Proposed Legislation

Protection of the Marine Environment of Bangladesh Act 1990, which primarily addresses pollution in the coastal and national waters and seaports of Bangladesh, and outside national waters, is not yet enacted. The Act provides control for oil or pollutants discharged, spilled or disposed into Bangladesh water from ships, ship transfer to land, land, ports, exploration of the sea bed, pipelines and offshore installations. It proposes the establishment of spill contingency plans without detailing the way in which this might function.

Draft Rules for the Environmental Control of Inland Water Transport applied to inland water and waterways throughout Bangladesh which are categorized as navigable by inland water transport, and to all waters served by inland water transport including ports and the approaches to ports. The proposed Rules control impacts from all inland water transport, ports, ship-related facilities, and ship related activities for the protection of inland water in regard to air emissions, handling and storage of harmful materials, solid and liquid waste discharges, dredging, and disposal of dredged sediments.

Proposed Draft Rules for Inland Ship Safety 1994 under the Department of Shipping (DoS) Institutional Development Action Plan as part of the implementation plan for establishing an Inland Ship Safety Administration (ISSA) within the DoS. Chapter II (Classification of Dangerous Goods), and Chapter VIII (Carriage of Dangerous Goods on Inland Ships) which specifies stowage and precautionary measures to be taken during loading and unloading are relevant to port handling of cargoes, but other than this the Rules contains no environmental controls.

2.12 Ratification of International Conventions

Bangladesh is signatory to twelve (12) International Conventions (although this does not include MARPOL 73/78 (Prevention of Pollution from Ships), OPRC (Oil Pollution Preparedness Response and Cooperation) or the LC Convention 72 (disposal of ship wastes). Consequently, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) is not strictly enforced in Bangladesh marine and coastal water, neither is ship in Bangladesh Ports subject to inspection for the purpose of enforcing MARPOL 73/78.

2.13 Legal Framework

Reservation of the Sundarbans was established in 1875/76 and was retained after the partition between East Pakistan and India. The Forest Act (Act No. XVI, 1927) consolidated the previous rules relating to forests, the transit of timber, duty liable on forest products and it has the following roles:

(i) Grant power to Government to reserve forests;
(ii) Grant power to impose duty on timber and other forest produce;
(iii) Prohibit the acquiring right over the land described in the notification except in accordance by rules defined by Government;
(iv) Prohibit the clearing of forest;
(v) Prohibit the removal of timber;
(vi) Prohibit the felling of trees;
(vii) Prohibit hunting, shooting, fishing poisoning of water, snares or traps;

Bangladesh Wildlife (Preservation) (Amendment) Act 1974. Provides for the following main effects:

(i) List species defined as Game Animals and Protected Animals
(ii) Sets rules regarding the protection and exploitation of wildlife, and
(iii) Enables the establishment of Wildlife Sanctuaries and National Parks

Protection and Conservation of Fish Act, 1 950 stipulates:

(i) Rules and regulations regarding the harvesting of fish,
(ii) Specifies the officials with authority to detect breaches, including search and investigation
(iii) Rules to prohibit the erection or use of fixed engines and construction of weirs, dams, bunds, embankments and other structures
(iv) Prohibits the destruction of fishes by explosives, gun, bow, in inland or coastal areas,
(v) Prohibits the destruction of fish by poisoning, pollution and effluents,
(vi) Prescribes the seasons during which the catching of fish can occur
(vii) Prescribe the minimum size
(viii) Prohibits fishing in all waters or any specified time

The following outlines the legal and regulatory framework for management of the water resources environment.

(i) The 1995 Environmental Conservation Act;
(ii) The 1997 Environmental Conservation Rules, including the Water Quality Standards (WQS);
(iii) The 1997 EIA Guidelines for Industries issued by the DoE;
(iv) The 1999 Environmental Court Act.

2.14 Bangladesh Environmental Conservation Act (ECA) 1995

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.

2.15 Bangladesh Environmental Conservation Rule (ECR) 1997

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 en+vironment 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

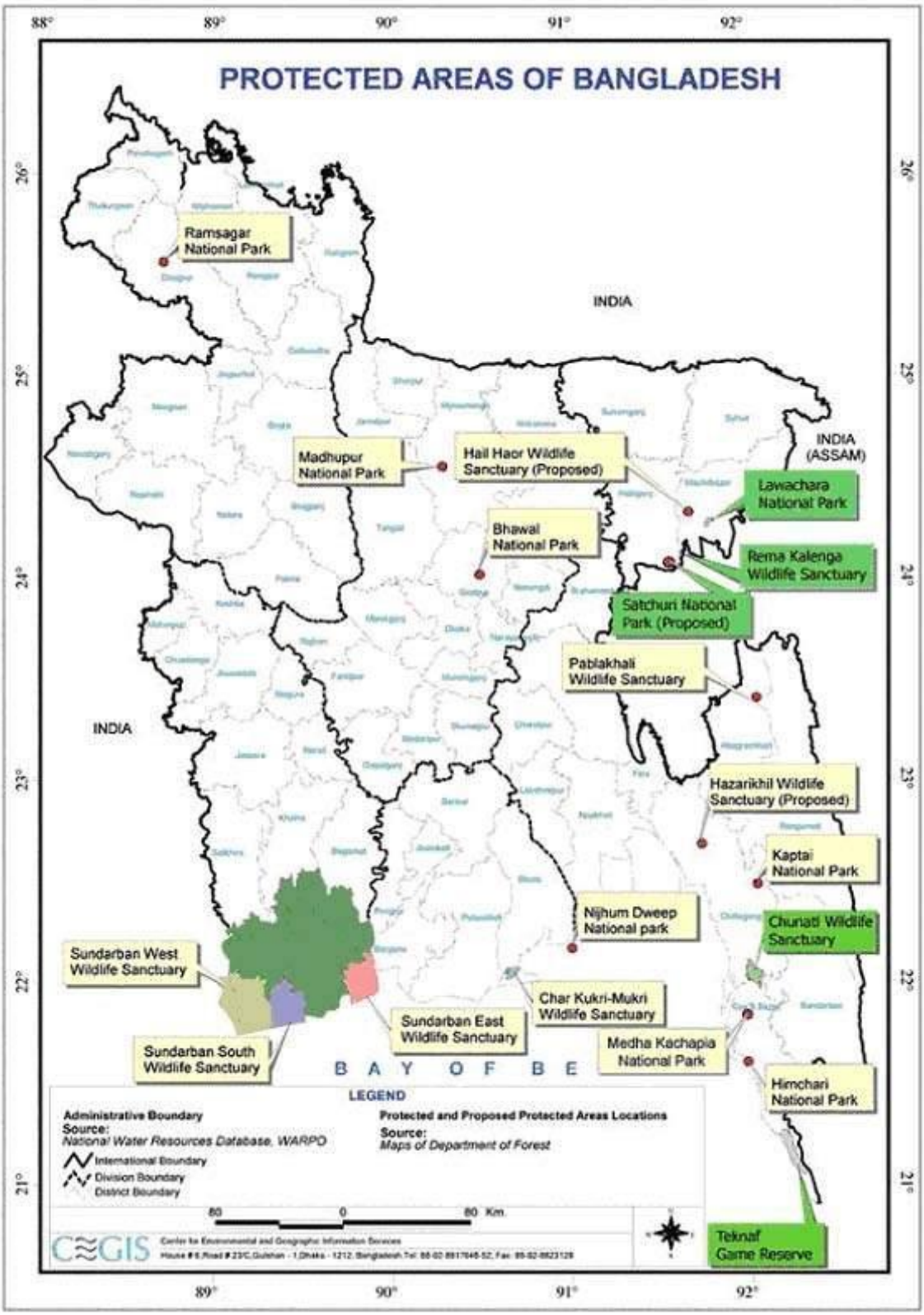
critical area' and reads, "(1) The Government will take the following into consideration in order to declare any area as Ecologically Critical area vide Section 5(1) of the Act (ECA 1995):

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

Figure 2.1 and Table 2.1 present map and list of protected areas of Bangladesh respectively. (2) 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: CEGIS

Figure 2.1: Protected Areas of Bangladesh

Table 2.1: Notified & Protected Areas of Bangladesh

SL No	Notified & Protected Area	Location	Area (ha)	Established
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 Hill Tracts	42087	1962/1983
15	Chunati	Chittagong	7761	1986
C	**Game Reserve**			
16	Teknaf	Cox's Bazar	11615	1983

2.16 Convention on Biodiversity

Bangladesh is a signatory of the Convention of Biodiversity committing the Government to the protection of biodiversity throughout Bangladesh. This requires the GOB to make a commitment to provide resources for the Protection and Management of Biodiversity.

2.17 Ramsar Convention

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".

2.18 Recommendations on World Heritage Site by Reactive Monitoring Mission

There are sites within the project area that are part of the World Heritage sites within the Sundarbans. The three seaward sanctuaries within the Sundarbans form the World Heritage site. These sites are regarded as being of the highest importance for Biodiversity Protection within the Sundarbans Reserve Forest despite the concerns raised about their representativeness (Saunders, 2000).

In 2016, the Reactive Monitoring Mission visited Bangladesh and the Sundarbans to assess the current state of conservation of the property following a decision of the World Heritage Committee.

The Reactive Monitoring Mission (2016) identifies three major issues that are posing threats to the Outstanding Universal Value (OUV) of the Sundarbans which are: (1) increasing salinity and siltation following the construction of the Farakka Barrage and increased water extraction and threatening the overall balance of the ecosystem; (2) likely pollution from coal ash by air, pollution from wastewater and waste ash, increased shipping and dredging and the cumulative impact of industrial and related development infrastructure related to the prospective construction and operation of the Rampal Power Plant; (3) lack of an integrated management system in the increasing port capacity and other coastal developments that are expected to result in increased shipping and dredging. The mission concluded that the property does not currently meet the requirements for inscription on the List of World Heritage in Danger. However, the mission made ten recommendations to prevent the OUV of the property from becoming irreversibly damaged. Among the recommendations, the following are related to the current project.

*"**R4:** Considering the potential threats to the property from increased shipping and required dredging the planned expansion and increase in use of the Mongla Port requires urgent clarification. It is recommended that the State Party halt all expansion activities until an independent, comprehensive and scientifically sound EIA has been conducted and provided to the World Heritage Centre and IUCN for their review and evaluation."*

*"**R7.** Develop, finalise and submit for review by the World Heritage Centre and IUCN, a detailed assessment of potential impacts of current and planned dredging and associated activities on the OUV and integrity of the property."*

*"**R10.b:** Considering the multiple activities outside the property that are impacting on its OUV, it is recommended that the State Party puts in place a system that allows management of the property in a more integrated manner. Such a system should ensure decisions for further economic development and associated activities such as shipping and dredging are not taken in isolation but are subject to a Strategic Environmental Assessment (SEA) for the property and its surrounding areas upon which it is dependent."*

2.19 Institutional Framework

The DoE under the ministry of Environment and Forest is the primary institution for environmental management and setting and enforcement of the environmental regulations. Its key duties related to the water sector include:

(i) Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution;

(ii) Setting the Water Quality Standard (WQS) for particular uses of water and for discharges to water bodies;

(iii) Defining EIA procedures and issuing environmental clearance permits - the latter being legal requirements before proposed projects can proceed to implementation;

(iv) Providing advice or taking direct action to prevent degradation of the environment;

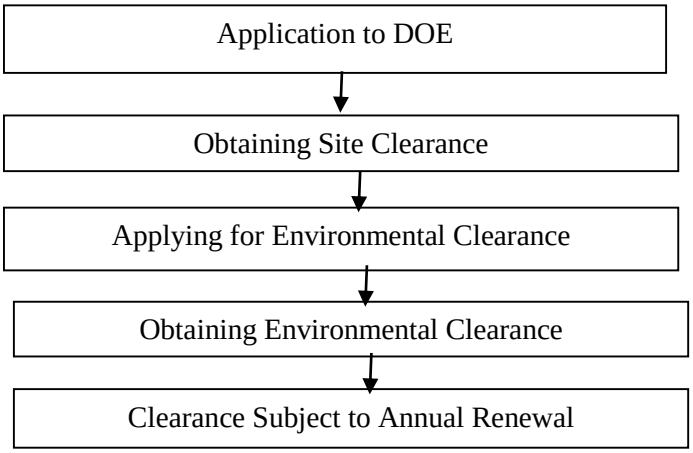
(v) Declaring Environmentally Critical Areas (ECAs) where the ecosystem has been degraded to a critical state. ECA status confers protection on land and water resources through a series of environmental regulations.

(vi) (The Forestry Department is responsible for Sensitive Area protection in the following four types of legally protected areas: wildlife sanctuaries, game reserves, reserve forests and natural reserve forests).

2.20 Environmental Clearance 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 proposed dredging will follow the procedures for 'Orange B' /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 DESCRIPTION OF PROJECT ACTIVITIES

3.1 General

The removal of sediments by mechanical dredging can have adverse impacts on marine species, habitats and ecosystem services. The impact may be due to physical or chemical changes in the environment at or near the dredging site. The extent of the impact depends on the size, characteristics and sensitivity of the dredged area and the dredging technique. The impacts of dredging activities are strongly influenced by the contamination of the sediment (if any) and local factors like water depth, rate of flow, tidal currents, wave action, type of seabed and sediment concentration of the water under natural circumstances, as well as the dredging method, the extent of the areas dredged (in terms of area and depth), the frequency and duration of dredging activities, the characteristics and the sensitivity of the areas dredged and their surroundings (in terms of distribution and importance of habitats and species), the dredging techniques applied as well as relationships with other uses and users of the system (cumulative aspects).

3.2 Study Area and the Major Problems

The navigation channel at the Pussur river entrance crosses a wide bar known as Outer bar. It exists between latitudes 21°35.29’ and 21°40.691’ at around 45 km seaward of Hiron Point and exposed to the open sea. Figure 3.1 shows the layout of the coastline, channels, the bar area and the existing navigation way together with navigation buoys. The bar is relatively stable and allows vessels having maximum draft of 8.5 m to cross it during normal high tide condition. However, depths at the anchorage area in the upstream towards Mongla port through Pussur Channel permits anchoring of more than 9 m draft vessel. So the Outer bar is the only obstacle for the ships of 10.5meter and above to enter into the anchorage area.

Figure 3.2 Shows the Sundarban Mangrove Forest and the proposed dredging location at Outer Bar area of Pussur Channel.

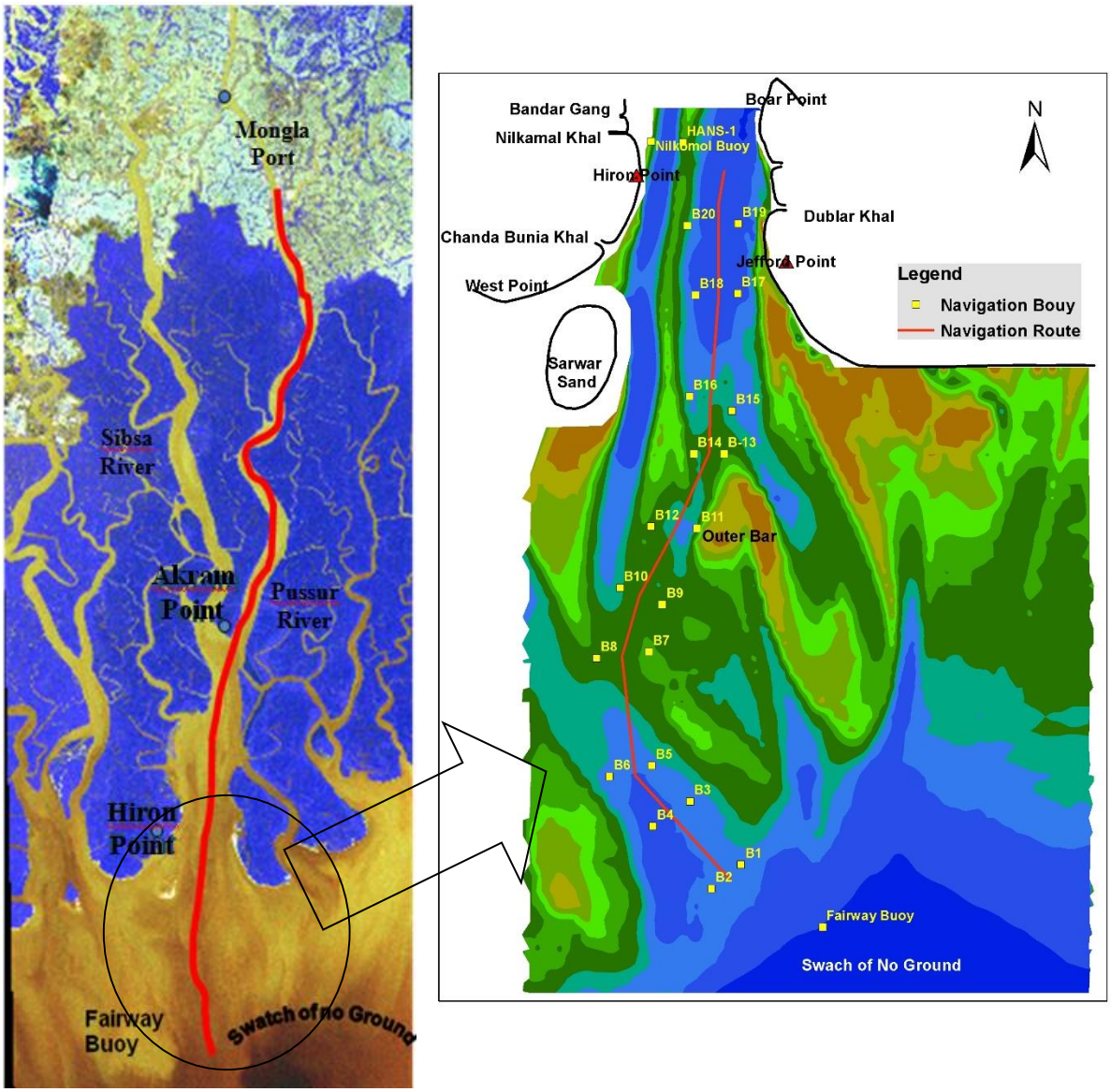


Figure 3.1: The Study Area

3.3 Activities Involved in Dredging

The proposed dredging operation at Outer Bar area of Pussur Channel has been considered to improve navigability of Mongla port so that vessels with more than 9 meter draft can efficiently move in the channel. The intervention will have a varying dredging width from 600 m to 900meter covering a length of about 10.78 km as shown in Figure 3.2.

The activities involved in dredging are primarily mobilization of the contractor with dredging equipment and accessories (suction pipe, discharge pipe, suction pump, discharge pump, anchorage system, etc.), pre-dredging hydro graphic survey at the proposed dredging location, dredging will be carried out preferably by trailing suction hopper dredger (TSHD), disposal of dredged materials at suitable site and post-dredging hydro graphic survey.

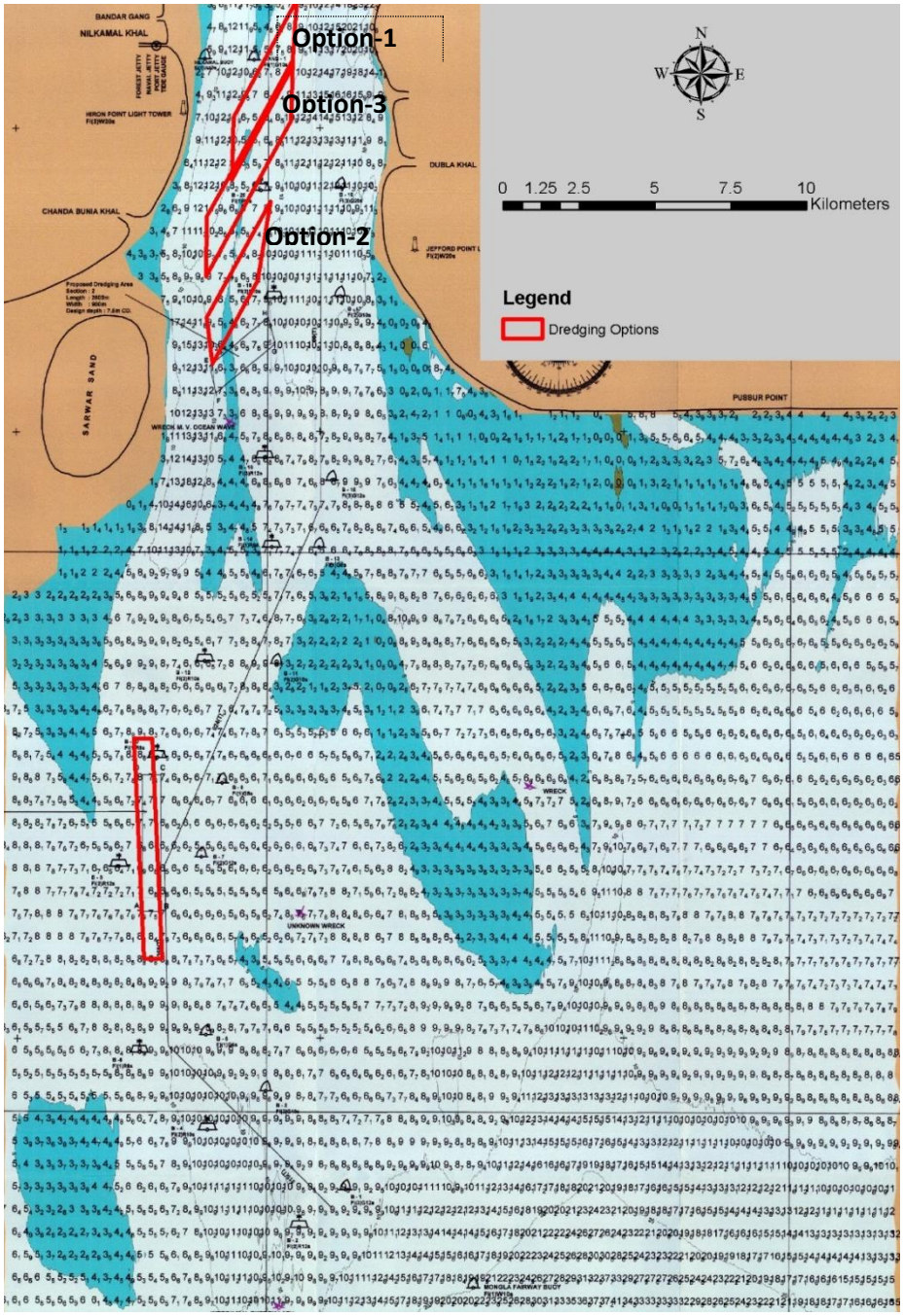


Figure 3.2: Proposed Dredging Location and Alignment

3.4 Use of Equipment and Capacity

For the proposed dredging operation Trailer Hopper dredger will be used fitted with accessories such as suction pipe of 800 mm diameter, discharge pipe of 750 mm diameter, anchorage system, etc. MPA will ensure that selected dredging company will deploy dredger suitable for dredging in the offshore area in hot and tropical climate and fully equipped with all accessories. The dredger will carry dredged materials to facilitate disposal of the materials at the designated locations. Average fuel consumption per cubic meter dredging will be one litre. Capacity of the dredger will be 1000 to 1500 cubic meter dredging per hour.
The dredgers to be deployed for the work will not be more than 10 years old.

