Annexure 6-2: Dolphin Conservation Plan

1.1 Gangatic Dolphin & Turtle Conservation Management Plan during Construction and Operation Period

The WB Policy (OP 4.04) describes the conservation of natural habitats, like other measures that protect and enhance the environment, to be essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank also supports, and expects borrowers to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank- promotes and supports natural habitat conservation andimproved land use by financing projects designed to integrate into national and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats.

Gangatic dolphins (Platanista gangeticagangetica) categorized as an endangered species by IUCN (International Union for Conservation of Nature). It is included in the Schedule 1 of the Indian Wildlife (Protection) Act1972. The species was declared as National Aquatic Animal of India by Honble Prime Minister, Dr. Man Mohan Singh on 5th October, 2009; a formal notification was issued on 10thMay, 2010. The stretch of the Brahmaputra River where the proposed project is to be implemented has been a good habitat for the Gangatic River dolphin. In order to understand the impact of the project on the dolphin and its habitat in and around project area, a study is proposed to be undertaken.

As per the secondary data and authentic reports as listed below, in Brahmaputra River, altogether 197 dolphins (27 calves, 32 sub-adults and 138 adults) were recorded from 82 locations of the river with an encounter rate of one dolphin per 4.2 km. the references are as below;

1. Conservation of Gangatic dolphin in Brahmaputra river system, India, Dr. Abdul Wakid, 2004
2. Report on the initiatives to involve the major stakeholders of Assam in the conservation of Gangatic dolphin, Dr. Abdul Wakid, 2009
3. Protection of endangered Ganges river dolphin in Brahmaputra river, Assam, India
4. Final technical report to sir peter Scott fund, IUCN, Dr. Abdul Wakid, 2009

Dr. Abdul Wakid, a Project Scientist at the Wildlife Institute of India and Head (honorary) of the Gangetic Dolphin Research and Conservation Division (GDRCD) of Aaranyak, an Assam based leading environmental NGO, has 17 years of experience in the scientific study and conservation activities of the Ganges River Dolphins in Assam State. He conducted a series of dolphin surveys in the Brahmaputra river system, starting from 2005. In the last census conducted in 2012, Dr. Wakid and his team estimated dolphin population in Brahmaputra river system as follows.

Brahmaputra river system (including 2 tributaries): 635 dolphins
Brahmaputra River (not including tributaries): 583 dolphins
Brahmaputra River between the Golpara Bridge and Bangradesh border: 92-96 dolphins

During the 2012 survey, Dr. Wakid recorded the highest density of the dolphin population in the section between the Goalpara Bridge and the Bangladesh border, including the river

stretches within the proposed bridge construction site of the Dhubri District. Highest density of dolphin population was recorded in the dolphin survey conducted in 2005. The breeding season for the Gangetic dolphins of Brahmaputra River is recorded as February to June. Dolphins are found in and around Dhubri area throughout the year but aggregate in the deep section of the river in the winter and more spread to the side channels during the summer. The population has had an upward trend since 2008 because of the lot of community engagement and awareness activities conducted since 2008.

In our Study area total 25 Dolphins are recorded. Population status and distribution pattern of dolphins near our Project Ghats in Brahmaputra River as per the reports are as below;

Table 1: Dolphins Status Around Project Sites

Sr.no of Dolphin Sighted area	Name of Ghats	Dolphin Occurrence	Name of dolphin sighted area	Location of sighted area	Dolphin No			
					Calf	Sub-adult	Adult	Total
1.	Guwahati	Yes	Guwahati	N26011/239//; E 91044/365	-	-	1	1
				N26010/981//; E 91044/175//	-	1	2	3
				N26010/610//; E 91042/587//	-	1	2	3
				N26010/699//; E 91041/066/	-	-	3	3
2.	Umananda	No	-	-	-	-	-	-
3.	Kacheri	No	-	-	-	-	-	-
4.	Lachit	No	-	-	-	-	-	
5.	Sonaram	No	-	-	-	-	-	-
6.	Rajaduar	No	-	-	-	-	-	-
7.	*Nagarbera*	No	-	-	-	-	-	-
8.	Alopatty Majorchar	No	-	-	-	-	-	
9.	Pijupara	No	-	-	-	-	-	-
10.	Jaleshwar	No		-	-	-	-	-
11.	Dhubri	Yes	**Dhubri**	N26001/149//; E 89059/756	-	-	1	1
			Dhubri	N26001/149//; E 89059/756	-	1	4	5
			Birsing Char	N26000/503//; E 89058/797	-	-	1	1
			(Birsing Char-Dhubri 2.75km)					
12.	Fakirganj	Yes	Fakirganj	N26002/508//; E 90002/877//	-	-	2	2
13.	Medartary Salmara	Yes	Medartary Salmara	N26054/036//; E 94016/985//	-	-	2	2
		Yes	**Patakata**	N26005/124//; E 90011/608	-	-	1	1
			(Patakata- Medartary Salmara **6.21km)**					
14.	Dudhpatil	No	-	-	-	-	-	-
15.	Kamalabari	No	-	-	-	-	-	
16.	Aphalamukh	No	-	-	-	-	-	
17.	Neamati	Yes	Neamati	N26051/841//; E 94014/656//	-	1	2	3
18.	Annapurna	No	-	-	-	-	-	-

Sr.no of Dolphin Sighted area	Name of Ghats	Dolphin Occurrence	Name of dolphin sighted area	Location of sighted area	Dolphin No			
					Calf	Sub-adult	Adult	Total
19.	Beranga	No	-	-	-	-	-	-
20.	Gandhi ghat	No	-	-	-	-	-	-
21	Silchar	No	-	-	-	-	-	-
	Total					**5**	**21**	**25**

Table 2: Turtle Locations as per Secondary Data[1]

Sr.No	Name of the ghat	District	Coordinates	Elevation a.s.l.in m
1.	Dibrugarh	Dibrugarh Dist. / Assam	27° 48´ N, 94° 09´E	94
2.	Jorhat	Jorhat Dist. / Assam	26°75´N, 94°22´E	116
3.	Majuli		26 56.994 94 15.676	68
4.	North Guwahati	Kamrup Dist. /Assam	26°11'N, 91° 44'E	55

Figure Error! No text of specified style in document.**1:Figure showing the critical dolphin locations at Dhubri Medartary ferry terminals**

