Initial Environmental Examination

Project Number: 38412-033
May 2018

India: Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program – Project 2

(Palasbari Subproject – Palasbari and Gumi Reach, Kamrup District)

Prepared by the Flood and River Erosion Management Agency of Assam for the Asian Development Bank.

CURRENCY EQUIVALENTS

(As of 1 March 2018)
Currency Unit – Rupee (₹)
₹1.00 = $0.01532
$1.00 = ₹65.27

ABBREVIATIONS

ADB	-	Asian Development Bank
DMO	-	disaster management organization
EARF	-	environmental assessment and review framework
EIA	-	environmental impact assessment
EIRR	-	economic internal rate of return
EMoP	-	environmental monitoring plan
EMP	-	environmental management plan
FREMAA	-	Flood and River Erosion Management Agency of Assam
FRERM	-	flood and riverbank erosion risk management
IUCN	-	International Union for Conservation of Nature
IWAI	-	Inland Water Transport Authority
MFF	-	Multitranche financing facility
MOEF&CC	-	Ministry of Environment Forest and Climate Change
NGO	-	nongovernment organization
PMU	-	project management unit
PPTA	-	project preparatory technical assistance
SEIA	-	summary environmental impact assessment
SIO	-	subproject implementation office
SPCB	-	State Pollution Control Board
WRD	-	Water Resources Department

WEIGHTS AND MEASURES

dB	-	decibel
ha	-	hectare
km^2	-	square kilometer
km	-	kilometer
m	-	meter
mm	-	millimeter
m^3/s	-	cubic meter per second
l	-	liter

GLOSSARY

porcupine	Tetrahedron-shaped concrete frames commonly made of six concrete members, each 3 meters long connected with bolts, which are placed in an arrayed manner in the riverbed to retard river water flow and induce sedimentation.
revetment	A riverbank protection structure constructed on the bottom or banks of a river by placing a layer of material, such as rock, stones, concrete blocks, or mattresses including sand-filled geo- textile containers.
spur	A river training structure built from the bank of a river in a direction transverse to the current, by placing a large quantity of rocks, stones, or concrete blocks (or earth armored with these heavy materials).

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2017 ends on 31 March 2017.

(ii) In this report, "$" refers to US dollars.

Executive Summary

1. The Government of India with assistance from the Asian Development Bank (ADB) is implementing the Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program under a multitranche financing facility (MFF) modality. The investment program will enhance the reliability and effectiveness of flood and riverbank erosion risk management (FRERM) in Assam. It will focus on three existing flood embankment systems (Palasbari-Gumi, Dibrugarh and Kaziranga) protecting key urban and productive rural areas along the Brahmaputra River. These areas are vulnerable to flooding because of infrastructure deterioration, and riverbank erosion. The investment program and its tranche 1 were approved in October 2010 by ADB and became effective in August 2011. The Tranche 1 implementation was closed on 31 July 2017.

2. The Palasbari and Gumi subproject activities for tranche 2 are a continuation of flood protection works along the Brahmaputra River in Palasbari and Gumi areas. The completed tranche 1 works in Palasbari and Gumi included (i) Palasbari river erosion protection under water works with 2 layers of geobags along 4.9 km (ii) improvement of embankment in Palasbari along 5.02 km, and (iii) Gumi river erosion protection with construction of 4.5 km revetment. The continuation works on river erosion protection in Palasbari under the tranche 2 will include: (i) riverbank protection works from Dokhola Hills to Makadhuj for a reach of 6.4 km, (ii) rehabilitation of existing spur at Chimina, and (iii) construction of a sluice gate on Kalbhog River. Under Gumi reach, the works have three components: (i) bank protection works between three existing deflectors; (ii) riverbank protection works at Borbhita area, over a length of 1.2 km; and (iii) riverbank protection works along the southern bank of the Brahmaputra River at Taparpathar area, over a length of 5 km. The above components of the Palasbari subproject area are planned to be implemented under the tranche 2 and expected to be approved by ADB in 2018.The environmental impact assessment (EIA) report for all project activities for Palasbari and Gumi subproject was prepared and disclosed on ADB website in June 2009. Therefore, for the continuation of work activities for Palasbari and Gumi under tranche 2 to be started in 2018, the EIA report needed to be updated (this report).

3. The EIA study was carried out from February 2015 to January 2016 (information collected till September 2017), and the environmental study covered the project area, as well as the area of direct and indirect impacts. The environmental assessment report was prepared in accordance with relevant applicable laws and regulations of the Government of India and in conformity with the ADB's SPS.

4. This updated EIA report was prepared to capture any change both from the environment and project design as the subproject will be implemented under the tranche 2. One of the most important activities during the update of the EIA report was public consultations, particularly with the affected people in order to keep them informed of the project implementation, and also to provide information on the potential impacts, as well as the project implementation schedule. Public consultations were carried out during economic assessment with the villagers on 12.2.2015 at Palasbari reach and on 13.2.2015 at Gumi Reach. Villagers were consulted in July 2015 (entire month) during RP survey and in later months. Official Public hearings for tranche 2 were carried out on 4th November 2015 at Gumi, and on 5th November 2015 at Simina, Palasbari. Public consultation was done again on 10th November 2016 in presence of ADB consultant at Palasbari. Although there was no significant concern raised by the affected people during the public consultations, it has been planned to continue public consultations throughout the project implementation period to ensure that any unexpected impacts can be handled timely and efficiently. Their only concern was early implementation of the project to protect them from flooding. This updated EIA report is based on most up-to-date subproject details/concept design provided by the Design Team of FREMAA during the preparation of this report. In tranche 2 information regarding demography, flooding pattern, the

recent floral and faunal diversity in the area, recent maps based on the feasibility study for tranche 2, and recent detailed project report (DPR) has been updated.

5. The structural works will focus on sustaining the functions of the existing flood embankment systems through renovation of deteriorated embankments, riverbank protection works construction of a new sluice gate at Kalbhog channel, and repair and restoration of spurs.

6. The tranche 2 works will generate various impacts on the environmental setting of the area: Some potential impacts including on river hydrology, morphology, and sediment transport are anticipated to be insignificant because of the nature of the civil works, which support the strengthening of the existing embankment systems to maintain their intended functions. Riverbank protection measures - with their focus on revetments and pro-siltation measures along the naturally developing banklines in an adaptive manner - will not alter the existing dynamic channel formation pattern of the Brahmaputra morphology. Nevertheless, river hydrology, morphology, and sediment transport will be systematically monitored under the tranche 2 and mitigation measures to minimize these potential impacts have been incorporated in the environmental management plan (EMP).

7. No significant negative impacts on the environment are anticipated: impacts are not anticipated on endangered species such as the river dolphin and endangered species along the Palasbari subproject area. While the dolphins can be seen in the Brahmaputra River, particularly at the confluence of tributaries and in deep channels, impacts can be avoided by ensuring that construction does not occur during the breeding season (between May and August) near the sighting locations. Kulshi River is an important dolphin habitat which is outside of the actual project implementation area. Dolphin and other endangered species found in the Brahmaputra River and other nearby areas are not exclusive to the project site. No damage to the habitat of these species is anticipated. There are no other environmental sensitive resources found in the project area which is likely to be affected by the project. Efforts should also be made to ensure that construction waste does not end up in the water and channels are not obstructed. All works along the river areas are minor and involve mostly earth works by local workers. Construction camps will be located outside of the villages and destruction of the existing vegetation will be minimum. Furthermore, care will be taken for construction not to obstruct the breeding period (April–August) in the fish breeding sites and for construction waste not to enter the river water. The project is likely to bring positive impact to wetlands, pond fisheries and agricultural productivity due to protection from flood and reduced sedimentation.

8. During the construction phase, a number of trees along the embankment are likely to be cut. If the compensatory afforestation at the rate of 1 : 3 (3 trees to be planted against each tree cut) are implemented effectively and survival rates are monitored, the result will be positive. The cost of compensatory afforestation is part of EMP. Project activities are likely to generate other adverse environmental impacts during construction, but these will be temporary. Project activities are likely to induce other environmental impacts during construction, but these will be temporary. Implementation of the prescribed mitigation measures in Chapter 5 (Anticipated Environmental Impacts and Mitigation Measures) including the environmental management plan and monitoring plan will minimize temporary impacts.

9. The suggestions received from the public/stakeholders have been integrated while developing the mitigation measures and the EMP and EMoP.

10. The institutional arrangement for implementing EMP has been established: the project management unit (PMU) will take an overall responsibility to implement the EMP and to address other environmental issues associated with the project, if any. The PMU will be equipped with professional environmental staff, and at the project site level the subproject implementation office (SIO) will have an important role as the first level of the project team to handle any unexpected

environmental issue and will monitor the implementation of the EMP by the contractor(s). The monitoring system has also been developed: the contractor will be required to submit a report on the implementation of the EMP on monthly basis, and the SIO will also routinely carry out field monitoring. The PMU will be assisted also by the project management consultant team with an environmental specialist as member of the team. Semi-annual reports on monitoring the implementation of the EMP and monitoring environmental quality will be submitted to ADB.

11. The grievance redress mechanism (GRM) has been established to provide opportunity to affected people to raise their concerns. The SIO will be the focal point in the field to receive public complaint, and the committee at the SIO level will resolve the public concerns. The committee in FREMAA with the support of the PMU team will handle the grievance, if the SIO could not resolve it. However, the GRM is not substituting any Court of Law. While complaints filed to the GRM of the project, complainant has its freedom to submit the case to the court.

12. Overall, there are no significant negative environmental and socio-economic impacts associated with the proposed project that cannot be mitigated to negligible or acceptable levels. There is full local community acceptance of the project. All required mitigation measures and monitoring are documented in the EMP. The observations and conclusions from the EIA, the project appears to be acceptable for implementation, as designed according to GoI and ADB environmental and technical standards and policy requirements.

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1. INTRODUCTION

1.0 Introduction

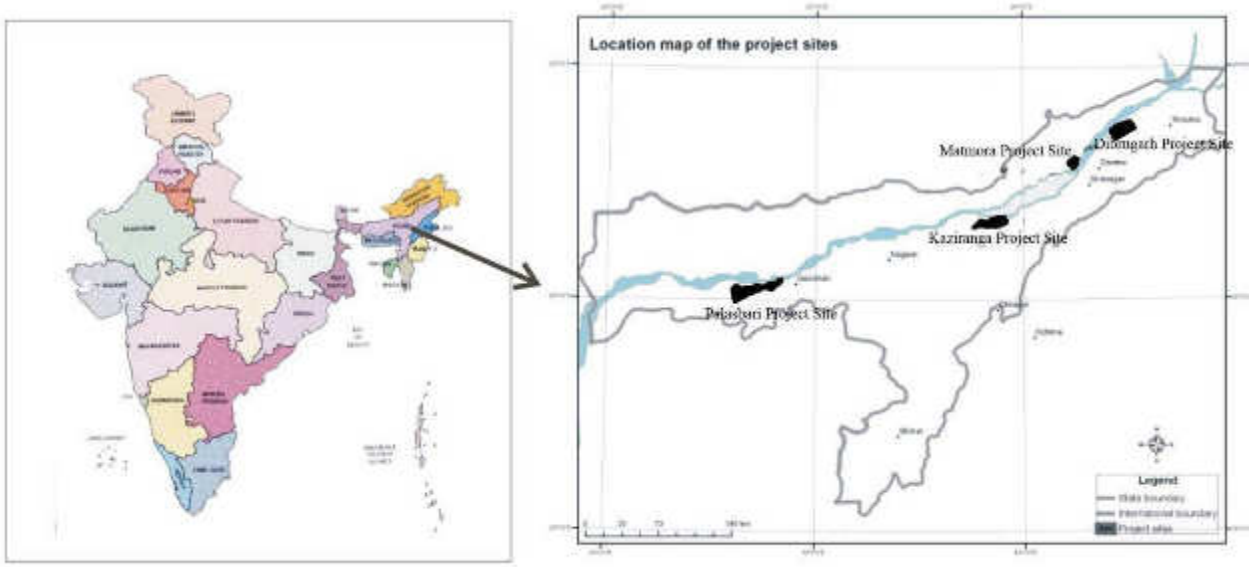
1. The Government of India with assistance from the Asian Development Bank (ADB) has implemented MFF Assam Integrated Flood and Riverbank Erosion Risks Management Investment Program (AIFRERMIP). The investment program will enhance the reliability and effectiveness of the Flood and River Erosion Management Agency of Assam (FREMAA). It will focus on three existing flood embankment systems (Dibrugarh, Kaziranga, and Palasbari) protecting key urban and productive rural areas along the Brahmaputra River. These areas are vulnerable to flooding because of infrastructure deterioration and riverbank erosion. The investment program and its tranche 1 was approved in October 2010 and became effective in August 2011. The tranche 1 implementation was closed on July 2017.

2. This updated environmental impact assessment (EIA) report focuses on the Palasbari and Gumi subproject. The original EIA report for Palasbari and Gumi was disclosed in ADB website on June 2009 that cover planned implementation in two tranches of MFF (tranche 1 and tranche 2). This updated report is basically to capture information from public consultations aiming to refresh affected people with the project and cover any change on environmental conditions.

1.1. AIFRERMIP Subproject Locations

3. Under AIFRERMIP, three most vulnerable reaches located in the State of Assam along the bank of Brahmaputra River have been selected. The locations of the subproject reaches are (i) Majirgaon - Nagarbera (Palasbari Reach) in south bank of Kamrup District, (ii) Oakland-Bogibeel (Dibrugarh Reach) in Dibrugarh District, and (iii) Bankoal-Moraiholla-Diffalupathar (Kaziranga Reach) in Golaghat District are shown in Map 1. This report covers the EIA of subproject for the Palasbari covering Palasbari reach and Gumi reach.

MAP 1: LOCATION MAP OF SUBPROJECT



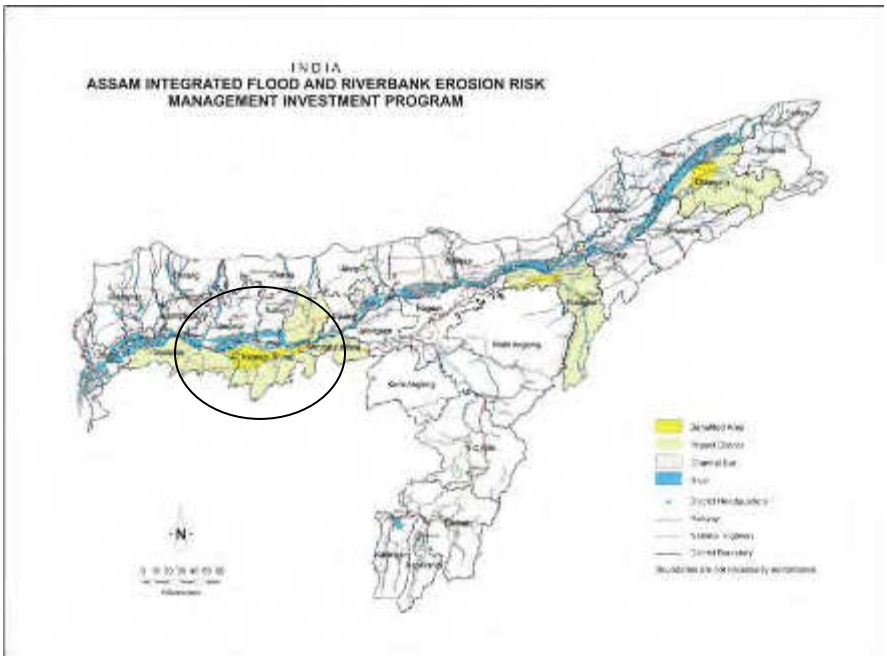
1.1.1. Nature, Size and Location of Sub-Project-Palasbari Reach

4. The proposed subproject (Palasbari reach) is located downstream of the narrowest point of the Brahmaputra River within the State of Assam, controlled by the two successive nodal points at Pandu and Soalkuchi. Sediment deposition in the Palasbari reach has resulted in the river widening and lateral erosion of the river banks for many decades. The length of the subproject is 74 kilometers (km). Tranche 2 involves apron and embankment works, construction of new sluice gate, protection work along the southern bank of the river Brahmaputra at Barbhita and Taparpathar area. The subproject location and alignment are shown in Map 2 and Map 3. The subproject area investigated under EIA study consist of 88,850 hectares (ha) of mostly agricultural and homestead areas confined between elevations 40–55 meters (m) above mean sea level.