3.5 Resources and Utilities

Dredging operation will continue for about 16 (sixteen) months starting from January 2018 to April 2019. 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 disposed in sanitary manner in the shore. Liquid waste will be handled in sanitary manner by observing recommended code of practice/standard.

3.6 Work Schedule

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 activity schedule is shown in **Figure 3.3**. This schedule may be changed depending on the field requirements as identified during the course of dredging operation.

Sl. No.	Activity	Years/ Months															
		2018												2019			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
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 & demobilization																
6.0	Reporting																

Figure 3.3: Activity Schedule

3.7 Implementing and Executing 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 at the Outer Bar area of Pussur Channel.

4 DESCRIPTION OF BASELINE CONDITION

4.1 Introduction

Determination of baseline conditions of biophysical environmental components of the project area is vital for robust impact assessment. In the following Sections a brief description of the existing biophysical environment in and around the project is precisely described.

Historically, transportation by vessels operating on rivers and oceans has been essential to the expansion of both the national and international trade. Rivers, canals, and oceans provide the "road" over which ever increasing amounts of cargo are transported, and they tie together the disparate elements of the world's economy. Before the advent of railroads and modern highways, ships provided the only practical way to move large amounts of cargo from location to location; now, in the modern world, carriage by ship or barge remains the most economical way to move goods, particularly those dealt in high volume and at low unit value, such as mineral ores and food grains. World-wide, it is estimated that by weight, some ninety percent of all international trade of goods moves by ship, an astounding figure, especially given the tremendous expansion in world trade in past decades.

Water transportation is environmentally sound, since ships and barges, when compared to other means of transportation, have the smallest number of accidental spills or collisions (DOT 1999). Further, water transportation is more fuel efficient per ton of cargo moved than other modes of transportation. But these assessments focus only on the actual operation of transportation systems and do not consider, for example, potential environmental problems associated with dredging, an activity essential for contemporary maritime transportation.

Larger vessels offer cost efficiencies for ship operators, they present new problems for port managers. As ships have become larger, they have acquired deeper drafts, demanding deeper water to accommodate their hulls. It is not ship draft alone that must be considered in navigational dredging. Other factors, such as increased beam and windage, create maneuverability problems in narrow channels. The needs of ports to accommodate larger vessels with deeper drafts, taken together with the natural process of sedimentation, create demands for the dredging of shipping lanes. In connection with maritime transportation, dredging is needed in three types of situations: i) to maintain present widths and depths by counteracting the natural redistribution of coastal sediments, ii) to widen and deepen existing channels for access by new, larger vessels, and iii) to create new port facilities where they have not existed before.

Dredging is recognized as having the potential for significant environmental impacts. There are environmental effects of the dredging itself, that is, the picking up of sediments, and of the later disposal of those sediments. With respect to the dredging some general environmental perturbations that may occur, include:

- disruption of bottom living communities,
- suspension of particulates in the water column,
- modification of local circulation and sediment transport patterns,
- increased salinity by channel deepening, salt water encroachment.

Likewise, the disposal of dredged materials may also have important environmental implications such as:

- burying bottom living communities,
- increasing water turbidity,
- modifying local circulation

Where the dredged materials are contaminated, there is also the risk of introducing toxic materials into marine food chains, posing human health hazards and damaging the potential for commercial and recreational fishing.

4.2 Physical Environment

4.2.1 An Overview of Coastal and Marine Environment of Bangladesh

Bangladesh is endowed with vast marine and coastal waters having an area of about 1.5 times more than that of her total land mass. The environment is under the dynamic interface between terrestrial systems and marine systems dominated by wave actions and tidal currents from the Bay of Bengal. The land territory of Bangladesh is linked to the seabed and subsoil in the Bay by a singular process of erosion and deposition that has (a) lifted much of Bangladesh's landmass out of the sea, and (b) shaped the highly unusual seabed throughout the Bay (ITLOS, 2010). The countries exclusive economic zone (EEZ) spans 166,000 sq. km and the shelf area covers roughly 66,440 sq. km (**Table 4.1**). Bangladesh sits in a broad and deep concavity at the northern limit of the Bay of Bengal, with Myanmar to its east and India to its west (ITLOS, 2010).

Table 4.1:Coastal area within the Exclusive Economic Zone of Bangladesh (200m depth)

Depth (m)	**Area (km^2)**
< 10	24,000
10 - 24	8,400
25 - 49	4,800
50 - 74	5,580
75 - 99	13,410
100 - 200	10,250
Total Continental Shelf	66,440
Total EEZ	166,000

Source: Khan et al. 1997; Hussain and Hoq, 2010

This marine and associated coastal zone in Bangladesh is characterized by sprawling estuaries, dense mangrove forest, coral reef-associated island and the world's longest sea beach. There are many sedimentary islands in the estuary and along the coastline, and about seven sq. km of new land emerges from the sea every year (ITLOS, 2010). Fishing is the most significant economic activity on these islands besides serving as an important base of operations for the Bangladesh Navy and Coast Guard with a great potential of ecotourism.

The geographical position and climatic condition of Bangladesh have made her coastal areas one of the highly productive areas of the world (Islam, 2003). Recent surveys gave an estimate of demersal standing stock between 150,000 and 160,000 t. within the exploited 10-100 meter shelf area (Saetre 1981, Khan 1983, Lamboeuf 1987). Eight species of Tuna and Skipjack (Khan, 1983) and a number of potential species of Mackerels, Shark, Ray, Sardines, Anchovies, Shad and cephalopods, soles and flat-fish, lobster, etc., are available in Bangladesh waters but detailed pelagic survey is yet to take place to provide a reliable estimate of their standing stock. The coastal and marine fisheries have been playing considerable roles not only in the social and economic development of the country but also in the regional ecological balance (Salam, et al. 2011).

Though the highest priority has always been accorded to the freshwater fisheries (as reflected in the number of projects implemented), it is impossible to acquire sustainable development and fulfill the protein requirement of the teeming millions from this subsector alone despite the marine fisheries has the lion's share of foreign exchange earnings. But most of these resources have been over-fished and are declining at an alarming rate (Khan *et al*., 2003). If similar level of management and development attention is paid to the marine sector through a holistic approach, it will pave the way to a greater achievement towards sustaining the fish stocks for livelihoods and food security for future generations.

4.2.2 Geo-morphology

The characteristics of the coastal morphology of Bangladesh (Islam 2004) are:

- A vast network of rivers and channels;
- An enormous discharge of river water, heavily laden with sediments, mainly suspended;
- A large number of islands within the rivers and channels and seaward of the coast line ;
- The "swatch of no ground" : a submarine canyon running NE-SW about 24 km south of the Bangladesh coast, partially across the continental shelf;
- A shallow northern Bay of Bengal, funneling to the coastal area of Bangladesh in the north;
- Strong tidal and wind actions; and
- Tropical cyclones and their associated storm surges.

The oceanography of the Bay of Bengal is dominated by three main factors: (i) wind direction; (ii) precipitation; and (iii) river discharges, all impacting on fish distribution and abundance. Surface currents in this region run clockwise from January to July and counter clockwise from August to December, consistent with the direction of the monsoon winds (Longhurst 1998). Three main rivers (the Ganges, Brahmaputra and Meghna) drain vast areas of the Himalayas, India and Bangladesh and discharge into the Bay of Bengal. The rivers render the surface waters of the northern part of the Bay almost riverine during the post-monsoon months (September and October); the lowest salinity (10.5 ppt) is observed during this time (Mustafa and Prova Dey 1994). In comparison, near-estuarine conditions prevail from January to June. The highest salinity (33 ppt) is reported in March (Mustafa and Prova Dey 1994). Strong salinity gradients exist from March to July and September to October, with hyper-saline conditions occurring from October to July. Thus, sea surface temperatures (SST) are highest in September (24.8^{o} C) and lowest in January and February (24.1^{o} C) (Mustafa and Prova Dey 1994).

The proposed dredging area of Outer bar is situated some 45 km seaward of Hiron Point and exposed to the open sea. The layout of the coastline, channels and the bar area is shown in **Figure 4.1**. Zulficar channel crosses the bar along an alignment with a minimum depth of about 6 to 8 m CD. The major physical process controlling the morphology of the Outer bar is the decrease in ebb current speed seaward of Hiron point, where the tidal prism is no longer confined to a distinct channel rather distributed in multiple channel. Towards the mouth of Pussur-Sibsa entrance, where the shores widen, there is a considerable divergence between flood and ebb channel as shown in **Figure 4.2**.

The coastal topography appears to be linked with the presence of a very deep trough in the center of the sea-bed, 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.

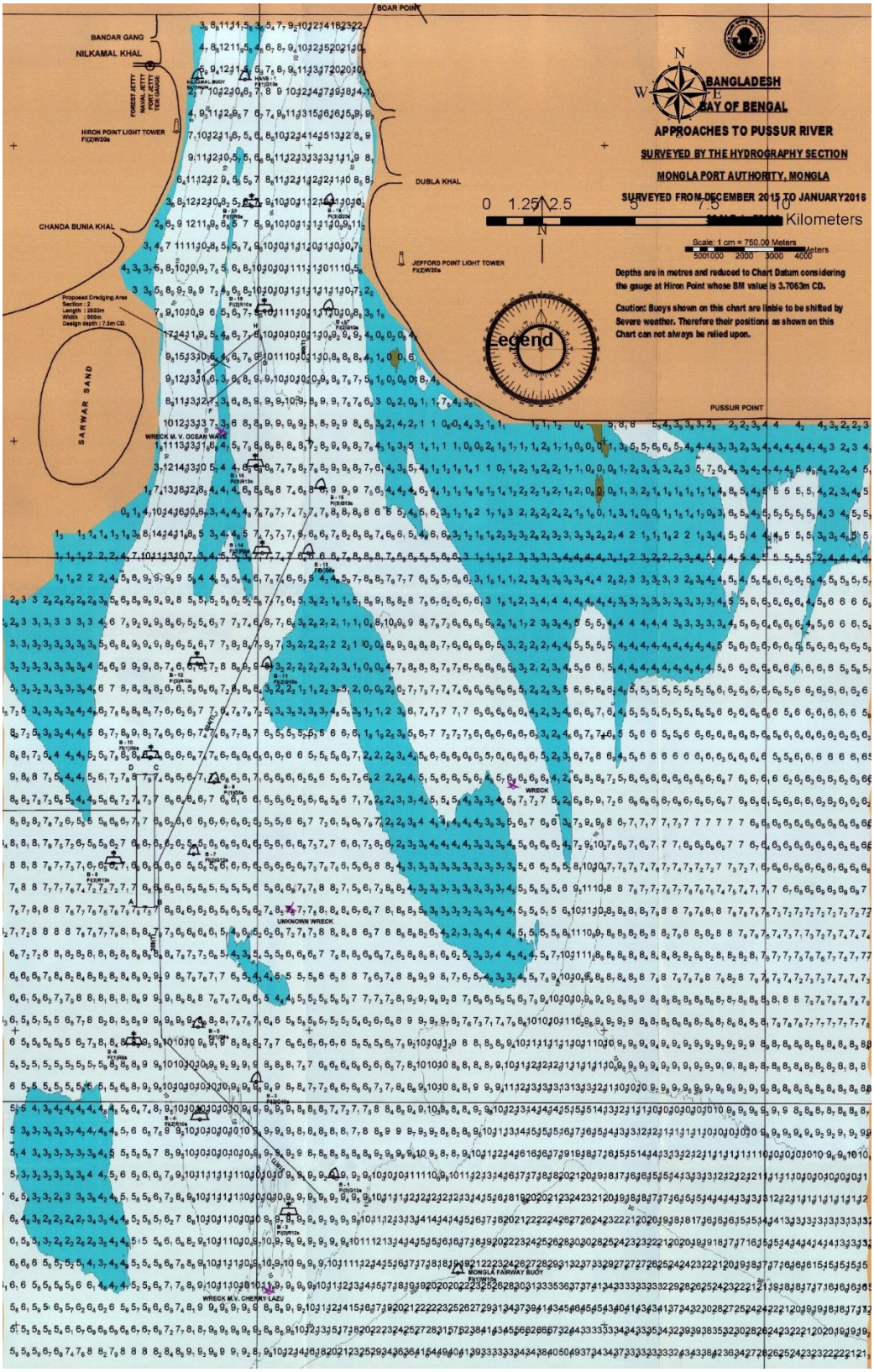


Figure 4.1: Hydrographic chart of Pussur Entrance based on surveyed data of December 2015 & January 2016

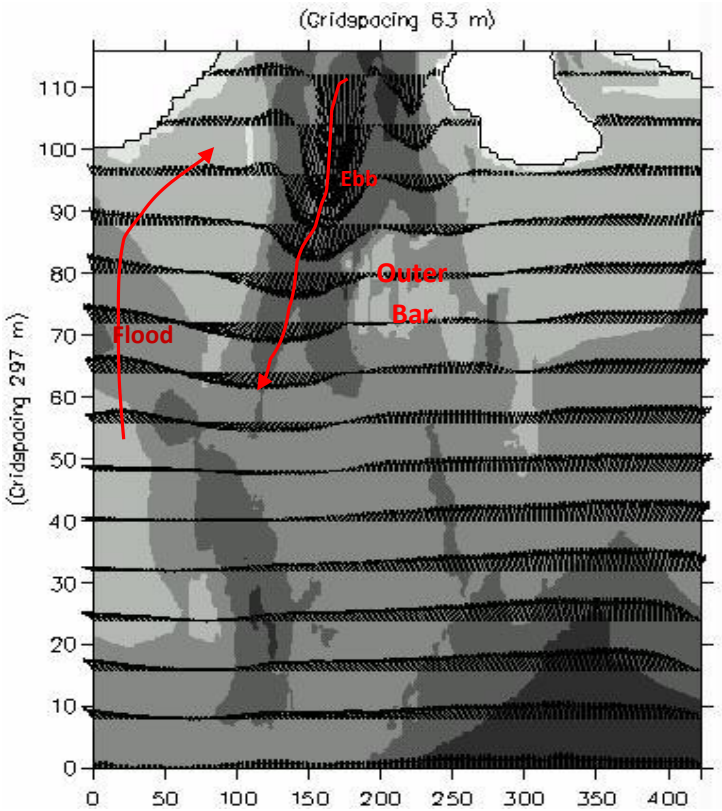


Figure 4.2: Transition between ebb and flood direction of flow at the Pussur entrance near Outer Bar; Gray color for the shallow water depth, dark color represents deeper area

4.2.3 Hydrology

Surface hydrology of the Bay of Bengal is basically determined by the monsoon winds and to some extent by the hydrological characteristics of the open part of the Indian Ocean. 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.

Water Level

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 4.3**). At Mongla, the maximum tidal range and the seasonal variation are about 4.39 m and 0.87 m respectively (**Figure 4.4**).

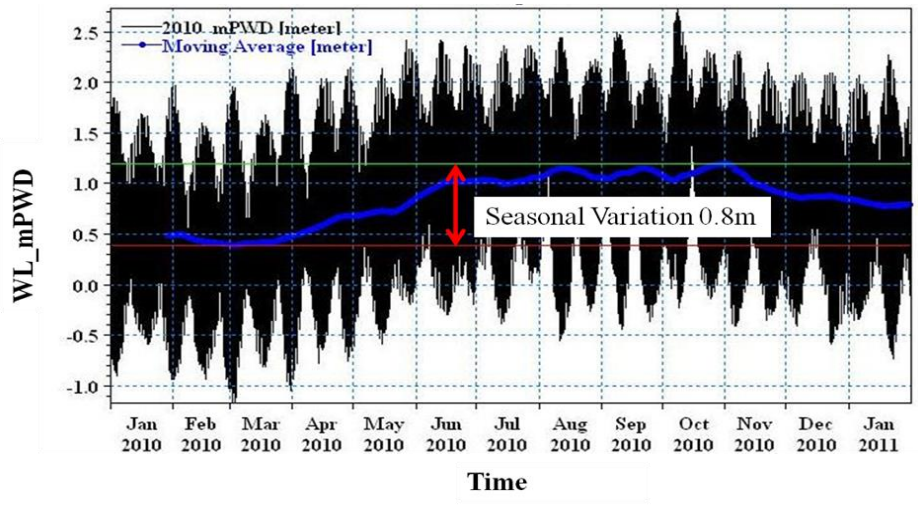


Figure 4.3: Water Level Variation at Hiron Point

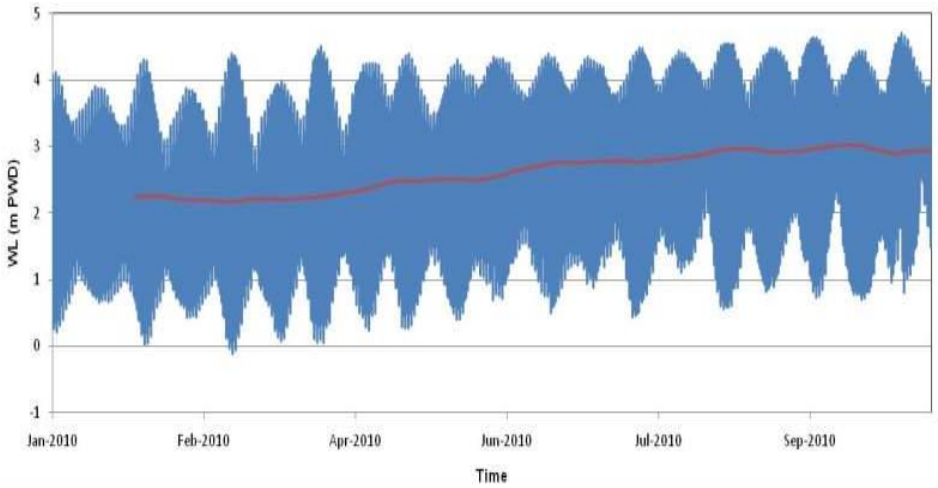


Figure 4.4: Water Level Variation at Mongla Port

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 4.2**). The tidal regime is larger at Mongla than at Hiron Point.

Table 4.2: Tidal levels at Mongla, and Hiron Point of the Pussur River in 2014 (m CD)

Stations	Lowest tide level	Mean level	Highest tide level
Mongla	-0.13	2.57	4.7
Hiron Point	-.03	1.92	3.96

Source: Bangladesh Tide Tables 2014

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 4.3** summarizes maximum flows in Pussur river during March 2011.

Table 4.3: Maximum discharge during flood and ebb tides

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

Flow measurement also carried out in 2015 in the Pussure river upstream of Mongla Port, which is presented in Table 4.4. Table 4.4 shows that the discharge at upstream of Mongla Port is substantially less compared to flow at Akram point during dry season since upstream flow through Gorai river is less.

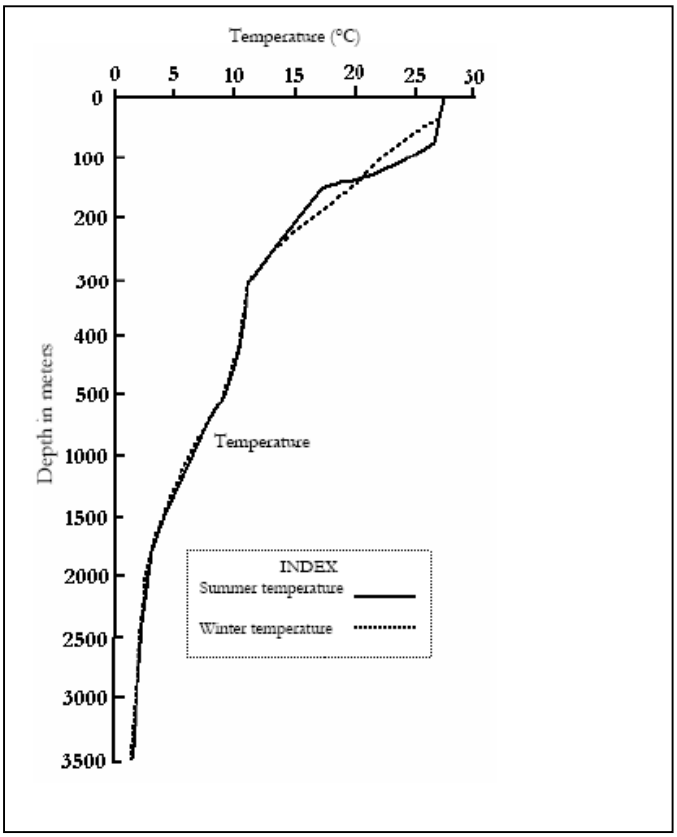
Table 4.4: Maximum measured discharge during flood tide and ebb tide at two locations (2015)

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	Near Mongla Port 1km upstream of Mongla Port	Pussur	03-07-2015 (half hourly)	Spring	5227	6272
2		Pussur	25-07-2015 (half hourly)	Neap	2434	3771
3	Chalna (11 km u/s from Mongla port)	Pussur	02-07-2015 (half hourly)	Spring	7162	4866
4		Pussur	26-07-2015 (half hourly)	Neap		3231

4.2.4 Temperature

The annual variation in temperature in the Bay of Bengal is not large, about 2°C in the south and 5°C in the north. According to Mustafa and Prova Dey 1994, sea surface temperatures (SST) are highest in September (24.8º C) and lowest in January to February (24.1º C).

In the Bay water has an inverse relationship with depth of water that is if the depth increases the temperature decreases (Figure 4.5). The figure shows that the sea water temperature decreases rapidly with depth.



(Source: Das, S.C., 2002)

Figure 4.5: Average vertical distribution of temperature in the Bay of Bengal (Source: Das, S.C., 2002)

4.2.5 Water Quality at the Proposed Dredging Site

Baseline information is important to measure changes in the benthic resources. The magnitude of change detected in the benthos can be used to assess potential effects on other ecosystem components. In general, when benthic assemblages are disturbed, community diversity, abundance and biomass are reduced. The composition of benthic communities can be used to infer the status of an estuarine system with respect to its physical, chemical, and biological conditions. Having knowledge of the importance of benthic fauna, water and sediment samples from the proposed dredge site were collected for establishing baseline condition.