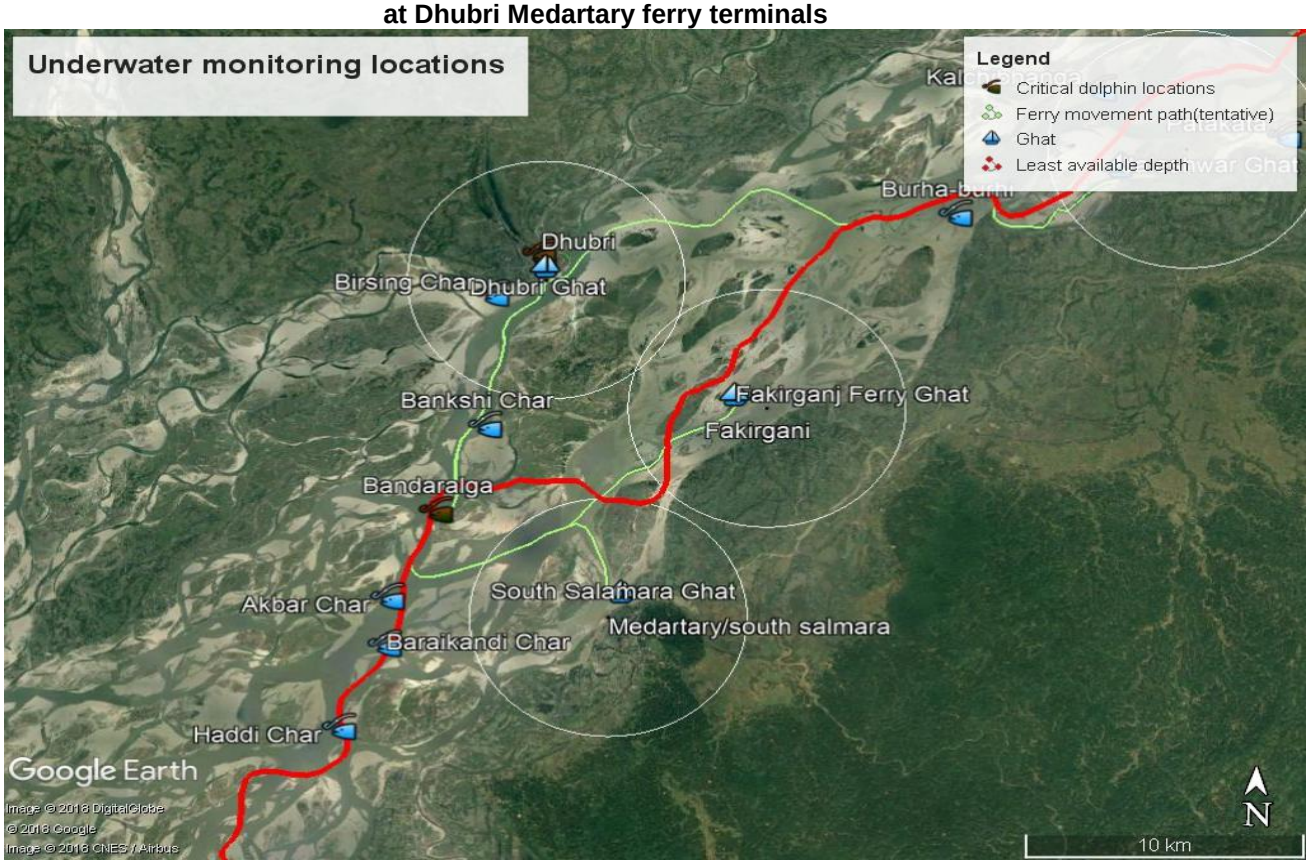


Figure 2: Figure showing the critical dolphin locations at Sonaram Rajadaur ferry terminals

[1] file:///C:/Users/Sif-1841/Downloads/12_chapter%204%20part%201%20(3).pdf

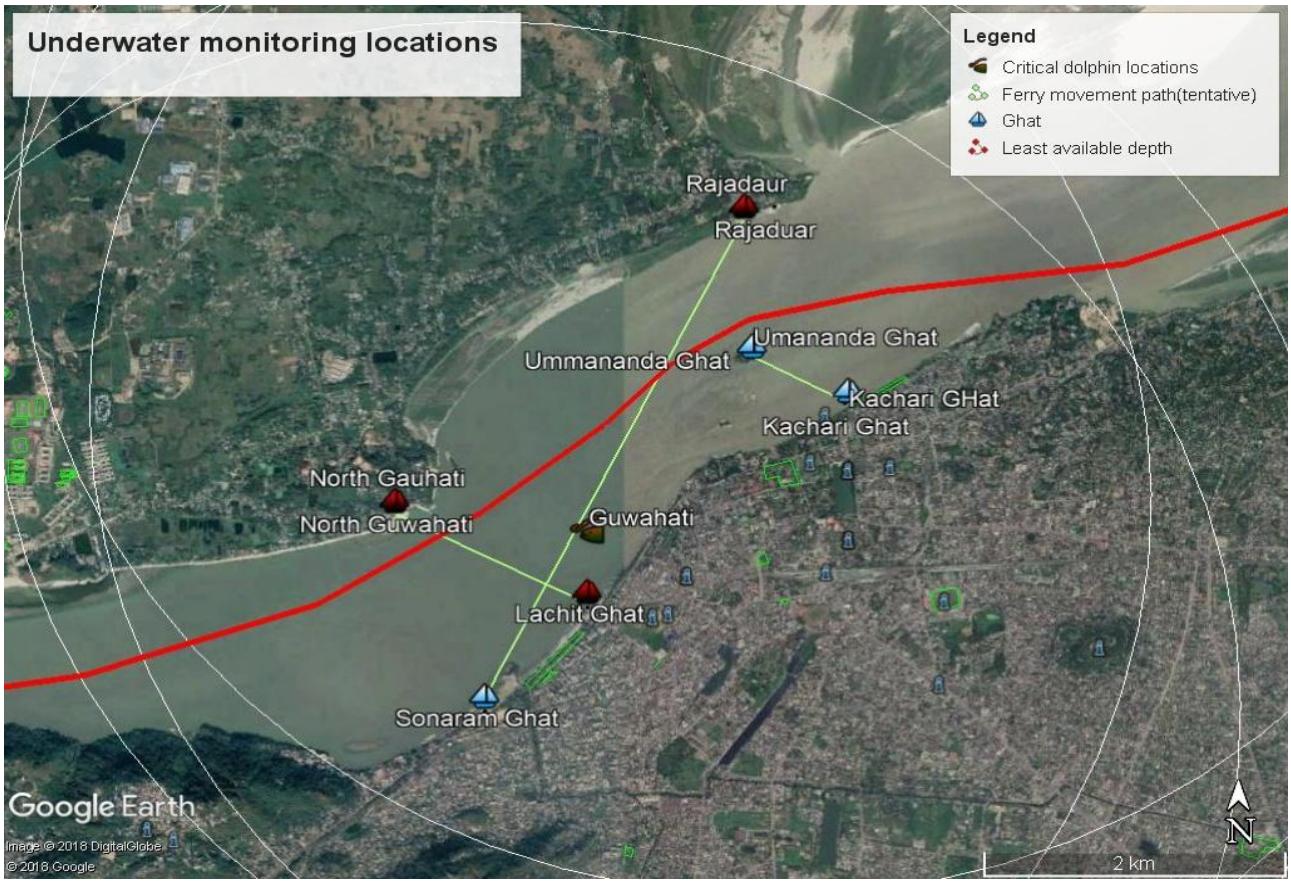

Underwater monitoring locations
Legend
Critical dolphin locations
Ferry movement path(tentative)
Ghat
Least available depth
Rajadaur
Rajaduar
Umananda Ghat
Ummananda Ghat
Kachari GHat
Kachari Ghat
North Gauhati
North Guwahati
Guwahati
Lachit Ghat
Sonaram Ghat
Google Earth
Image © 2018 DigitalGlobe
© 2018 Google
2 km
N