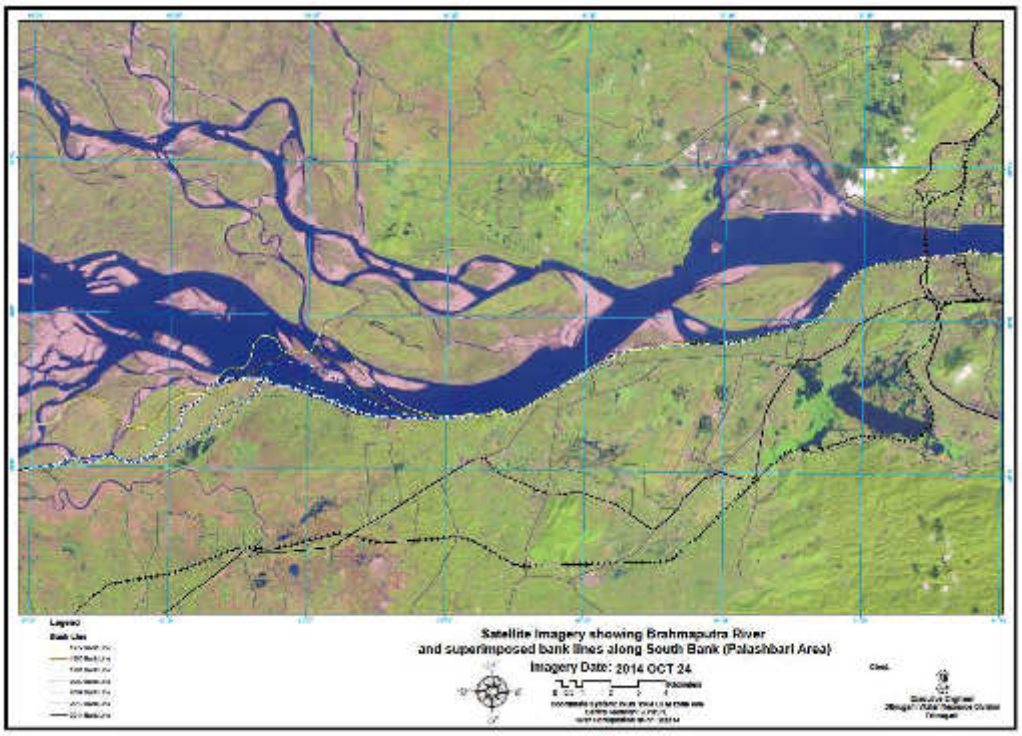
5. The Palasbari subproject was divided into two reaches – Palasbari and Gumi. There are three project components under Palasbari reach: (i) bank protection works from Dokhola Hills to Makadhuj for a reach of 6.4 km; (ii) rehabilitation of existing spur at Chimina; and (iii) construction of sluice gate on Kalbhog River. There are three components under Gumi reach: (i) bank protection works, between these deflectors; (ii) bank protection works at Borbhita Area over a length of 1.20 km; and (iii) bank protection works along southern bank of Brahmaputra River at Taparpathar area, over a length of 5 km. The above components of Palasbari subproject area is being planned to be implemented under the tranche 2 and expected to be approved by ADB in 2018.

6. This updated EIA report was prepared to capture any change both from environment and project design as some of the components of the subproject will be implemented under the tranche 2. The initial EIA as well as the updated EIA were prepared to identify any potential impacts and prepared environmental management plan (EMP) to avoid and minimize the impacts. Study for preparation of updated EIA report was carried out from February 2015 to January 2016.

Map 2: Location Map of the Subproject (selected subprojects)



Map 3: Alignment of the Subproject (Palasbari Reach)



1.2. Extents of the EIA Study

7. The updated environmental assessment was done in tandem with the preparation of the feasibility report of tranche 2. The updated EIA is based on most up-to-date subproject details/ concept design provided by the Design Team during the preparation of this report. Minor changes may occur in the subprojects structural component, but these changes are expected to be limited to implementation schedule. References have also been made on the pre-feasibility and feasibility reports of tranche 1 and 2.

8. The EIA study covered all activities proposed for the integrated flood and riverbank erosion management in Palasbari reach. The core impact area covers section of Brahmaputra River including complete reach length, its immediate upstream and downstream sections, area within 100 meters (m) either side of the reach, project benefit area, and beels/wetlands/ tributaries connected with the river in the reach area.[1] The study area has been extended to cover a buffer zone of 8 km wide[2] on either side of the embankment to analyses the land use, identify environmentally sensitive locations, if any, and understand the overall drainage pattern of the area. Geographical Information System (GIS) techniques have been used based on recent satellite data of the project area to analyze the baseline physical, ecological and cultural landscapes and to gather the relevant data for EIA purpose. Impact on aquatic life including

[1] Core zone of the impact was taken as 100 m on either side of the reach based on the expert judgement as most of the project activities related to embankment renovation and/or new construction, bank protection will primarily be limited to this zone.

[2] The study area has been selected based on the following two considerations: The subproject specific benefit area which is varying up to about 8 km from the embankment in case of Palasbari reach. The practice adopted by Ministry of Environment and Forests (MoEF&CC), Government of India for delineating environmental assessment of the project, which is 10 km around the project boundary.

dolphin, their breeding/spawning areas, migratory route of fishes have also been assessed as there are no major endangered wildlife in the project location. Assessment of vegetation cover, migratory route of animals, and sourcing of construction material particularly borrow earth and aggregate has also been undertaken.

1.3. Approach and Methodology

9. The EIA study was carried out using reconnaissance survey, review of previous studies, field visits, consultation with stake holders & NGOs, review of existing data, assessment to identify adverse impacts, and the preparation of environmental management plan (EMP). Under secondary data review, the available published literature, documents and maps (e.g. topographic, geological maps, forest, satellite imagery, Google image maps etc.) related to the influence area was reviewed. The existing policies, legislations, guidelines and manuals related river bank protection and environment in India and ADB's policies and guidelines were also reviewed. Apart from the above the detailed project report (DPR) were thoroughly reviewed. The assessment also builds on the Brahmaputra morphology study using satellite imagery, risk maps, and studies on the influence of spurs and anti-erosion activities of the Water Resources Department (WRD) in Assam. Discussions were carried out with people living in Brahmaputra neighborhood, nongovernment organizations (NGOs) and Village Councils, etc. The scope of the EIA extends well beyond the vicinity of the proposed structural measures and covers the entire Brahmaputra River section fronting the existing and proposed measures, and to the extent possible, 8 km radius as the general impact zone. While the immediate 100-m corridor centered along the existing and proposed embankment alignments as the primary impact zone where most of the adverse impacts may occur. The decision to expand the environmental assessment impact zone to 8 km radius is based on the following: (i) to ensure that environmental impacts attributable to the project are comprehensively identified and assessed; (ii) allow flexibility in the detailed design of tranche 2 measures, which will adapt to the rapid changes in Brahmaputra River morphology, by providing a comprehensive environmental baseline information, and (iii) recognizes that FRERM measures to influence the flow direction and promote siltation in strategic areas may have environmental impacts downstream. As part of alternative analysis, comparisons were made among different alternatives of realignments, as well as comparison of selected option with "no project" option in terms of environmental, social and technical parameters.

10. Updated EIA is based the original approved EIA (as it was prepared for all component activities for Palasbari and Gumi for the tranche 2). Approved EIA document (original EIA) for both the tranches 1 and 2 remains valid and serves as the basis for updating. The final design of tranche 2 works is within the investigated areas described in the original EIA studies and there is no major structural change. Therefore, the updated EIA includes updated environmental baseline data, impact assessment, mitigation and result from the latest public consultation carried out in February, July and November 2015.

1.4. Data Collection

11. Data was collected through primary and authenticated secondary sources for establishing the existing environmental conditions of the project area.

12. Site visit was carried out to collect the primary data from the site. Additional information for tranche 2 were collected from DPR of tranche 2 of Palasbari, Water Resource Department, Bokakhat; Feasibility report of tranche 2; Economic Assessment conducted by Omeo Kumar Das Institute of Social Development. Primary baseline data was also collected for noise, water

quality, air quality (2015) and soil. Recent demographic data were collected from the census reports (2011) of the districts. Since dolphin is an endangered species, special efforts were made to identify areas where they are frequently sighted including their breeding grounds. Data collected, sources, and application are summarized in Table-1.

Table 1: Information Collected and Sources for Tranche 1 and Tranche 2

Information Collected	Sources	To be Used in
Project location, project objectives, project designs, and sourcing of construction materials	Pre-feasibility Report; Concept design prepared by TA Concept team and WRD DPR	Project description and impact assessment
Wildlife, forest areas in project vicinity, flora and fauna details, and possible ecological impacts and mitigative actions	Department of Zoology, Gauhati University; District Forest Office; Department of Environment and Forests, Govt. of Assam	Project description impact assessment and mitigative actions, alternative analysis, and economic assessment economic assessment ,
Engineering details	TA consultants, DPR, WRD, Tranche 2 documents	Project description, impact assessment, and mitigative actions
Existing quality of the environment, land use, meteorological data, possible impacts because of the project and proposed action plans, identification of ecologically sensitive locations, regulatory compliance	Primary/ Secondary data collection; Department of Environment and Forests; Department of Fisheries; District Forest Office; Report, Census Govt. Of Assam; IMD Regional Office, Guwahati, State Pollution Control Board, Assam	Project description, impact assessment and mitigative actions, management plan, and environmental economic assessment
River geomorphology, hydrology, and flood pattern demographic data	Published Research; Govt. Reports; Unpublished Doctoral thesis's, ARSAC reports, Brahmaputra Board, WRD, and GSI Reports and Census reports 2011	Project and environmental descriptions, and impact assessment

1.5 EIA Contents

13. This EIA report is presented in accordance to ADB's SPS. The content of the report includes Executive Summary, introduction, rules and regulations related to environment, project description, environment description, anticipated environmental impacts and mitigation measures, analysis of Alternatives, information disclosure and public consultation, grievance redresses mechanism, and environmental management and monitoring plan.

14. The update EIA report has been prepared by: Dr. Jayanta Das, National Environmental Expert, PMC, Tetra Tech ES India Pvt. Ltd.

2. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1. Regulatory Requirements

2.1.1. ADB's Environmental Safeguard Policy and Requirement

15. The ADB SPS covers three important risks to be taken into consideration for ADB funded projects. These three risks are risks associated with environment impact, involuntary resettlement impacts, and indigenous people impacts. The ADB SPS described the objective of adopting environmental requirement is to ensure the environmental soundness and sustainability of ADB funded projects, and to support the integration of environmental consideration into project decision making process. The environmental safeguard requirements are triggered by the likely environmental impacts and environmental risks. Therefore, all ADB activities had to be screened as early as possible to determine the appropriate extent and type of environmental assessment, and appropriate study to be undertaken to enable identifying potential impacts and potential mitigation measures.

16. With regards to the critical habitat, ADB prohibited any activities in the critical habitat, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critical endangered species, and (iii) any lesser impacts are mitigated.

17. As per ADB's SPS, projects are categorized into Category A, B, C and FI. Project with significant impacts affecting the larger area are category A projects, project with lesser significant and site specific impacts are category B, projects with minimal and no potential impacts are category C projects while projects having funding through FI are FI projects. Based on ADB's safeguard policy objective and considering ADB's principle in dealing with riverine habitat, the Palasbari-Gumi subproject has been categorized as a Category B project, because the impact of the work is localized. The overall tranche 2 covering Kaziranga, Palasbari and Gumi, and Dibrugarh is categorized as "A" from environmental safeguard requirement under ADB SPS, because the Kaziranga subproject areas is in the border of the Kaziranga National Park.

18. For category A projects, detailed EIA study and careful monitoring and management of environmental and social implications to ensure that impacts are manageable and will not become a trigger to generate cumulative and irreversible impacts. On this basis, the Palasbari project will also become subject of strict environmental monitoring, in which, semi-annual report must be submitted to be used as a tool to monitor the effectiveness of implementation of environmental management and monitoring plans.

2.1.2. Regulatory Requirements of the Government of India and Assam State

19. The Government of India has framed various laws and regulation for protection and conservation of natural environment. These legislations with applicability to this project are summarized below in Table 2 and approval and monitoring framework is depicted Figure 1.

20. As the project does not require forest land diversion and the project is not falling within any protected areas (National Parks, Tiger Reserve and Wildlife Sanctuaries) or defined Eco Sensitive Zone area, thus no clearance is required from Forest Department, Assam and from National Wildlife Board, MoEF&CC, Government of India.

Table 2: Applicable Key Environmental Legislation at a Glance

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Environmental Protection Legislations					
Environment Protection Act-1986 and Rules	To protect and improve overall environment.	Applicable for all the projects which have environmental impacts associated with its development and operation	No permit required. Permit is required as per various laws and rules framed under the act	MoEF&CC	Contractor and PIU
EIA Notification 14th Sep 2006 and amendment till date	Requires prior environmental clearance for new, modernization and expansion projects listed in schedule 1 of EIA Notification, 2006	Considered Not Applicable (EIA Notification 2006 does not classify for embankment construction). Borrowing of earth for embankment and road construction as may be required, will require prior environment clearance under mining category.	Environmental clearance for borrowing of earth	MoEF&CC	Contractor
Air (Prevention and Control of Pollution) Act, 1981, 1987	An act to prevent and control Air pollution	Applicable. The applicability is due to emission from operation of construction equipment like batching plants, DG sets.	Consent to Establish (CTE) & Consent to Operate (CTO)	SPCB	Contractor, should obtain CTE & comply its conditions for setting up each facility, batching plant, DG set as prior to its establishment from SPCB CTO should be taken by contractor

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
					for batching plant, prior to operation and it should be renewed before the expiry of permit.
Water Prevention and Control of Pollution) Act, 1974, 1988	An act to prevent and control water pollution.	Applicable. It is applicable for the projects having potential to generate effluent during any stage of the project. Effluents are expected to be generated during construction stage from construction camps.	Consent to Establish & Consent to Operate	State Pollution Control Boards	CTE should be taken by contractor for disposal of sewage and construction of septic tank/soak pit prior to start of construction from SPCB. Compliance to the conditions mentioned in the CTE should be done by Contractor.
Noise Pollution (Regulation and Control Act) 2000 and amendment till date	Ambient Noise Standards for different areas and zones	Applicable due to generation of noise during construction.	No permits issued under this act	SPCB	Contractor and PMU to ensure compliance to Ambient Noise Level Standards.
Hazardous & Other Wastes (Management and Transboundary Movement) Rules, 2016	Protection to public against improper handling storage and disposal of hazardous waste. The rules prescribe the management requirement of hazardous wastes	Applicable. Project may generate hazardous waste (Waste Oil) during construction	Authorization for storage and handling of hazardous waste	SPCB	Contractor should obtain authorization for handling, storage and disposal of hazardous waste (Waste Oil) along with CTE/CTO for air and water act. Also, compliance to

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	from its generation to final disposal.				the conditions mentioned in authorization should be ensured by contractor and PMU
Manufacture, Storage, and Import of Hazardous Chemicals (MSIHC) Rules, 1989	Usage and storage of hazardous material	Applicable only for storage of highly inflammable liquids like HSD/LPG	No specific permit is required, however precautions defined under the material safety datasheets should be followed for use of hazardous substances listed under the schedules attached to this notification if any proposed to be used. Safety requirements should have to be complied if storage quantity exceeds the regulated threshold limit	Chief Controller of Explosives,	Contractor and PMU. Compliance to the rules should be ensured
Construction and Demolition Waste Management Rules, 2016	To manage the construction and demolition waste	Applicable Applies to all those wastes resulting from Construction, repair & demolition of any civil structure of individual or organization who generates construction and demolition waste such as building material,	Approval required from local authorities, if waste generation is >20 tons in a day or 300 tons per project in month	Local Authorities. Segregation, management and disposal of waste as per rules.	Contractor and PMU. Compliance to the rules should be ensured

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
		rubble, debris.			
Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable. Plastic waste is unlikely to be generated in small quantities.	No authorization to be obtained. Waste management and minimization to be done. Fee to be paid to local bodies, if applicable	Local bodies	Not Applicable
The Batteries (Management and Handling) Rules 2001	To regulate the disposal and recycling of lead acid batteries	Applicable Applicable for disposal of used lead acid battery if likely to be used in any equipment during construction stage.	No specific registration required. Compulsion to buy and sale through registered vendor only.	MoEF&CC	Contractor
Forest Conservation and Wildlife Protection Legislation					
The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules 1981 and amendments till date	To protect forest by restricting conversion of forested areas into non- forested areas and deforestation	Not Applicable[3]. (No forest land is being diverted. However large no. of tree cutting is envisaged for which NOC from forest department as per applicable rules of the state.)	Forest Clearance / Permission for tree cutting.	Forest Department, MoEF&CC	NOC should be obtained from forest department prior to tree cutting. Compensatory plantation should be carried out as per state forest policy.
Wild Life Protection Act, 1972, 1993	To protect wildlife through notifying National Parks and Sanctuaries and buffer areas around	Not Applicable for this subproject.	Wild life clearance	Chief Conservator Wildlife, Wildlife Wing, Forest Department,	Not Applicable