The Consultant visited the prosed site of dredging on 05.02.13 and collected some pertinent data on some physical parameters from the proposed Outer Bar dredged and adjoining areas. Water samples from two different locations (about 8-10km apart) were collected. Samples from i) surface, and ii) 5m depth were collected from each of the two locations. The samples were kept in cool ice box to preserve the zoo- and

phyto-planktons for later identification in the laboratory. Some physical parameters like surface water temperature, salinity, conductivity and TDS were also measured for the sampling sites and adjoining areas (Table 4.5).

Table 4.5 presents these data against each sample location. Also water sample was collected at the propsed site and analyzed at the BUET Laboratory as shown in Table 4.6. The Table shows very high values of EC, TDS, BOD and COD, which means that water is contaminated by chemical pollutants (i.e. oil and grease from ships).

Table 4.5: Water quality data from the proposed dredging site and adjoining areas

Sample Site	**Surface Water Temp (°C)**	**Salinity (ppt)**	**Conductivity (mS/cm)**	**TDS (gm/lit)**
Site 1. N 21°38′45.4″; E 89°29′10.8″	22.2	25.0	39.3	24.0
Site 2: N 21°35′46.6″; E 89°27′46.5″	21.8	25.2	39.6	24.2
Near Sarwar Sand N 21°40′00.0″; E 89°27′95.5	22.6	21.3	30.0	20.5
Between Sarwar Sand & Dublar Char N 21°42′32.4″; E 89°29′50.0″	22.3	19.5	31.3	18.7

Source: Field Survey, 2013

Table 4.6: Water quality data at the Outer Bar area of proposed dredging site

Sl. No.	**Parameters**	**Unit**	**Concentration Present**	**Bangladesh Standard for Drinking Water**	**Remarks**
1	pH	-	7.91	6.5 – 8.5	Within Limit
2	Electrical Conductivity at 25ºC	µS/cm	40300	-	-
3	Turbidity	NTU	4.14	10	Within Limit
4	Dissolved Oxygen (DO)	Mg/l	6.65	6	Good
5	Total Dissolved Solids (TDS)	Mg/l	27011	1000	Very High
6	Total Suspended Solids (TSS)	Mg/l	258	10	Very High
7	Chemical Oxygen Demand (COD)	Mg/l	1144	4	Very High

8	Biochemical Oxygen Demand (BOD5)	Mg/l	100	0.2	Very High
9	Manganese (Mn)	Mg/l	-	0.1	Below Detectable Limit (BDL)
10	Total Alkalinity (as CaCO3)	Mg/l	-	-	BDL

Source: Field Survey 2013; Data anlyses by BRTC, BUET

4.2.6 Quality of bed materials at the proposed dredging site

Table 4.7 shows chemical properties of bed material at the proposed dredging site of MPA. The table shows high salinity of sea bed materials at the Outer Bar area along with the presence of heavy materials such as Nickle (Ni), Lead (Pb) and Cadmium (Cd).

Table 4.7: Chemical properties of bed material at the proposed dredging site

Sample No.	**Year/ Date**	**pH**	**Salinity (EC) ds/m**	**Organic Matter %**	**Ca**	**K**	**N %**	**P**	**B**	**Zn**	**Cd**	**Pb**	**Ni**
					Milli-equivalent /100 gm soil			**µg/g soil**					
1	5 Feb, 2013	6.9	12.3 High Salinity	0.40 Very low	8.38 Very high	1.14 Very high	0.020 Very low	9.7 Low	2.02 Very high	0.88 Low	0.37	20.85	48.27
2	5 Feb, 2013	6.9	14.4 High Salinity	0.34 Very low	7.50 High	1.28 Very high	0.017 Very low	6.2 Low	1.01 Very high	0.64 Low	0.34	7.48	29.95

Source: IWM Field Survey

4.3 Biological Environment

4.3.1 Introduction

Though the marine biodiversity remains less studied than the other freshwater and terrestrial biodiversity, yet it is noted that there are more animal phyla in the marine domain than the land. Thirty-five phyla (11 pelagic) are marine; of these 14 are endemic whereas only 14 occur in freshwater, where none are endemic, 11 are terrestrial with one phylum being endemic and 15 phyla are symbiotic with four being endemic.

The Bangladesh coast supports about 587,400 ha of natural mangroves (Mahmood, 1986) providing the habitat of several species, particularly the younger stages of shellfish and finfish (Mahmood, et al. 1994). A total of 50 species of crabs (Quader, 1994), 30 species of mollusks (Salam, et al. 2011) have so far been recorded from the coastal and marine habitats of the Bay of Bengal. Fourteen species of seaweeds were recorded from the St. Martin's Island (Rahman, 1999). Four species of Acropora and 10 other coral reef genera have been reported from off shore islands, seafronts of newly formed islands and some low lying coastal areas are often carpeted with sea grass (Hussain and Hoq, 2010).

4.3.2 Fishery Resources

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 earning 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 4.8.

Table 4.8: 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
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

The dredging location is known to be an important habitat for the cetaceans (dolphins, porpoises and whales). The narrow geographic band between the coastline and the Swatch of No Ground is unique habitat for the seasonally mobile population of the Irrawaddy dolphin (*Orcaella brevirostris*). Farther offshore but still occurring in habitat influenced by freshwater inputs is the Indo-Pacific humpback dolphin (*Sousa chinensis*) and finless porpoise (*Neophocaena phocaenoides*). Then, a relatively short distance from the fluvial habitat is the Swatch-of-No-Ground where a burst of biological productivity created by upwelling currents supports large groups of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), Pantropical spotted dolphins (*Stenella attenuata*) and Spinner dolphins (*Stenella longirostris*), as well as a possible resident population of Bryde's whales (*Balaenoptera edeni*).

The diversity of cetaceans occupying this relatively small area is remarkable, and rigorous abundance estimates of shushuks/Ganges dolphins (*Platanista gangetica*), Irrawaddy dolphins and finless porpoises indicate that large populations of these species remain. In fact, the Irrawaddy dolphin population in Bangladesh is probably the world's largest, possibly by an order of magnitude.

However, optimism about the long-term survivability of cetaceans in these waters is tempered by increasing threats from incidental killing in gillnet fisheries, depletion of prey due to a loss of fish and crustacean spawning habitat and to massive non-selective catch of fish fingerlings and crustacean larvae in small mesh mosquito nets, and toxic contamination from large, upstream human population centers. An additional threat is declining freshwater flows from upstream abstraction in the Ganges-Brahmaputra-Meghna river system as well as sea-level rise caused by global climate change.

On January 29th 2012 three new wildlife sanctuaries (Chandpai, Dhangmari, and Dudhmukhi) were declared for the protection of threatened Ganges Dolphin (Platanista gangetica) and Irrawaddy dolphins (Orcaella brevirostris) by the Ministry of Forests and Environment. The three wildlife sanctuaries safeguard 19.4 miles (31.4 km) of channels with a total area of 4.1 sq miles (10.7 sq km). Around 12 km from Ghagmari check-post of Chandpai Range to Karamjal check-post through Dhangmari canal and Pussur River, 15 km from Jongra check-post to Andharmari check-post through Mrigamari check-post and five km from Dudhkhali check-post to Supati canal through Bemara canal have been declared as safe havens for the dolphins. Bangladesh Inland Water Transport Authority (BIWTA) has been allowing large vessels to go to Mongla from the Bay of Bengal through the Sundarbans from 28 April 2011. Two of the three sanctuaries lie within the navigation route of the vessels to the Mongla Port (Figure 4.6). These sanctuaries may not be directly linked with the dredging but movement of large vessels in the Pussur River may affect the dolphins and other aquatic animals.

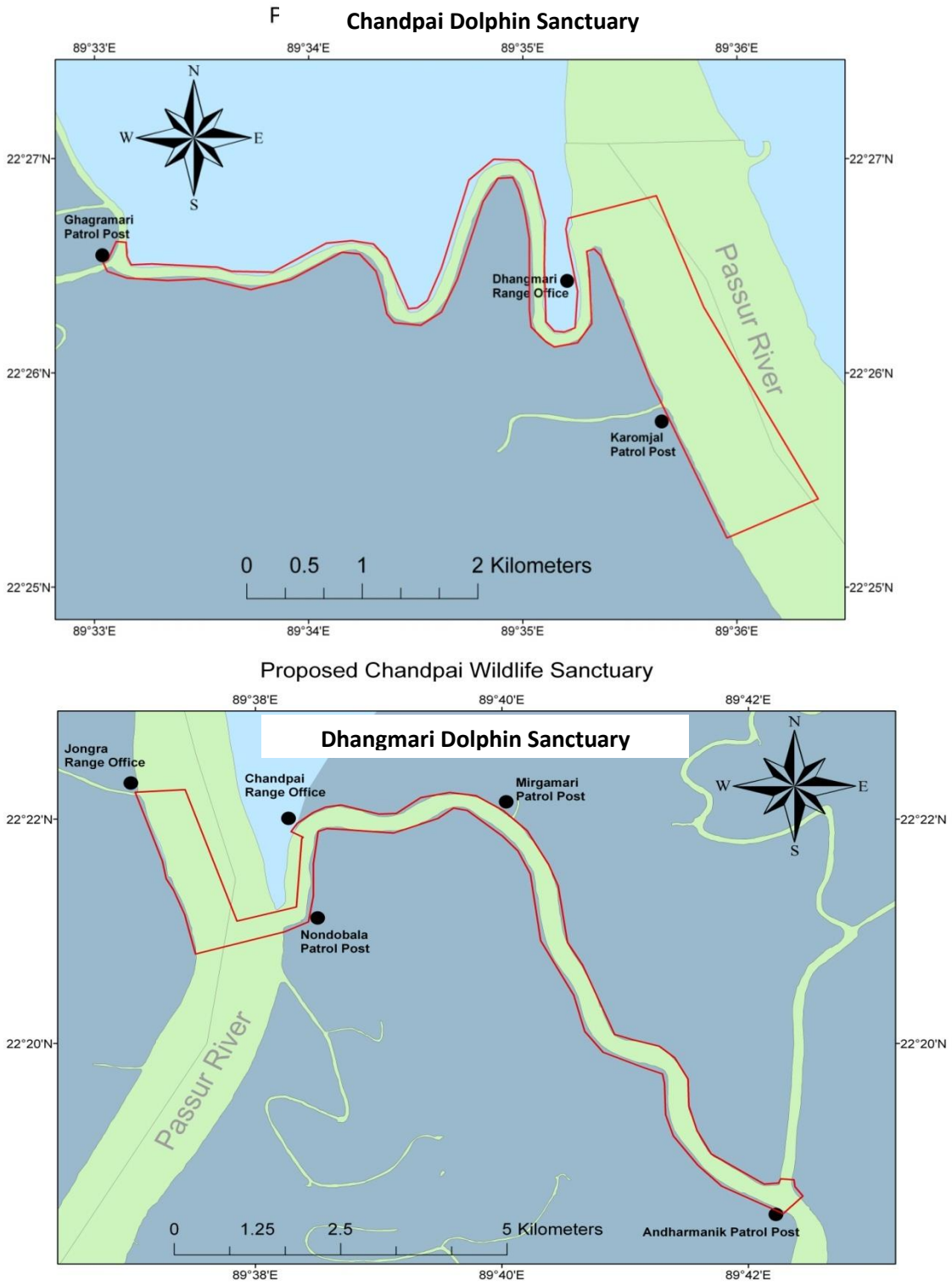


Figure 4.6: Locations of the two dolphin sanctuaries declared by the MOEF.

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 4.9).

Table 4.9: 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 demersals	0.46	0.46	1.45
Small demersals	0.31	0.48	2.26
Small mesopelagics	0.00	0.09	6.12
Small pelagics	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 favourable 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 4.7) have been identified so far. They are south patches, south of south patches, middle ground and Swatch of no Ground.

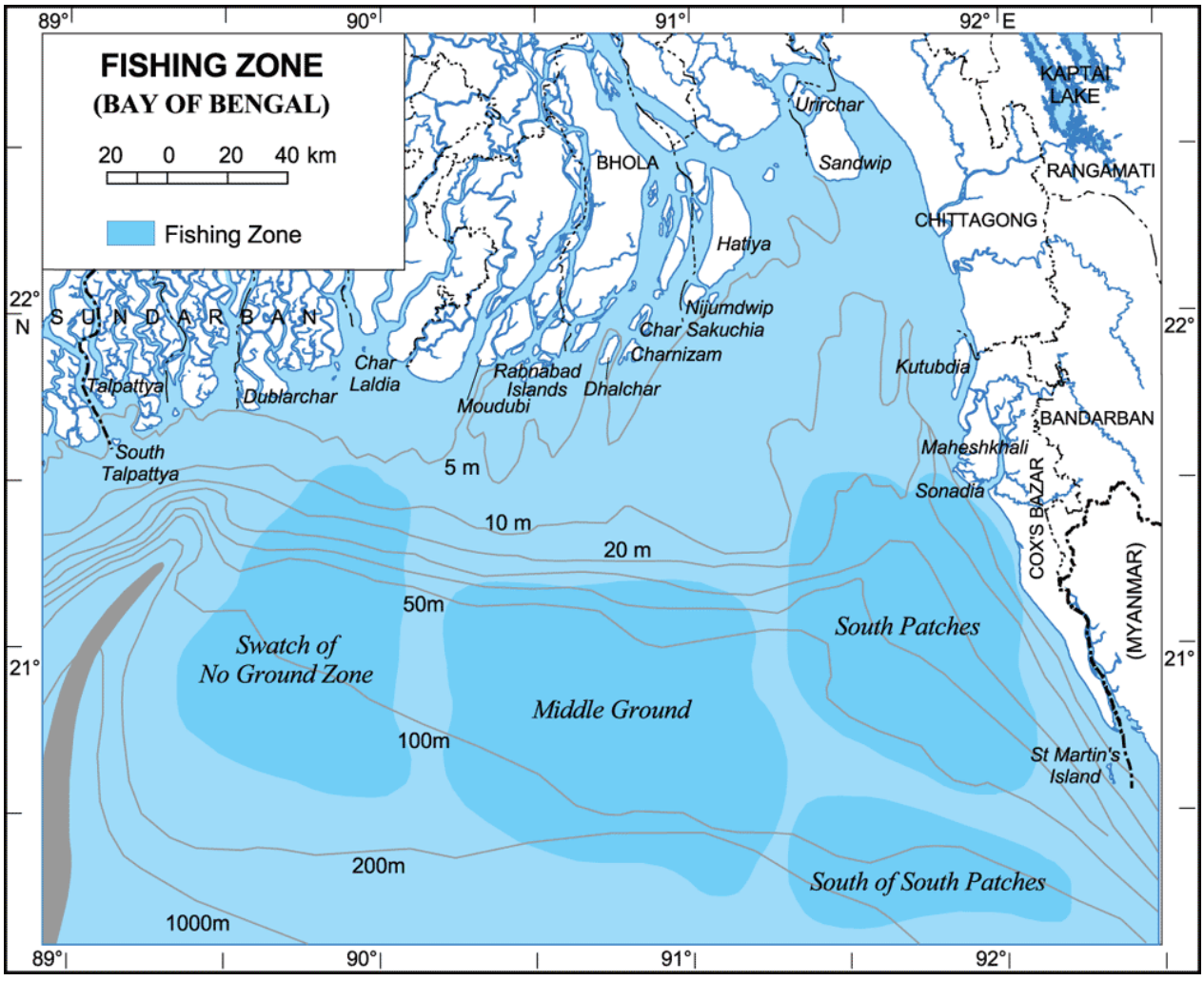


Figure 4.7: Identified Fishing Grounds in the Bay of Bengal

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, seabream, jawfish, mullet, pomfret, ribbon fish, anchovy, hilsa, oil sardine, tuna, mackerel and skipjack.

4.3.3 Analysis of biological samples

Three sediment samples from the each of the two locations were collected using a Van Veen Grab Sampler and stored in the icebox. Identification of the benthic fauna to the nearest taxon, species composition, 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.

One of the other methods for establishing the baseline condition is by Sediment Profiling Imagery (SPI). The data gathered from SPI is used for determining the impacts of dredging on the sea bed and also for the disposal area. This method could not be used. However, Table 4.10 presents Benthic fauna identified from mud sample of Sampling Site No. 1

The soil sample is dominated by sand. In total 17 specimens of animals were observed. They are all Polychaetes (Phylum Annelida). The identification is done up to family level (Table 4.10).

Table 4.10: Benthic fauna identified from mud sample of Sampling Site No. 1

Serial	Fauna : Taxa	Number	Remarks
1	Burrowing polychaetes (Glyceridae)	2	One rotten
2	Tube dwelling polychaetes (Eunicidae)	7	Rotten
3	Tubicolous unknown polychaetes	2	Tube present
4	Pelagic unknown polychaetes	2	Rotten, one seems to be in breeding stage
5	Unknown polychaetes	4	Rotten
	TOTAL	**17**	

Comments:

- The dominance of polychaete number indicates the abundance of organic materials in the sampling area.
- The site is very important in terms of biological diversity of invertebrate animals.
- The site seems to be natural breeding ground of polychaetes.
- 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 and produce eggs.
- The area is ecologically sensitive.

Table 4.11 presents Benthic fauna identified from mud sample of Sampling Site No. 2. The soil sample is dominated by sand. About 5% of plant materials observed. In total 3 specimens of animals were observed. They are all polychaetes (Phylum Annelida). The identification is done up to family level (Table 4.11).

Table 4.11: Benthic fauna identified from mud sample of Sampling Site No. 2

Serial	Animals	Number	Remarks
1	Tubicolous unknown polychaetes	3	Tube present only
2	Unknown rotten plant materials	-	Not counted
	TOTAL	**3**	

Comments:

- The dominance of tubicolous polychaete numbers in the sample indicates the area is sand dominated.
- The number of polychaetes representative is low and some sources of pollution are expected.
- The area ecologically degraded.

Water Samples: No sieves were used for sampling the phyto- and zoo-planktons and as a result the samples hardly contained any planktons. In general, the sampling site 1 which is nearer to the shoreline is more biologically rich than site 2A. The samples collected did not comply with the standard sampling protocols meant for collecting and preserving benthic fauna and conduct limnological studies. However, proper sampling protocol and preservation could help in establishing the biological richness and identifying the gaps in information of the area.

5 SOCIAL IMPACT ASSESSMENT

5.1 The Context

Mongla port is the second biggest and most eco-friendly sea-port of the country, situated in the Mongla Upazila of Bagerhat district. The port is located at the confluence of Pussur River and Mongla Nulla, approximately 71 nautical miles (about 131 km) upstream from the Fairway Buoy (approaches to the Pussur River) of the Bay of Bengal. The port is well protected by the world largest mangrove forest known as Sundarbans. The port was developed initially about 18 km up at Chalna, which was opened to foreign vessels as an anchorage on 11 December 1950. The anchorage was shifted to Mongla in 1954 as the place could accommodate sea-going vessels with greater draughts. The port of Mongla had long retained its name Chalna (Uddin 2006).

The Mongla port has trade links with almost all major ports of the world, although vessels arriving here are mostly from ports of Asia, the Middle East, Australia, Europe and North America and the ships rarely come to Mongla from the countries of Latin America or Africa. In addition to promotion of imports and exports of the country, the port contributes to development of many industries and trading houses in surrounding places and along with this, of new infrastructures and job opportunities. Many local people are working in the port directly in loading and unloading vessels (Uddin 2006; Rahman 2006).

Pussur River is a big river in the Sundarbans area as an extension of the Rupsa River. South of Khulna, the Bhairab or the Rupsa flows further south and is renamed as Pussur near Chalna and falls into the Bay of Bengal flowing to the right of Trikona and Dubla Island (Dublarchar). South of Mongla Upazila the river flows into the Sundarbans. The river is joined by Mongla canal at about 32 km south from Chalna. Flowing further south the river meets the Shibsa at about 32 km north from its mouth and debouches into the sea keeping its original name Pussur. The river is very deep and navigable throughout the year and large marine ships can easily enter Mongla Sea Port through it. The Pussur is an important river route through which Khulna-Barisal steamboats and other vessels ply. The total length of the river is about 142 km. The Pussur and all its distributaries are tidal channels (Chowdhury 2006).

The Mongla Port Authority provides facilities and services to the international shipping lines and other concerned agencies providing shore based facilities, so that bigger draft ships can enter into the port channel safely. Based on this port, the community of Mongla Upazila developed their socio-economic and livelihood status. But due to morphological behaviour of the river system, sedimentation and erosion pattern of the Pussur River it is frequently changing. The continuous and high siltation in the channel poses extreme threats and uncertainty to safe manoeuvring including economic handling of the ocean going vessels. Therefore, to ensure safe navigation route, intelligent dredging at proper location, alignment and timing for optimum dredging volume is a need of the day.

Prior to implementation of the proposed dredging project, it is imperative to conduct a systematic study on Social Impact Assessment (SIA) to assess the socio-environmental impact, if any, with recommendation of appropriate mitigation plan. Generally, the aim of SIA is to identify the human consequences of a proposed action, giving particular attention to the mitigation of adverse or unintended aspects and particularly important in developing countries where large numbers of people are dependent on the resource base for their subsistence and livelihood (Sadler and McCabe 2002). A report on SIA along with EIA report is required to be submitted to the DoE to obtain Environmental Clearance in conducting dredging at the Outer Bar area of Pussur Channel.

5.2 Study Aim and Objectives

The broad aim of the study is to identify the need and social impact assessment of the proposed dredging project at the Outer Bar area of Pussur Channel.

The objectives of the study are:

- ✓ To explore the social impacts of the proposed dredging project at the Outer Bar area of Pussur Channel;
- ✓ To identify the positive and negative impacts of proposed dredging project on socio-economic environment of the area;
- ✓ To know the people's view about the proposed interventions.

5.3 The Project Area

The Pussur River forms part of a very big and complex river system. Numerous tributaries and channels connect the Pussur River with other rivers like Sibsa, the Ganges and Jamuna. Flow conditions in all these rivers determined the current and morphological condition in the Pussur River. The navigation channel at the Pussur River entrance crosses a wide bar known as Outer Bar. It exists between 21º35´29´´ and 21 º 40´69´´ at around 45km seaward of Hiron Point and exposed to the open sea. The bar is relatively stable and allows vessels having maximum draft of 8.5m to cross it during normal high tide condition. However, depths at the anchorage area in the upstream towards Mongla Port through Pussur Channel permit anchoring of more than 9m draft vessels. So the Outer Bar is the only obstacle for the ships of 9m and above to enter into the anchorage area. If the depth of the Outer Bar would be increased to make safe passage of 9m draft vessels in normal high tide, Mongla Port could handle more ships means handling of more cargoes.

5.4 Social Impact Assessment (SIA) Methodology

Both primary and the secondary data sources were used. Basically qualitative approach was used for primary data collection considering the field condition. Few quantitative and qualitative data were collected from different secondary sources. In addition, data were collected following good practice guidelines using appropriate methods and for a reasonable length of time to allow long-term trends to be assessed.