Figure3:Figure showing the critical dolphin locations at Kamalabari Neamati ferry terminals

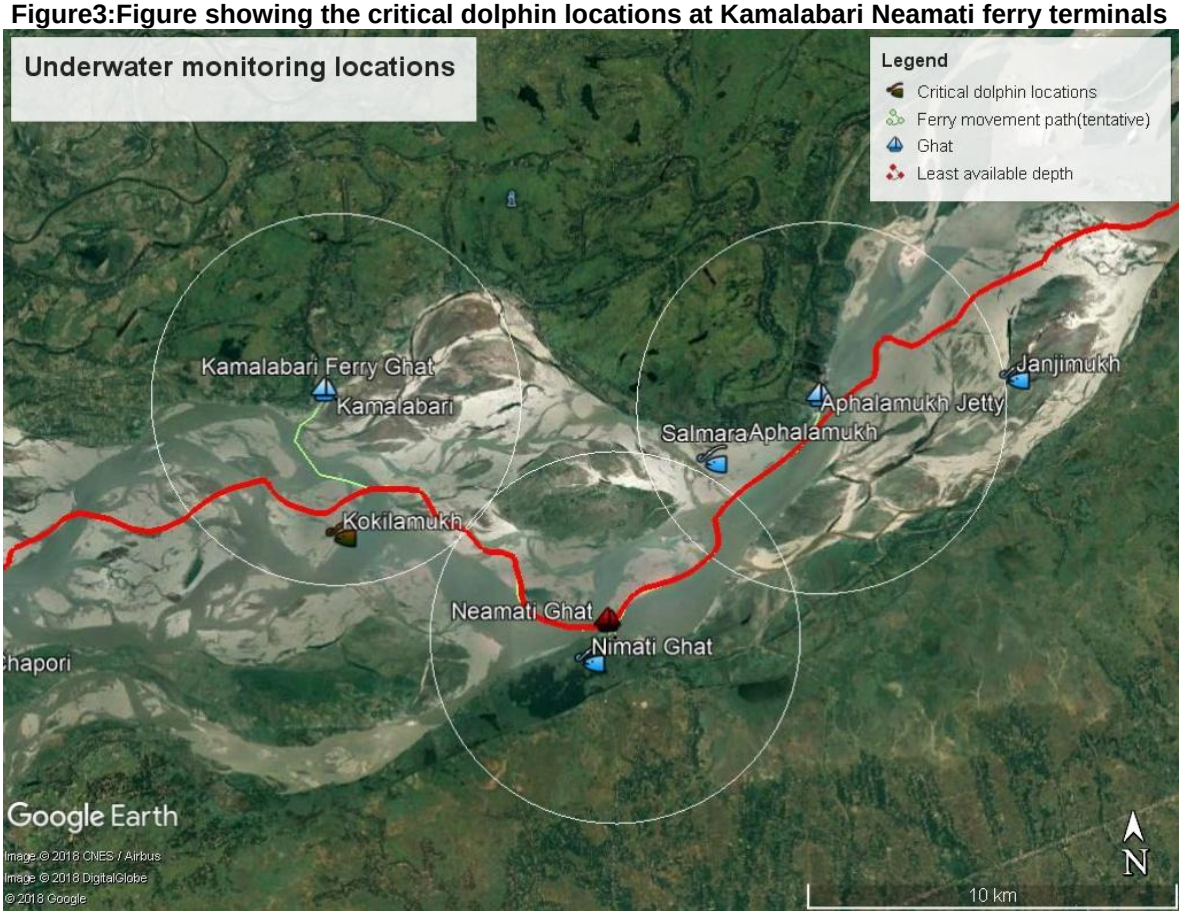
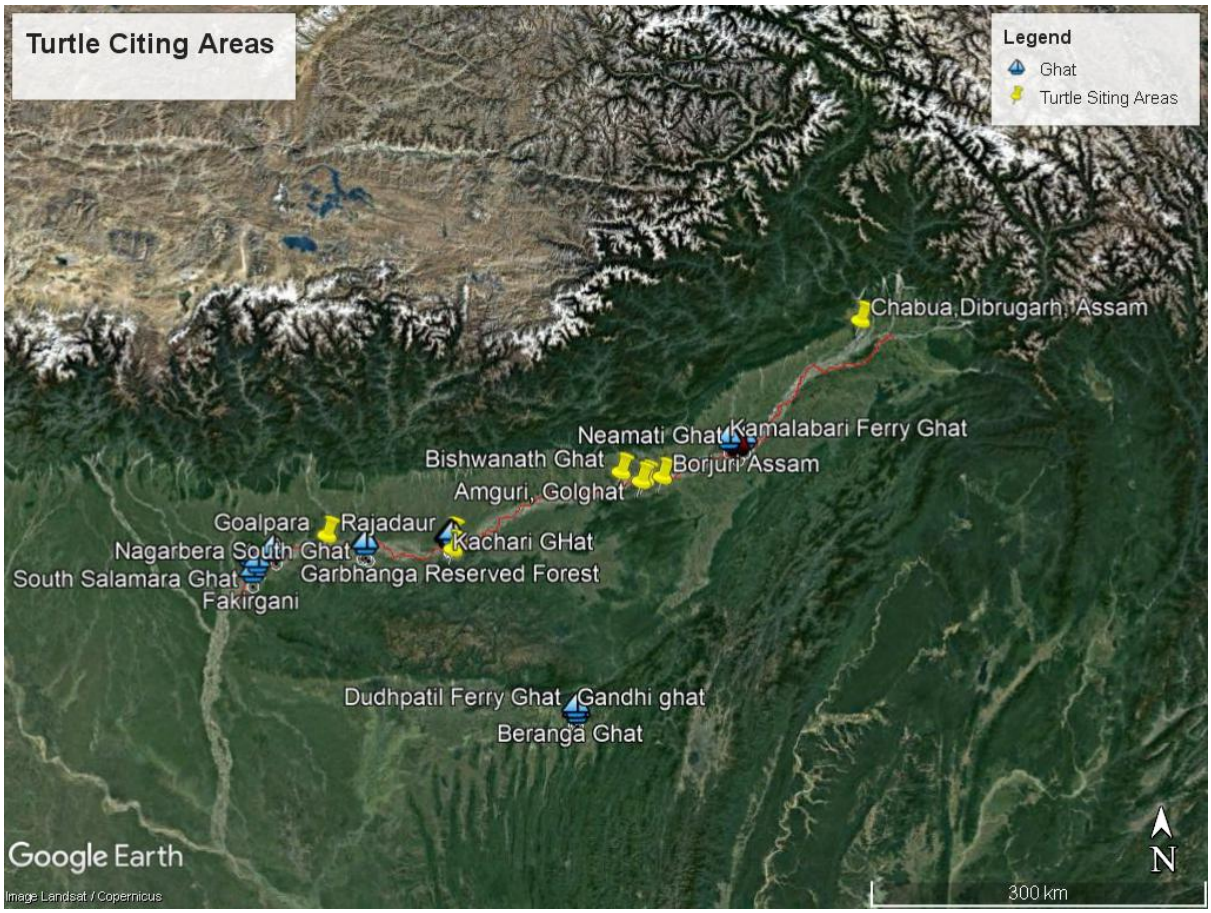