[3] The land revenue records need to be verified again to ascertain if any forest land is required to be diverted. If yes, then this ACT shall be applicable and necessary clearance for forest land diversion will have to be obtained. Permission for tree cutting in any case would be required from concerned forests/district authorities.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	these zones			MoEF&CC	
Eco Sensitive Zone	The expansion of industrial area, townships, infrastructure facilities and such other activities which could lead to pollution and congestion shall not be allowed within "No Development Zone" except with the prior approval of the Central Government.	Not Applicable for this subproject.	Permission To be obtained prior to start of construction	MoEF&CC	Not Applicable
Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto	Applicable		Biological Diversity Act, 2002	Contractor and PMU. Compliance to the rules should be ensured during construction phase
Safety and Other Related Legislations					
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of on-site and off-site Disaster Management Plans for accident-prone areas.	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation phase which may lead to	No permits issued under this act	Central, State & District Crisis Group	Not Applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
		continuous, intermittent or repeated exposure to death, or injury.			
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Not Applicable. The project does not involve storage of any chemicals (HSD) beyond the threshold limit during construction and	No permits issued under this act. Owner of project should take out insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material	Collector of the Area	Not applicable
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material	Not Applicable as no explosive (as described in act & rules) should be used in the construction and operation stage of the project.	Permission for storage and usage of explosive	Chief Controller of Explosives	Not applicable
Petroleum Rules, 2002	Use and Storage of Petroleum products	Applicable as storage of HSD/LPG or any other petroleum product may be required for the project purpose	License to store petroleum beyond prescribed quantity.	Chief Controller of Explosives/DC	Contractor
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	Applicable, for all the vehicles at site during construction & operation phase	No permit issued under this Act	Motor Vehicle Department (Licensing authority, registration authority &State Transport Authorities)	Contractor to follow Rules for all the construction vehicles being used at site during construction purposes

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
The Gas Cylinder Rules 2004	To regulate the storage of gas / possession of gas cylinder more than the exempted quantity	Applicable if contractor store more than the exempted quantity of gas cylinder.	License to store gas cylinder more than the regulated quantity	Chief Controller of explosives	Contractor. Compliance to the rules should be ensured
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains found in India. According to this Act, area within the radii of 100m and 300m from the "protected Property" are designated as "protected area" and "controlled area" respectively. No development activity (including building, mining, excavating, blasting) is permitted in the "protected area" and development activities likely to damage the protected property is not permitted in the "controlled area" without prior permission of the Archaeological	Applicable only if any intervention is planned within 300 m of archaeological protected sites falling along the ROW	No objection certificate	Archaeological Dept. GoI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	Not applicable yet as no intervention planned within 300m of these sites.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	Survey of India (ASI).				
Guidelines for evaluation of proposals/requests for ground water abstraction for drinking and domestic purposes in Notified areas and Industry/Infrastructure project proposals in Non-notified areas, 2012	To regulate extraction of ground water for drinking and domestic purpose	Applicable if ground water is extracted for meeting drinking/ domestic water needs of contractor workers	No objection certificate	Central ground Water Authority/Board & MoEF&CC	Contractor
Other Regulations					
• Workmen's Compensation Act 1923 • Contract Labour (Regulation and Abolition) Act, 1970 • Minimum Wages Act, 1948 • Payment of Wages Act, 1936 • Equal Remuneration Act, 1979 • Child Labour (Prohibition and Regulation) Act, 1986 • Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979 • The Building and Other Construction Workers (Regulation of Employment and Conditions of • Service) Act, 1996 and the Cess Act of 1996 • The Factories Act, 1948 • Hazardous Wastes (Management and Handling) Rules, 1989Chemical Accidents (Emergency • Planning, Preparedness and Response) Rules, 1996					

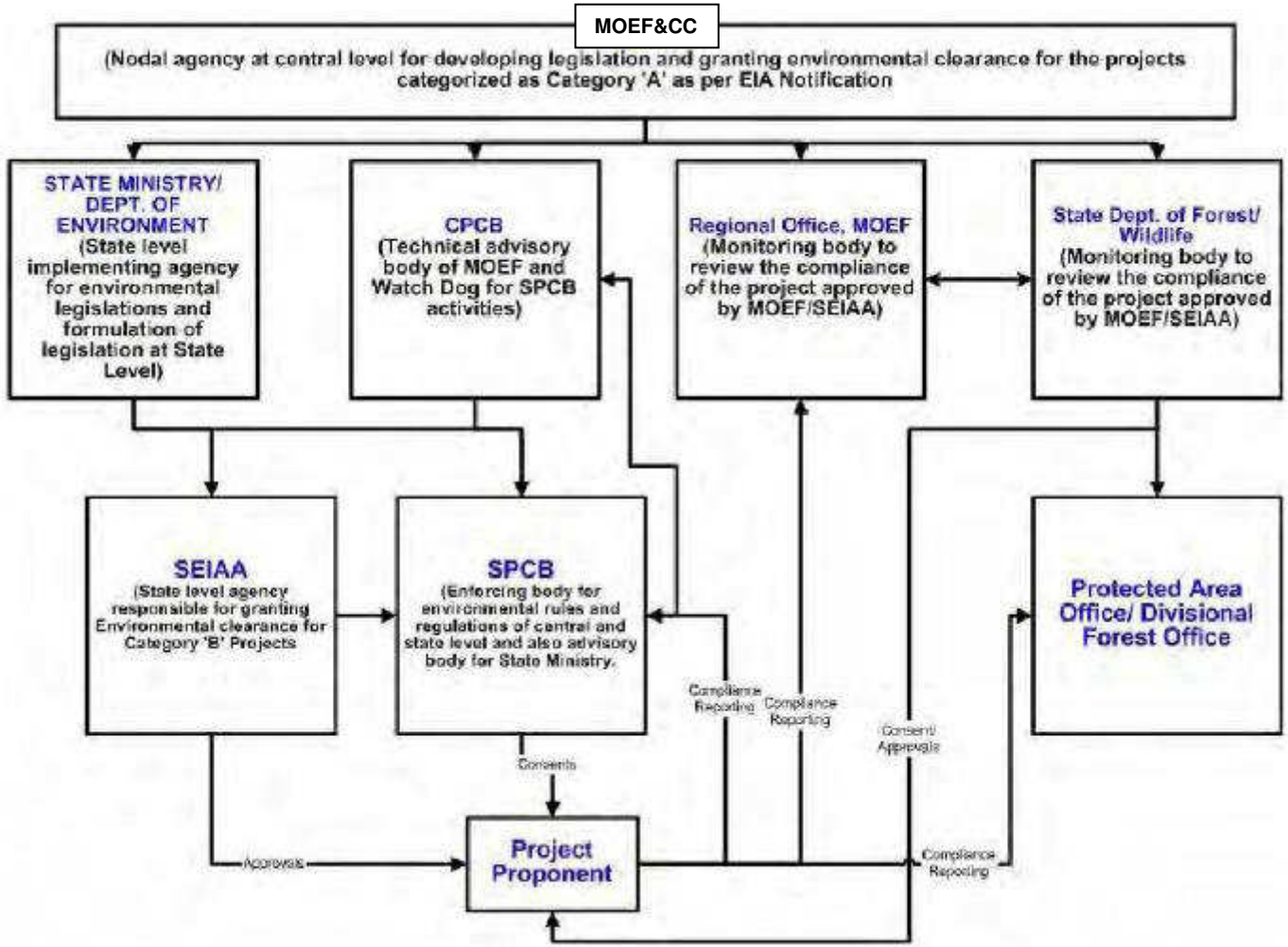


Figure 1: Legislative Interface between various Central and State Authorities

3. DESCRIPTION OF THE PROGRAM AND SUBPROJECT

3.1. Rational for AIFRERM Project

21. India is one of the most disaster-prone countries in the world. Flooding is a major recurrent natural disaster, causing damage of average $450 million annually with increasing incidence in the recent years. The country has a flood prone area of 46 million ha (accounting for some 14% of the geographical area and 25% of cultivable area). A national level policy framework for flood management is promoting short- to long-term programs for both structural and non-structural measures with a basin wide approach with improved catchment management. More than 18 million ha in flood prone area has so far been protected with flood embankments and other structures, whereas nationwide flood forecasting and warning system has been set up. However, large gaps still exist between the policy framework and operations at the individual state level.

22. Flooding in the Brahmaputra plain in Assam is a complex phenomenon with different factors often changing roles. These factors are: (i) the Brahmaputra River in high spate has the potential to flood major parts of the plain for extended period of time; (ii) tributaries flood their adjacent plains, but for shorter periods being of short term character in steeper hilly parts with longer-term flooding, influenced by Brahmaputra water levels, in their lower floodplains; and (iii) local rainfall can cause flooding (local floods associated with drainage congestion) even when rivers not over spilling, but commonly drain away after hours or days. Overall, the effective FRERM requires a long-term basin wide approach with a sound planning framework integrating short- to longer-term programs including (i) improved catchment management, (ii) multipurpose reservoirs including flood cushion where feasible, and (iii) balanced combination of structural and non-structural measures to cope with immediate annual risks.

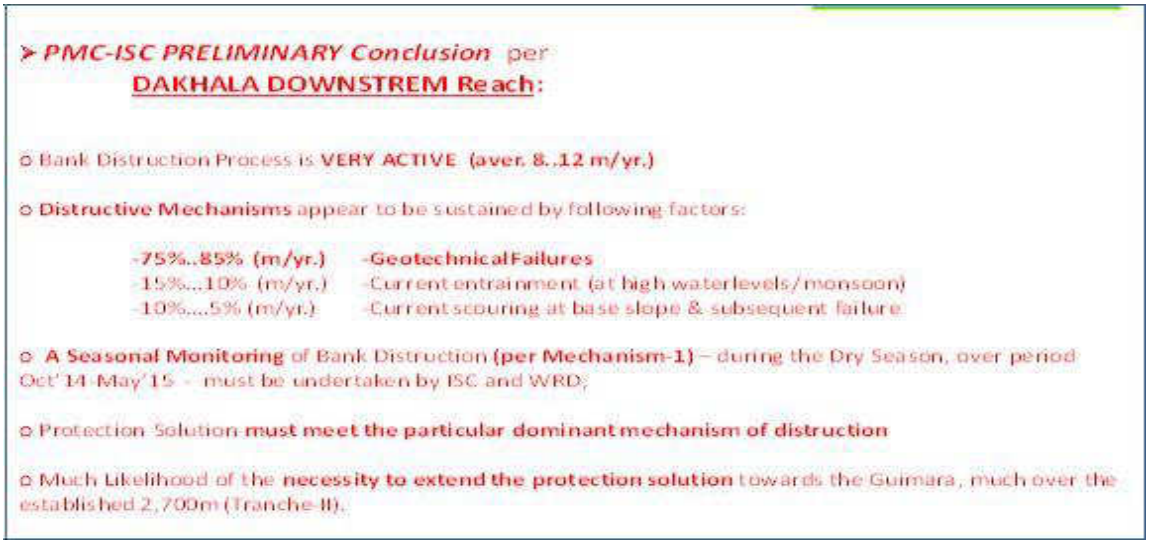
23. While Assam has flood embankment systems protecting 50% of its flood prone areas, their effectiveness is limited due to deterioration associated with poor maintenance, riverbed rising, and failure from river erosion. High priority needs to be accorded to improve the existing embankments along high value locations with assured maintenance, with provision of riverbank protection where feasible, exploring more cost-effective and flexible options adaptive to highly dynamic river process following the international and national best practices. Alternative risk management measures need to be pursued in other areas with flood proofing, strategic retirement of embankments, and a range of non-structural measures including risk mapping and advance warning, and safety nets for the people displaced by flooding and river erosion. These need to be implemented with comprehensive strengthening of the relevant policy, planning, and institutional basis, data and knowledge base, and participatory mechanisms to ensure accountable program delivery and management.

24. The government has continued to place higher priority to flood management. This is in line with the paradigm shift of the country's disaster management strategy to focus more on preparedness as opposed to post-disaster responses, as well as a growing concern on the impacts of climate change. Within this framework, the State Government of Assam has initiated steps towards establishing sound policy, planning, and institutional framework of water resources management. A draft State Water Policy has been prepared with a vision to establish institutions for integrated water resources management based on river basins. It also envisages a holistic flood management plan as an essential instrument, along with the reforms and strengthening of key sector organizations such as WRD and local level participatory disaster management organizations.

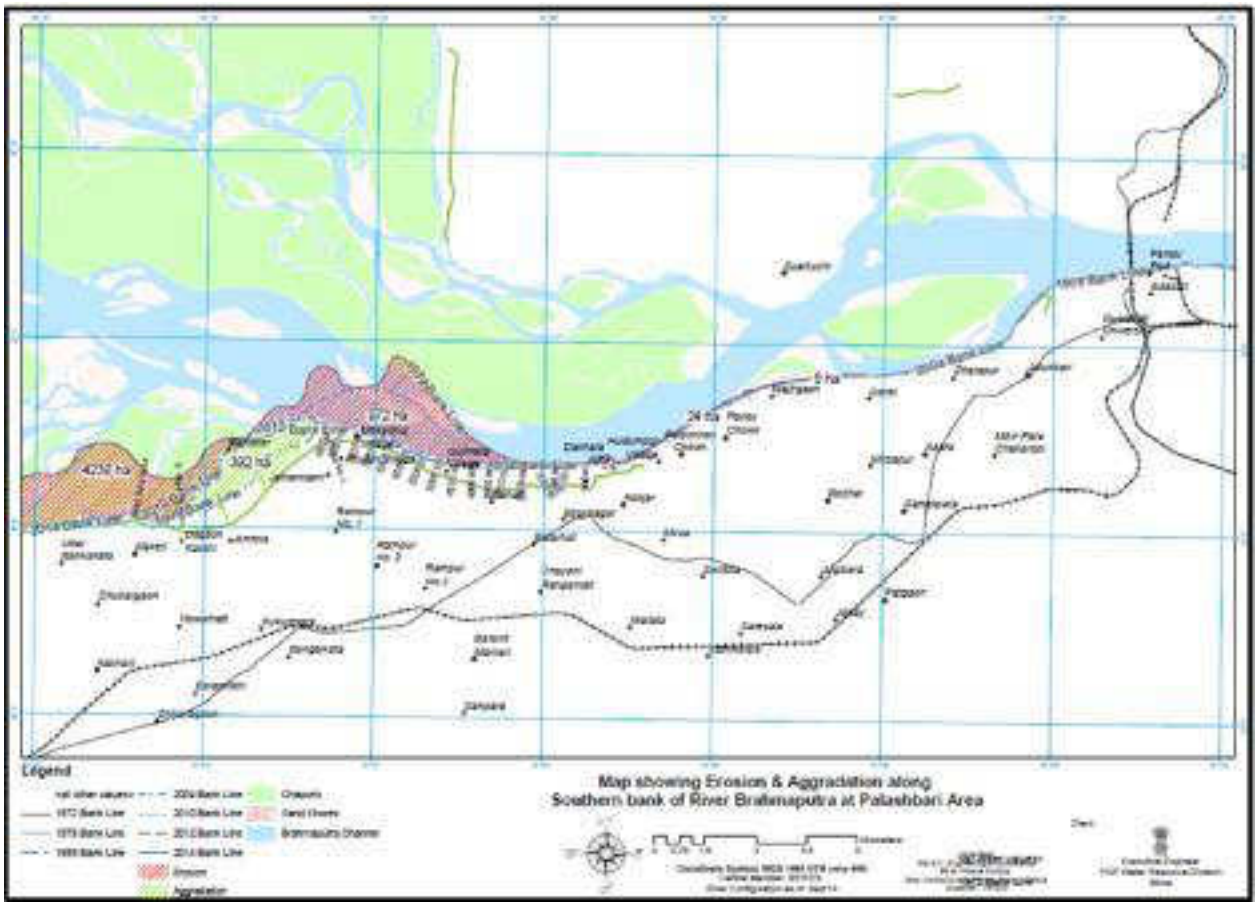
25. The AIFRERMIP has been executed with funding from ADB's loan to support the state government's initiatives for effectively managing the risk of flood and river erosion problems with

long-term integrated perspective. Effective structural and non-structural measures in strategic locations of the state are planned under this initiative. Structural measures in tranche 2 will focus on proper functioning as per the intended design of the existing embankment systems protecting key urban and productive rural areas and requiring upgrading and protection against river erosion exploring alternative (cost effective and sustainable) designs, whereas non-structural measures will extend to the most vulnerable locations to the impacts of chronic flooding. Significant emphasis will also be placed on establishing sound data and knowledge base to effectively manage or respond to the dynamic natural river processes while not disturbing them as much as possible. Palasbari subproject is part of above initiative itself.