5.4.1 Checklist Preparation and Testing

Considering the objectives of the study a checklist was prepared for the study. Following the ToR and practical requirements of the project, the checklist was prepared which was shared with other experts of the project. Based on their feedbacks, some points were added or dropped and final checklist was prepared.

5.4.2 Semi-structured Interviews

Sensitive and thoughtful interview yields fruitful results and understanding. According to Pretty et al. (1995) and Alam (2009), semi-structured interviewing is a guided conversation in which only the topics are predetermined and new questions or insights arise as a result of the discussion and visualized analysis. In semi-structured interviews the context, the participants, the way the interview is conducted, and timing are important as the questions themselves.

In semi-structured interviews consultant has to be self-critical, aware of biases, open, and a good listener and observer. Also need prior preparation, the use of an interview guide or checklist, use of different visual tools to encourage participation and dialog, to be an attentive listener and humble, to assess and judge responses, and to record responses and observations (Pretty et al. 1995). For the present study, semi-structured interviews were conducted for Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs).

Under the qualitative methods FGDs, KIIs and public consultations in addition to observations were carried out findings of which have been presented below (Table 5.1):

Table 5.1: Methods followed with number of participants

Method	Number	Number of Participants	Organization/locality
Focus group discussions	3	21	• Khulna Forest Department (Wildlife Circle) • Khulna Forest Division (Conservator of Forests office) • Dublarchar island
Key informant interviews	6	6	• District Fishery Officer (Khulna) • Director, Department of Environment (Khulna) • Project Director, Dredging at the Outer bar Area of Pussur Channel.
Public consultations	4	17	• Local people of Mongla • Local people of Dublarchar island • Local people of Nilkomol • Tourist Boatmen

5.4.3 Focus Group Discussions (FGDs)

Discussion with the local people and stakeholders, acting the consultant as a facilitator is considered important technique for data collection. FGDs are a strategy that aims to generate discussion and interaction within small groups of local people. Through discussions, the consultant attempts to learn about socio-cultural characteristics and processes within groups. These FGDs were different from the consultation and other discussion meetings that the consultant facilitated throughout the investigation process (especially at the beginning and ending). The participants primarily shared their experiences and information with the consultant without any hesitation.

Alam (2009) and Henderson (2009) mentioned that the truthfulness of the information and the speed of generation are higher when they come from groups. It also helps to identify key knowledgeable persons and explore the limitations provided by the power relationships among participants. The strength of FGD relies on allowing the participants to agree or disagree with each other so that it provides an insight into how a group thinks about an issue, about the range of opinion and ideas, and the inconsistencies and variation that exists in a particular community in terms of beliefs and their experiences and practices. For this study 3 FGDs were conducted in three different places using a semi-structured questionnaire. One is conducted at the office of Khulna Forest Department (Wildlife Circle); another at the offices of Conservator of Forests, Khulna Forest Division and the last one at the Dublarchar island of Sundarbans.

Photo 1: Discussion with the fishing community at Dublarchar Island

Photo 2: Discussion with the local people at Mongla Port

Photo 3: Discussion with the DFO, FD, Khulna

5.4.4 Key Informant Interviews (FGDs)

KIIs are qualitative in-depth interviews with people who know what was going on in the community. The purpose of key informant interviews was to collect information from a wide range of people including community leaders, professionals, or residents who have firsthand knowledge about the community. These community experts, with their particular knowledge and understanding, can provide insight on the nature of problems and give recommendations for solutions. Before selecting key informants it is important to map out the population of interest, or target population. This target population could include all community residents living in a particular area, or could be a particular portion or group within that geographical region (such as a racial/ethnic minority, adolescents, or women). Once the consultant identifies the target population he can better brainstorm possible key informants who are knowledgeable and closely linked to the study issues.

This technique is very appropriate for the present study to understand the motivation and beliefs of community residents on a particular issue, to get information from people with diverse backgrounds and opinions, and be able to ask in-depth and probing questions. For the present study 6 KIIs were conducted with a semi-structured questionnaire; this helps to get more candid or in-depth answers because sometimes the FGDs prohibit researchers from candidly discussing sensitive topics or getting the depth of information. Sometimes the FGDs can prevent some participants from frankly voicing their opinions about sensitive topics.

For the present study the KIs were District Fishery Officer (Khulna), Director of Department of Environment (Khulna), personnel's of Mongla Port Authority and resident of Dublarchar Island.

Photo 4: Discussion with the Director of DoE, Khulna

Photo 5: Discussion with the Project Director, Dredging at the Outer bar Area of Pussur Channel

Photo 6: Discussion in Mongla Port Authority office

5.4.5 Public Consultations (PCs)

Public consultation is a new participatory tool to gained information from people. Public consultation, or simply consultation, is a regulatory process by which the public's input on matters affecting them is sought. Its main goals are to improve efficiency, transparency and public involvement in large-scale projects or laws and policies. It usually involves notification (to publicise the matter to be consulted on), consultation (a two-way flow of information and opinion exchange) as well as participation (involving interest groups in the drafting of policy or legislation). In this study 17 public consultations were carried out including Forest Department personnel's, peoples of Mongla, Nilkomol and Dublarchar island as well as tourist boatmen.

Photo 7: Discussion with the Director of DoF, Khulna

Photo 8: Discussion with the Chief Conservator of Forests,

5.4.6. Observations

Observation is a method to be used for data collection when a study is carried out on a dynamic situation and identify the interrelationship of the person and the situation (Alam 2009). Observation basically focuses on community and ethnic groups; knowing immediate impact of an event and aspects of everyday life and get an insider's view of reality. A good physical observations both road and waterways were made at different places in the proposed dredging project area at the outer bar area of the Pussur Channel. While doing observations consultants also made necessary interaction and sharing points with the local future potential affected persons.

5.5 Findings of the Social Impact Assessment (SIA)

5.5.1 Situation Analysis of the Project Area

General occupation of the community people of Sundarbans are Goalpata (*Nypha fruiticans*) harvester, honey collector, shrimp fry collector, fisherman and NTFPs collector. The proposed project intervention has no direct impact to any community as the dredging will be conducted at the Outer Bar area of the Pussur Channel. Local community said that the proposed dredging area is the fishing ground and our survey also verified it. The consultant observed that two fishing groups were catching fish from the side of the Outer Bar. Mongla Port Authority also reported that sometimes propeller of the ships been affected by the fishermen's fishing net. Dublarchar island is the nearest locality from the project area where more than 3000 fishermen were living on a seasonal basis and they used to catch fish from the deep sea. Forest Department mentioned that community of Dublarchar enters into forest to collect Goalpata to make their temporary houses who also collect their daily firewood. Sarwar Sand or Mujiberchar was the newly accredited land which was found located near the project area. The land is composed of pure sand and already several

mangrove floral species been naturally regenerated. During field visit it was observed that fishermen used that land for taking rest during fishing period.

Photos 9-11: Livelihoods of the Sundarbans

5.5.2 Dublarchar Island

Dublarchar is an island with a beautiful beach and only one island near the outer bar area of the Pussur Channel. The other attraction of the island was the fishing activities that used to take place every year between mid-October and mid-February (*Kartik* to *Falgun* months). Fishermen from other parts of the country, especially from Chittagong, assemble there (more than 3000 fishermen) during the period to catch fish and dry them on the sunny beach. The proposed dredging intervention will increase the capacity of catching fish for the fishing community especially for the Dublarchar fishing community which would be a kind of livelihood augmentation.

Photos 12-14: Landscape view of

They reported that when the dredging intervention will be finished, they will catch fishes near their locality within 2-3 km. Although the intervention will hamper the fishing community on a temporary basis but it will create an increased scope for the future to catch more fishes. They also added if the dredging materials are deposited at the Dublarchar this will be better for the fishing community as the land height will be raised and will help them protecting against tidal surge. Dredging materials can be transported by the dredging ship. They also added: if the dredging materials are deposited at the Sarwar Sand this will be much better by increasing opportunity to catching fish within a short distance and also increase the employment opportunity of new people.



Photos 15-17: Livelihood of Dublarchar

5.5.3 Mongla Port

The main purpose of the proposed dredging intervention is to create safe passage for the 9m draft vessel to enter at the Mongla port. Mongla port has capacity to handle more ships than the present time. After completion of dredging, more ships will be able to enter directly to the Mongla which means increase the opportunity of business and socio-economic development of the area. Local communities are supportive to the proposed dredging intervention. Nevertheless, more ships in Mongla port have a chance to increase the spread of HIV/AIDS by the seamen those who come from different countries. Community mentioned that several NGOs and practitioners are working in that area with the sex workers who are imparting training on safety of them as well as customers. Moreover, day by day this business has been reducing due to awareness raising activities of government and NGOs.



Photos 18-20: Ships are waiting for unloading at the

5.5.4 Forest Department (FD)

According to Forest Department dredged materials cannot be disposed within Sundarbans Reserve Forest (SRF) area. They think that if the dredging materials are disposed into the forest boundary that will hamper the forest biodiversity and the rate of mortality of forest trees will increase by the siltation and salinity. FD also opined that if the dredging materials are disposed into the Dublarchar Island that will hamper the existing natural floral as well as faunal species of the island. In case of disposal of the dredging materials into the Sarwar Sand Island, FD has the opinion that this will increase the illegal activities like cutting of forest trees and poaching of wild animals by the newly settled fishing community in the Sarwar Sand Island. But if the dredging materials are disposed into the deep sea they have no objections.

5.5.5 Department of Environment (DoE)

DoE has no objection if the dredging intervention will be started to follow the EIA guidelines of DoE properly. They have a suggestion that dredging intervention should be carried out in a way that could have a minimal or no negative impact to the fish community, marine aquatic resources and wildlife of the Sundarbans.

5.5.6 Department of Fisheries (DoF)

DoF has no negative opinion about the proposed dredging but care should be taken during intervention activities as the project does not create any negative impact on the local fish habitat as well as other aquatic resources like dolphin, sea turtle and other zooplankton. DoF suggested that the dredging materials may be disposed into the Sarwar Sand Island that can have minimum negative impact on the deep sea aquatic resources and it will create a new scope for the fishermen community. However, DoE will not allow materials disposal as Sarwar Sand Island lies within SRF jurisdiction. Materials disposal will damage mangrove vegetation.

5.5.7 Sarwar Sand Island

Sarwar Sand Island (some called it as *Mujiberchar*) is a barren and newly accredited island which is located near the Outer Bar project area. The island accredited approximately 4-5 years ago and is composed of pure sand which flown with the sea wave/tidal wave and regular tidal inundation. From the field observation, it was revealed that the island is suitable for natural regeneration of mangrove floral species. Already this island is occupied by several mangrove tree species like Keora (*Sonneratia apetala*), Baen (*Avicennia officinalis*), Gewa (*Excoecaria agallocha*), Kakra (*Bruguiera gymnorrhiza*), Dhundul (*Xylocarpus granatum*), Hargoza (*Acanthus ilicifolius*) along with different grass species like Malia (*Cyperus javanicus*) and Nal (*Eriochlea procera*). From the discussion with the fishermen in Dublarchar Island, it was revealed that if the dredging materials deposited at the Sarwar Sand Island the island will be raised and they would be able to use it as their new land to catch more fishes within short period of time from the deep sea. This island will create a new scope for huge employment and income to the fishermen community. However, as per concern of forest department no materials disposal shall be allowed on Sarwar Sand Island due to the fact that it falls within SRF (a world heritage site).

Photos 21-23: Landscape view of Sarwar Sand Island

5.6 Overall SIA of the Proposed Project:

Table 5.2: Overall SIA findings of the proposed project

SN	Component	Positive impact	Negative impact	Remarks
1	Economy	Highly positive	Lighter ships may be affected	Still positive
2	Employment generation	Highly positive	Some lighter seamen may be affected	Still highly positive as they will get work in other places
3	Fishing communities and resources	Highly positive	Minor affect during dredging period	Significantly positive
4	Commercial factors	Highly positive	No negative impact	Highly positive for the locality and country
5	Traffic and transport	Highly positive	No negative impact	Increased the movement of vessels
6	Development process	Highly positive	No negative impact	Highly positive for the locality and country
7	Resettlement	Minor positive	Minor negative impact during dredging period	If dredging materials will be deposited the scour holes of the Pussur channel or the shallow area near Dublar char or in the deep sea, no resettlement is needed.
8	Living standard	Highly positive	No negative impact	Positive due to increased income of fishes and in Mongla Port area
9	Public utilities		Slightly negative impact during dredging period by water supply and solid waste	No mentionable negative impact
10	Position of women	Create employment	No negative impact	Due to increased space of the islands (near Dublarchar) as well as in Mongla Port area
11	Sanitation and health		Some impact during dredging period	No mentionable negative impact
12	Chance of increase HIV/AIDS		Highly negative impact	Need to ensure health care service by government and NGOs
13	Safety	Positive impact	No negative impact	Due to increased capacity of patrolling of coast guard
14	Culture	Positive impact	No negative impact	Increase social interaction among fisher community and in Mongla

SN	Component	Positive impact	Negative impact	Remarks
15	Community organization	Positive	No negative impact	Likely to develop some community organizations
16	Social relation	Highly positive	No negative impact	Backward linkage (Mongla) affect will be highly positive and outer bar area relation will also improve

5.7 Conclusions of Social Assessment

The SIA study suggests that the project is immediately needed for the Mongla Port to increase the vessel movement and to restart the Mongla Port in full pace. Our survey suggests that all the affected persons and concerned authorities are willing to start the dredging activities. Although the dredging project has some minor negative impacts but overall the project have positive impacts on several fields like economy, employment generation, fishing communities and resources, traffic and transport movement, commercial factors and community development. Therefore, the proposed dredging activities should be carried out with involving local community with less affect to the marine ecosystem and Sundarbans. In line with the findings of the present study the followings may be recommended:

a. The dredging activities needs to be done in a way that it must affect less the marine ecosystem and Sundarbans

b. The dredging activities needs to be done without affecting the livelihood of the people operating around the proposed area;

c. Needs to ensure the participation of local people as a labour and involved them with other project activities as much as possible.

6 ANALYSIS OF ALTERNATIVE SITES

6.1 Introduction

Consideration of suitable site selection for dredging as well as safe disposal of dredged materials 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 materials, which requires technical, environmental and social considerations. The dredged materials are, in principle, disposed on the locations where natural sedimentation may not be expected and there is no scope of re-suspension of dredged material 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 assessed the capital and maintenance dredging based surveyed hydrographic charts of 2015 and 2016 at three alternative locations around proposed dredging site at Outer bar of Pussur Channel. The bathymetric survey result shows that approximately 10.395 million cubic meter of dredged material will be required to handle in an environmentally safe and sound manner. **Figure 6.1** shows the locations of alternative disposal sites in the offshore area of Pussur Channel.

6.2 Disposal of Dredged Materials

The extent to which dredging as well as disposal of dredged materials might affect marine features 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).

6.3 Analysis of Alternatives

Coastal disposal of dredged material constitutes one of the most important problems in coastal zone management and in some coastal 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 marine 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 marine 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:

- Open-water disposal.
- Confined disposal.
- Beneficial use.

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 disposal 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.

In the previous study, the deep sea located around 25km south of the proposed dredging site was selected as the most suitable disposal location comparing with two other sites: Sarwar Sand (N $21^0$42'18.6"; E $89^0$27'23.2") located about 10 km north-northwest of the dredging site and Dublar char located about 16.5 km north-northeast of the dredging site. However, comments were received from environmental experts that the designated location at deep sea would be within the recently gazetted Marine Protected Area - The Swatch of No Ground. Moreover, dolphin habitats are also observed at the Swatch of No Ground. The disposal of the materials into this location may hamper the biodiversity, dolphin habitat and fish habitat. The Sarwar Sand (Bangabadhu Island) was discarded in the previous report since this area is already developed and the fishermen community in the area opposed disposal of the dredged materials at the location. Hence, the disposal plan has been revisited and three new locations (shown in **Figure 6.1**) have been identified.

As shown in **Figure 6.1**, disposal location-1 is 4 km southeast from dredging site in the Pussur channel and 25 north-northeast from the dredging site in the estuary; disposal location-2 is 12 km southeast from dredging site in the Pussur channel and 18 northeast from the dredging site in the estuary; and disposal location-3 is 38 km south-southwest from dredging site in the Pussur channel and 12 southwest from the dredging site in the estuary. Location-1 is the concave bank of the Pussur channel in the Sundabans mangrove forest where erosion is taking place and disposal of the dredged materials at this location will reduce the risk of bank erosion and loss of the mangrove forest. However, area of this location is very small to accommodate the dredged materials from the two sites though the depth of this channel is quite considerable (about 6-8m w.r.t. CD) and it is about 25km away from the dredging site in the estuary. Location-2 is the shallow submerged area at the left bank of the Pussur entrance and there is a potential of developing new mudflats and mangrove

forest if dredged materials are disposed at this location. However, MPA has to take initiatives, as part of the mitigation plan, to enhance mangroves at the developed mudflat. Location-3 is a shallow submerged char at the southwest of the dredging location in the estuary which is accreting gradually. However, this location is far away (38 km) from the dredging site in the Pussur channel and dredge material transportation from that site is not feasible since it will be very costly and hamper navigation in the area. Another location has been identified at 7.5km east-northeast of the Fairway Buoy of the Mongla port which is 13-19m deep w.r.t. CD. Analysing water flow direction at this location it has been found that water flows northward during flood tide and southward during ebb tide, nullifying the risk of increased siltation near the present shipping route.

Considering all these factors, four options have been selected for multicriteria analysis which is presented in **Table 6.1**. These options are:

Option 1: *Disposal of dredged materials from the dredging location in the Pussur channel to disposal location-1 and disposal of dredged materials from the dredging location in the estuary to disposal location-2;*

Option 2: *Disposal of dredged materials from both dredging locations to disposal location-2;*

Option 3: *Disposal of dredged materials from the dredging location in the Pussur channel to disposal location-2 and disposal of dredged materials from the dredging location in the estuary to disposal location-3;*

Option 4: *Disposal of dredged materials from the dredging location in the Pussur channel to disposal location-2 and disposal of dredged materials from the dredging location in the estuary to disposal location-4.*

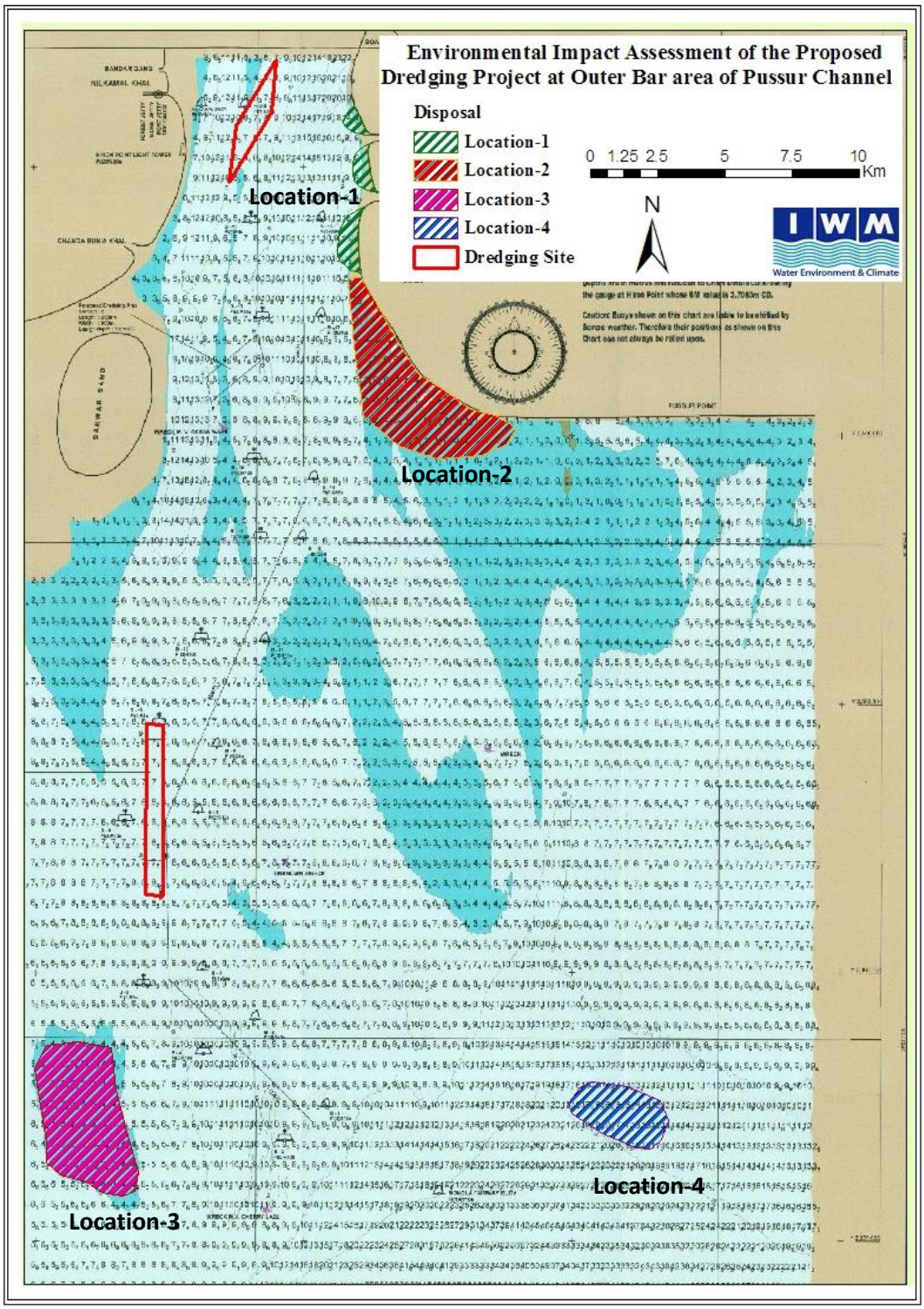


Figure 6.1: Potetial locations for dredged material disposal

Table 6.1: Multi-criteria analysis of three dredged material disposal sites

Parameters	**Option-1** **Location 1 & 2**	**Option-2** **Location 2**	**Option-3** **Location 2 & 3**	**Option-4** **Location 2 & 4**
Distance	3	1	2	1
Vegetation Loss	-1	-1	-2	0
Beach improvement	3	3	1	0
Human habitation	2	3	1	0
Costs	2	1	1	2
Controlled placement of dredged material	2	2	-1	2
Volumetric capacity	4	3	2	5
Potential conflicts	-3	-4	-3	-1
Monitoring	2	2	1	2
Regulation	-4	-4	-3	-2
Recolonization Potential	2	3	2	3
Terrestrial Biodiversity loss	1	1	-1	0
Benthic biodiversity	0	1	-1	0
Turbidity	-3	-2	-2	-1
Natural habitat loss	-2	-1	-3	0
Fishing community	2	3	0	0
Total	**10**	**11**	**-6**	**11**

Table 6.1 shows that option-1 has a high value of multi-criteria analysis. In this option, the dredged materials from the channel will be disposed into the 19-20m deep scour holes. The location is being eroding naturally and the mangroves are being lost. Disposal of dredged materials in this area will reduce erosion vulnerability of Sundarbans land. Moreover, disposal of the dred ged materials from the estuary in the shallow region will enhance land reclamation in the Sundarbans area and new mangroves are very likely to grow in the reclaimed area. However, cautions should be taken in order to minimize dispersion of the dredged materials while disposal in order to minimize re-siltation rate as well as loss of bio-diversity. Moreover, dykes with sand-filled geo-tubes and silt curtains should be placed before disposing the materials at location-1 in order to prevent blockage of drainage canals near location-1.