Figure4:Figure showing the critical Turtle Locations near ferry terminals


Turtle Citing Areas
Legend
Ghat
Turtle Siting Areas
Chabua,Dibrugarh, Assam
Neamati Ghat
Kamalabari Ferry Ghat
Bishwanath Ghat
Borjuri Assam
Amguri, Golghat
Goalpara
Rajadaur
Kachari GHat
Nagarbera South Ghat
Garbhanga Reserved Forest
South Salamara Ghat
Fakirgani
Dudhpatil Ferry Ghat
Gandhi ghat
Beranga Ghat
Google Earth
Image Landsat / Copernicus
N
300 km

1.1.1 Impact Assessment of Project activities on Gangatic Dolphin and Turtle Conservation

It was reported that accidental killing of dolphins through getting trapped or entangled in fishing nets were higher than the past. Other threats for dolphins in the rivers included oil spill from boats and ships, river erosion, low water depth during winter, use of harmful fishing gears (especially current net) and making cross dam of bamboos across rivers for fishing. As reported by local people, the practice of intentionally trapping and/or killing of dolphins in the rivers for commercial reasons is gradually gaining momentum for oil extraction. Remains of the dolphin body, particularly the head, are used in the brush pile fishery – certain sections of the river close to the banks is fenced using bamboos and piles of tree branches are used to provide a temporary refuge for the fish during the dry season when water level gets low. During dry season the fenced area is netted and fishes are caught. By putting the remains of the dolphin body and head together with the tree branches fishes are attracted by the smell as they decompose

1.1.2 Gangatic Dolphin and Turtle Conservation (Impact Mitigations)

Further in waterways project mostly the impacts on aquatic fauna area associated with vessels movement and related activities. As only terminal construction and operation activities are included in the EIA scope, hence the impact of construction and operation activities on Dolphin is negligible. Impact due to increased sedimentation due to Off-shore construction activities and their mitigation shall be included in EIA report. Though Dolphins will be impacted due to the movement of vessels operation only and for conservation of dolphin (if any) detailed strategic plan is prepared, which should be implemented by terminal authority.

Water abstraction upstream decrease river depth and the appearance of sand bars during winter season cause danger to the dolphins as the river is divided into small segments, causing a segregation of populations in deeper pools, narrowing of the gene pool, increase in the intensity of fishing, increase in river traffic, pollution due to release of untreated effluents from industries, incidental and/or intentional capturing for oil extraction for use as fish attractant, liniment and aphrodisiac, etc., have become the major threats for its survival.

The freshwater dolphins being an iconic species for the river ecosystem serve as a link between people and freshwater and a symbol of a healthy ecosystem. The positive side for the conservation by the presence and increase in the population of dolphins will mean that rivers are clean enough to draw water supplies, there is more and diverse assemblage of fish to support people and dolphins, effluents will need to be adequately treated before release, enough water in the rivers to reduce saltwater intrusion, restoration of floodplains, etc

Accidental killing of dolphin in the form of by-catch in net fishing is a major threat for dolphins in the rivers of the project area. It was reported that accidental killing of dolphins through getting trapped or entangled in fishing nets were higher than the past. Other threats for dolphins in the rivers included oil spill from boats and ships, river erosion, low water depth during winter, use of harmful fishing gears (especially current net) and making cross dam of bamboos across rivers for fishing. As reported by local people, the practice of intentionally trapping and/or killing of dolphins in the rivers for commercial reasons are gradually gaining momentum for oil extraction. Remains of the dolphin body, particularly the head, are used in the brush pile fishery – certain sections of the river close to the banks is fenced using bamboos and piles of tree branches are used to provide a temporary refuge for the fish during the dry season

when water level gets low. During dry season the fenced area is netted and fishes are caught. By putting the remains of the dolphin body and head together with the tree branches fishes are attracted by the smell as they decompose.

Measures during Construction Phase:

- Relevant information (e.g. encounter with vulnerable species during engineering work) shall be shared with the State Environment and Forest Department and concerned regional environmental experts.
- Anti-poaching measures during the construction phase should be strengthened to check for any violation of existing regulations. Awareness campaign to be made among the workers to aware them on the endangered and other important species.
- Construction vehicles must be operated at safe speed to avoid collision with wildlife. Training should be provided for the vehicle operators and warning signs should be installed.
- Change of geology and topography should be kept minimum.
- Avoid constructing labour camps and construction yards near the river banks.
- To minimize impacts, noisy operations should be avoided during breeding season of the dolphins (February-July).
- River flow should not be blocked at all times for free movement of dolphins.
- Measures such as the creation and monitoring of an exclusion zone of a 500m radius for at least 30 minutes before the start of construction activities shall be followed. If dolphins are observed in the exclusion zone, construction works should be delayed until they have left the area. If dolphins enter the exclusion zone after construction has commenced, construction works should cease until they have left
- All activities that increase soil erosion or contribute to nutrients and pollutants to water need be minimized both onsite and off-site by using measures such as silt curtain.
- Construction activities should be carried out in close supervision of the dolphin ecologist.
- Construction works should be avoided or kept minimum in vicinity of the dolphins' favourable microhabitats (downstream of shallow areas/sandbars, tributary junctions)
- Dolphins are likely to prefer water depth range between 4.1 to 6 m. Therefore, movement of sediment and influx of soil/silt etc. should be avoided to keep the favourable depth range.
- In case rare birds of prey are observed near the construction area, the construction work will be avoided during their breeding season.
- Before construction of piers the construction site must be checked for the presence of threatened turtles, migratory birds, and other threatened species and their nests. If the turtles and/or their nest are found inside or near the construction area the animals and/or the eggs must be physically moved to safer habitat areas under the guidance of the local wildlife experts.
- All boats or ferries transporting construction material and workers will have propeller guards installed to prevent injury and death of dolphins, turtles and other aquatic fauna.
- One of the threats to bird and turtle habitat is conversion of the river edges from natural soft embankments into hard concrete embankments. Therefore the natural bank slope is preserved and location of the bridge piers will avoid such areas. No construction camp, borrow areas or disposal sites will be established within 100m of the shorelines at the highest water level period.
- All avoidance, mitigation and enhancement measures and monitoring plans proposed to address impacts on flora, fauna and the threatened species should be updated during the detailed design stage by conducting detailed studies such as identification

of the migrating routes of dolphins and birds, exact locations of turtle nesting grounds, etc.