26. The PMC´s field monitoring of the Dakhala Reach destruction evolution, during the years of the tranche-I implementation (2012–2015), has put into evidence the feasible tendency of damage/ destruction rates of the southern riverbank. PMC-comparisons with setback rates - registered over the period of the PPTA-stage (2009–2010) - show a significant increase of four times (actual 14–16m/year) of the destruction rate, at Dakhala Reach, within the 2-year period upon initiation of Tranche-I. The destruction processes of the southern riverbank of the Dakhala Reach involves the estimated rhythms of the main destructive processes (Map-4 – Bank erosion between 1972-2014) that had been identified at the referred river reach. These data are showed in the following.



Map 4: Areas Threatened by Erosion and Accretion, and Location of Existing Brahmaputra River Embankments-Palasbari Reach (1972–2014)



3.2. The Palasbari Subproject

27. The Palasbari subproject is located on the southern bank of the Brahmaputra River in the Palasbari Circle of Guwahati Sub-Division, District of Kamrup. The subproject has been defined over a 74 km reach of the Brahmaputra River (the Palasbari Reach) that runs from around the confluence of the Jaljali River, which is near the village of Nagarbera and defines the downstream limit of the reach to around the confluence of the Khanijan River, which is near the village of Majirgaon and defines the upstream limit of the reach.

28. The Brahmaputra River shifted over time to the southern bank where it has formed a more established channel since about a decade. Most of the bank is clayey with slow erosion rates, however, in places starting to undercut the existing embankment. The related loss of flood protection could endanger the development of the area west of Guwahati including the airport and required for the extension of the city. A case of regular hardship and occasional disaster through negligence can be observed in Palasbari. The town area is supposed to be protected against flooding by an embankment. But the mouth of the Kalbag tributary that discharges through that embankment is not provided with a regulating structure. Therefore, the town is regularly flooded from the backside through this tributary. Without plugging of the river Kalbag confluence with the Brahmaputra the embankments are of no use.

29. As mentioned, the Palasbari subproject area is located downstream of the narrowest point on the Brahmaputra River within the State of Assam, controlled by the two successive nodal points at Pandu and Soalkuchi (northern bank). Sediment deposition within the reach has

resulted in the formation of a large clustered island or *char* in the river accompanied by lateral erosion of the river banks for many decades. As a result, the system of embankments has had a long history of erosion and retirement. The succeeding Figure presents the areas undergoing or threatened by accretion, erosion, and location of existing bank protection, and the areas that will be protected against flooding.

30. Map 5 demonstrates tributary flooding in the Jaliali River during July 2004, when the Brahmaputra (shown in white with 2008 low-water channels) was at its peak. Water levels in the Brahmaputra create a substantial backwater effect up the Jaliali River inundating a large area behind the embankment in the Palasbari reach. Local observations confirm that in general water levels in the protected areas behind embankments are lower than in the Brahmaputra at full spate. Already differences of 30 centimeters matter, as the higher water level would damage crops or flood houses. As such the main purpose of the embankment strengthening is to reduce the risk of high floods from the primary source, the Brahmaputra.

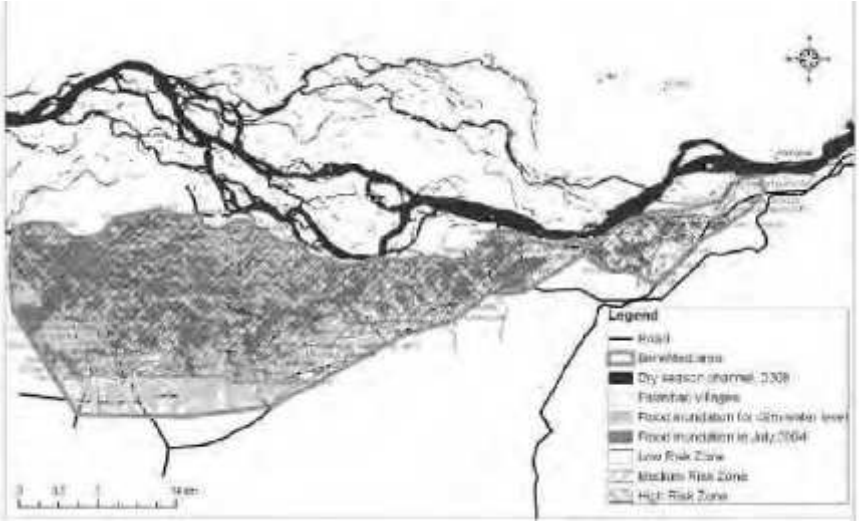
31. A nearly continuous system of embankments and bundhs has been constructed by the WRD and maintained along the length of the sub-project area, stretching from just downstream of the nodal point to Nagarbera Hill. Dakhala Hill is one exception where the embankment is interrupted by the high ground of this rock outcrop. Bank protection works, in the form of rock spurs and land spurs, have also been constructed by the WRD along various portions of this reach. The chainage system is interrupted by the boundaries of the various divisions of WRD. The sections of the dyke system are as follows:

Approximately 9.8 km of embankment from the outfall of Kanjan River (Ch. 0 km) to the start of the Marginal Bundh,

Approximately 4.9 km of bundh opposite the town of Palasbari,

Approximately 21 km of embankment from the end of Marginal Bundh to the village of Gumi, and

Approximately 38 km of embankment from Gumi to Nagarbera Hill at the mouth of the Jaljali River.



Map 5: Palasbari Flooded Area at HFL (49 m) and Maximum Observed Flood

3.2.1. Objectives of Sub-Project

32. Objectives of the subproject are given below

(i) Improvements for the deteriorated flood embankment systems protecting key urban, productive rural, and other strategic areas in the four districts;
(ii) Provision of associated flood protection and drainage facilities such as sluice gates and regulators, improvements in local drainage channels, etc.;
(iii) Provision and support for construction of platforms in areas not protected by embankments or as additional measures to modify the hazard;
(iv) Provision of riverbank protection works along critical reaches with the main purpose of ensuring the embankment stability; and
(v) Plan all future measures in a participatory manner involving local stakeholders, linked to community disaster risk management activities and making use of latest scientific tools and understanding of the site conditions.

3.2.2 Benefits of AFRERM & Palasbari Subproject

33. Benefits of the AFRERM broadly are given below:

(i) Reliable flood protection;
(ii) Mitigation of local drainage problems;
(iii) Reduced flood risk through temporary shelter;
(iv) Reduced riverbank erosion supporting reliable embankments and a more predictable river course; and
(v) All measures planned in a participatory manner, closely linked to community-based disaster risk management measures, designed according to latest state-of-the-art technology applying Assam specific experience, implemented as quality works, and monitored and adapted as needed.

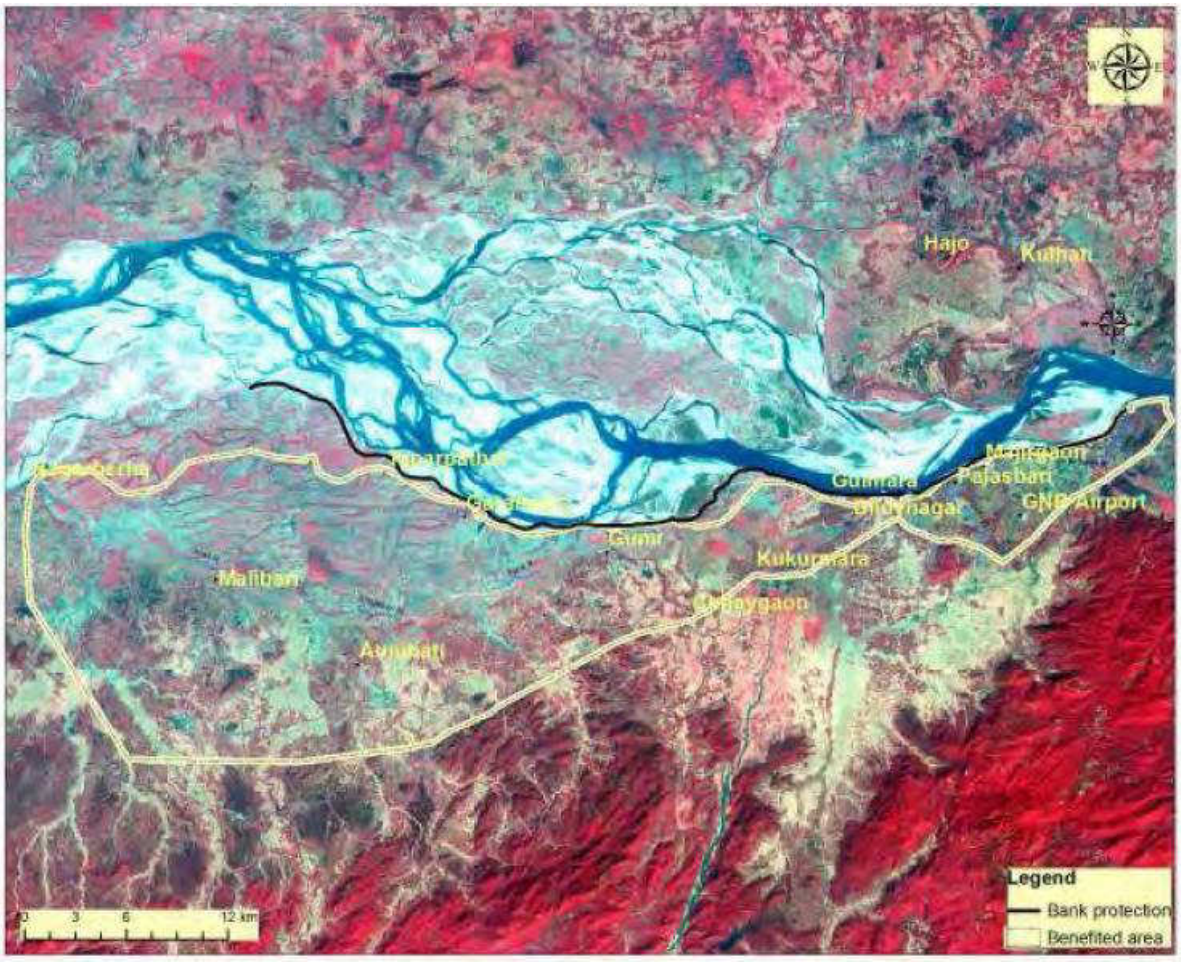
3.2.3 Benefits of the Palasbari Subproject under Palasbari Reach.

34. Protection work at Borbhita 1.2 km, riverbank protection works at Taparpather 5 km under Gumi Reach. Compared to a without project scenario, reliable riverbank protection will avoid future land loss in the area. Future provisions (for adaptation work, which means additional riverbank protection protecting the existing work from outflanking) have been incorporated into the economic feasibility study to respond to additional unpredictable erosion in this area.

35. A stable riverbank and strengthening of the existing embankment system will avoid future flood losses in a larger area.

36. Associated with bed level rise, there is a substantial difference between the area flooded at high flood level without embankment and with embankment. The succeeding Figure shows the areas flooded at different levels. The existing embankment system provides a certain safety from flooding at this moment.

Map 6: Palasbari subproject – Benefited area



Map: **Map 7: Satellite Image of Palasbari subproject area: (Image –2014)**

Map 8: Satellite Image of Palasbari subproject area: During Flood (Image –2014)

37. To establish the feasibility of flood and riverbank erosion management measures for certain areas, interventions were planned based on the existing river situation. These measures were prioritized based on urgency, implementation costs, and benefits from reduced risk of flooding and riverbank erosion. To cover potential changes in location of future work, this EIA considered a larger area of assessment, beyond the scope of this subproject extending to the full (upstream and downstream) Brahmaputra River section where existing and proposed embankments and pro-siltation works will be installed.

38. The Palasbari Reach has considerable significance from the hydrological perspectives but less significant on terrestrial ecology. The Palasbari Reach along the Brahmaputra river has few sighting records of dolphin in deep channels and in the confluence of the tributaries. Some chelonian (turtle) activities were also reported seasonally in less human dominated riverbank. The reach is severely being affected by continuous bank erosion and flood inundation caused by the Brahmaputra over the last few decades threatening the existence of Palasbari town. The project activity though will not prevent the desired flow of nearby wetlands. The present project will therefore positively contribute towards providing protection to Palasbari town, and the adjoining villages and agricultural lands of Palasbari and Gumi reach.

3.2.4. Subproject Components and Activities

3.2.4.1. Structural Measures

39. Works have been proposed to retire substantial portions of the existing embankment specifically in the upstream area near the airport. In total, around 11.2 km of retired embankment are to be constructed. In the downstream area towards Gumi and beyond the existing embankment provides sufficient protection, even though it does not have 1.5 m free board as required throughout. The design assumes a High Flood Level of 50-year return period.

40. Immediate protection consists of limited quantities of material dumped along the eroding bank at approximately low water level. The material is designed to launch down the slope during bed scour to provide a single layer of temporary coverage that is expected to last one or two seasons. This material would form the base layer for the follow-on comprehensive main protection.

3.2.4.2. Civil works under Palasbari Subproject

41. The total estimated cost for the subproject is ₹850 million for Palasbari reach and ₹888.5 million for Gumi reach. The work will be implemented over 3 years.

- **Palasbari Reach** (Map-9)

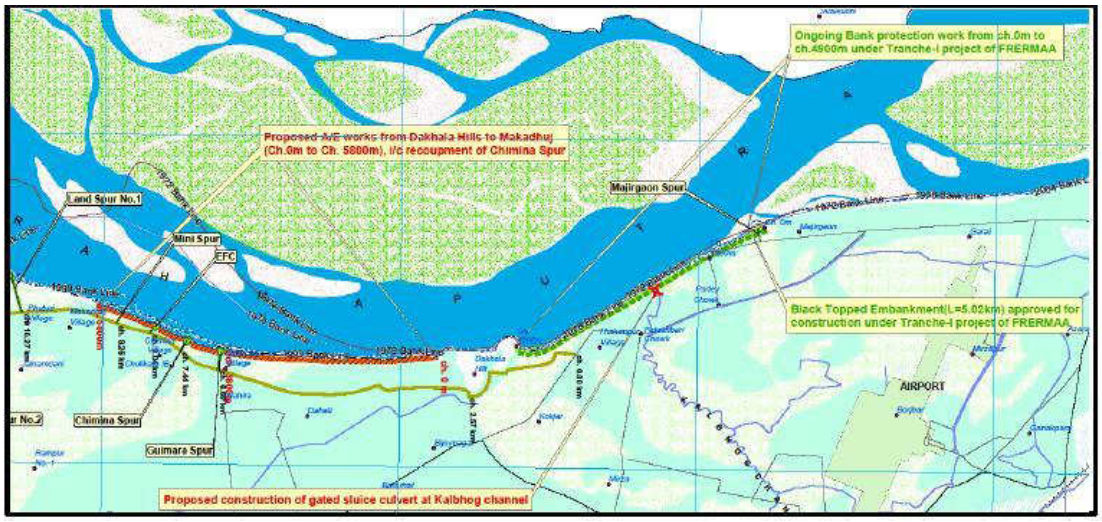
42. Bank protection works for 6.4 km from Dakhala Hill to Makadhuj. The protection works include:

(i) a 30 m wide apron, with four layers of geo-bags filled with sand;
(ii) a 3 m wide and 0.9m thick toe key made of cement concrete block in PVC coated cages;
(iii) 0.4 m thick pitching with CC Block, over a geo-fabric sheet.

43. Additionally, the need for an additional structural intervention was created along the targeted reach, by the works on the riverbank itself, namely:

(i) Rehabilitation of land spur at Chimina (loose dumping of boulder, dumping boulders in wire net boxes at the apron area.
(ii) Construction of five gated new sluice on Kalbhog River. This work includes construction of five shutter sluice on Kalbhog River, on the Palasbari embankment, under construction within the ongoing framework of Tranche-I.

Map 9: Tranche 2 work sites under Palasbari Reach



- **Gumi Reach** (Map-10)

44. A. Bank protection works, at the upstream part of Tranche-I's Gumi Protection works.

45. The proposal incorporates strengthening of the upstream and downstream banks of the deflectors which are damaged. The works include:

(i) four layers of sand filled geo-bags at apron for a width of 30 m,
(ii) a 3-m wide and 0.9 m thick toe key, with boulders in crates, and
(iii) 0.6 m thick boulder pitching on bank slope above toe key.

46. Protection works, along the southern riverbank of Brahmaputra at Borbhita area, over a length of 1.20 km.

47. The proposal incorporates provision of continuous bank revetment for a reach length of 1.2km to prevent bank migration at the downstream end of the ongoing ADB funded project in the Gumi sub-reach, under Tranche-1.