Option-2 and Option-4 have the highest value according to the multi-criteria analysis presented in **Table 6.1. Loction**-2 is being naturally accreted and sediments are depositing here naturally due to tidal pumping. Option-2, i.e., disposal of dredging materials in location-2 will enhance natural accretion trend in the area which is in line with a building with nature approach. Initiatives to grow mangroves in this area will increase the Sundarbans mangrove forest. Before disposal, dykes/bunds should be constructed in order to prevent dispersion of disposed sediment at location-2.

Option-3 is not a very feasible option since the sediment dispersion rate will be very high since the disposal location-3 is very shallow. Hence, disposal at this location will increase the risk of resiltation of the disposed materials into the navigation channel. Moreover, it will increase turbidity of water and deteriorated water quality will have significant impacts on fisheries and other marine habitats.

Option-4 also obtained the highest value in the multi-criteria analysis because location-4 is very deep and away from the Sundarbans and identified fishing zones in the Bay of Bengal. If the dredged materials are disposed at this location, sediment dispersion will be very localized and will not go beyond a few hundred meters. As a result, the impacts on the environment will be negligible. Moreover, disposal of dredging materials in location-2 will enhance accretion in the area which will be beneficial for land reclamation and potential growth of mangroves on the reclaimed land.

Table 6.2: Descriptions on parameters of multi-criteria analysis

Distance	Transporting dredged material to distant site may cost more, require more logistic support, disrupt navigation, etc., so the farthest site will have less score based on cost consideration.
Vegetation Loss	Loss of terrestrial vegetation due to disposal of dredged soil or loss of phytoplanktons – the primary producer - due to turbidity, oil spill, etc.
Beach improvement	Beneficial use of the dredged material, if any.
Human habitation	There is no human habitation near the dredging site, however seasonal habitation of the fishermen in the islands is present. Whether disposal of the dredge material will benefit the seasonal human habitations?
Costs	Transporting dredged material to distant site may cost more, so the farthest site will have a negative score on the project.
Controlled placement of dredge material	Includes planning, volume, material characterization and evaluation, site characterization, disposal site management, containment, etc.
Volumetric capacity	Capacity of the disposal site to accommodate the volume of dredged material.
Potential conflicts	Any potential conflicts with the existing regulations, policies of the government or any other nature.
Monitoring	Access to monitoring may either be easy or difficult, costly, etc.
Regulation	Existing regulations, procedures, protocol, etc., that need to be followed.
Recolonization Potential	Disturbance to the habitat is obvious and temporary in nature. Any information based on which it may be determined that the disturbed habitat (along with the benthic, demersal fauna) will recover within a time frame and the species will recolonize.
Terrestrial Biodiversity loss	Dredged materials disposed on the coastal vegetation or disturbance due to dredging or disposal to the terrestrial biodiversity, particularly the species dependent on the resources that occur at the dredging site.

Benthic biodiversity	Based on the baseline information assess the status of the benthic biodiversity. If there are more species it will mean positive.
Turbidity	Considering the physical characteristics determine the impact of the turbidity plume, concentration, etc. For example the turbid conditions will prevail longer if there is little movement of suspended materials due to less current or wave action.
Natural habitat loss	Relates to the area, level of physical alteration of the natural habitat.
Fishing community	Benefits harvested by the Fishing community after the dredging operation.

6.4 Final Site for Disposal of Dredged Material

From the above comparative analyses among three potential options, Option-1 and 4 in obtained the maximum scores and have been assessed as the most suitable options for disposal of dredged materials. Considering the cost and environmental impacts, the Mongla Port Authority is considering Option-4 as the most viable option. The selected disposal option consists of two disposal locations, location-2 and location-4 shown in **Figure 6.1.** In this option, dredged materials from the dredging location in the Pussur channel will be disposed at location-2 and dredged materials from the dredging location in the estuary will be disposed at location-4. Trailer Hopper dredger will be used in the dredging operation and will carry dredged material to facilitate disposal of the materials at the designated location so that the existing navigation route of the Mongla port is not hampered by disposal pipes.

The hydrographic charts of the years 1999, 2004, 2005, 2006, 2007, 2008, 2012, December 2013, November 2014 and January 2016 have been collected from the Mongla Port Authority and analysed for assessment of the erosion-deposition pattern in the disposal location-2. Erosion frequency of 10 years is evident at Location-2 from the time series hydrographic chart analysis. Hydrographic chart analysis is presented in **Table 6.3** and **Figure 6.2.** It is found that the erosion process ended in 2004 and again started in 2014 after 10 years. The disposal of dredged materials at this location will stop the eroding process of the area and new mangroves are very likely to grow in the reclaimed area.

Table 6.3: Erosion-Accretion scenario for different period near disposal location-2

Period	Erosion/Accretion
1999-2004	Erosion
2004-2005	Accretion
2005-2006	Erosion-Accretion
2006-2007	Erosion-Accretion
2007-2008	Accretion
2008-2012	Erosion-Accretion
2012-2013	Accretion
2013-2014	Accretion
2014-2016	Erosion

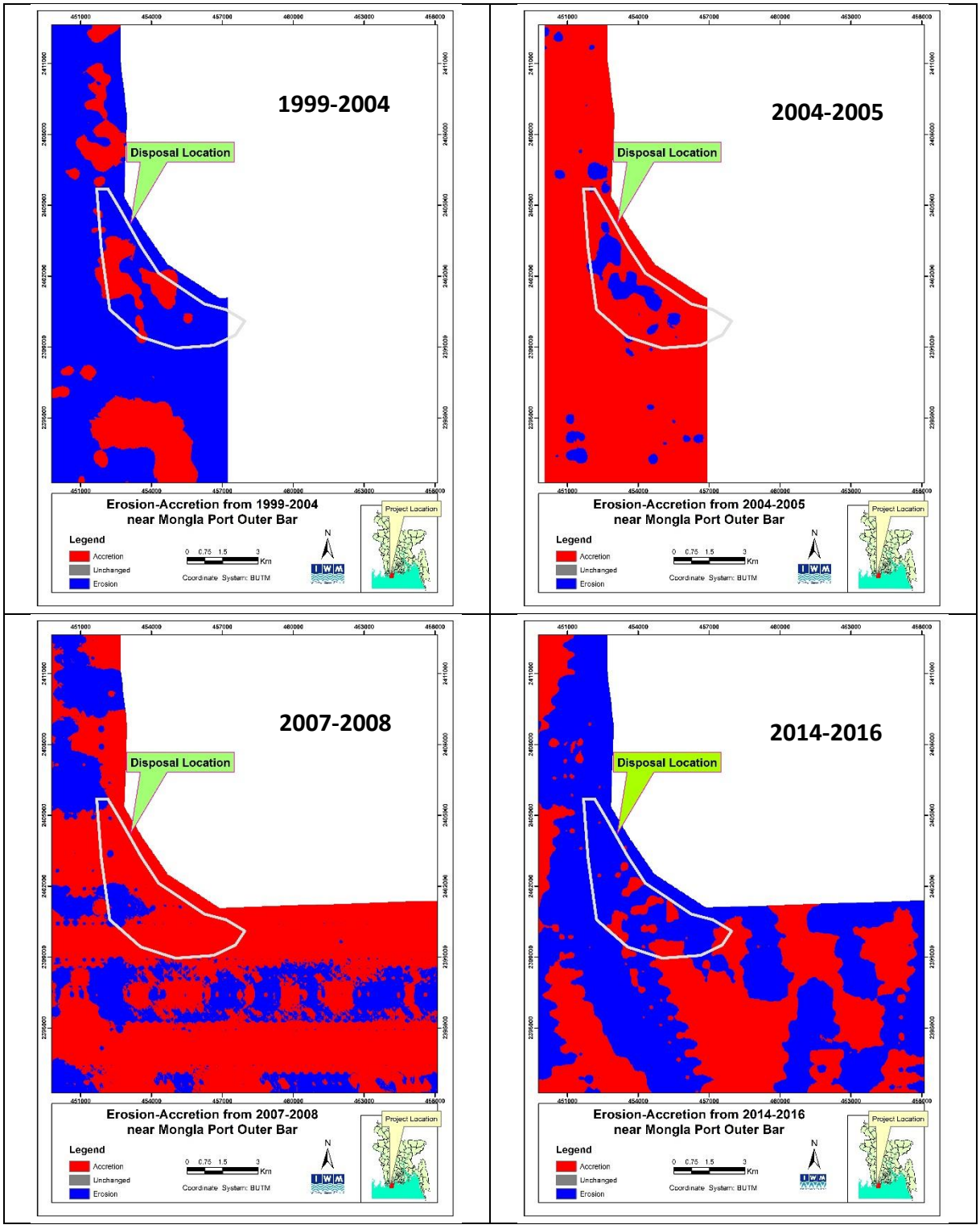


Figure 6.2: Erosion-Accretion pattern for different period near disposal location-2

In order to ensure safe disposal of the dredged material it is to be disposed at the designated location during the low tide condition. A typical scenario of depth averaged velocity field during low tide is shown in **Figure 6.3.** The directions of the velocities indicate that the disposal of dredged material if released during low tide at the designated location as shown in **Figure 6.1** will be guided to the deep sea.

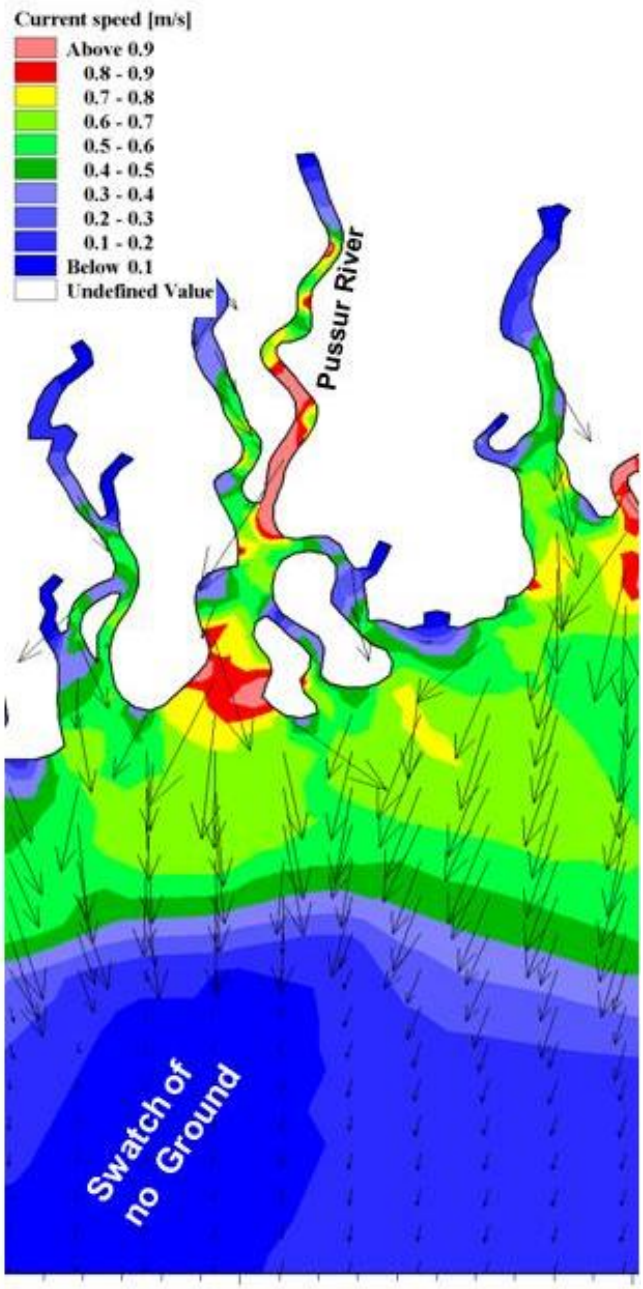


Figure 6.3: Typical depth average velocity field at low tide condition

7 ASSESSMENT OF IMPACTS

7.1 Project Bounding

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 the Outer Bar in the Offshore of Bay of Bangal in the Pussur Channel (**Figure 3.1**). "Impact area" encompasses the geographic extent of the significant environmental and socio-economic impacts resulting from implementation of the proposed dredging activities of Mongla Port Authority.

7.2 Scoping /Identification of Valued Environmental and Social Components (VESCs)

For maintaining navigable 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.

The scoping process has identified 13 project area impacts and direct operational impacts of public nuisance (noise, vibration, air pollution due to gaseous emission, etc.), and traffic disturbance. Valued environmental components, which is very likely to be impacted by dredging activity is presented in Table 7.1.

Table 7.1: Valued Environmental and Social Components (VESCs)

A. PROJECT AREA IMPACT	**B. DIRECT IMPACT**
1. Waterway transportation	1. Public Nuisance (Noise, Vibration, Air pollution)
2. Scouring of channel bed and erosion of river bank	2. Waterway Traffic disturbance
3. Economic Livelihood	
4. Common Resource Rights	
5. Wage paid Employment	
6. Sedimentation	
7. Water Quality	
8. Capture Fishery	
9. Turbidity	
10. Contamination of disposal site	
11. Nutrition	
12. Loss of benthic flora and fauna	
13. Mangrove vegetation	

7.3 Assessment of Impact on Valued Environmental and Social Components (VESCs)

Based on field investigation data and past experience the VESCs have been identified and shown in **Table 7.2**. The VESCs/VECs 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 7.2: Impact Identification Matrix on VESCs

Valued Environmental and Social Components (VECs)	**Future Without Project**	**Future with Project (No Mitigation)**
PROJECT AREA IMPACTS		
Navigation:		
Waterway Transport	-	+
Channel Sedimentation	-	+
Erosion of Channel	0	0*
Surface Water Quality	-	-
Contamination of disposal site	0	-
Turbidity	0	-
Economic Livelihoods:		
Port Labourer	-	+
Fishing HH	0	+
Boatmen HH	-	+
Land less HH	0	+
Common Resource Rights:		
Benthic flora and fauna	0	-
Mangrove Vegetation	0	0
Agricultural Output:		
Capture Fisheries	-	+
Wage Paid Employment:		
Dredging operation	-	+
Social Management	-	+
Human Nutrition	-	+
Navigability	-	+
DIRECT IMPACTS DUE TO INTERVENTION		
Public Nuisance	0	-
Traffic disturbance	0	-

Rating of Impacts:

+ Positive trend

0 Present baseline status

- Negative trend

0* To be taken care in the project design

7.4 Development Options

Two options are considered to assess impact due to the proposed intervention. These options are summarized

below.

Option-0: Base condition, where there will be no intervention as such.

Option-1: Dredging at the Outer Bar of Pussur Channel. The major activities under this option are:

- Capital dredging at Outer Bar area, and
- Disposal of the dredge materials.

7.5 Impacts Matrix of the Proposed Dredging Operation

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 7.3** present impact matrices for dredging. Many of the impacts listed can be mitigated substantially by adopting standard working procedures and ensuring responsible behaviour of the contractor. Impacts of dredging are summarized below:

- Substrate removal and thus habitat and species removal (recolonization or recovery of disturbed areas may be possible);
- Spreading of sediments and associated contaminants in the surrounding. Settlement of these suspended sediments can result in the smothering or blanketing of subtidal communities and/or adjacent intertidal communities;
- Alteration of the bottom topography and hydrography, and thus destruction of local habitats and the risk of direct physical/mechanical stress to benthic, demersal and/or pelagic species;
- Alteration of the sediment composition, i.e. of substrate characteristics in the surrounding of the dredging site, resulting in a change of nature and diversity of benthic and demersal communities, e.g. decline of individual density, species abundances or biomass;
- Re-suspension of sediments and short-term increases in the level of suspended sediment giving rise to changes in water quality which can effect marine flora and fauna, both favourably and unfavourably, such as increased turbidity and the possible release of organic matter, nutrients and or contaminants depending upon the nature of the material in the dredging area;
- Release of nutrients resulting in increase in eutrophication and direct impact on organisms due to reduced transparency and consumption of oxygen (the increase in turbidity due to re-suspension of sediments caused by dredging);
- Habitat changes from hydro-morphological regimes changes;
- Effects on fish or sea snakes or marine turtles or fish-eating bird species or cetaceans (dolphins, whales) from increased turbidity as well as related effects on estuary functions, such as changes in biodiversity or reduction of spawning areas, affecting migratory or daily movement routes of fish, marine turtles, dolphins, etc.

Table 7.3: 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 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 emission, oil spill from dredging equipments. • Obstacle to navigation traffic. • Occupational health and safety risk.
Post Dredging Works	Impact on Resource System	• Improved waterway traffic. • Biodiversity.	• Hydro-morphological adjustment. • Erosion and sedimentation.
	Impact on User System	• Navigation traffic. • Employment. • Socio-economic development. • Attraction of tourists.	• Erosion and accretion. • Need maintenance dredging.

Figure 7.1 and Figure 7.2 present impacts on biophysical and ecological environment.

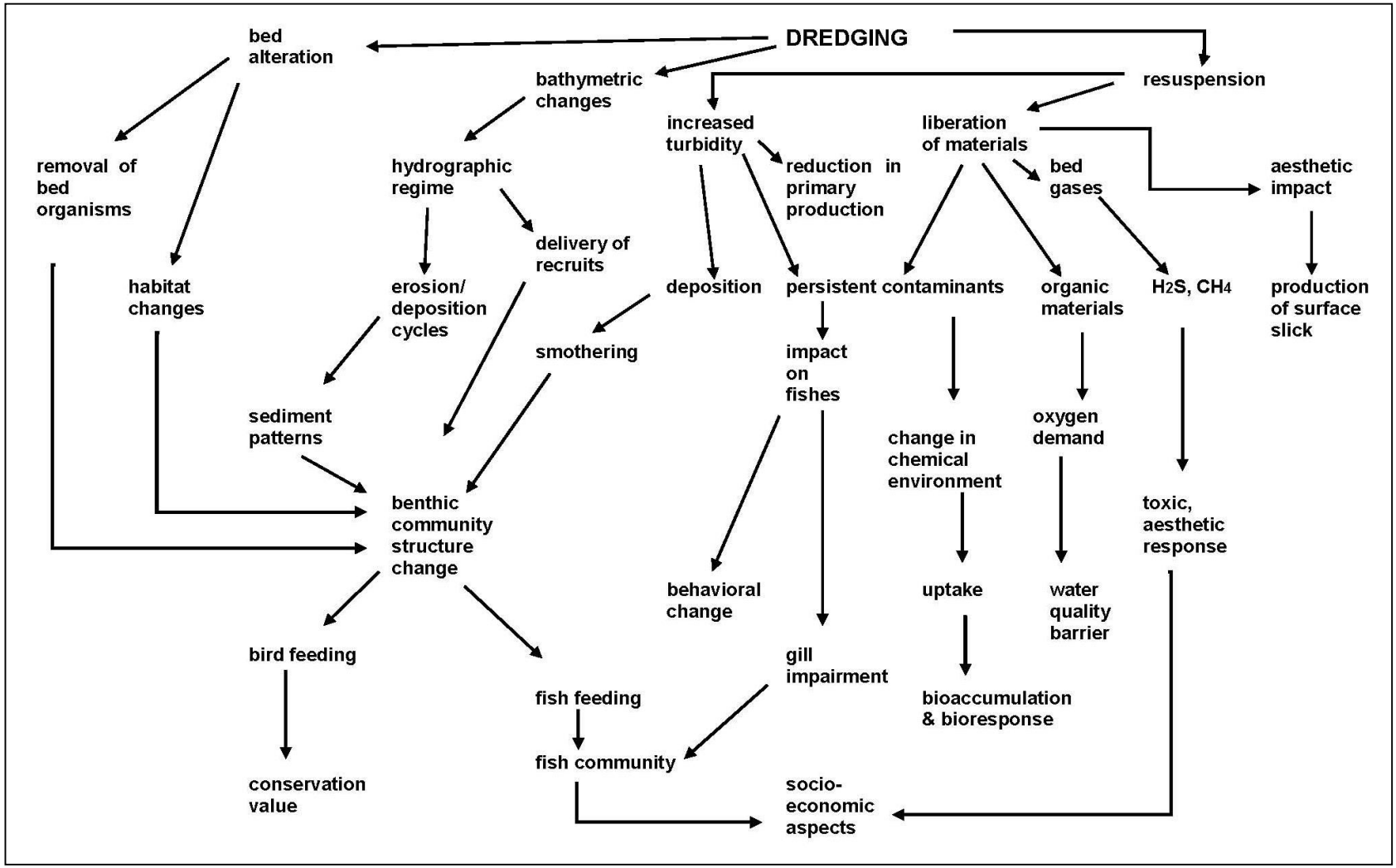


Figure 7.1: Potential impacts of dredging on the ecosystem and natural resources indicating Valued environmental factors

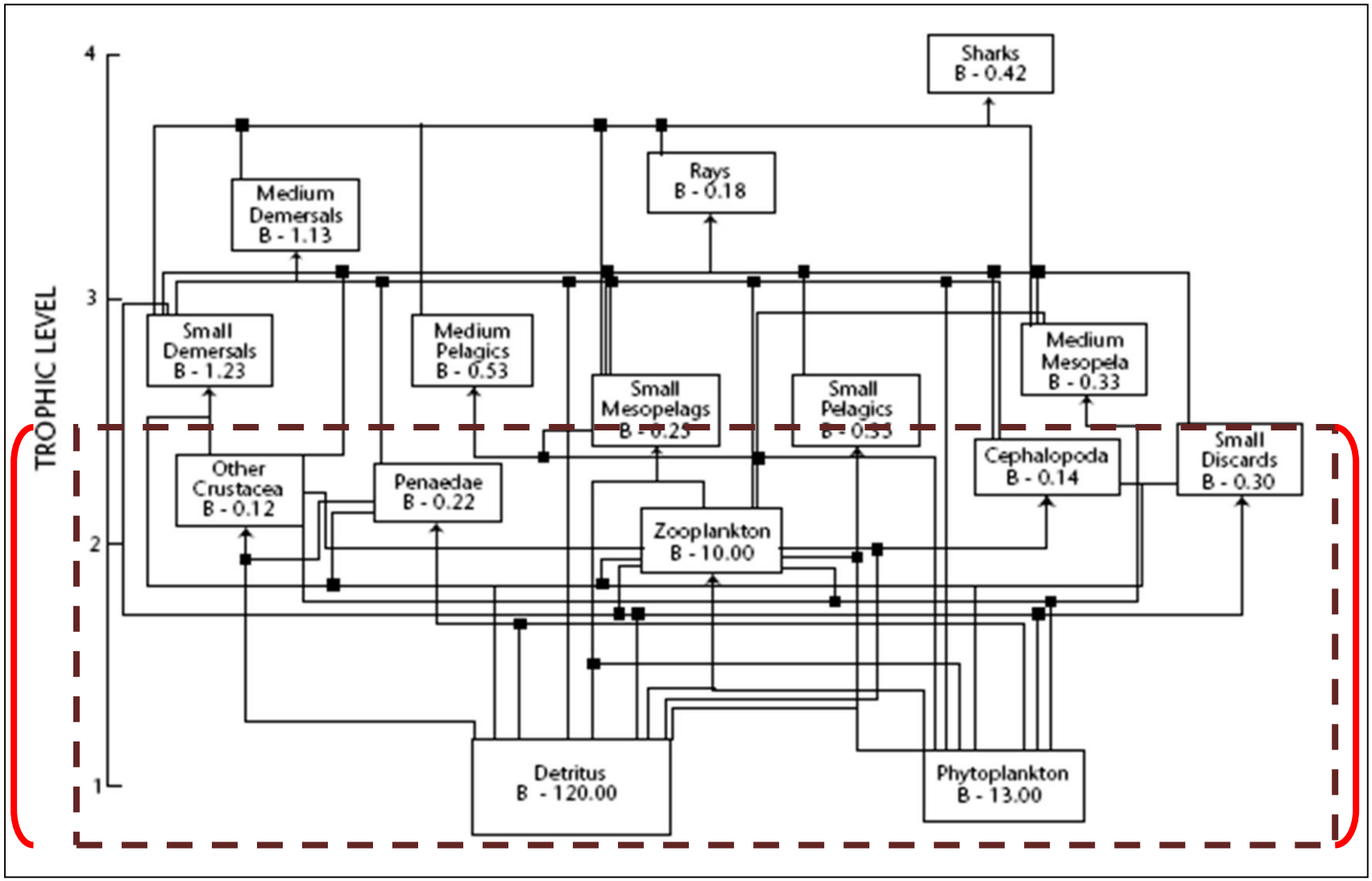


Figure 7.2: Trophic model of the coastal waters of Bangladesh, Bay of Bengal (after M.G.Mustafa 2003). Dredging removes/affects the aquatic animals within the trophic levels 1 and 2 (DASHED BOX - indicated by parentheses) which form the basis of the food chain and ultimately all animals dependent on these food chain links are affected.