Measures During Operation Phase:

- For conservation of dolphin instruction should be given to all vessels operators and all employee and staff that no dolphin or any other endangered species should be harmed due to any reason.
- Instruction should be given to vessel operator that in case any accident with dolphin occurs that should be reported immediately to terminal authority.
- Vessel should be instructed for not using sharp lights and sounds as they may disturb aquatic organisms.
- Provision for propeller guards should be provided for all the vessels to minimize the propeller inflicted injuries and scars.
- Regulation of vessel speed in Dolphin habited area
- Select the dredgers and dredging methods to minimize sediment dispersion during excavation and lifting process;
- Spoil dispersion out fall characteristics to be evaluated by collecting grab water samples during dredging operations and operations modified accordingly;
- Sub-surface aquatic disposal is required, minimum one metre below the water surface;
- Careful mapping of sensitive areas directly affected by the dredge;
- The exclusion criteria for dredging are;
  - Dredge 100m away from the chars, reed lands, mudflats
  - Contractors will avoid sensitive habitats like scours, mudflats for dredge material disposal.
  - The exclusion criteria for disposal of dredged material are:
    - Along the chars
    - River confluences
    - Low current areas
    - Shallow areas
    - Deeper sections of the rivers during dry season
- Preventative maintenance of equipment to mitigate negative environmental impacts such as leakages and spillages
- The mess size of the iron wire to be used to fix the boulders below the steps at Ghats close to the water line or river edge should be four inches instead of eight inches.
- No indigenous grasses should be planted in the landscape terraces between two
- Ghats as in the spaces natural amphibious/aquatic grasses of riparian zone of the river grow
- There should be minimum or no noise under the water during implementation of the project.
- If any mechanized boat is used during implementation of the project, the same may be propeller guard.

1.2 Gangatic Dolphin and Underwater Noise Impacts Management Plan during Construction and Operation Period

1.2.1 Underwater Noise Monitoring:

Underwater noise monitoring shall be carried out by using hydrophones at the critical locations where the dolphins have been spotted. A hydrophone is used to identify underwater noise levels by using piezoelectric transducer that generated electricity when subjected to pressure changes in a denser medium than air such as water. This shall aid in understanding the baseline noise levels at the critical locations to carry out noise modelling

in the future scenario. The major sources of underwater noise shall include the existing vessels during construction phase along with construction equipment such as dredger and motorized pumps. During the construction phase the underwater noise contributors shall include new vessels and dredgers used to maintain the least available depth.

The underwater noise monitoring locations are identified taking into account the study carried out for dolphin citing locations[2], the least available depth as per IWAI 1985, and the locations identified for Ghat terminal construction. The critical locations are shown in the images below in **Figure 1, 2 and 3**.

The underwater noise monitoring locations are considered based on the proximity (in the range of 600mts) of the dolphin locations to the least available depth and probable ferry movement paths. The noise monitoring shall be carried out by vessel based survey to identify the noise levels produced by various sources such as a ferries, dredgers and aquatic fauna. As this survey is to be used as a baseline data, the sound pressure levels shall be monitored for both day and night to identify the highest cumulative levels for worst case scenario conditions.

1.2.2 Impact Due to High Noise Generation During Movement on Aquatic Organisms

Vessels / dredgers generate substantial broadband underwater noise from their propellers, motors, auxiliary machinery, gear boxes and shafts, plus their hull wake and turbulence. Diesel motors produce more noise than steam or gas turbines, but most long distance (low frequency) noise is generated by the hissing cavitation of spinning propellers. Noise generation from the ship movement is continuous type of noise generation. Noise generation from ferry vessel movement vary from 110-140 d(B). This order of noise generation may have impact on behaviour of various aquatic organisms and may lead to other injuries like tissue injury, temporary & permanent hearing loss. However physical impact on aquatic species is not anticipated as the aquatic species moves away from the source of disturbance (barge) and usually do not come close. But impacts of this level of noise can be significant on behavioural responses and audiometry of aquatic species, turtles and dolphins in particular. These impacts are analysed and presented in the following sections:

1.2.3 Impacts on Behavioural Response of Aquatic Organisms and on Auditory System of Dolphins Due to Noise Generation from Moving Barges / ferry vessels

This assessment has been carried out considering the outputs of various studies vs noise and using mathematical techniques (underground noise modelling) to assess the expected noise from vessel movement in IWT. The studies references are presented first followed by noise modelling outputs followed by impact on auditory System of Dolphins.

Study by Southall et al. (2007)[3]and Environmental Impact Statement of South Embley Project: A review of various studies into behavioural disturbance in high frequency cetaceans from continuous man-made noise was carried out. As per review it was concluded that not all behavioural responses are equally significant. Behavioural changes may be relatively minor and/or brief, have the potential to affect important behaviours such as foraging, breeding and resting. Study concluded that the behavioural changes to levels below 120 dB re 1 µPa were relatively minor or brief in case of harbour porpoise. Significant and sustained avoidance behaviour was recorded when noise

[2] **Conservation Of Gangetic Dolphin InBrahmaputra River System, India**A. Wakid

[3] Southall et al. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33(4).

levels exceeded 140 dB re 1 µPa in case of harbour porpoise. *For turtles and Dolphin this level is 150 dB and 177 d(B) respectively.*

Study by Kelkar (2008)[4]into the habitat use and distribution of the Ganges River Dolphin in the VGDS. As per the study it was concluded that the number of motorised boats and boat noise were not significantly correlated with dolphin encounter rates. Small boats equipped with outboard engines can produce source levels in the order of 160 dB re 1 µPa at 1 m, with the received levels of over 120 dB re 1 µPa at 1 m up to 500 m. *Although the study results suggest that boat noise is not displacing dolphins*, it is not conclusively showing that such noise levels do not impact Dolphin behaviour.

Table 3: Vessel noise at different speeds

Vessel, speed	SL (0.2–40 kHz)	SL (2–12.5 kHz)
dB re 1 µPaRMS at 1 m	dB re 1 µPaRMS at 1m	
2-stroke, 2.5 knots	112 ± 1.0	108 ± 3.0
4-stroke, 2.5 knots	110 ± 2.6	106 ± 2.2
2-stroke, 5 knots	139 ± 1.0	132 ± 3.0
4-stroke, 5 knots	138 ± 2.6	134 ± 2.2
2-stroke, 10 knots	149 ± 0.6	146 ± 0.6
4-stroke, 10 knots	152 ± 0.3	144 ± 0.5

(Source: Acoustics in marine ecology' (Vessel noise effects on dolphin's communication -Vol. 395: 161–175, 2009doi: 0.3354/meps08204)

Vessels to be used for material transportation from the terminal can be considered under category of bulk carriers. Ship movement speed in / near the sanctuary areas is to be restricted to 5 km/h only.