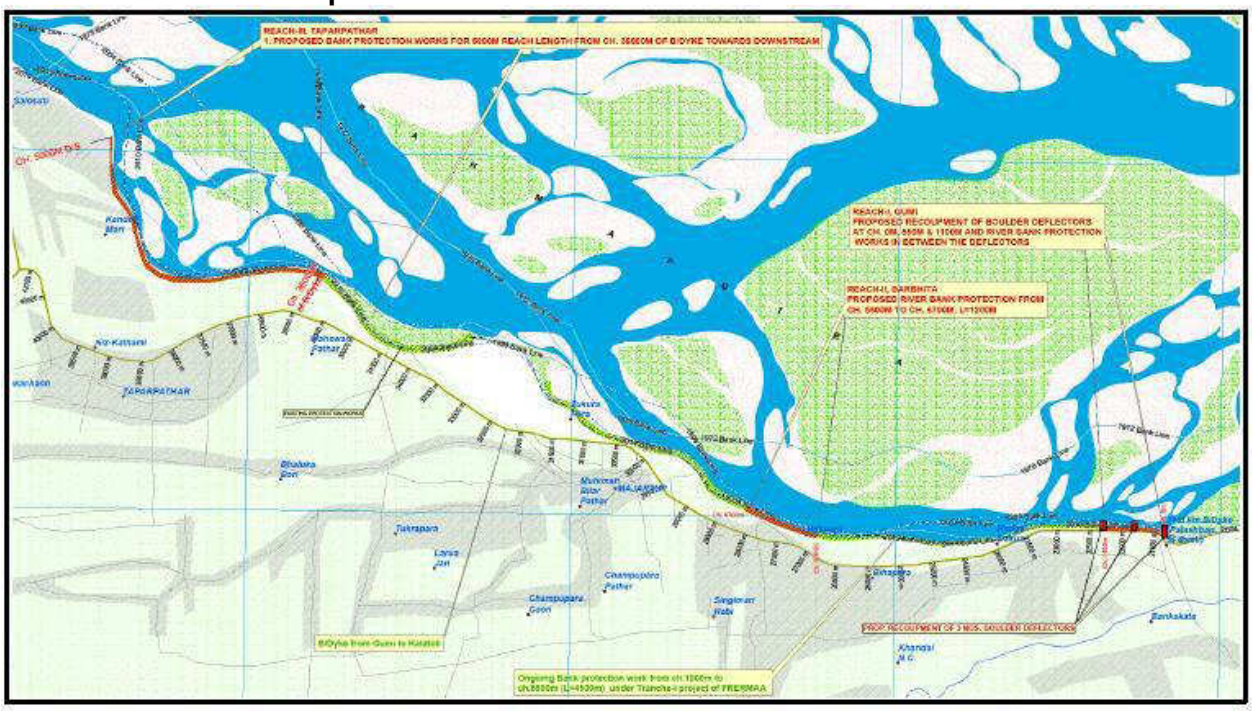
48. The works include:

(i) 4 layers of sand filled geo-bags, within an apron for a width of 30 m;
(ii) a 3 m wide 0.9 m thick toe key with boulders in crates; and
(iii) 0.60 m thick boulder pitching on bank slope above toe key.

49. Riverbank protection works along southern bank of river Brahmaputra, at Taparpathar area, over a length of 5 km. The proposal incorporates provision of continuous bank revetment for a reach length of 5 km to prevent bank migration in this reach. The work includes:

(i) four layer of sand filled geo bags, at an apron for a width of 26 m;
(ii) a 3 m wide 0.9m thick toe key, using gabion boxes filled with geo-bags; and
(iii) three layers of sand filled geo-bags in bank pitching, with vertical and horizontal paneling using polypropylene gabion boxes filled with sand filled geo-bags

Map 10: Tranche 2 work sites under Gumi Reach



3.2.5. Non-Structural and CBFRM Measures

50. **Land Use Guidelines**. Land use guidelines are aimed at ensuring that land use across the floodplain is consistent with the likelihood, risk, and hazard of flooding. For this purpose, current and likely future land use in flood-prone areas will be reviewed, especially the expected population growth and its impact on future flood risk and damage in higher-risk areas. In addition, the use of land use zoning to preserve wetlands and protect existing flood storage areas from further development will be assessed.

51. **Building and Development Guidelines.** While building and development controls are also not expected to provide a panacea for reducing flood risk and flood impacts in Assam, the flood proofing of public infrastructure is one area where improvements might be possible (to ensure it is ready and effective to return to service after a flood). The Program will assess flood damage to buildings and public infrastructure to identify possible improvements. The United Nations Development Program Disaster Management Project's work has been considered on the design and construction of flood-resilient buildings.

52. **Flood Forecasting and Warning (FFW).** Flood forecasting is a means to an end to provide timelier and more accurate flood warnings. It is the warning that is essential, rather than the forecast. While a variety of public agencies participate in the flood forecasting and warning (FFW) process in Assam, most villagers receive no formal flood warnings—they generate their own warning by watching the river during the flood season, considering local rainfall. The Program will review the elements of FFW process, paying special attention to warning needs of villages and possible improvements in communities and flood emergency management. An important element of an improved FFW system is anticipated to be the provision of local forecasts by the Water Resources Department, i.e., the translation of regional forecasts by Central Water Commission (CWC) into clear and easily understandable warnings to villages. Local communities will be centrally involved in this process.

53. **Flood Emergency Planning and Management**. Flood emergency planning includes prevention, preparation, response, and recovery activities. Flood emergency planning and management (FEPM) is and will remain a central plank of flood risk management in Assam—flooding is a regular recurring natural event that cannot be prevented or eliminated by structural measures. Flood emergency planning will to be reviewed and probably strengthened at the village, district, and state levels (e.g., using the army for evacuation).

54. **Community-Based Flood Risk Management (CBFRM).** CBFRM is one area where considerable opportunity exists to reduce the impacts of floods on village communities. Under the Program, comprehensive community surveys will be undertaken to address community concerns on flood risk management. Based on the responses, a CBFRM plan will be prepared, including raised platforms and associated facilities (e.g., permanent latrines, a raised tube-well for water supply, and permanent public buildings that are needed during flood emergencies, such as the local school and dispensary, and emergency shelter), along with community nonstructural programs, such as flood warning and flood education.

55. **Flood Education.** Villagers appear to be very aware of floods and highly flood resilient. The need for further flood education in villages will be assessed in the community surveys. Flood management in Assam is fragmented across many different agencies. The Program will promote cooperation and the exchange of ideas and information between the different agencies through workshops, seminars, etc. (a form of flood education).

56. **Financial Measures.** When in emergency accommodation during floods, flood-prone villagers cannot afford kerosene for cooking purposes. Relief payments—whether in cash or kind— are a financial measure (and a form of insurance) aimed at reducing the impacts of flooding. Under the Program, the system of flood relief payments, food, and stock fodder issue and other relief measures will be reviewed, and possible improvements will be pursued

3.2.6. Construction Material for Bank Protection

57. Use of inert or natural material is proposed. Geo-textile bags filled with sand shall be the preferred option. It is very stable material and used worldwide. The engineered bags life is much beyond 30 years, the economic life of the Project. Use of geotextile is considered beneficial even from aquatic fauna aspect. (Refer Appendix 1 which provides the extract of the research carried out by Hannes Zellweger on use of geotextile bags for river erosion control in Bangladesh). Instead of boulder Cement concrete blocks will be used.

3.2.7. Implementation Schedule and Project Cost

58. The project will be implemented over a period of two years (up to October 2020). Some of the remaining works of tranche 1 (Assam Water Resource Center, Building) will continue in tranche 2 simultaneously. The Institutional Strengthening, hydrological modeling and such other activity which were initiated in tranche-1 will be utilized during the tranche 2 period. The total estimated cost of the sub-project for structural works is estimated as ₹888.5 million.

4. DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

4.1. Introduction

59. It is necessary for the environmental assessment studies to establish baseline for valued environmental attributes that are likely to be affected by the proposed developmental activities. The study of the existing environmental conditions will establish the pre-project physical, biological and socio-economic conditions, and predict associated environmental impacts caused during the construction and operation phases of the project.

60. During the preparation of original EIA, emphasis was given to data collection on the physical environment, biological environment, and socio-economic environment of the study area (i.e. 8 km buffer zone around the embankment). These data are considered to be of prime importance considering the nature and location of the proposed subproject focused on the Palasbari and Gumi Reach in Kamrup district of Assam.

61. The update EIA 2017 has been prepared by data and information collected for preparing 2009 EIA which are still relevant such as data on (i) physiography and drainage, (ii) topography; (iii) geology; (iv) soil conditions (vi) Biological information (available species) and (v) hydrology. Biological information was again verified with the recent literature and consulted with Forest Department for any changes. The updated EIA 2017 has also included some new and updated data and information on (i) climate especially data on mean monthly rainfall (2016), (ii) water quality on selected Palasbari areas (2015); (iii) ambient air quality (2011, 2012); (iv) morphology with update data on pattern of erosion and accretion (v) soil quality data (2014). While data on Socio-economic Environment has been updated by using census data 2011 and socio-economic survey in 2012-2013, 2014, and 2015.

4.2. Description of Physical Environment

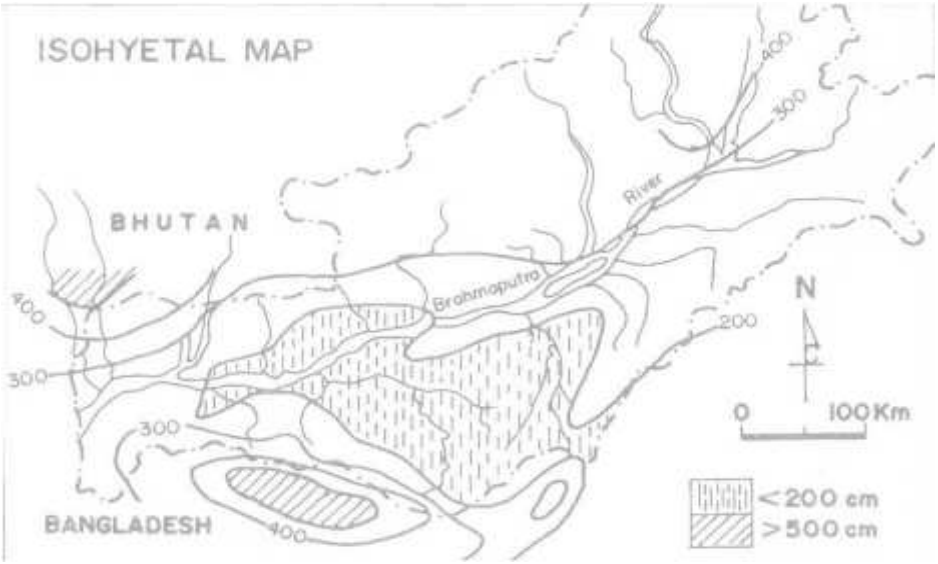
4.2.1. Climate

62. The climate of the region is sub-tropical with a hot, humid summer season dominated by the southwest monsoons from early-June to mid-September and a cool, dry winter from late October to the end of February. The pre-monsoon season starts in the early part of March until May marked by occasional thunderstorms and rising temperatures during the day. The post (retreating) monsoon season from last part of September to mid-October generally represents fair weather conditions with declining rainfall as well as.

63. The Brahmaputra Valley in Assam forms an integral part of the subtropical monsoon regime of Eastern Asia receiving a mean annual rainfall of 230 cm with a variability of 15–20%. Distribution of rainfall over different river basins in Assam shows marked spatial variations, e.g. from as low as 175 cm in the Kopili basin located in the central part of the valley to as much as 410 cm in Jiadhol basin close to the Matmora reach in upper Assam. The isohyetal map of the Brahmaputra Valley and adjoining highlands (based on IMD data) has been shown in Map 11.

64. Monsoon rain from June to September account for 60–70 % of the annual rainfall in the region, while the pre-monsoon season extending from March to May provides 20–25 % of the rainfall, caused primarily by depressions moving from west and by local convectional storms. The pre-monsoon rains are primarily controlled by the position of a belt of depressions called the Monsoon Axis extending from North-East India to the head of the Bay of Bengal. During its North-South oscillations in summer this axis moves closer to the foothills of the Himalayas resulting to heavy precipitation in Assam and adjoining highlands.

Map 11: Isohyetal Map of the Brahmaputra Valley and Adjoining Highlands[4]



65. In the absence of any meteorological station in the Palasbari Reach, the meteorological data from IMD station at Borjhar (LG Bordoloi Airport, Guwahati), which is located at 5 km distance in the southeast direction, has been used. Annual rainfall pattern of last 12 years (1901–2014) and mean monthly rainfall at Borjhar in Year 2012 are shown in figures 2 and 3, respectively.

66. Mean monthly maximum temperature varies from 23°C to 32°C, whereas mean monthly minimum temperature ranges from 10°C to 25°C. The monthly variation of maximum and minimum temperatures at Borjhar Meteorological Station are shown in Figure 4.

67. Powerful atmospheric systems called cloudbursts that trigger intense rainfall in limited areas causing flash floods of great fury, and destruction are being experienced in greater frequency along the foothill region of and in the immediate downstream areas in the Brahmaputra plains. The situation aggravates further if such extreme climatic events trigger landslide and slope failure in the upper watersheds or temporarily block river courses creating dams that subsequently break sending surging flood waves downstream. During the 1950 Assam earthquake, a massive landslide in Arunachal Himalayas blocked the Subansiri River - a major tributary of the Brahmaputra for days together creating a dam that was eventually released in a deluging flood that greatly devastated the downstream areas in Dhemaji and Lakhimpur districts of Assam. On 10 June 2000, a massive flood occurred in the upstream parts of the Brahmaputra basin in India reportedly because of a sudden failure of a landslide-induced dam in the neighboring uplands. Cloudburst and landslides related flash floods occurred in 2004 in the Manas and Beki rivers of Assam due to failure of landslide dam upstream of Kurichhu hydro-electric project in Bhutan that caused highly destructive flood and channel avulsion. On October 7 2004, a flash flood in Jinari river of Assam was triggered by a cloudburst over Meghalaya that caused great havoc in the downstream areas in Assam. Cloudburst again occurred in 2015 and affected Chaygaon area in Palasbari subproject.

[4] Goswami, D.C. 1998. Fluvial regime and flood hydrology of the Brahmaputra River, Assam. *Memoir Geological Society of India*, No.41: 53-75.