Bangladesh Cetacean Diversity Project (BCDP) principal researcher, Rubaiyat Mansur Mowgli over a telephonic conversation with Dr S. M. A. Rashid, Ecologist, IWM informed that considering the volume of the dredged material there may not be any significant impact on the diversity, abundance and habitat of the cetaceans. However, during the months of February - April the water at the Swatch of No Ground is very clear and utmost care will be required in disposing the dredged soil and the disposal of the soil should be well below the surface and at no instance should either be at or near the surface of the Bay. One of the consequences of the disposal will be increase in the turbidity and the dolphins may temporarily move away from the area. However, the swatch of no ground has been discarded considering the objections from the environmentalists.

The new proposed area is location-2 (**Figure 6.1**) will be beneficial for the environment since the land is very shallow and there is a potential of land reclamation and enhancement of the Sundarbans area by growing mangroves in the reclaimed land. Location-4 is also away from the swatch of no ground (marine protected area) and the depth of the area is about -20mCD which ensures minimal dispersion of the dredged materials, especially if it is disposed during the low tide.

The most likely impact of dredging is the loss of benthic habitats at the bed of the dredging stretches. However, the dredging stretch in the estuary (Figure 6.1) is only 7260m long and 600m wide which is very insignificant compared to the wide sea. Moreover, the dredging stretch in the Pussur Channel is 3703m long and 900m wide whereas the channel is more than 7000m wide at the location. The benthic environment at the other stretches will not be impacted due to dredging at these stretches.

The effects of maintenance dredged material deposition on benthic community structure have been well studied (Van Dolah et al. 1984; Wildish and Thomas 1985; Kleef et al. 1992; Rees et al. 1992; Roberts et al. 1998; Smith and Rule 2001). Different types of effects have been identified and large differences in recovery rates have been observed. Consequently, it has been very difficult to draw any general conclusions concerning the impact of dredged material deposition on the benthic community structure or recovery rates. Although it is acknowledged that there are many factors which affect the response and recovery of benthic communities from dredged material placement, e.g. sediment type, frequency and timing of deposition, several authors have postulated that recovery rates have been relatively rapid (several months) in environmentally stressed or high-energy ecosystems (Oliver et al. 1977; Rosenberg 1977; Hirsch et al. 1978; Ray 1983; Flemer et al. 1997; Ray and Clarke 1999). This observation is supported by the findings of small-scale defaunation experiments (e.g., McCall 1977; Mattsson and Notini 1985; Levin and DiBacco 1995). Species in such ecosystems: estuaries and marine ecosystems with high wave action or tidal movement, for example, are adapted to survive in such variable environments (Boesch 1974; Hirsch et al. 1978; Dauer 1984, Ysebaert et al. 2000). This suggests that the magnitude and frequency of natural perturbations are possibly major factors in affecting recovery from dredged material disposal.

Recovery from disturbance has been shown to be dependent to a large extent on the ability of the surrounding, undisturbed community to supply migrating adults and/or recruiting larvae (Hirsch et al. 1978; Zajac and Whitlatch 1982; Diaz 1994; Lu and Wu 2000, Bolam and Fernandes 2002). This is particularly important in cases where the perturbation destroys the original community and recovery starts from totally defaunated sediments. For example, Zajac and Whitlatch (1982) found, in a series of experimental defaunations in a small estuary, that high densities in the surrounding area in spring and summer corresponded to high densities in the recolonisation plots, and correspondingly low densities during autumn and winter. Beukema et al. (1999) found that nearly all the species surrounding their experimental sediments (120m2) had recolonized within 6 months from defaunation. Consequently, low diversity, stressed systems may recover more rapidly from severe disturbances because there is always a local supply of initial colonisers. In less-stressed habitats, the low abundance

of opportunistic species implies that early colonisers will be a limiting factor for recovery from a disturbance.

8 OUTSTANDING UNIVERSAL VALUE (OUV) AND SUNDARBANS

8.1 Outstanding Universal Value (OUV) of the Sundarbans

In general, the meaning of OUV is as follows. Outstanding: For properties to be of outstanding universal value they should be exceptional, or superlative — they should be the most remarkable places on earth. Universal: Properties need to be outstanding from a global perspective. World Heritage listing does not aim to recognize properties that are remarkable from solely a national or regional perspective. Value: What makes a property outstanding and universal is its "value", or the natural and/or cultural worth of a property. This value is determined based on standards and processes in the Operational Guidelines for the Implementation of the World Heritage Convention (the Operational Guidelines, Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage, 2013). The Committee considers a property as having Outstanding Universal Value if the property meets one or more of the ten criteria set by the World Heritage Center (WHC).

Sundarbans: The Sundarbans Reserve Forest (SRF), which is located in the south-west coastal region of Bangladesh between the river Baleswar in the East and the Harinbanga in the West, adjoining to the Bay of Bengal, is the largest contiguous mangrove forest in the world. Lying between latitude 21° 27′ 30″ and 22° 30′ 00″ North and longitude 89° 02′ 00″ and 90° 00′ 00″ East and with a total area of 10,000 km^2, 60% of the property lies in Bangladesh and the rest in India. The land area, including exposed sandbars, occupies 414,259 ha (70%) with water bodies covering 187,413 ha (30%).

The three wildlife sanctuaries in the south cover an area of 139,700 ha and are considered core breeding areas for a number of endangered species. Situated in a unique bioclimatic zone within a typical geographical situation in the coastal region of the Bay of Bengal, it is a landmark of ancient heritage of mythological and historical events. Bestowed with magnificent scenic beauty and natural resources, it is internationally recognized for its high biodiversity of mangrove flora and fauna both on land and water.

The immense tidal mangrove forests of Bangladeshs' Sundarbans Forest Reserve, is in reality a mosaic of islands of different shapes and sizes, perennially washed by brackish water shrilling in and around the endless and mind-boggling labyrinths of water channels. The site supports exceptional biodiversity in its terrestrial, aquatic and marine habitats; ranging from micro to macro flora and fauna. The Sundarbans is of universal importance for globally endangered species including the Royal Bengal Tiger, Ganges and Irawadi dolphins, estuarine crocodiles and the critically endangered endemic river terrapin (Batagur baska). It is the only mangrove habitat in the world for Panthera tigris species.

In 1997, Sundarbans was recognized as UNESCO World Heritage Site considering two (two) i.e. criterion (ix) and criterion (x). Criterion (ix) and criterion (x) are illustrated below;

(ix)be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;

(x) contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

According to guidelines, to be deemed of Outstanding Universal Value, a property must also meet the conditions of integrity and/or authenticity and must have an adequate protection and management system to ensure its safeguarding.

Characterization of Sundarbans was made by the Committee in the perspective of criteria (ix) and (x), which is described in the following section.

Criterion (ix): The Sundarbans provides a significant example of on-going ecological processes as it represents the process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities. These processes include monsoon rains, flooding, delta formation, tidal influence and plant colonization. As part of the world's largest delta, formed from sediments deposited by three great rivers; the Ganges, Brahmaputra and Meghna, and covering the Bengal Basin, the land has been moulded by tidal action, resulting in a distinctive physiology.

Criterion (x): One of the largest remaining areas of mangroves in the world, the Sundarbans supports an exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Royal Bengal Tiger. Population censuses of Royal Bengal Tigers estimate a population of between 400 to 450 individuals, a higher density than any other population of tigers in the world.

The property is the only remaining habitat in the lower Bengal Basin for a wide variety of faunal species. Its exceptional biodiversity is expressed in a wide range of flora; 334 plant species belonging to 245 genera and 75 families, 165 algae and 13 orchid species. It is also rich in fauna with 693 species of wildlife which includes; 49 mammals, 59 reptiles, 8 amphibians, 210 white fishes, 24 shrimps, 14 crabs and 43 mollusks species. The varied and colourful bird-life found along the waterways of the property is one of its greatest attractions, including 315 species of waterfowl, raptors and forest birds including nine species of kingfisher and the magnificent white-bellied sea eagle.

8.2 Impact on the Sundarbans

The potential impact of dredging is localized at the dredging and disposal locations. The project activities will have insignificant impact on on-going ecological and biological processes of Sundarbans (criterion ix) since sediment plume is not dispersed into the Sundarbans and does not increase the turbidity. Again proposed dredging does not affect the Sundarbans' exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Royal Bengal Tiger since impact is localized and dredging and disposal processes are building with nature. The reasons of negligible impact on OUV is explained in details in the following sections.

The present dredging of the Pussur River is proposed at the river stretch, which has been experiencing river bed scouring and formation of bars at the outer bar area over the years. The dredging is suggested to deepen the river for improvement of navigability for safe ship movement. This dredging process at this location is building with nature since river deepening is occurring naturally. In order to reduce the sediment dispersion extent and turbidity level of river water, silt curtain is proposed as a mitigation measure. Monitoring is also suggested to control the dredging to limit the increase level and extent of turbidity, i.e. during spring tides at high current speed dredging will remain closed.

The dredging will be done along the river flow and turbidity of water is very likely to increase along the river not transversely, which implies no impact on the Sundarbans area. Again during spring tides i.e. in full moon and new moon dredging will remain stop since high current, higher tidal range are likely to disperse sediment plume to the Sundarbans. The dredged material disposal plan includes disposing of dredged material on naturally accreting zone, eroding bank to reduce erosion of mangroves.

The Project will not remove or have on effects on habitats required to maintain the diversity of fauna and flora in the Sundarbans WHA (Criterion x) since chance of change of physical environment is very insignificant such as change of turbidity and other water quality parameter. In relation to retaining the

Integrity of the World Heritage Area (Sundarbans), the proposed dredging Project does not cause loss to any whole OUV element (Wholeness Criterion), there will be no reduction in the size of the WHA property.

Figure 8.1 shows the WHA area of the Sundarbans (Source: Bangladesh Forest Department, 2013) and the proposed dredged materials disposal locations. It is evident from the map that none of the disposal locations is within the WHA area of the Sundarbans and there is no scope of loss of the mangrove forest due to dredging and dredged materials disposal locations. Rather, there is a huge potential of growth of mangroves on the land reclaimed by the disposal of the dredged materials at location-2. It is also likely to increase the area of the Sundarbans and enhance the natural environment.

The growth of the mangroves at location-2 is expected to provide a unique, irreplaceable habitat making significant contributions that benefit the coastal ecology. In general, mangroves preserve water quality and reduce pollution by filtering suspended material and assimilating dissolved nutrients and serve as a diverse habitat for many species including insects, crustaceans, mollusks, fish, amphibians, reptiles, birds, and many other invertebrates. Up to 80% of the global fish catches are directly or indirectly dependent on mangroves (Fujimoto 2000). Mangroves are essential to maintain coastal fisheries, protect property and coastlines from the effects of cyclones and storms and protect coral reefs from sediments and pollutants.

The dredged materials cannot be disposed at the Sarwar Sand or Bangabandhu Island since it is within the World Heritage Area of the Sundarbans. Disposing the dredged materials at the Bangabadhu Island and resulted increase of turbidity may disturb the aquatic ecology within the WHA.

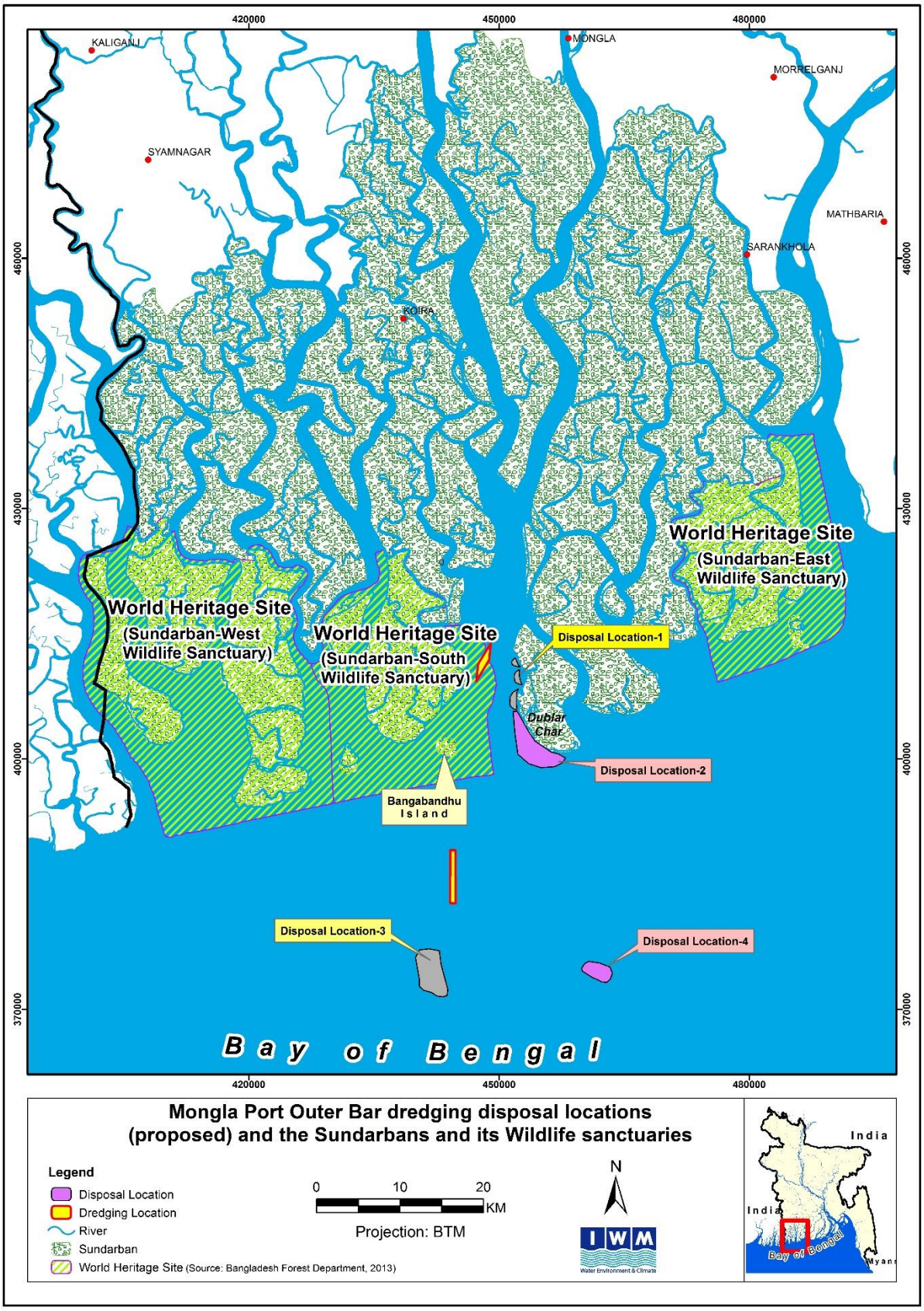


Figure 8.1: The World Heritage Area (WHA) of the Sundarbans and the proposed dredged material disposal locations

9 IMPACT MITIGATION AND ENVIRONMENTAL MANAGEMENT PLAN (EMP)

9.1 Impact Mitigation

This Chapter presents potential impacts due to proposed dredging and its mitigation measures along with environmental management plan (EMP) to offset /reduce those impacts. The aim of EMP is to plan and design the interventions with a view to minimizing environmental negative impacts and maximizing benefits. As part of the aims and objectives of environmental assessment it is necessary to identify mitigation measures to avoid, minimize or ameliorate these negative impacts. In addition to that there are deliberate, specifically targeted measures that can be taken to readdress losses from negative impacts. Table 9.1 presents primary and subsequent impacts on the benthic flora and fauna due to dredging activity.

The ecological safety of dredging works is currently one of the most discussed topics in the dredging sector. Ecologists are concerned about the state of the marine environment and continuously monitor the execution of dredging works and their influence on the sea.

The impact of turbidity by dredging works on the environment can be reduced by modifying the overflow chutes in a way that the excess water flowed back into the sea below the water line or by choking the overflow using trailing suction hopper dredgers. Choking the overflow is a very efficient technique to reduce the spreading of sediments. But it comes only to full value when the system is fully automated and does not require the constant concentration of the dredge crew.

Table 9.1: Impact due to Dredging and Mitigation Measures

Development Activity	**Primary Impacts or Environmental Disturbance**	**Secondary and Tertiary Level Environmental Impacts**	**Mitigation Measures**
1. Actual Dredging or Burrowing of 'Cutter Head'	1a. Disturbance of seafloor, the suspension of fine sediments and the re-deposition of coarse factions.	1a1. Direct physical destruction of benthic habitat, and attenuation of light - impeding photosynthesis of sea grass, phytoplanktons, macro-algae and other autotrophs.	1a1a. Use of 'Silt Curtains' at burrow pit, ensuring that lower end of 'skirt' is resting upon the seafloor, and ensuring that top of the 'skirt' is always above the surface of sea.
			1a1b. Monitoring and where necessary repairing and/or replacing leaky pipes and faulty couplings of the dredged material discharge pipes.
			1a1c. Applying velocity reduction measures where materials are deposited such as baffles to precipitate solids and curtail turbid influences in effluent stream.

Development Activity	**Primary Impacts or Environmental Disturbance**	**Secondary and Tertiary Level Environmental Impacts**	**Mitigation Measures**
			1a1d. Decrease time frame over which the dredging operation is to take place, to avoid the daily re-suspension of sediments.
			1a1e. Ameliorate the impacts of the daily re-suspension of sediments by the suctioning of sediments that have resettled.
			1a1f. Ameliorate re-suspension of sediments by confining dredging operations to calmer sea states.
			1a1g. Assist re-colonization of seafloor by benthic plants and invertebrates by ensuring that the gradient or slope of the walls of burrow pit or channel is not at an angle steeper than 35 degrees.
		1a2. "Blanketing" or smothering effects on benthic habitat and sessile and slow-moving invertebrates.	1a2a. Institute monitoring programme to ensure that light penetration at seafloor is at least 25% of surface irradiance 2,000 ft. downstream of silt curtains.
	1b. Decrease in Dissolved Oxygen and increase in BOD.	1b1. Physiological stress and lethal effects on benthic invertebrates and to a lesser extent, fin-fishes.	1b1a. Completion of dredging operation in as short a time-frame as possible.
	1c. Suspended Solids from un-dissolved components of human waste and domestic effluents.	1c1. Suspended solids would impeded light penetration in the water column and erode or arrest photosynthesis.	1c1a. Application of BEST Treatment technology reduces TSS to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces suspended solids to insignificant levels in the water column.
	1d. Sedimentation associated with settlement of flocculent faction of human waste and domestic effluents.	1d1. Blanketing of seafloor and suffocation of slow-moving and sedentary invertebrates.	1d1a. Application of BEST Treatment technology reduces Total Suspended Solids (TSS) to less than 10 mg/l, this in combination with effluent recycling and reuse regime reduces to insignificant levels suspended solids to insignificant levels in the water column.

Development Activity	**Primary Impacts or Environmental Disturbance**	**Secondary and Tertiary Level Environmental Impacts**	**Mitigation Measures**
	1e. Increase in BOD substances and consequent reduction in dissolved oxygen.	1e1. Precipitation of physiological stress and in extreme circumstances death in relation to sessile and slow moving invertebrates.	1e1a. Application of BEST Treatment technology reduces BOD to less than 10 mg/l; this in combination with effluent recycling and reuse regime reduces BOD to insignificant levels in the water column.

Suggested mitigation for the dredging project includes the following:

- Curtains placed on dredge to trap sediments and therefore limit the lateral movement of turbid water;
- Dredged material dispersion outfall characteristics to be evaluated by collecting grab water samples during dredging operations and operations modified accordingly;
- Dredging to a slightly greater depth than absolutely necessary to pick up more, heavier, material so as to facilitate fallout of dredge material when released in open water;
- Dredging to a slightly greater depth than absolutely necessary so as to reduce the need for maintenance dredging;
- No dredging in periods of rapid water movements, for example, in the afternoon when trade winds are strong, or during the rainy season when large influxes of fresh water could move significant volumes of sediment laden waters to the Sundarbans mangroves;
- The connection of a conical reflective shield to the outlet as silt suppression and dispersion control mechanism;
- Careful mapping of sensitive areas directly affected by the dredge;
- Preventative maintenance of equipment to mitigate negative environmental impacts such as leakages and spillages.