Study by Plon, S, Koper, R.P., and Endangered Wildlife Trust: This study establishes the noise level generation from different vessel types. The noise level from different types of vessel is given in **Table 4**. But no relation between the noise generated with the speed of vessel is highlighted in this study.

Table 4: Noise Level from Different Type of Vessel

Sound sources	Types of sound	Pulse duration (sec)	Main Frequency (KHZ)	Source sound level d(B)
Cargo vessels	Continuous	n.a.	0.0-0.5	195
Small vessels	Continuous	n.a.	1.0-10.0	160-170

(Source: Plon, S, Koper, R.P., Endangered Wildlife Trust)

Under Ground Mathematical Noise Modelling: Noise are the mechanical waves and the energy content dissipates in surroundings with the distance of the waves movement. Noise level received by the receiver is not of same intensity as the noise intensity at the source. There is always a propagation loss associated with the noise transmission distance. Thus noise received can be written as follows:

RL = SL-PL
RL- Received noise level
SL- Source Sound Level
PL-Propagation Loss

PL can be estimated using simple equation

[4]Kelkar, N. (2008). Patterns of habitat use and distribution of Ganges river dolphins Platanista gangetica gangetica in a human dominated river scape in Bihar, India. Master Thesis, Manipal University, Centre for Wildlife Studies, Bangalore

PL = Nlog10 (R),
where
N is scaling factor
and R is distance of receptor from source.
N values differ for different environments.

Propagation loss is high in shallow waters due to strong interface with the surface of the river bed. N values for shallow waters vary from 15-20.For mathematical noise modelling purpose minimum noise levels considered are 130 d(B) due to barge movement and maximum noise levels are taken to be 160 d(B) (20 d(B) more than highest noise levels as per reference studies above to consider worst case scenario). Considering the noise level variation from 130-160 d(B) and N value variation from 15-20, noise level modelling carried out at different receptor distances of22.5 and 15 m from the centre line of the vessel. The results for noise level modelling are presented in **Table 5.**

Table 5: Noise Level Modelling Result

Source Sound Level (SL)-dB	**130**	**160**	**130**	**160**	**130**	**160**	**130**	**160**
Scaling Factor considered (N Value)	15	15	20	20	15	15	20	20
Distance of receptor (R)in meter	22.5	22.5	22.5	22.5	15	15	15	15
Propagation Loss (PL)	20.25	20.25	27	27	17.7	17.7	23.6	23.6
Received Noise Level in dB by receptor	109.75	139.75	103	133	112.3	142.3	106.4	136.4

Output of Underwater Noise Modelling: An estimation is carried out to assess distance ofachieving the safe threshold noise level of 150 d(B) for turtle and 177 d(B) Dolphin from behavioural consideration prospective as per EIA Study of “South of Embley Project” sited above. The same is given at **Table 6**for scaling factor of 15 and 20 N. It is concluded that noise level of 150 d(B) can be achieved at distance less than 4.6 m from centre of the ship for turtle. However, the maximum beam of ship which will ply in waterway is 11.4 m. *Thus possibility of occurrence of organism at 4.6 is comparatively less.*

Table6: Distance estimation for achieving 150 d(B) of noise from centre ofthe vessel

Description	**Scenario 1-considering N Value 15**		**Scenario 2-considering N vale 20**	
	For Turtles	**For Dolphins**	**For Turtles**	**For Dolphins**
Threshold Safe Noise Level -dB	150	177	150	177
Source Sound Level (SL)-dB	160	160	160	160
Safe Distance-R (m)	4.6	Noise level generated are less than the threshold safe level	3.16	Noise level generate dare less than the threshold safe level

1.2.4 Impact on Auditory System of Dolphins Due to Noise Generation from Moving Barges

When the dolphin’s auditory system is exposed to a high level of sound for a specific duration, the sensory hair cells begin to fatigue and do not immediately return to their normal shape (NRC 2005). This causes a reduction in the hearing sensitivity, or an

increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hair cells will eventually return to their normal shape. This effect is called a temporary threshold shift (TTS) as the hearing loss is temporary. If the noise exposure exceeds the critical sound energy level, the hair cells become permanently damaged and the effect is called permanent threshold shift (PTS). **Table 7**below summarises the noise exposure criteria adopted for assessing hearing damage (PTS or TTS) and behavioural effects on the Ganges River Dolphin from vessel noise. The noise exposure criteria are based on the review presented by Southall et al. (2007) and also adopted by NOAA (US National Oceanic and Atmospheric Administration) in 2011.

Table 7: Noise exposure criteria for physiological (PTS and TTS)

Impact	Noise exposure criteria
Permanent threshold shift	SEL 215 dB(M) re 1µPa2s
Temporary threshold shift	SEL 195 dB(M) re 1µPa2s

Source: NOAA & Bangladesh Regional Waterway Transport Project 1-ESIA Report, BIWTA

However, noise generation anticipated from vessel movement is between 110-140 d(B) which is below the noise exposure criteria to cause PTS/TTS in dolphins. Thus impact on auditory systems of dolphins is not anticipated due to noise generation from barge movement.

1.2.5 Impact Due to Masking of Biological Important Noise of Aquatic organism by Noise Generated from Moving Barges

Another impact of high noise level generated from moving barges is masking of biologically important sounds. These sounds may interfere with communication and social interaction and cause changes in behaviour as well. The zone of masking impact will be highly variable and depends on many factors including the distance between the listener and sources of the signal and masking noise, the level of the signal and masking noise, and the propagation of noise from the signal and masking source to the listener. It is however important to note that masking of communication and echolocation signals naturally occurs by the ambient noise environment. Man-made noise causes additional masking of a signal only when it is of a higher level than the ambient environment within the species critical hearing bandwidth at the signal's dominant frequencies. Echolocation clicks produced by the Ganges River Dolphin have dominant energy around 65 kHz (Sugimatsu et al., 2011)[5]. This is well above the dominant frequency range of most man-made noise, including pump noise. Masking of echolocation signals is therefore not a significant issue for most man-made sources (Richardson et al., 1995).

Thus it can be concluded that noise generation due to barge / ferry vessel movement is notanticipated to interfere with echolocation ability of Ganges Dolphins. The Brahmaputra River Dolphin is likely to produce communication signals, such as whistles, squeals orclicks, based on communication signals produced by other river dolphins. These signalsgenerally have energy at much lower frequencies than the echolocation clicks, i.e. as low as 1-6 kHz. **Communication signals are therefore more likely to be masked by man-made noise than echolocation clicks**. Noise reduction measures will help in minimizing the noise generation from barge movement and will minimize masking of communication signals generated by dolphins.