Figure 2: Actual Rainfall in Kamrup District in 2012

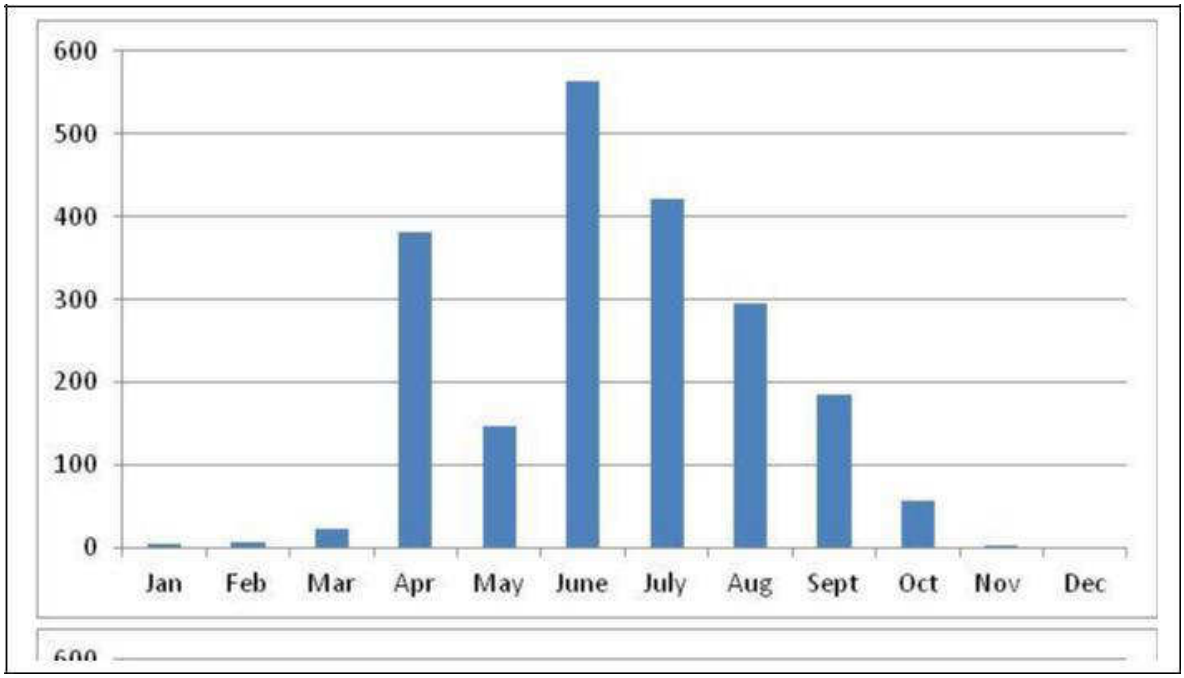
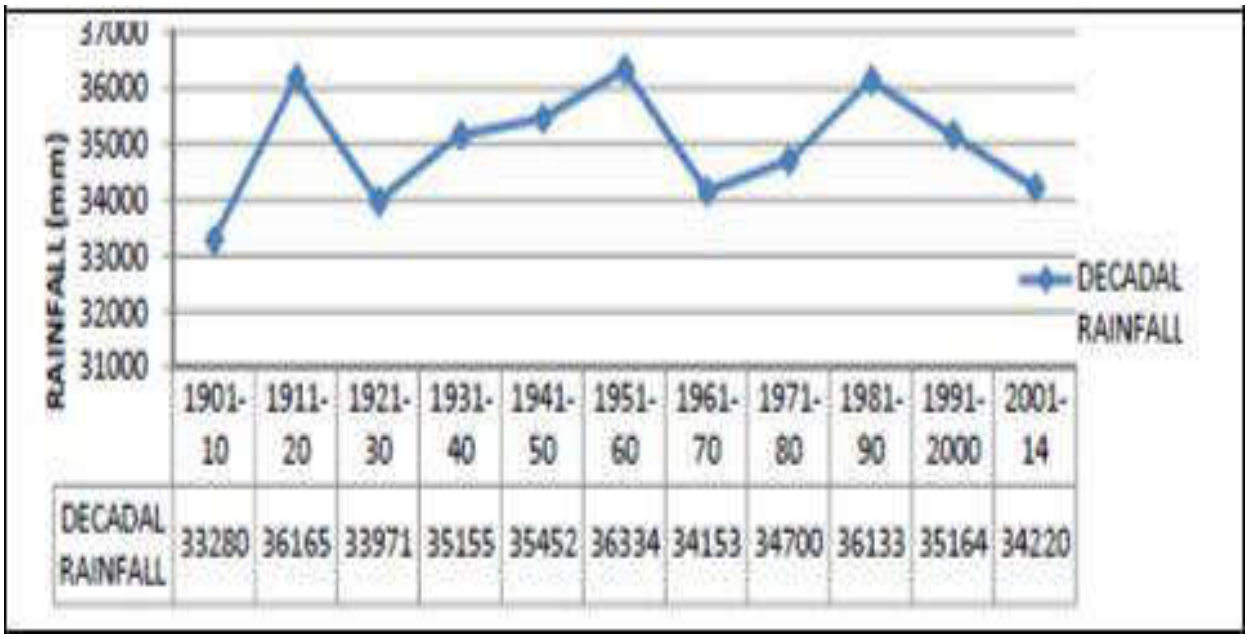
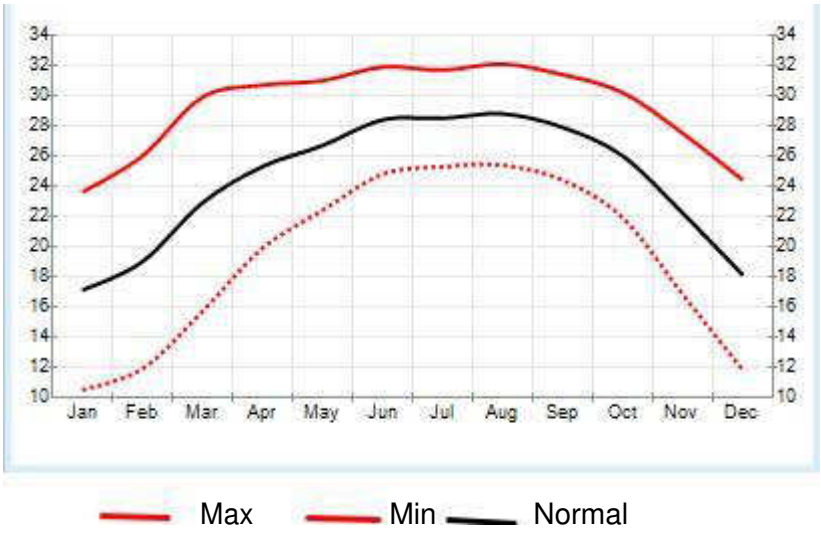


Figure 3: Dacedal rainfall variation in Kamrup district from 1901 to 2014





Temperature			
Months	**Normal**	**Warmest**	**Coldest**
January	17.1°C	23.6°C	10.5°C
February	19.0°C	26.0°C	11.9°C
March	22.9°C	29.9°C	15.7°C
April	25.3°C	30.7°C	19.9°C
May	26.7°C	31.0°C	22.4°C
June	28.4°C	31.9°C	24.8°C
July	28.5°C	31.7°C	25.3°C
August	28.8°C	32.1°C	25.4°C
September	27.9°C	31.4°C	24.4°C
October	26.0°C	30.2°C	21.9°C
November	22.2°C	27.5°C	16.8°C
December	18.1°C	24.4°C	11.8°C

Figure 4: Monthly temperature variation at Borjhar Airport 2014

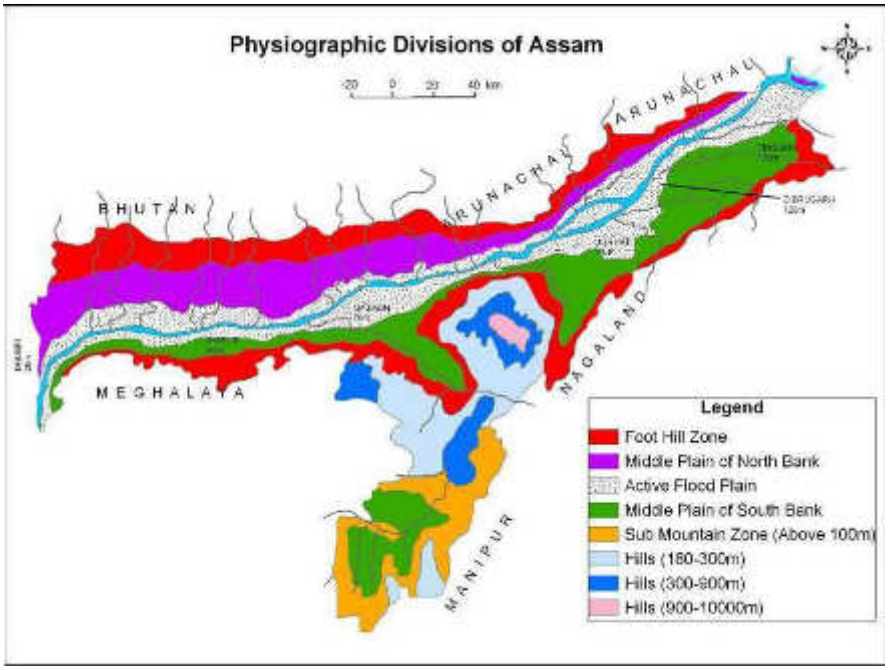
4.2.2. Physiography and Topography

68. There is a good measure of homogeneity among the project areas in terms of their riverine location in active floodplain tract along the bank of the Brahmaputra River, their composition consisting almost entirely of young alluvial soil, and acute vulnerability to flood and erosion. However, in terms biodiversity, urbanization, socioeconomic base, minerals and industries, and infrastructure, there are considerable variations in each sub-project. The physiography of Assam consists of (i) Foothill Zone, (ii) Middle Plain of North Bank, (iii) Active Flood Plain, (iv) Middle Plain of South Bank, (v) Sub-mountain Zone, and (vi) Hills. These divisions are shown in Map 12.

69. The Palasbari Reach, like the other three reaches under the NEIFREM project, is in the active floodplain zone along the bank of the River Brahmaputra. The reach consists of a variety of landscape elements *viz.,* rivers, floodplains, wetlands (beels), swamps and occasional hillocks.

70. The Palasbari Reach extends along a 74 km length of the southern bank of the Brahmaputra River in Kamrup District, from the confluence of the Jaljali River in the west to the confluence of the Khanajan River in the east. The District of Kamrup extends across both sides of the Brahmaputra River. The southern portion of Kamrup comprises three major physiographic zones: a Southern Foothills Zone, which consists of the Khasi foothills; an Active Floodplain Zone, which lies adjacent to the Brahmaputra and contains many 'charlands'; and a Middle Plain, which covers the intermediate area containing many beels and swampy areas, and a number of pronounced 'hills', which represent more refractory rock outcrops. Two hills that are of relevance to the Palasbari Sub-project are Dakhala Hill and Nagarbera Hill, which respectively mark the break in the Brahmaputra embankment and the confluence of the Jaljali River and the Brahmaputra. The Palasbari Reach consists of a mix of active floodplain and middle plain zones, with elevations falling in a westerly direction from about 50 m around the village of Majirgaon to about 40-45 m around the village of Nagarbera.

Map 12: Physiographic Divisions in Assam



71. The immediate hinterland of the Palasbari Reach is consisting of largely of the middle plain zone characterized by beels, wetlands and hills. Drainage is often poor. To the west of Dakhala Hill, the main drainage system of the hinterland is the Kulsi-Deosila River, which has a combined catchment area of 3,770 square kilometers (km^2) and forms a complex system of interconnecting anabranches, distributaries, flood runners and beels. The Deosila River, which rises on the Meghalaya Massif, appears to be the dominant river of this system. Originally, the Kulsi River formed the downstream reach of this system, flowing into the Brahmaputra to the west of Nagarbera Hill (Map 14). However, riverbank erosion from the Brahmaputra has truncated the mouth of the Kulsi River into two separate channels, one of which now flows into the Brahmaputra to the north of Nagarbera Hill, the other joining the Jaljali River to flow into the Brahmaputra to the south of Nagarbera Hill. A number of northerly flowing tributaries cross NH-37 to join the Kulsi-Deosila system. Over time, riverbank erosion from the Brahmaputra caused the River Khulsi to form two flood runners that delivered Brahmaputra floodwaters into the hinterland and across to the Jaljali River. The Brahmaputra embankments now prevent this behavior. Drainage congestion problems exist over much of the lower area of the Khulsi-Deosila System, especially where the various rivers and drainage channels come together to form the Jaljali River (Map-13).

72. To the east of Dakhala Hill, the main drainage system of the hinterland is the Khanajan River, which is an outlet channel of Deepar Beel that joins the Brahmaputra close to the village of Majirgaon, together with its anabranches, and tributaries. There is a sluice gate in the outlet channel of the Khanajan River that is used to regulate water levels in Deepar Beel. However, this sluice gate is only operational when the Brahmaputra is not in flood.[5] To the west of the Khanajan River, a drainage channel referred to as Kalbhog Channel flows to the Brahmaputra close to the town of Palasbari via a sluice gated outlet in the Brahmaputra embankment. This sluice gate is currently non-functional but was used during the rainy season to irrigate agricultural fields in the hinterland (and provide water for fishing). Another sluice gate at Nahirais functional and is used for irrigation during the rainy season. Major Beels[5] in the hinterland are located along both drainage systems.[6]

73. The topography of the project area is characterized by flat tract that forms a part of the active floodplain including the chars (sandbars) within the banklines of the River Brahmaputra. The valley as a whole slope gently from the northeast at an average gradient of 13 cm/km. The gradient is about 17cm/km in its upper reach near Dibrugarh, which reduces to 10 cm/ km near Guwahati. The monotony of the floodplain lying at an average elevation ranging from 50 m to 120 m above MSL is broken at places by protruding arms of isolated hillocks of Archaean origin. The Dakhala hill (elevation 138 m) and the Nagarbera hill (167 m) are two such prominent hillocks located within this project area. Both these hillocks, made up of granite and gneisses, are northerly outcrops of the Meghalaya plateau. The western part of the project area from Dakhala to Nagarbera presents a relatively low-lying tract due to their peculiar structural position in relation to the geology and tectonics of the highlands to the south.[7] The floodplain belt in this stretch is marked by large number of degraded wetlands, abandoned river channels, waterlogged and drainage congested areas. The relief map based on analysis of satellite data showing topography of the Palasbari Reach is presented in Map 14.

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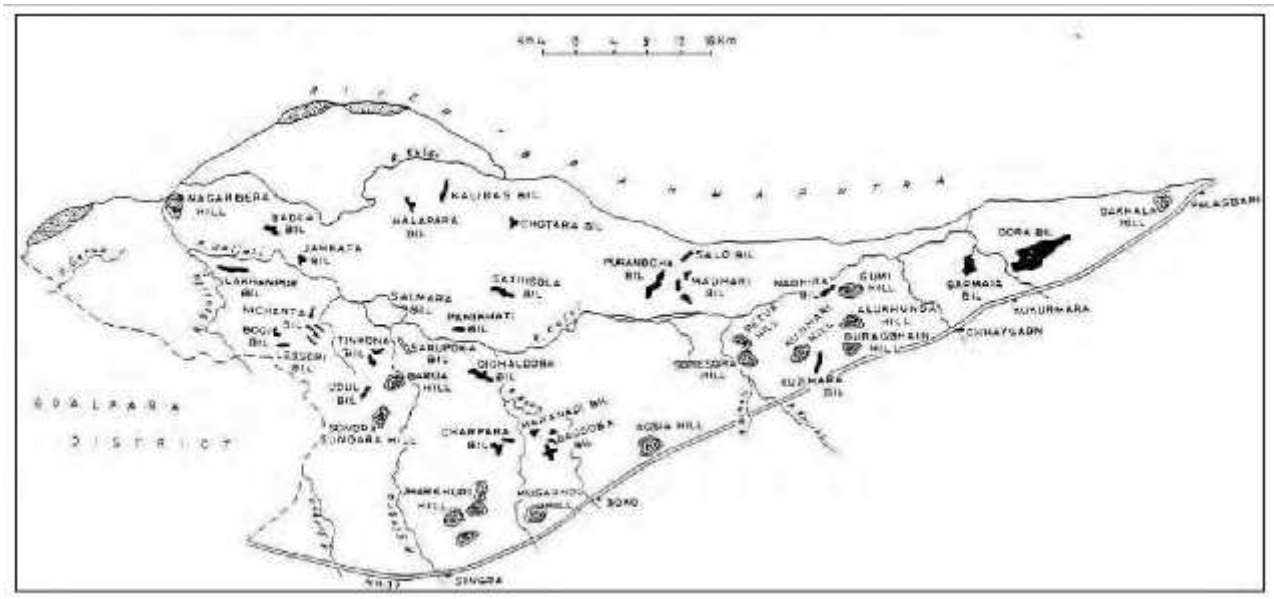
[5] When the Brahmaputra River is in flood, water levels in the Brahmaputra are typically much higher than in Deepar Beel, causing flooding around the beel.

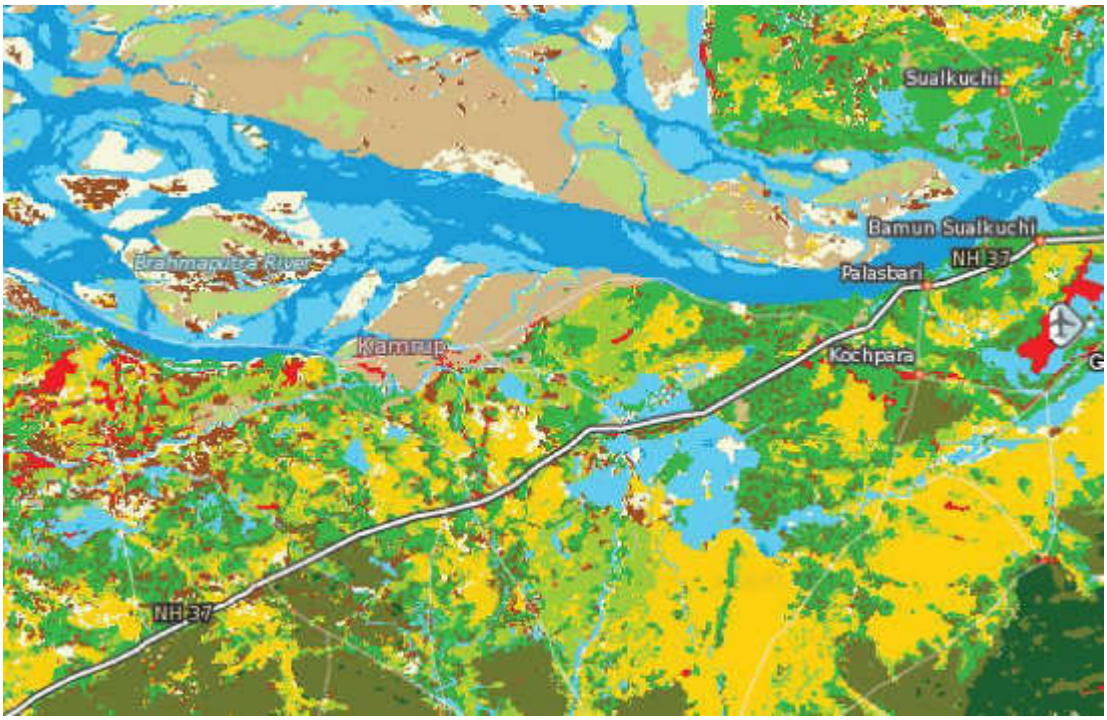
[6] Deepar Beel is a wetland of national and international significance and a designated RAMSAR site.