Table 9.2 indicates the potential negative impacts on IECs at different stages of dredging operation and suggests mitigation measures.

Table 9.2: Summary of negative impacts and mitigation measures

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
Pre-dredging activities			
Engagement of Environmental and other Technical staff	Without adequate technical staff, it would be difficult to implement EMP as prescribed.	• Contractors and MPA should hire all technical staff needed for effective implementation of the EMP. • Contractor‘s staff: Aquatic Biologist, Occupational Health and Safety Specialists, Environmental Technicians. • MPA staff: Environment Management Specialist, Environment Monitoring Specialist, Dredging specialist.	MPA and the Contractor
Preparation of guidelines for effective handling of dredged materials	Without proper guidelines for management of dredged materials, there will be environmental problems.	• Prior to the mobilization of Contractors, MPA will ensure that the dredged materials should be handled properly after dredging and before disposal. • Site-specific Dredged Material Management Plan with proper containment compartments, use of silt traps and drainage provision for the dredging and disposal sites.	MPA and the Contractor
Plan for sediment sampling to be carried out	Sediment may be contaminated posing threat at disposal sites	• Toxicity levels should be tested before dredging and verification to be carried out • Proper plan for contaminated/toxic dredged material management	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
Verification of dredging area	The projected dredge volume to be re-assessed through verification prior to commencement of dredging.	A bathymetry survey and analysis should be conducted jointly by Contractor and MPA orby independent monitoring agency for verification of dredging alignment in the selected routes.	MPA and the Contractor
Safety of navigating vessels	Dredging location and activities in the waterways may result in traffic congestion or accidents or disturbance to fishermen boats and navigating ships/vessels.	Installation of navigation signs and aids in the dredging and disposal sites to alert the vessels passing the area.	MPA and the Contractor
Inclusion of environmental Clauses in Construction Contracts	Compliance by the Contractor to requirements defined in the ESIA and EMP.	Specific environmental and biodiversity conservation clauses will be added to contract specifications and a separate environmental bill-of-quantities section will be prepared.	MPA and the Contractor
Dredging Operation			
Dredging: excavation	• Increased sediment concentration in water, increased turbidity of water, loss of transparency, impacts on marine and benthic habitats. • Impacts on morphology and bathymetric changes	• Select dredging equipment with low risk of sediment dispersal. The Contractor should select the dredging methods to minimize suspension of sediments, minimize destruction of benthic habitat, and increase the accuracy of the operation. Suspended sediment concentrations due to dredging activities should not exceed 4,000 mg/l near the dredger; • Monitor the dredging operation and, if necessary, change the dredging plan to minimize amount of	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
		material being dredged (or the number of dredgers allowed to operate) at any one time; • Suspend dredging works during new moon and full moon for one cycle to reduce the extent of dispersion of sediment plume; • Inspection and monitoring of dredging activities should be conducted to evaluate the effectiveness of impact prevention strategies, and re-adjusted where necessary; • An ongoing ecological monitoring will be in place to evaluate the impacts of the dredging and develop additional mitigation measures as required; • Ensure adequate measure to protect channel bed and banks through proper design and construction of training works; • Use of silt curtain in order to control sediment dispersion within the dredging area.	
Dredging: Lifting	The release of suspended sediments during lifting can cause mortality to fish. Increase in turbidity, due to sediment re-suspension, also reduces light penetration in to the water thus resulting in to reduction in primary productivity for phytoplankton.	• Select dredging equipment with low risk of sediment releases from lifting; • Use of silt curtain in order to control sediment dispersion within the dredging area.	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
River Traffic	• The presence of disposal pipes, barges and associated vessels will pose a risk to the navigating boats/vessels; • There is also risk of collision of construction boats with dolphins.	• Provide proper navigational lighting and navigation aids for the barges and associated vessels; ensure submergence of the pipeline so that they do not obstruct the navigation channel; • Check all navigational lights routinely to ensure that they are working properly; • Limit the motor boat speed to ≤15 km/h in accordance with the best international practices and to avoid any collision with dolphins; • Pingers set at 145dB at 70kHz(maximum) to be used to chase away dolphins from the construction and dredging areas thus minimizing the chances of any collision with dolphins. Pingers should be operated intermittently under supervision of experienced operators and if operated continuously for longer periods may harm or drive away other aquatic fauna, particularly fishes.	MPA and the Contractor
Noise from dredging activities	• Noise and vibration under water: Disruption to fish migration and disturbance to dolphins • Noise and vibration above water: disturbance to the animals and birds of the Sundarbans	• Reduce the dredger noise at source by isolation of exhaust systems and by keeping engine room doors shut; • Limit the noisy dredging to daylight hours, where possible, rather than at sunrise or sunset (significant for wildlife) or during night time hours. Where	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
		unavoidable, the contractor should ramp up the levels of engines or other noise producing sources, so that the noise slowly increases. This will encourage marine and terrestrial fauna to move away from the source area prior to significant noise emissions.	
Exhaust emissions	Air pollution and release of greenhouse gases from construction equipment	• Inspect and maintain equipment in good working condition. Proper maintenance of engines ensures full combustion with low soot emissions. • Use low-sulphur heavy fuels to reduce noxious emissions. • Provide exhaust filtering. • Gaseous emissions to be monitored daily and emissions should be within limits as prescribed in the DOE air quality standards	MPA and the Contractor
Oil spills	• Oil spill will cover large area from a specific point location through tidal and wave action in the Pussur estuary and the bay	• Refueling of barges and boats with a proper care to avoid any spills; • Make available spill kits and other absorbent material at refueling points on the barges; • Monitoring of oil spill and use of spill kits.	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
Bilge water	Waste water disposal from the barges and associated vessels	Properly collect, treat and dispose the bilge water	MPA and the Contractor
Post-dredging activities			
Transportation of dredged materials	Accidental leakages and spillage during dredged materials transport	• Ensure regular inspection and maintenance of the carrying barges; • Develop emergencyor contingency plan to prevent and contain accidental spills, collisions, fire or any other natural or man-made incident; • Provide notification about the dredging activities to the navigating boats/vessels to minimize risks of collision; • Provide adequate training to staff at dredging site to operate heavy equipment.	MPA and the Contractor
Placement of dredged materials	Dispersion of sediments and release of high sediment laden runoff from the placement sites.	• Prior to filling commencing, the disposal areas at location-2 where the water depth is less and there is a delta building process, should be enclosed by sand-filled geo-tubes and subdivided into compartments; • Use of silt curtain to prevent dispersion of sediment plume.	MPA and the Contractor

Activity/Issue	Negative Impacts on VECs	Mitigation Measures	Implementation and Supervision
Drainage Congestion	• There are khal outlets near disposal location-1; which can be blocked by disposed sediment at his location and hamper drainage. If these khals are blocked drainage congestion will occur; • Drainage congestion may occur if the dredged materials block drainage of the reclaimed area at disposal location-2; • If the drainage is hampered water logging in the catchments will affect ecology of the area.	• Remove sediment accumulation at the outfalls of the natural khals; • Before disposal, dykes/bunds should be constructed in order to prevent blockage of drainage canals near location-2; • Use of silt curtains will prevent sediment dispersion and khal blockage.	MPA and the Contractor
Worker‘s Health and Safety	• Health impact from the exposure to hazardous and chemical materials and casualty from drowning or criminal attack.	• relevant standards including fuels and hazardous substances management plan, drinking water management plan, spill control arrangements for fuels, firefighting equipment availability at the work station and safety precautions will be taken to transport, handle and store hazardous substances, such as fuel.	MPA and the Contractor

9.2 Environmental Management Plan

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. The main components considered for EMP are: Compensation plan, Mitigation Plan, Enhancement Plan, Monitoring Plan, Institutional setup and People's participation.

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, design, implementation and post implementation stages of the project:

Planning and Design Phase:

- Establishment of pre-project socio-economic baseline status;
- Preparation of guideline for handling wastes in sanitary manner.

Operation Phase:

- Traffic obstruction;
- Operation risk;
- Handling dredging equipment;
- Control of public nuisance;
- Health safety and insurance for workers;
- Engage monitoring consultant to check dredging work and its performance.

Maintenance Phase:

- Monitoring erosion and accretion pattern around intervention area;
- Monitor water quality at the intervention and disposal sites;
- Monitoring benthic species at the intervention and disposal areas;
- Monitoring of impacts and post project assessment, and
- Socio-economic monitoring (Navigation traffic, fisheries catch, benthic flora & fauna, health & nutrition).

9.3 Impact Timing

A 5-year 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.

9.4 Impact Monitoring Approaches and Parameters

The environmental monitoring plan will be executed by the contractor and third party will monitor the execution of the EMP to assist MPA. The longer term monitoring of the project will be carried out to address any change in socio-economic condition, change in benthic community, water quality, fishery, etc. A management feedback system is required so that information from the monitoring can be fed back into decision taking and corrective action if required. Cost of monitoring including required resource personnel shall be included in the project budget.

To assess impacts of dredging and disposal material, benthic grabs may be obtained in the vicinity of a dredge area and disposal area when the operation is in progress. The objectives of sampling will be:

1. to define the impacts of dredging and disposal on the benthos;
2. determine the spatial extent of dredged material dispersion from the discharge point;
3. follow the rate of recovery of the benthos; and
4. a seasonal survey, sampling to ascertain benthic conditions may be conducted to yield a background against which the short-term impacts of dredging and disposal could be used to assess the potential for long-term impacts.

A monitoring plan has been prepared to be carried during implementation of the project to ensure contractors‘ compliance with the mitigation measures is given in **Table 9.3** along with the monitoring indicators and frequency to record the response of the project on the natural system. DSC will be responsible for supervision of implementation of the plan.

Table 9.3: Environmental Monitoring Plan

Activity/Parameter	Monitoring parameters	Guidelines/ Standards	Monitoring Method	Frequency	Responsible Parties
Locations of dredging	River morphology and bathymetric changes, sensitive species	Monitoring	Inspection and field survey, report review	Pre-monsoon and post-monsoon	Contractor, MPA, CSC
Natural Calamities (Flood, Cyclone/Storm Surges)	Consider climate condition and natural calamities occurred in the last couple of years	Monitoring	Inspection and field survey, report review	-	Contractor, MPA, CSC
Dredging: Excavation	Turbidity, transparency and increased suspended sediment concentrations, benthic habitats.	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Dredging: Lifting	Suspended sediments during lifting, toxic chemicals or nutrients such as phosphates and nitrates, anaerobic sediment and organic matter	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
River Traffic	The presence of barges and associated vessels and discharge pipelines	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Noise from dredging activities	Noise and vibration under water and above water	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Exhaust emissions	Air pollution and release of greenhouse gases from construction equipment	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Oil spills	Oil spills	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
	Careful and proper handling of oil and other hazardous liquids by trained personnel	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
	Handling/disposal of oil and liquid wastes at designated site	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Bilge water	Waste water disposal from the barges and associated vessels	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC

Activity/Parameter	Monitoring parameters	Guidelines/ Standards	Monitoring Method	Frequency	Responsible Parties
River Water Quality	Suspended sediment concentrations, turbidity and transparency	Monitoring	Inspection and field survey, report review	Quarterly for 4 years	Contractor, MPA, CSC
	Oils and fuels	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
	Site runoff	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Waste from ships	Oil containing wastewater, solid waste from ships, water quality	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Dredging: Transportation	water quality from dredge material carrying hopper barges	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Dredging: Placement	Dispersion of sediments and release of high sediment laden runoff from the placement sites.	Monitoring	Inspection and field survey, report review	Daily	Contractor, MPA, CSC
Air Quality	CO, NO_x, SO_X, O_3, $PM_{2.5}$, PM_{10}, Wind Speed, Wind Direction, Humidity, Temp	Air quality standard of DOE, Bangladesh	Sampling and laboratory analysis	Quarterly for 4 years	Contractor, MPA, CSC
Noise	Measurement of noise L_{eq} in dBL	Noise Pollution Control Rules (2006) of Bangladesh	On site monitoring	Quarterly for 4 years	Contractor, MPA, CSC

Activity/Parameter	Monitoring parameters	Guidelines/ Standards	Monitoring Method	Frequency	Responsible Parties
Surface water Quality	pH, EC, Temp, Turbidity, DO, Major ions (Na, Ka, Ca, Mg), Total Phosphate, Total Nitrate, BOD5, Plankton	Surface water quality standard of DOE, Bangladesh	Sampling and laboratory analysis	Quarterly for 4 years	Contractor, MPA, CSC
Groundwater/ Drinking water quality	pH, EC, Temp, Major ions (Na, Ka, Ca, Mg), As Fe, Mn, E.Coli	Drinking water quality standard of DOE, Bangladesh	Sampling and laboratory analysis	Quarterly for 4 years	Contractor, MPA, CSC
Soil Sample at Source	pH, EC, Mg, Cl, Na, K, Total Organic Carbon, Total Phosphate, Total Nitrate	Soil quality standard of DOE, Bangladesh	Sampling and laboratory analysis	Quarterly for 4 years	Contractor, MPA, CSC
River Bed Sediment (RBS)	Total Organic Carbon, total phosphate, total nitrate, heavy metals (As,Cd,Hg, Pb, Cr, Zn, Ni), Shell fish, macro invertebrates		Sampling and laboratory analysis	Quarterly for 4 years	Contractor, MPA, CSC
Worker's Health and Safety	Check quality of food and accommodation at construction camp; Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; Check toilets are close to construction site and separate toilet for female workers; First Aid Box with required tools and medicines	Monitoring	Inspection and field survey, report review	Monthly	Contractor, MPA, CSC

Activity/Parameter	Monitoring parameters	Guidelines/ Standards	Monitoring Method	Frequency	Responsible Parties
Personal Safety Equipment (PSE)	Check of personal protective equipment (PPE) for worker at the sites;	BNBC, Monitoring	Inspection and field survey, report review	Regularly	Contractor, MPA, CSC
Safety Training	Undertake safety orientations for all personnel.	Induction Records	Inspection and field survey, report review	Prior to commencing work onsite.	Contractor, MPA, CSC
Health and Vector Borne Diseases	Undertake checks at all sites	Monitoring	Inspection and field survey, report review	Regularly	Contractor, MPA, CSC
Labour Standards	Patrolling construction area for child labor; check that labourers have contract letters and check age, working conditions and documentation	ILO, GOB	Inspection and field survey, report review	Regularly	Contractor, MPA, CSC

9.4.1 Environmental Monitoring Report Format

Items that require monitoring shall be decided on according to the sector and nature of the project, with reference to the list of items presented in **Table 9.4**. A format of the monitoring report is presented in **Annex B**.

Table 9.4: Sample Monitoring Form

1. **Pre-Dredging phase**
   - Recruitment of appropriate manpower;
   - Preparation of dredging and dredge material disposal plan.

2. **Dredging Phase**

Air Quality
Date:

Location	parameter	Value (24 hour average)	DOE Standard	Comments

Water Quality
Date:

Sl. No.	parameter	Unit	DOE Standard	Comments

Sediment Quality
Date:

Sl. No.	parameter	Unit	Standard	Comments

Benthos Organism
Date:

Sl. No.	Species	Unit (no/m^3)	Location-1	Location-2
1				
2				
No. of Species				
Total				

3. **Post Dredging Phase**

Air Quality
Date:

Location	parameter	Value (24 hour average)	DOE Standard	Comments

Water Quality
Date:

Sl. No.	parameter	Unit	DOE Standard	Comments

Sediment Quality
Date:

Sl. No.	parameter	Unit	Standard	Comments

Benthos/Plankton
Date:

Sl. No.	Species	Unit (no/m^3)	Location-1	Location-2
1				
2				
No. of Species				
Total				

9.5 Contingency Plan / Emergency Response Plan

MPA needs to ensure that the Contractor prepares contingency plan to address risks due to adverse weather condition including tornado/cyclone, depression in the Bay of Bangle, oil spill, fire and accidental events. Contingency plan identify corrective actions should undesirable or unforeseen impacts occur. **Table 9.2** and **Table 9.3** present detailed EMP and EMP monitoring plan respectively for minimizing and offsetting anticipated negative impacts and ensuring desired environmental quality standard due to proposed dredging interventions. There shall be firefighting equipment, worker's health safety arrangement including evacuation measure by the contractor in case of any unforeseen event occurs. Following paragraphs highlights on Emergency procedures in the event of cyclones and accidental spill response.

9.5.1 Emergency Procedures in the Event of Cyclones

The following are to be included as key criteria of the emergency procedure in the event of a Cyclone:

- MPA will brief the Contractor about adverse weather condition in the project area and ensure proper training by the Contractor to his dredging crews.
- MPA will ensure that the Dredging Contractor be equipped with safety measures including arrangement of PPE, life jacket, rescue vessel and rescue team to take prompt action in case of such natural calamities.
- The Contractor shall be vigilant about the weather forecast and stop dredging operation immediately and take refuse in the safe area in the country side as soon as adverse weather/depression in the area of intervention is declared by the Meteorological department.
- The Manager of the Contractor shall immediately inform the DSC and PD of MPA of such situation.
- The incident is to be reported as part of the incident reporting and measures put in place to ameliorate loss from such an incident.

9.5.2 Spill Response and Emergency Procedures

Objective

- To minimize the risk of spills or unplanned situations that might cause environmental harm.
- To ensure that contingency measures are in place and implemented in the event of such spills or unplanned situations

Environmental Risk

Dredging Contractor is required to confirm Emergency Response Procedures, via training prior to the commencement of works and for this reason environmental risk associated with spill response and emergency procedures is low.

The offshore booster pump presents a risk of spills and for this reason regular inspections will be required.

The Contractors vessels shall be equipped with suitable spill kits and will be operated in accordance with the Maritime Safety Queensland (MSQ) approved Shipboard Oil Pollution Emergency Plan.

Reclamation Management – Although of very low risk the potential for a structural failure of the facility needs to be considered.

Spill Response and Emergency Procedure Management Strategies Action	**Responsibility**
All refueling is to be done by licensed fuel suppliers in accordance with their Standard Operating Procedures.	
Refueling will take place at wharves suited to tanker access. In the event that it is necessary for the contractor to refuel vessels or plant in the works area operations will be in accordance with industry standards.	Contractor
Provide a Construction Workplace Plan, prior to the commencement of any works.	Contractor
Maintain an Emergency Contact List with an up to date copy retained	Contractor
Minimize the stored volumes of fuel, lubricants and oil in discrete containers on board vessels. When required they will be stored in a secure area and any spills will be cleaned immediately.	Contractor
Vessel crew are to regularly check equipment for evidence of leaks and fitness of hydraulic hoses and seals, and conduct maintenance or repairs as necessary to prevent drips, leaks or likely equipment failures. Inspections of the dredge, pipeline and the booster pump(s) are to be undertaken daily to meet this requirement	Contractor
The pipeline offshore outlet point is to be inspected a minimum of once a week and directly after any storm event. During this inspection the outlet will be moved if required to ensure the dredge material is spread evenly across the designated area. The GPS position of the outlet point shall be recorded.	Contractor
For minor spills, provide spill kit including; bilge socks, heavy duty absorbent polypropylene pads, floating booms and blowback refueling collars on vessels for use in the event a substance is spilled either on deck or to waters to handle a spill of up to 160 liters.	Contractor
For major spills, undertake actions as specified in the MSQ approved Shipboard Oil Pollution Emergency Plan.	Contractor
A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained	Contractor
Daily Visual Monitoring of the reclamation sites are to be undertaken and any concerns to be reported to DSC and MPA to instigate management actions.	Contractor

Incident/Complaint/Risk/ Query and Response Form Date reported:	Date of Incident/Complaint:	Reporting method: (e.g phone)
Time reported:	To whom was it reported?	Time of incident:

Notification Protocol

For any incident causing or threatening to cause harm to the environment or of any significant events: (Notification by any means possible)

Take all reasonable and practicable measures to halt or contain adverse effects;

Then immediately: Notify Project Manager;

Then immediately: Notify DSC and PD, MPA.

Written notification to follow within 3 days, in the form of this incident report and investigation.

Contact List

Notifications Organization	**Name of Contact**	**Contact Details**
During Works – Project Manager of Dredging Contractor		
DSC - In the event of a modifiable activity or incident		
Biological Monitor - In the event of a fauna injury		

9.6 Institutional Arrangements

At all times during the planning and operation (dredging) phase of the Project, MPA's project director will have the final say on all administrative and technical decisions. The key agencies or units which will have to play major roles in the implementation of the EMP are:

- Mongla Port Authority (MPA)
- The Contractor
- Third Party Monitoring firm
- Bangladesh Department of Environment (DoE)

The implementation oversight of all safeguard items in the EMP and indeed the construction contract will be with MPA.

In case of absence of expertise on environmental management plan, MPA shall appoint a third party monitor to supervise and quality control of execution of the monitoring plan by the contractor, as stated in **Section 9.4** and **Section 9.5** and submit the quarterly monitoring reports. MPA will make services, facilities, property and support counterpart personnel available to the third party monitor.

9.7 Cost of Environmental Management Plan

For successful implementation of EMP, provision of appropriate budget shall be in place in the bid document. No separate payment shall be made for fulfilling the requirements of EMP except as specified in **Table 9.5**. For items not specified here, all costs shall be deemed to be included in the unit rates and/or lump sum prices of the various other items in the Bill of Quantities.

Table 9.5: Bills of Quantities for EMP

Item No.	Items of Work	Cost in Lac BDT
1	Contractor's Budget (for development and implementation of management plans, Monitoring, etc.)	600
2	Environmental and Social Consultants for dredging and environmental monitoring (for 3 years: pre, during and post dredging)	400
3	Independent supervision consultants (2 persons for 12 months each)	72
4	Biodiversity monitoring, incl. invertebrates, benthos, fish catch for five years	50
5	Annual Bird Census for 3 years	20
6	Environmental Enhancement Programme: Mangrove plantation	500
Total		**1,642**

10 FINDINGS, CONSUSIONS AND RECOMMENDATIONS

10.1 Findings

The findings of the proposed dredging project based on EIA prepared are as follows:

- The proposed dredging planned for improvement of navigability at the Outer Bar area of Mongla Port is not going to create any long term irreversible impact on the ambient environment. In most cases, the implementation of the dredging operation will cause short term environmental impacts;
- Handling of dredge materials will not require any land acquisition for the project. The dredged materials will be disposed in the deep scour holes in the channel, shallow accretion prone area or deep sea;
- The dredged material is relatively free from toxic materials so that there is little risk to handle the materials;
- The implementation of project will improve navigability of deep draft vessels, thereby increasing foreign trade of the country and overall socio-economic development;
- Mitigation and monitoring measures have been developed in the EMP. The EMP will be implemented by the Mongla Port Authority and the authority will engage monitoring Consultant for supervision and monitoring of dredging activities, and
- Public consultation conducted during EIA preparation reveals that the key stakeholders including port users, inhabitants, etc. are in favour of the project.