Measures for Avoidance and Mitigation of Noise Impacts on Aquatic Ecology

[5]Sugimatsu et al. (2011). Annual Behavioral Changes of the Ganges River Dolphins (Platanista gangetica) Based on the Three Long-Term Monitoring Seasons using 6-Hydrophone Array System. IEEE Symposium on and 2011 Workshop on Scientific Use ofSubmarine Cables and Related Technologies, (pp. 1-7). Tokyo

- Vessel speed should be restricted to 2.7 knots in VSDS. Hooting should also be prohibited in sanctuary areas.
- Vessel should be fitted with the dolphin reflectors
- Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel Provision of propeller guards with vessel to minimize injury to the aquatic fauna
- Barge/vessel movement will be restricted to the designate route only to minimize noise disturbance of Aquatic life.
- If any aquatic mammal spotted, then the measures should be taken to push it away through sirens/signals and creating noise signals.
- If any accident of aquatic mammal occurs, then that should be reported to AIWTDS for rescue action through wild life or forests departments.
- All vessels should follow MARPOL for managing their liquid and solid waste. No vessel should discharge the liquid and solid waste in the river. All waste should be discharged at vessel repair facility only. AIWTDS should develop the stringent norms to be followed by vessel operators and should develop the system of penalizing based on polluters pay principle in case the standards are not met or violated
- Material having potential to generate the dust like sand stone aggregates should be transported under covered conditions to minimize dust generation and its settlement on river surface.
- Provision of oil water interceptors with the bilge tank to separate oil prior discharge of bilge water into river. Bilge water should be discharged as per MARPOL requirements.
- The proposed oil spill control and management plan (Annexure 9-1 to 9-6) should be effectively communicated for any emergency situations.
- Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible
- Regular maintenance of vessels engine and Propellers.
- River training works should be carried out at the bank locations which are prone to erosion to minimize sedimentation & impact on water quality &aquatic organisms
- Adequate depth to be maintained to prevent grounding under low flow conditions. Information on available depths should be conveyed to the navigators through online systems by AIWTDS. River Information System being developed by AIWTDS willserve this purpose.
- Maintaining flood plains & riparian corridors wherever possible and limit potential damage to the navigation channel.
- Restricting the project activities in breeding and spawning ground of the fisheries which are majorly the bends in the meandering river.
- A possible solution to the impact caused by the project during the construction and operation phase of the project is to provide dolphin deterrent devices (ADD) on the terminals and vessels. A deterrent devise is a mechanical audio signal generating instrument which can generate ultrasonic signals to keep the dolphins away from the activity area. These devices could be helpful in other project activities as well like during maintenance dredging as they are portable in nature. An ADD is a device with a low intensity (source level: < 150 dB re 1 µPa at 1 m) and emits signal in the middle to high frequencies (2.5 – 10 kHz) with higher harmonic frequencies (up to 160 – 180 kHz).
- Design measures like bandalling and design of groin should be considered which can reduce the dredging requirement and help in meeting depth, width and steerage needs and reduces dredging requirement
- Modern design vessels having low draught say 2 m instead of 2.5 m for equal payload should be procured by IWAI for transportation. Modern vessel- better

technology vessels or with retrofits with quieting techniques to reduce further the noise generation (specifically cavitation's noise).

- Regular patrol and inspections should be carried out to monitor the activities in waterway. Also regular monitoring of environmental attributes as proposed in environment planning plan of this should be carried out for the waterway to keep track of the condition of the environmental attributes.
- The navigation channel should maintain a minimum distance of 100m horizontally and 500m either side along the river at the confluence point of majortributaries with river Brahmaputra.

Enhancement Measures:

Support for promoting fish productivity through setting up or supporting existing fish nurseries. Also providing training and awareness support through reputed institutes or experts like CIFRI for better fishing techniques. Provision of supporting Studies for conservation of Dolphin and other sensitive studies should be made

1.2.6 Assessment Underwater Noise Impacts and Management Framework

Table8: Underwater Noise Management Framework

Sources	Impacts	Mitigations
Construction Phase		
Dredging activities for maintaining least available depth	Communication masking could happen due to long time exposure at a particular location	Use of cutter suction dredger or bucket dredger for lesser noise generation. Bubble curtains should be provided to keep the aquatic fauna from accidents
Ghat renovation and construction	Construction of piers and other permanent structures ahead of the bank shall lead to underwater noise.	Provision of acoustic deterrent devices at critical locations.
Construction material transportation through river channel	Movement of additional vessels through the river during construction phase of the project shall add to the existing underwater noise	• Use of signages in critical locations so that the speed and underwater sound could be regulated • Construction works should be ceased when the dolphins are observed near the work area.
Intake wells for water pumping at the ghat locations	May lead to permanent or temporary hearing loss base on the proximity to the source	Use of low speed pumps or reduction in running speed so as to reduce the noise.
Operation Phase		
High speed vessel movement.	Movement of vessel at high speeds in areas where underwater ecology (cetacean and other fishes) is present	Use of signage in critical locations so that the speed and underwater sound could be regulated
Dredging activities for least available depth maintenance	Communication masking could happen due to long time exposure at a particular location	Use of cutter section dredger or bucket dredger for lesser noise generation. Bubble curtains should be provided to keep the aquatic fauna from accidents
		Use vibratory hammer. Under conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
		Monitor sound levels during pile driving to ensure that they do not exceed the NOAA (National Oceanic and Atmospheric Administration, USA) or any other

Sources	Impacts	Mitigations
		international recognized criteria.
		Implement measures to attenuate the sound when sound pressure levels exceed the NOAA or any other international recognized criteria. Methods to reduce the sound pressure levels include but are not limited to: • Installation of underwater enclosures to minimize sound • Surrounding the pile with an air bubble curtain system or air-filled coffer dam. Using a smaller hammer to reduce the sound pressure. The sound produced in pile driving has a direct relationship to the force used to drive the pile. A smaller hammer will have less force on the pile therefore producing less sound.
	High Underwater Noise Impact on Dolphins	A possible solution to the impact caused by the project during the construction and operation phase of the project is to provide dolphin deterrent devices (ADD) on the terminals and vessels. A deterrent devise is a mechanical audio signal generating instrument which can generate ultrasonic signals to keep the dolphins away from the activity area. These devices could be helpful in other project activities as well like during maintenance dredging as they are portable in nature. An ADD is a device with a low intensity (source level: < 150 dB re 1 µPa at 1 m) and emits signal in the middle to high frequencies (2.5 – 10 kHz) with higher harmonic frequencies (up to 160 – 180 kHz).