[7] Goswami, D. C. and Das, P. J., 2002: Hydrological Impact of Earthquakes on the Brahmaputra River Regime in Assam: A case study in exploring some evidences, Proc. 18th National Convention of Civil Engineers, Nov. 9-10, 2002, pp. 40 -48.

Map 13: Physiography and Drainage of the Palasbari Reach



Map 14: Topography and Land use under Palasbari reach, 2014-2015



Source: Bhusban, ISRO

4.2.3 Water Environment

74. The State of Assam in general and the Brahmaputra Valley in particular, is endowed with vast water resources potential. The Brahmaputra River and the 33 major tributaries joining it in Assam including the main trans-Himalayan tributaries of Subansiri, Jia Bharali, and Manas carry about 30% of the country's total water resources potential. Surface water bodies covering about 8,251 km^2 account for 10.5% of the total geographical area of the State. Of these, the river

systems including waterlogged areas occupy 6,503 km^2. The annual surface water availability is over 53 million ha m. Besides, there are 3,513 wetlands in the Brahmaputra valley covering 1012.3 km areas in Assam. Groundwater is also plentifully available at shallow depth in the valley and the utilizable ground water resources estimated at over 2 million ha m.

4.2.3.1. Surface Water

75. In the Palasbari Reach, the Kulsi River, a major south bank tributary of the Brahmaputra originating in the Meghalaya plateau to the south, drains a large area running westward parallel close to the Brahmaputra and eventually joining it through Jaljali River near Nagarbera hill. The important sub-tributaries originating in the Meghalaya hills that join the Kulsi River in the plains are the Boko River, the Singra River, the Kharkhari River and the Deosila River. The drainage map of the reach showing major tributary rivers and wetlands is presented in Map 15.

76. The Kulsi River has a basin area of 750 km^2 with a maximum discharge of 191 cubic meters per second (m^3/s) and a minimum of 7.5 m^3/s. The annual rainfall in the basin is about 167.2 cm. The river has suffered truncation of its course and diversion at several places since 1974 forcing it to take the present course, out falling into the Brahmaputra near Nagarbera.

77. Close to the starting point of the Palasbari Reach, the Khanajan River, which is an outlet channel of the **Deepar Beel** - a wetland of national and international significance, designated as a Ramsar Site, meets the Brahmaputra River.

78. To the west of Khanajan, a small channel called Kalbhog flows across the embankment and joins the Brahmaputra near Palasbari (Ch. 4.9 km). A sluice gate at Palasbari discharges the landslide water and carries Brahmaputra water to the agricultural fields during the monsoon season. The sluice gate located near the embankment is presently non-functional. The local people consider water for irrigation along with the advantage derived for fishing during the flood season a great boon. Another sluice gate at Nahira is functional and used for irrigation during the rainy season. Truncation and diversion of the Kulsi near the embankment has created several wetlands like the Kalidas beel, Alikash beel, along with extensive drainage congestion in the downstream areas. The distribution of major wetlands and other water bodies in Palasbari Reach located within the 8 km buffer zone around the embankment is shown in Map 15.

79. Water quality monitoring and analysis in regard to physico-chemical as well as biological parameters was carried out on samples collected from three locations in the project area. The locations of the sampling points are shown in Map 16. The results of the analysis are presented in Table 3 and these are compared with the water quality criteria of designated best use given by Central Pollution Control Board (CPCB). (Refer Appendix 2).

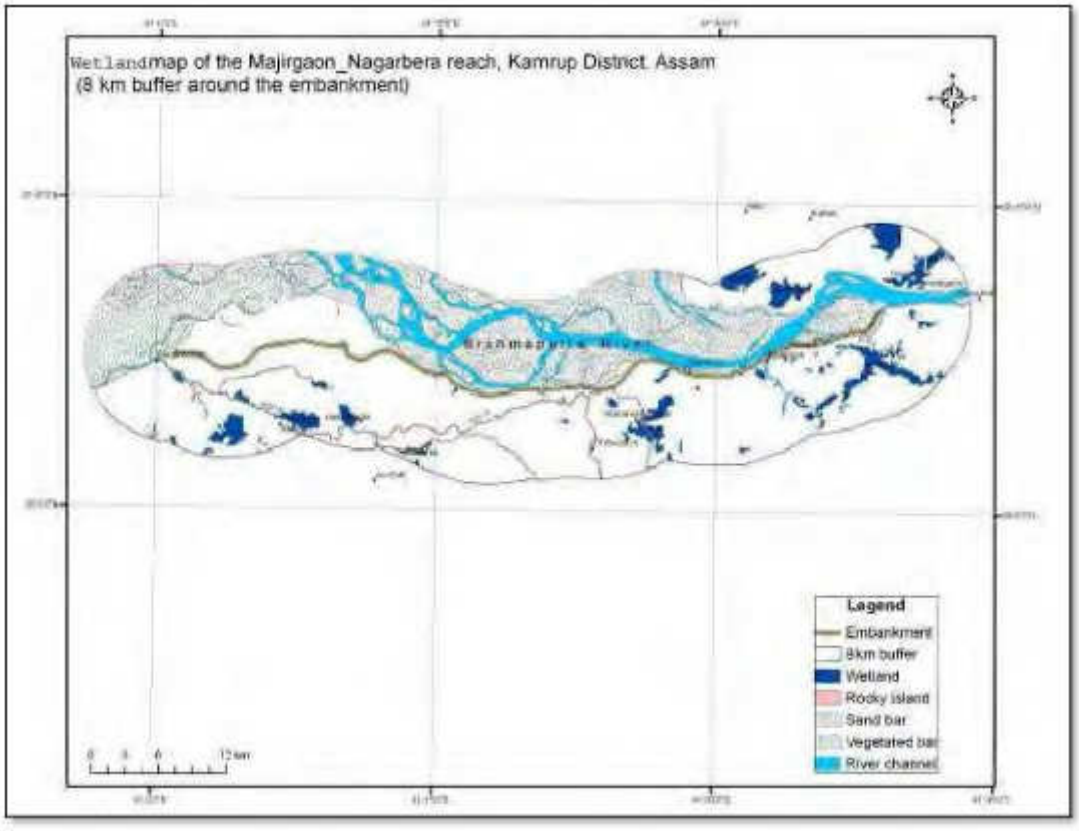
80. The comparison of the surface water samples analyzed against the water quality criteria for designated best use shows that the water quality of the project area meets the criteria of Class 'C' "Drinking Water Source after Conventional Treatment."

Table 3: Surface Water Quality at Selected Locations in Palasbari Reach

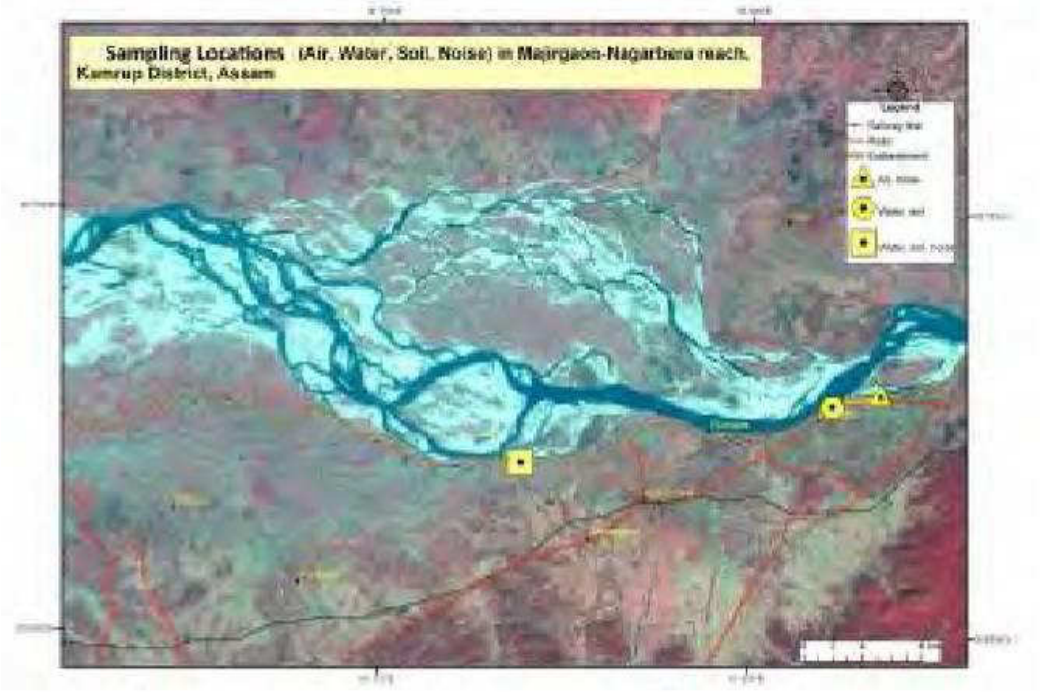
Parameter	Unit	**Palasbari*** (May, June 2014) (Tranche 1 site/ Tranche 2 site)	**Gumi*** (May, June, 2014) (Tranche 1 site/ Tranche 2 site)
Temperature	(ºC)	25	25
pH	-	7 / 6.8	7.1 / 7.1
TSS	mg/L	43 / 48	45 / 49
TDS	mg/L	194 / 178	105 / 108
DO	mg/L	7 / 7.1	6.8 / 7.1
BOD	mg/L	0.8 / 0.6	0.8 / 0.5
COD	mg/L	2.86	2.86

(Pollution Control Board, Assam during Tranche 1, results are from the work sites and from Trance 2 sites)

Map 15: Wetland and other Waterbodies of the Palasbari Reach (8 km buffer around the embankment)



Map 16: Sampling Locations of Water, Soil, Air and Noise



4.2.3.2. Hydrological and Morphological Aspects

81. The hydrological characteristics of the Brahmaputra Valley, as a whole, are dominated by the intensely powerful monsoon rainfall region of the eastern Himalayas, the freeze and thaw cycle of Himalayan snow, and the immensely dynamic fluvial processes of the river and its tributaries. It is also influenced by the unique characteristics of the physical terrain and tectonic framework of the region.

82. The river carries an average annual discharge of 19,830 m^3/s. The highest recorded daily discharge at Pandu upstream of the Palasbari stretch was 72,726 m^3/s (August 1962). The summer high flows and winter low flows vary in certain years as much as 20 times. The annual flood of the river with a magnitude of 48,200 m^3/s has a return period of 2.2 years, while the maximum recorded flow has a return period of 133 years.

Table 4: Hydrological and Hydraulic parameters of Palasbari subproject area:

Design Parameters	Value	Remarks
Discharge Q	66,422 m^3/s	50 years return period at Pandu
	46,495 m^3/s	70 % of total discharge at site
HFL	50.38 m	At Pandu
	48.31 m	at Guimara
	49.06 m	At Kalbhog
Velocity V	41.80 m	At Guimara
	3.0 m/s	At Kalbhog
Silt factor	0.90	

83. The water yield in Brahmaputra River per unit area of its basin is highest among the large rivers of the world. The enormously large variations in the daily discharge are remarkable feature of its flow regime.

84. Brahmaputra is one of the most heavily sediment charged rivers in the world carrying an average annual suspended sediment load of 400 million metric tons at Pandu Station with an average daily rate of about 2.1 million tons during the raining season (May through October). Transport rates as high as 26 million tons per day has been recorded during the peak flow. The river carried significantly higher sediment loads during the period 1955-60, which may be related to the 1950 earthquake that caused enormous landslides in the Himalayan slopes generating large debris load for the river. The amount of sediment carried as bed load by the Brahmaputra at Pandu is estimated to be 5–15% of the total sediment load.

85. The river carries more water per unit area of its basin than any other river of the world and is second only to the Yellow River in the People's Republic of China in terms of sediment yield. The pattern of sediment yield in the major tributaries of the Brahmaputra River in Assam is shown in Table 6. The high sediment yield in the tributary rivers as well as the mainstream of the Brahmaputra is attributed mainly to the extremely potent rainfall regime, easily eroded rock formations, frequent seismic events causing massive landslides in the hill slopes, and human depredations in the watersheds through harmful land use practices like unorganized shifting cultivation, encroachment of water bodies, forest areas and hill slopes.

Table 5: Water and Sediment Yields of Selected Tributaries of the Brahmaputra River, Assam

River	Drainage area (km^2)	Water yield ($m^3\ s^{-1}\ km^{-2}$)	Sediment yield (tons $km^{-2}\ yr^{-1}$)
Brahmaputra at Tsela d' Zang (People's Republic of China)	191222	0.0105	100
Pasighat (India)	244700	0.0231	340
Pandu (India)	500000	0.0306	804
Bahadurabad (Bangladesh)	580000	0.0331	1128
Dibang	12120	0.1066	3765
Lohit	22077	0.0709	1960
Subansiri	27400	0.0756	959
Jia Bharali Puthimmari	11300	0.0858	4721
Puthimmari	1787	0.0403	2887
Pagladia	383	0.1087	1883
Manas	36300	0.0232	1581
Kulsi	750	0.0797	135
Buridhing	4923	0.0788	1129
Desang	3950	0.0382	622
Dhansiri	10240	0.0184	379
Kopili	13556	0.0182	230

(Source: After Goswami, 1985)[8]

[8] Goswami, D.C.1985. Brahmaputra River, Assam, India: Physiography, basin denudation and channel aggradation. *Water Resources Research, Amer. Geophys. Union,* 21: 959-978.

86. The flood inundation scenario in the Palasbari Reach based on analysis of satellite data shows the area affected during the flood of 2004, which is considered to be among the most severe ones to occur in this region. The area covered by inundation was 2,364.67 ha, which accounts for 18.27% of the geographical area in the 8 km buffer around the embankment. Villages affected are Dakhala, Satrapara, Bholapara, Guimara, Chimina and Futuri. Although protection measures are taken up to save present Palasbari township from Majirgaon to Dakhala Hills under ADB funded project under FREMAA (Tranche-1).

Table 6: Pattern of Flooding in 8 km Buffer Zone of Palasbari Reach (as on July 13 2004)

Particular	Area (ha)	Area (%)
Flooded Area – River Side	239.69	1.85
Flooded Area – Country Side	2124.98	16.42
Total Flooded Area	2364.67	18.27
Total Area in 8 km Buffer	12939.34	100.00

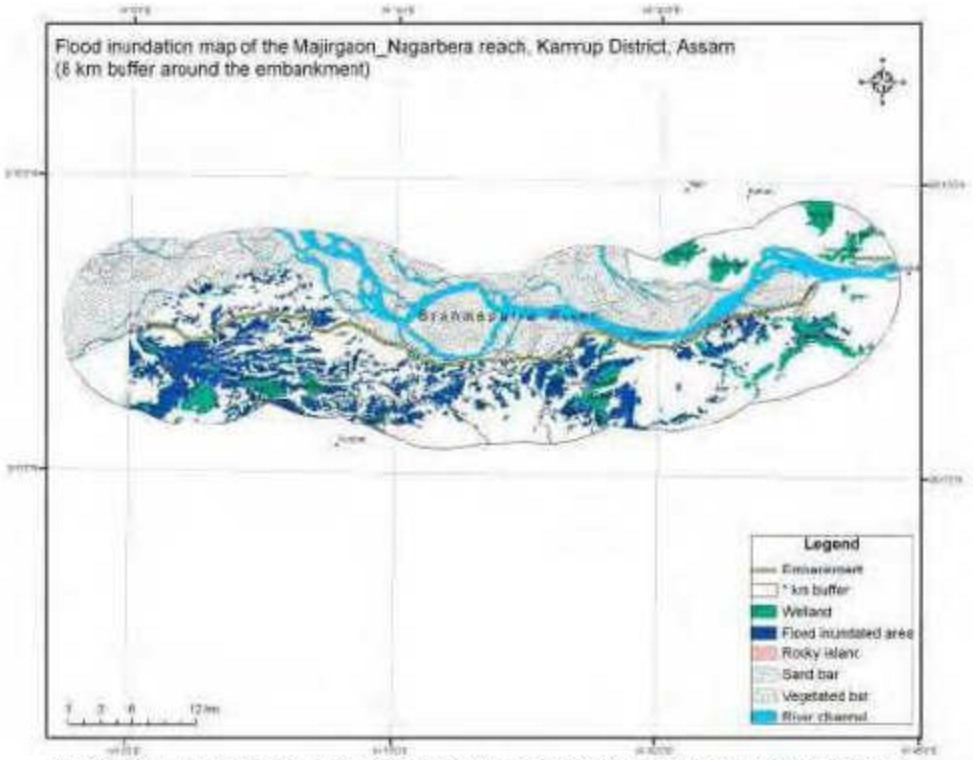
87. The morphology of the Brahmaputra River is characterized by intense braiding, bar formation, and extremely dynamic bankline and bed configuration. The morphology and behavior of the river undergoes drastic changes in response to variation in the flow regime and pattern of sediment transport and deposition in the river following the seasonal rhythm of the monsoon.