10.2 Conclusions

Dredging in the outer bar area in the Pussur Entrance does not have any significant impact on biological and physical environment. Identification of disposal locations and disposal of dredged material has been one of the major challenges in this EIA study and is addressed involving technical, social and environmental considerations. Four potential alternative options were identified and conducted comparative analyses against pertinent technical and socio-environmental parameters to choose the most preferred options for disposal of the dredged materials; these sites are: i) Scour holes near the eroding bank of the Pussur channel and shallow accretion prone area near Dublar char, ii) shallow accretion prone area near Dublar char, iii) shallow area in the estuary, iv) deep sea away from the Swatch of No Ground and the fishing zones. The analyses assessed deep sea as the most suitable site for disposal. Moreover, a combination of the erosion prone area of the Pussur channel and the shallow accretion prone area near Dublar char is another feasible option. Furthermore, disposal of all dredged materials at the shallow accretion prone area can also be considered. In order to ensure safe disposal of the dredged material, it is to be released during the low tide condition. The typical scenario of depth averaged velocity field during low tide condition as shown in **Figure 6.2** summarizes the directions of the velocities. The dredging operations should be suspended during new moon and full moon for one cycle, when the current velocity is maximum, to reduce the extent of dispersion of sediment plume. Trailer Hopper dredger is suggested to be used in the dredging operation which will carry dredged material to facilitate disposal of the materials at the designated location.

The environmental study shows that the proposed dredging in the Outer Bar area of Pussur Channel will not result any long-term significant adverse environmental impacts. Social survey findings from FGDs, KIIs, public consultations and observations suggested that the dredging intervention has no direct negative impact to the local community. It was reported that the proposed dredging area is near fishing grounds and dredging will ultimately enhance the capacity of catching fish, which would be a kind of livelihood augmentation. However, the likely negative impacts can be avoided through implementation of EMP to an acceptable level. Environmental and social benefits of the Project outweigh the negative impacts. Therefore, it is strongly recommended that DoE authority may accord necessary environmental clearance to such a project of national importance.

10.3 Recommendations

Followings recommendations are made based on baseline conditions, impacts, mitigations measures and importance of the project:

- The implementation of the project is suggested to follow the recommended mitigation measures as outlined in the Environmental Management Plan (EMP). The EMP shall be included in the bid document of civil works and need to become part of the civil works contracts. Civil Works Contractor shall execute the EMP. The timely implementation of EMP will reduce negative impacts;
- Both MPA and the contractor shall abide by relevant environmental rules, regulations including workers' health and safety aspect, prevention of air and water pollution, protection of aquatic fauna and flora, etc.;
- Dredge material shall be disposed in designated location following environmental code of practice.
- MPA shall engage a third party to supervise and quality control of monitoring plan to assist MPA

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Annex A: TOR Approved by DOE (Updated)

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

Memo No: DoE/Clearance/5064/2011/ 496 Date: 10/10/2017

Subject: Approval of Updated Terms of Reference for EIA of the Proposed Dredging at Outer Bar Area of Pussur Channel of Mongla Port Project.

Ref: Your Application dated 24/08/2017.

With reference to the above, the Department of Environment hereby gives approval of Updated ToR for Environmental Impact Assessment (EIA) in favour of the proposed Dredging at Outer Bar Area of Pussur Channel of Mongla Port Project subject to fulfilling the following terms and conditions.

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

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

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

IV. The project authority shall submit the Updated EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority and NOC from other relevant agencies for operational activity etc. to the Bagerhat District Office of DoE in Bagerhat with a copy to the Head office of DoE in Dhaka.

V. This Updated ToR Approval shall render void the earlier ToR Approval on 18/04/2011 memo. DoE/Clearance/5064/2011/80.

10.10.2017

(Syed Nazmul Ahsan)
Director (Environmental Clearance)
Phone # 8181673

Chief Engineer
Mongla Port Authority
Mongla, Bagerhat-9351.

Copy Forwarded to :

1) PS to the Hon'ble Secretary, Ministry of Environment and Forest, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Khulna Divisional Office, Khulna.
3) Deputy Director/ Office In-charge, Department of Environment, Bagerhat District Office, Bagerhat.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

MINISTRY OF SHIPPING

MONGLA PORT AUTHORITY

MONGLA, BAGERHAT

Terms of Reference

On

Environmental Impact Assessment of Dredging at Outer Bar Area of Pussur Channel of Mongla Port

1 INTROOUCTION

1.1 Background

Sea Port plays an important role to the development of national trade and commerce in the sector of world trade, sea transport is recognized and considered to be the highest utilized mode. Transport cost is a great factor to world trade and to minimize transport cost bigger ships with modern technological facilities are being introduced. Alike modern ports of the world Mongla Port is keen to provide highest port facilities, so that bigger draft ships can enter in to the port channel safely.

Mongla Port is situated on the east bank of Pussur River, approximately 131 Km upstream from the Fairway buoy (approaches to the Pussur). The Pussur River forms part of a very big and complex river system. Numerous tributaries and channels connect the Pussur River with other rivers like Sibsa, the Ganges and Jamuna Rivers. Flow conditions in all these rivers determined the current and the morphological condition in the Pussur River. The navigation channel at the Pussur River entrance crosses a wide bar known as outer bar. The bar is relatively stable with sea bed elevation of -6.4 m CD (chart datum). With the existing depth in the outer bar, maximum 8.5 m draft vessel can cross the outer bar and enter the port at normal high tide. But the depths over the anchorage area of the channel permit anchoring of more than 10.5 m draft vessels. Outer bar area is the only obstacle for the ships of 10.5 m and above to enter into anchorage area. If the depth of the outer bar would be increased to make safe passage of 10.5 m draft vessels in normal high tide, Mongla port could handle more ships means handling of more cargoes.

Mongla Port is in well position to provide enough facilities for handling cargoes of North and South-West Zone of Bangladesh as well as its adjoining border areas of India, Nepal and Bhutan. For these regions Mongla Port is considered to be the most suitable port from the point of view of trade and commerce.

After completion of Paksey Bridge and Rupsa Bridge, Mongla Port has overcome way obstacle getting direct access for cargo scheduled for the northern parts of the country as well as boarder area of India, Nepal and Bhutan. The Dhaka-Mawa-Mongla highway has already been built up with its necessary expansion with container load bearing capacity. This road link of Mongla-Dhaka has shortened a distance of about 100 km comparing to that of Chittagong-Dhaka. Moreover, after construction of Padma bridge will eliminate the time consuming ferry crossing at Mawa-Kawrakandi and this will attract Dhaka base traders (garments and others) to use Mongla Port.

Institute of Water Modelling (IWM) carried out a Feasibility study for improvement of Navigability of Mongla port and submitted a technical note in 2004 on outer bar dredging. Based on mathematical modelling, hydrographic charts, hydro-morphologic characteristics, etc. the study assessed the length, width and depth of dredging and accordingly quantified capital dredging volume. The report suggested conducting capital dredging by international tender and prior to dredging pre-dredging hydrographic surveys to be carried out as the channel surround outer bar area at Pussur entrance is very dynamic. The dynamic behavior of the channel may change the estimated quantity of dredged volume over time. Following the

suggestion of IWM, Mongla Port Authority took initiative to dredge at Outer Bar and engaged IWM to carry out the Environmental Impact Assessment in 2012. IWM carried out a detailed EIA and submit the final report on May 2013. Then Mongla Port Authority applied to Department of Environment (DoE) for Environmental Clearance of the Project and DoE issued the clearance certificate on August 2013. But till now the project could not be implemented due to delay in approval of the project by the Government of Bangladesh.

In meantime, the Reactive Monitoring Mission from WHC-IUCN visited the Sundarban on 22-28 March, 2016 and submitted a report which recommended regarding Outer Bar dredging as stated below:

> *"The EIA for the dredging of the Pashur River, adjacent to the property, did not include a specific assessment of the potential impacts on the property's OUV and requested the State Party to submit this to the WHC"*

For the above reason Mongla Port Authority has decided to review the EIA report carried out by IWM in 2013 incorporating the potential impacts on the property's (The Sundarban) OUV.

1.2 Objectives

The overall objectives of this assignment is to review and update the **"Environmental Impact Assessment (EIA) study report carried out by IWM in 2013 for the proposed dredging project at the outer bar area of the Pussur Channel"** to increase navigability to facilitate easy entrance and maneuvering of more than 10.5 meter draft ships in the anchorage area of Mongla port. The study will assess the biophysical & socio environmental impact and the potential impacts on the property's (The Sundarban) OUV, if any, with recommendation of appropriate mitigation plan in the project area.

2 SCOPE OF WORK

The consultant will work with the scope defined with in this "Terms of Reference". In support of EIA, the following studies need to be earned out.

- An inventory of the marine species and habitats in the areas to be dredged and surrounding impact areas including Sundarban.
- A hydrodynamic model to evaluate the potential for the proposed dredging of the Outer bar area and its impact on hydraulic conditions and morphology of the upstream navigation channels like Pussur and Sibsa rivers.
- Sediment sampling and laboratory testing to determine the quality of the potential for release of contaminants during dredging.
- Water quality sampling at the dredging area to provide baseline water quality condition.

- Review and update the Environmental Impact Assessment (EIA) report of Outer Bar Dredging to include an assessment of impacts on the Outstanding Universal Value (OUV) of the Sundarban/ World Heritage Site as per article 172 of *Operational Guidelines for the Implementation of the World Heritage Convention, UNESCO-WHC.*

However, The EIA shall incorporate the following components/items:

- Executive summary
- Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
- Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)
- Project activities: A list of the Outer bar dredging activities to be undertaken during site clearing/mobilization, construction as well as operation (dredging).
- Project schedule: The phase and timing for development of the dredging at Outer bar in the Pussur channel Project.
- Resources and utilities demand: Resources required to develop the project, such as construction material and demand for utilities (water, electricity, sewerage, dredge material and waste disposal and others), as well as infrastructure to support the project.
- Map and Survey information: Location map, Cadastral map showing land plots (project and adjacent area)
- Baseline Environmental Condition should include, inter alia, following:

  a) Physical Environment : Geology, Topology, Geomorphology, Soils, Meteorology and Hydrology

  b) Biological Environment :Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna

  c) Environmental Quality : Air, Water, Soil and Sediment Quality

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

  a) Traffic and transport
  b) Public utilities: Water supply, sanitation and solid waste
  c) Economy and employment
  d) Fishing activities, fishing communities, fishing resources, commercial factors

Terms of Reference (ToR) for Environmental Impact Assessment of Outer Bar Dredging 3

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

- Management Plan/Procedure:

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

  b) An outline of the environmental management plan shall be developed for the project.

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

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

  Beneficial impacts (Summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials).

- Conclusion and recommendation

3 CONSULTING TEAM

The following composition is suggested for the consulting team

EIA Specialist/ Team Leader with considerable working experience in the coastal areas and capable of conducting IEE, EIA, Environmental Management plan, Environmental Mitigation plan, Environmental Monitoring plan.

Sociologist/ Water management Institutional expert will examine how the Environmental Management Plan could best be incorporated in the government structure and integrated with the project implementation activities.

Ecologist having considerable working experience in the coastal areas to assess baseline information on aquatic life and fisheries and the impacts on project implementation.

Coastal Morphologist to study past changes in channel morphology and the impacts of dredging in the navigation channel based on model result.

GIS Specialist to assist consultants providing relevant maps and preparing project maps including extraction of data from remote sensing analysis.

Data Analyst/ Field Researcher will assist the consultant in field activities including analyzing primary and secondary data.

The proposed EIA study may require 12.5 person-month of local professional input. The estimated consultant staffing requirements are shown in the following table:

SL No.	Position	Nos.	Month	Person-month
1	EIA Specialist/ Team Leader	1	3.0	3.0
2	Sociologist/ Water management Institutional expert	1	1.5	1.5
3	Ecologist	1	1.5	1.5
4	Coastal Morphologist	1	1.5	1.5
5	GIS Specialist	1	1.0	1.0
6	Data Analyst/ Field Researcher	2	2.0	4.0
	Total	7		12.5

3.1 Qualification and Task

QUALIFICATION AND TASK OF PROFESSIONALS

SL	Discipline	Qualification and Tasks
1.	EIA Specialist/ Team Leader	Minimum Masters degree in Environmental Engineering/ or Water Resources Engineering/Geography with considerable working experience in the coastal areas and capable of conducting IEE, EIA, Environmental Management Plan, Environmental Mitigation Plan, Environmental Monitoring plan. He/ she should have at least 12 years professional experiences including experience in leading and managing a study team connected to Environmental study.

Tasks:

His/ her major responsibilities shall Include but not necessarily be limited to the following:

- Coordinate all the component of the study
- Review relevant available environmental reports including reports on siltation problem to improve navigability in the approach channel at outer bar and to Pussur River
- Prepare work plans, and schedules
- Prepare an Initial Environmental Assessment, Environmental Impact Assessment, Environmental Management Plan, Environmental Mitigation Plan, and Environmental Monitoring plan EMP for the work under the project
- Assess the baseline environmental condition following Physical environment, Biological environment and Environmental quality like air, water, soil and sediment quality etc.
- Assess the potential impacts of the project activity on surrounding environment
- Reporting

2.	Sociologist	Minimum Masters degree in sociology/ economics/ social welfare with considerable working experience in the coastal areas. He/ she should have at least 12 years working experience in planning and design of project affected people.

Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Examine how the Environmental Management Plan could best be incorporated in the government structure and Integrated with the project
- Carry out focus group discussion/ discussions for collecting local information on social condition, cultural values etc.
- Design survey for identifying the project Affected Persons (PAPs), assessing their losses, prepare a comprehension matrix.
- Assess social impacts caused by the proposed dredging project at the outer bar such as impacts on employment, safety issues and other adverse impacts upon income or living standards etc.
- Assess socio-economic environment following Traffic and transport, Public utilities like water supply, sanitation and solid waste including economy and employment
- Reporting

3.	Ecologist	Minimum Masters degree in Fisheries/ Zoology with minimum 10 years working experience including 5 years professional experiences in coastal fisheries sector/ fisheries project.

Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Establish baseline information on existing Fishing activities, fishing communities, fishing resources, commercial factors, etc at the project area.
- Assess impact on fisheries resources caused by the proposed dredging project at the outer bar
- Assist team leading in planning and collecting relevant field data program in connection with fishery study
- Provide mitigation measures on the adverse affect if any on fishery due to the proposed dredging project at outer bar and assist team leader in planning environmental management plan
- Reporting

4.	Coastal Morphologist	Minimum Masters in Civil/ Water Resources Engineering with minimum 10 years professional experience in hydraulic and coastal morphology with comprehensive intellectual and professional knowledge and skill. Experience in tidal river/ coastal zone morphology is preferable

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Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Identify the present morphological process in tidal environment and erosion-deposition pattern of the project area
- Study previously developed morphological/sediment transport/ mud transport model of the project area including updating of the model
- Establish baseline morphological behavior based on model result and available data, historical sounding chart
- Evaluate the potential for the proposed dredging of the Outer bar area and its impact on hydraulic conditions and morphology of the upstream navigation channels like Pussur and Sibsa rivers
- Reporting

5. GIS Specialist — Minimum B. Sc. Degree in Civil Engineering/ Water Resources Engineering/ Urban and Rural Planning/ Hydrology/ Masters in Geography. He/ She should have at least 5 years experience in producing GIS coverage, counter maps Digital elevation model.

Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Preparation of Arc view based contour maps of basins, difference maps of basins and bed topography
- Preparation of project map showing existing and proposed condition
- Preparation of map, power point presentation for workshops and reports
- Assist the study team in reporting

6. Data Analyst/ Field Researcher-1 — Minimum Bachelor degree in Civil Engineering/ Water Resources Engineering. He/ She should have at least 5 years experience in collecting field hydrometric and sediment data including analysis of data etc. Should have sufficient experience In computer programming and Data Analysis.

Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Participate field data collection program on dissolved oxygen, turbidity, total dissolved solids, BOD, COD etc. and arranging for laboratory analysis for results under the guidance of EIA Specialist/ TL.
- Participate secondary data collection on hydrometric and others according to the need of the study team
- Data consistency checking and data processing under the guidance of modelers
- Analysis of hydrological data analysis under guidance of senior modelers
- Assist study team as and when required

7.	Data Analyst/ Field Researcher-2	Minimum Bachelor degree in Civil Engineering/ Water Resources Engineering. He/ She should have at least 5 years experience in collecting field hydrometric and sediment data including analysis of data etc. Should have sufficient experience In computer programming and Data Analysis.

Tasks:

His/her major responsibilities shall Include but not necessarily be limited to the following:

- Participate field data collection program on dissolved oxygen, turbidity, total dissolved solids, BOD, COD etc. and arranging for laboratory analysis for results under the guidance of EIA Specialist/ TL.
- Participate secondary data collection on hydrometric and others according to the need of the study team
- Data consistency checking and data processing under the guidance of modelers
- Analysis of hydrological data analysis under guidance of senior modelers
- Assist study team as and when required

4 DURATION OF SERVICES AND REPORTING

The study will be carried out within a period of 3 (Three) months. The Final EIA report will be issued in two separate volumes: the executive summary in one volume and the balance of the report in a second volume. The report should be organized according to the following outline:

Executive Summary;
Policy, Legal and Administrative Framework;
Description of Proposed Development;
Description of the Environment;
Assessment of Environmental Impacts;
Environmental Management Plan;
Environmental Mitigation Plan;
Environmental Monitoring Plan;
List of References

However, during the project period the reports to be submitted are as follows:

- 10 (Ten) copies of the Inception Report shall be submitted within 15 days of signing the contract.
- 10 (Ten) copies of Interim shall be submitted at the end of 1st month
- 10(Ten) copies of the draft final Report shall be submitted at the end of 2.5th month
- 15 (Fifteen) copies of the Final Report shall be submitted at the end of study period incorporating the comments, If any from the client and DOE.

Annex B: Environmental Monitoring Report Format

Contents:

1 Background and Purpose
1.1 Background
1.2 Dredging Need
1.3 Purpose

2 Description of Activities (during the Reporting Quarter/Periods)
2.1 Mobilization of Contractor's Personnel and Equipment
2.2 Activities Carried Out
2.3 Observance of environmental quality standard
2.3.1 Marine flora and fauna
2.3.2 Water quality
2.3.3 Waste management
2.3.4 Spill response and emergency procedures
2.3.5 Noise and air quality
2.3.6 Communication and reporting
2.3.7 Documentation and record keeping
2.3.8 Environmental awareness training
2.3.9 Complaint handling procedures
2.11.6 Incident and non-conformance reporting

3 Checklist of Environmental Compliance Monitoring

Sl. No.	Item	Means of compliance monitoring	Compliance achieved (Yes/No)	Remarks (Reason, mitigation)
1	EIA report prepared and submitted for environmental clearance certificate?	Enquiry with MPA		
2	Validity of environmental clearance	Through Checking ECC		
3	Protected area in the intervention area?	Checking map of environmental hot spot		
4	Impact on mangrove vegetation?	Checking map		
5	First Aid Kit for working team	Through Physical Inspection		
6	Use of PPE (Personal Protective Equipment)	Through Physical Inspection		
7	Water Quality Monitoring	Sampling as per Table 9.3		
8	Benthic Monitoring	Sampling as per Table 9.3		
9	Hydrographic Survey Monitoring	Through site visit		
10	Noise	Sampling as per Table 9.3		
11	Exhaust emissions	Sampling as per Table 9.3		
12	Oil spills	Sampling as per Table 9.3		
13	Air quality	Sampling as per Table 9.3		
14	Soil Sample at Source	Sampling as per Table 9.3		
15	Channel Bed Sediment (CBS)	Sampling as per Table 9.3		
16	Worker's Health and Safety	Through Physical Inspection		
17	Run off quality at disposal site	Sampling as per Table 9.3		

Sample Monitoring Form:

1. **Pre-Dredging phase**
   - Recruitment of appropriate manpower;
   - Preparation of dredging and dredge material disposal plan
2. **Dredging Phase**

Air Quality
Date:

Location	parameter	Value (24 hour average)	DOE Standard	Comments

Water Quality
Date:

Sl. No.	parameter	Unit	DOE Standard	Comments

Sediment Quality
Date:

Sl. No.	parameter	Unit	Standard	Comments

Benthos Organism
Date:

Sl. No.	Species	Unit (no/m^3)	Location-1	Location-2
1				
2				
No. of Species				
Total				

3. **Post Dredging Phase**

Air Quality
Date:

Location	parameter	Value (24 hour average)	DOE Standard	Comments

Water Quality
Date:

Sl. No.	parameter	Unit	DOE Standard	Comments

Sediment Quality
Date:

Sl. No.	parameter	Unit	Standard	Comments

Benthos/Plankton
Date:

Sl. No.	Species	Unit (no/m^3)	Location-1	Location-2
1				
2				
No. of Species				
Total				

Appendices

Appendix A: Map showing dredging location and disposal sites
Appendix B: Map showing pre-dredging hydrographic chart
Appendix C: Map showing post dredging hydrographic chart

Annex C: Comments and Responses on the Final EIA

Comments and Response Matrix

High officials of the Department of Environment, including the Director General, DOE and Director (Environment Clearance), gave valuable comments/suggestions at presentation on "Environmental Impact Assessment (EIA) of the Proposed Dredging Project at the Outer Bar area of Pussur Channel" held on 22 February 2018. The comments and respective responses are included in this Report and referred in the following table.

Table C.1: Comments and Response Matrix

Sl No.	Comments	Response
1	Show the map of the World Heritage Site of the Sundarbans and the dredged materials disposal location.	Figure 8.1, Page 74.
2	What is the impact of the dredging works on the benthic materials?	Section 7.5, Page 69-70.
3	What is the erosion–accretion trend at the disposal location near Dublar Char?	Section 6.4, Page 59-60.
4	There should be an independent third party monitoring of the environmental issues.	Section 9.4, Page 86. Section 9.6, Page 94.
5	Format of the monitoring report is to be added to the EIA report.	Section 9.4.1, Page 91-92. Annex B, Page-B1-B3
6	A Contingency Plan including disaster management plan is to be incorporated in the EIA report.	Section 9.5, Page 92-94.
7	The Approved TOR for the EIA study is to be incorporated to the EIA Report as an Annex.	Annex A, Page A1-10.
8	The impact on the World Heritage area of the Sundarbans should be elaborated more.	Section 8.2, Page 71-73.