Ecosystem/ Biodiversity – related Factors	Predicted Impacts		Mitigation Measures
	During Dredging	Post-Dredging	
Aquatic Habitat alteration: Water quality, benthic environment, transportation of dredged materials	Increase in turbidity, suspended materials, transparency hindering sunlight penetration and affecting phytoplanktons	Localized effect, recovery in a short time	Select the dredgers and dredging methods to minimize sediment dispersion during excavation and lifting process; Spoil dispersion outfall characteristics to be evaluated by collecting grab water samples during dredging operations and operations modified accordingly; Sub-surface aquatic disposal is required, minimum one metre below the water surface; Careful mapping of sensitive areas directly affected by the dredge; The exclusion criteria for dredging are; Dredge 100m away from the chars, reed lands, mudflats Contractors will avoid sensitive habitats like scours, mudflats for dredge material disposal. The exclusion criteria for disposal of dredged material are: Along the chars River confluences Low current areas Shallow areas Deeper sections of the rivers during dry season Preventative maintenance of equipment to mitigate negative environmental impacts such as leakages and spillages.
Benthic fauna	Changes in species composition Fluctuation in population Habitat alteration due to increase in depth	Changes in species composition Changes in vertical depths May impact livelihood of some people	
Aquatic Species Affected (Dolphins, turtles, etc.)	Noise and disturbance-changes in movement routes and pattern	May recover over time	
Terrestrial Habitats: Chars, Mudflats, Reeds & Grasslands	Sediment deposition	Sediments may render mudflats unsuitable for migratory birds	
Terrestrial Species	Localized disturbances due to presence of labourers, other activities	Recovery over time	
Habitat degradation of benthic invertebrates and some fishes	The nursery and rearing ground of diverse benthic invertebrates and fishes may be damaged due to the operational activities i.e., cutter head circulation, flat open	Turbidity increases, as a result some fishes, bivalves and gastropods loss their natural habitat due to the excess alteration of optimum water quality.	To avoid this scenario, the suction pump/ cutter head of the dredgers may be controlled through pressure diminishing. Pre and post dredging sampling of mud of the dredging points can be sampled and analysed.

Ecosystem/ Biodiversity – related Factors	Predicted Impacts		Mitigation Measures
	During Dredging	Post-Dredging	
	scraper movement, etc.		
Habitat and feeding ground destruction of shellfishes	During this whole process the bottom dwelling crabs and other benthic community are compelled to shift their scavenging route and eventually affect their feeding and subsequent breeding.	The dredging may leave them scattered and misplace the populations to some extent. After the extraction of sand and mud, some artificial depressions may be created to inhabit some new organisms	Mitigation is not relevant to impact on shellfish
Disruption in feeding and breeding migration	Agitating water throughout the dredging period may confuse the fish school and interrupt their migration	The new environment in the topography of water after dredging may misdirect the fish migration which will result in the unwanted dispersal of fish/fishes out of its/their natural navigation area.	A 20% leverage on the water quality standards for pH, turbidity, DO, TSS, etc., as mentioned in the ECR 1997 to be maintained
Physiological deformities in fishes	Elevated temperatures during dredging increase the metabolism, respiration and oxygen demand of fish and other aquatic life, approximately doubling the respiration for a 10° C.	The physiological changes may lead to long term deformities in fish body which ultimately can somehow affect their copulation, swimming and associated movements.	No temperature changes are expected during dredging process.
Lifting of sediments after excavation	Due to turbidity aquatic fauna have to face several challenges (like, scarcity of food, hampering of respiration & breeding, etc.) to survive. Photosynthesis process of aquatic flora will be reduced adversely.		-Suitability of lifting on the proposed spots has to be evaluated carefully.
Transportation of sediment materials through pipes	• Pathway may be polluted and dirty due to leakage during carrying of sediments. • Great disturbance may be occurred to the terrestrial fauna. • Flora of influenced areas may be damaged.		-Carrying equipment should be well designed. -Have to make appropriate plan for transportation of sediments. -Priority should be given to the safety of wildlife during transportation.
Disposal of sediments in the river and on land	-Habitat of terrestrial flora and fauna may be occupied in a broad scale. -Natural activities of fauna (both terrestrial & aquatic) like, movement, feeding, breeding etc. may face several adverse effects. -Existence of endangered species of the affected area may be threatened.		Disposal of sediments should be well planned. -Activities should be performed through maintaining the natural environment of wildlife. -Proposed sites have to justify for the protection & safety of wildlife.

Ecosystem/ Biodiversity – related Factors	Predicted Impacts		Mitigation Measures
	During Dredging	Post-Dredging	
Depth of dredged materials at Disposal Sites	Some benthic organisms such as burrowing polychaetes, amphipods and molluscs can colonize newly deposited sediments through vertical migration, therefore, if dredged material depths are limited to within the vertical migration capacity of these organisms (20-30 cm), recovery rates may bequicker than if colonization is dependent upon the lateral migration of juveniles and adults from adjacent areas and larval settlement.		Management options for the permitting process can include, but are not limited to: 1) Full or partial approval of the dredged material proposed for disposal; 2) Prohibition of sediments proposed for disposal; or, 3) Special management restrictions for disposal of the suitable material(e.g., limits on disposal quantities, specification of frequency, timing, equipment, etc.). Management actions for the disposal site following unfavourable monitoring results may include, but are not limited to: additional confirmatory monitoring to delineate the extent of the problem, capping to isolate the sediments from potential biological receptors, and/or closure of the site.
Habitat Type (disturbance history)	Shallow benthic habitats (<20 m depth, Hall 1994) experience relatively frequent wave, wind, and current induced disturbances and thus are typically inhabited by low-diversity, selected benthic assemblages that can readily re-establish themselves under conditions of high frequency disturbances (Dauer1984, Clarke and Miller-Way 1992, Ray and Clarke 1999). These communities are naturally held in early succession stages and therefore, are able to recover more rapidly than communities in deeper, more stable environments (Newell*et al*. 1998, Bolam and Rees 2003).		
Sediment Type	Rapid recolonization of soft-bottom benthic habitats is frequently associated with either unconsolidated fine grain sediments (Cruz-Motta and Collins2004) or the rapid dispersion of fine-grained dredged material by currents(Van Dolah *et al*. 1984). Newell *et al*. (1998) characterized typical recovery times at 6-8 months for mud habitats and 2-3 years for sand and gravel substrata.		
Spatial Scale of Disturbance	The spatial scale of the dredged or disposal area may be proportional to recovery times (Zajac *et al*. 1998, Guerra-Garcia et al. 2003). For small-scale disturbances, the edge/surface area ratio of the disturbed area is larger than for larger disturbances, therefore colonization through adult immigration from surrounding undisturbed areas may facilitate recovery. With larger disturbed areas, the central portion of the disturbed areas is reliant upon settlement from the water column for colonization, which is very dependent on seasonal recruitment patterns and local hydrodynamics.		
Timing and Frequency of Disturbance	Avoiding dredging activities after seasonal larval recruitment periods is a common practice when possible. Deposition of sediments in several smaller units rather than one deep deposit also may be less detrimental to the benthos. In a microcosm study, sediment deposited in a single event caused more severe changes to nematode assemblages than the same amount of sediment deposited in smaller doses (Schratzberger *et al*. 2000).		