88. The Jaljali River is the main tributary within the sub-project area, running north under National Highway 37 to near chainage 15 km of the Brahmaputra Dyke and then running roughly parallel to the Brahmaputra River, passing within a kilometer of Nagarbera Hill at km 60, where it confluences with the Brahmaputra River. Significant bank retreat has recently occurred downstream of Nagarbera Hill.

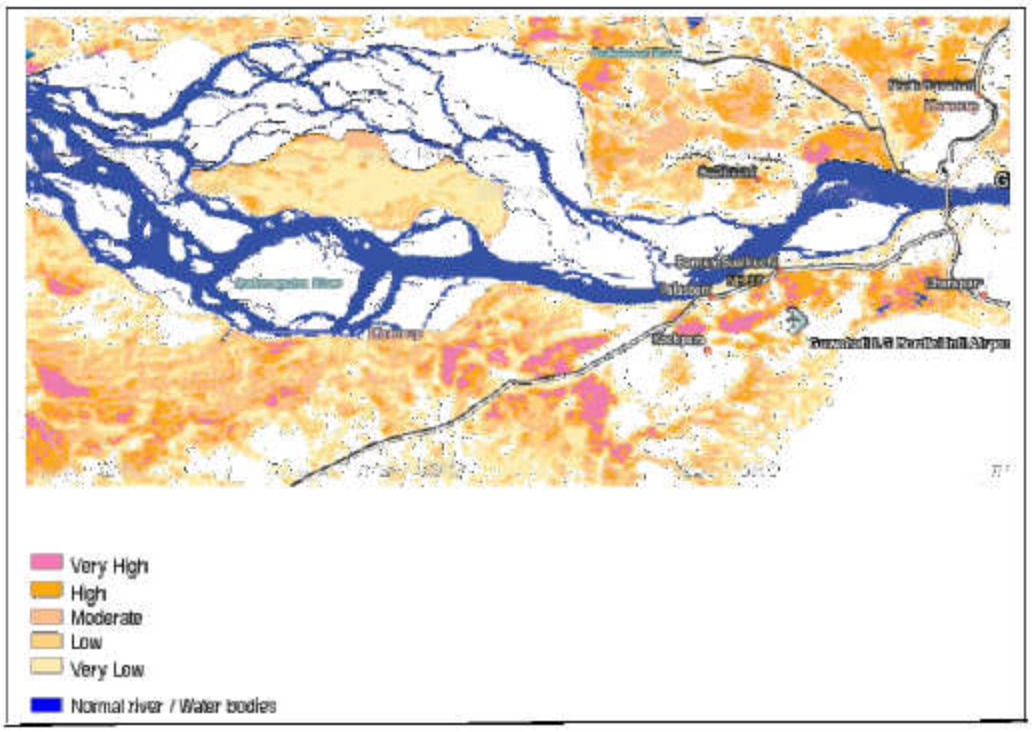
89. The general trend of south-bank tributaries, such as the Jaljali River, is for significant portions of the channel to run parallel to the Brahmaputra River for many kilometers. This is because the south-bank tributaries generally carry very little sediment and are thus diverted in the downstream direction by the heavy sediment deposition of the larger river. Therefore, when Brahmaputra bank erosion occurs at the mouth of these south-bank tributaries, the tributary's channel length can be shortened significantly. This in turn seems to have a destabilizing effect on the platform of the upper portions of the tributaries as they adjust to the new channel slope. This process has been observed within the Kaziranga sub-project area. The effect has not been documented along the Jaljali River. However, this may be because there is very little infrastructure near the Jaljali River.

90. Inundation of the Jaljali River floodplain has been documented from satellite images captured during periods of high flooding in the Brahmaputra River. It is not clear if this inundation is from high flows in Jaljali River and heavy rainfall alone, or if there is a backwater effect causing poor drainage during periods of high water in the Brahmaputra. The result is that significant portions of the floodplain are inundated during the flood season.

Map 17: Flood Inundation Map of Palasbari Reach



Map 18: Flood Hazard Map of Palasbari Subproject Area 2012



91. The Brahmaputra is a classic example of a braided river - a river in which the channel exhibits successive bifurcation and rejoining of flow around sand bars and islands. In case of the Brahmaputra in its Assam reach, a combination of multiple factors, such as excessive sediment load, large and variable flow, easily eroded bank[9] materials, aggradation of the channel have been identified as the possible underlying factors. Further, the braiding mechanism is related to the presence of narrow sections (nodes) where the bank, are stable due to the existence of resistant rocks, like the one near Guwahati, in the immediate downstream of which the channel fans out developing an intricately braided channel as evidenced in the Palasbari reach.

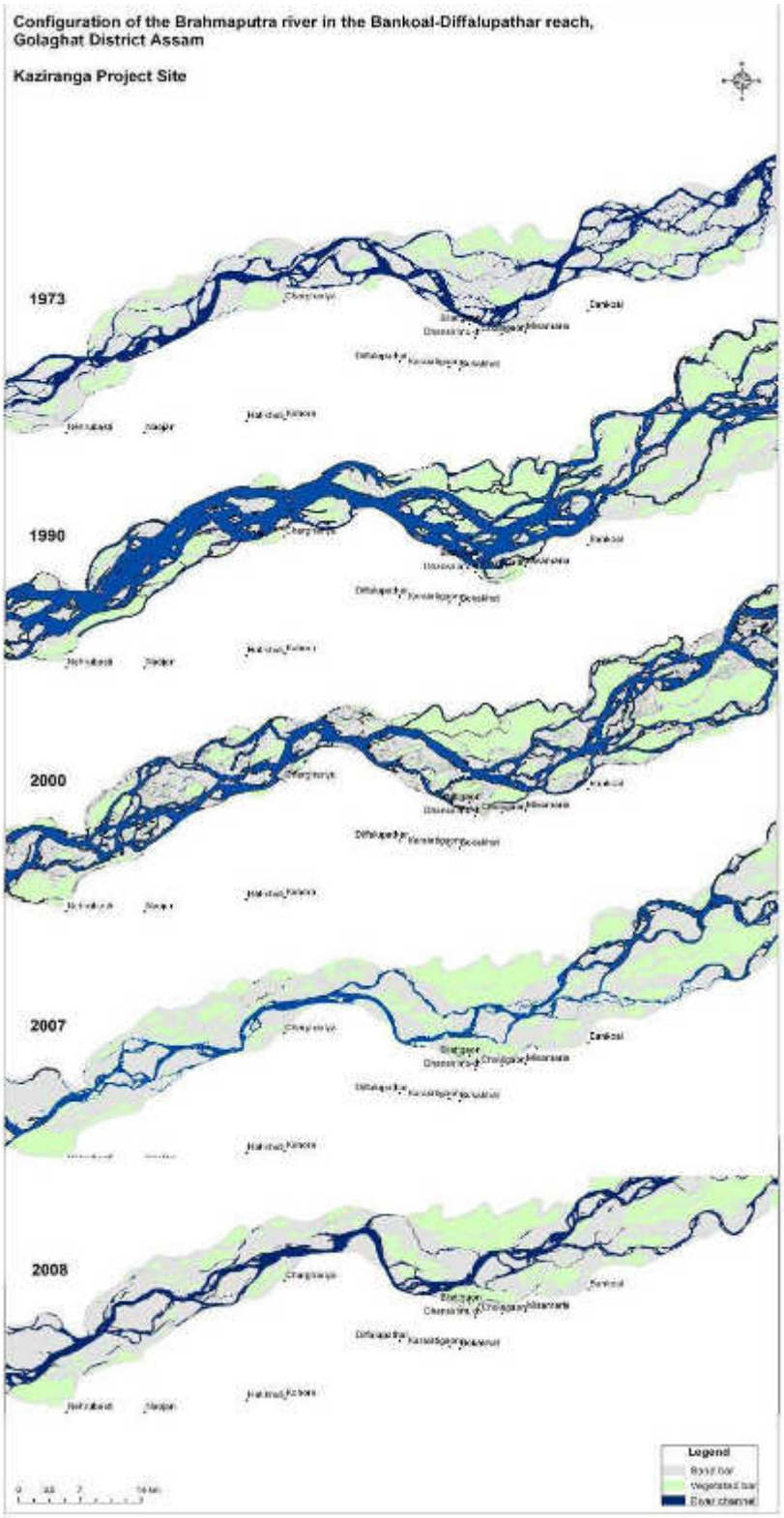
92. Another striking feature of the river's morphology is the continuous shift of the thalweg (deep channel) from one location to another within the bankline of the river. Bank materials of the Brahmaputra consist mainly of varying proportions of fine sand and silt with only occasional presence of clay. There is a relatively fine-grained top stratum and a coarser substratum.

93. Bank failures are rampant in numerous locations like the Palasbari Reach. These failures are largely seen as a function of hydraulic character of the flow and engineering properties of bank materials. Shear failure in the upper bank materials is by far the most widespread mode of bank failure in the river. These are caused either by undercutting of the upper bank materials by channels during the high floods producing an overhanging cantilevered block that eventually fails or by over steeping of bank materials due to migration of the thaleng closer to the bank during the falling stages. The latter process seems to be more dominant in case of the Palasbari Reach.

94. The bed regime of the Brahmaputra is characterized by drastic changes in bottom configuration and occurrence of bed forms of greatly varying sizes ranging from small size ripples of few centimeters wavelength to giant size dunes and waves of dozens of meters. The dynamic pattern of the channel configuration and movement of the Brahmaputra in the Palasbari reach is demonstrated for different years based on the SOI topographical map of 1911 and the IRS satellite images for 1977, 1991, 2000, 2006, 2008 (Map 19). The movement of the thalweg (deep channel) towards the south bank and its present position hugging the backline where existing protection measures viz. embankments and spurs are under serious threat is well evidenced in the succession of images presented. The pattern of erosion and accretion of the bank during the period 1911 to 2008 based on analysis of satellite as well as conventional data using GIS. The rates of erosion and accretion estimated from this analysis for the period 1911-2008 are 16,119.83 ha and 1831.08 ha, respectively, giving a net loss of around 14,288.75 ha of land. Pattern of Erosion and Accretion of the Brahmaputra Bank in the Palasbari Reach (1972 - 2014) is shown in the map-20. Bathymetric survey results are shown in figure-5.

[9] Goswami, D. C., 2002. Channel Pattern, Sediment Transport and Bed Regime of the Brahmaputra River, Assam. In S. K. tendon and B. Thakur (eds.). Recent Advances in Geomorphology, Quaternary Geology and Environmental Geosciences: Indian Case Studies, Manisha Publications, pp. 143-156.

Map 19: Pattern of Channel Configuration and Thalweg Movement of the Brahmaputra River in Palasbari Reach (Year 1911 through Year 2008)



Map 20: Pattern of Erosion and Accretion of the Brahmaputra Bank in the Palasbari Reach (1972 - 2014)

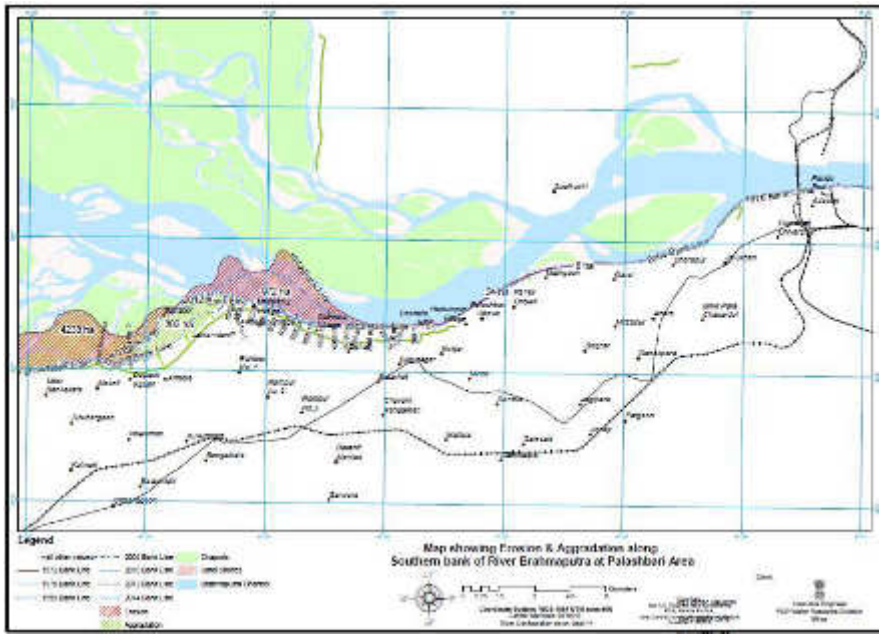
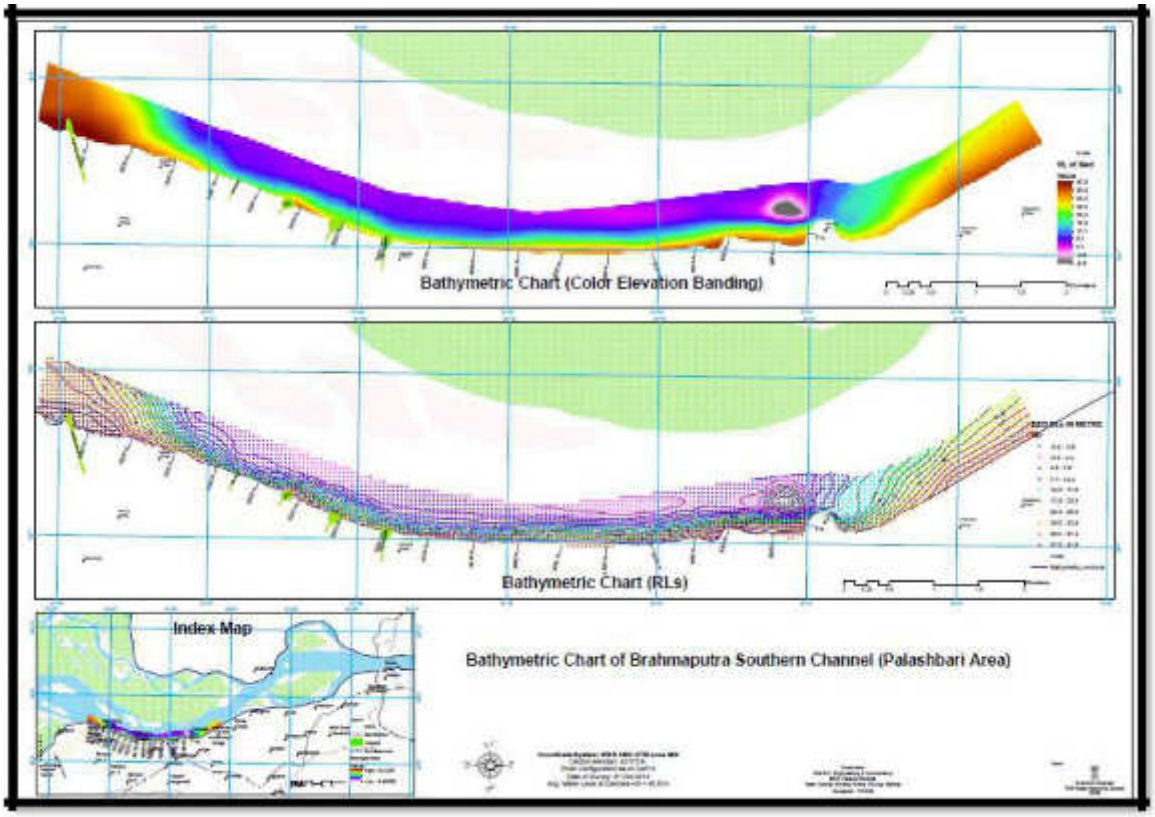


Figure 5: **Bathymetric Chart of Brahmaputra Southern Channel (Palasbari Area)**



95. The pattern of bankline migration in the reach during different time periods is shown in Map-21. There has been persistent regression of the backline in most of the locations where cross sections are taken although at varying rates (Table 7). The pattern of shifting of the bankline during the present decade as depicted on the map for the period 2000–2007 shows regression in all the sections except a minor amount of progression (forward shifting) in one cross-section.

Map 21: Bankline Migration (in m) of the Brahmaputra River in the Palasbari Reach at Selected Cross-sections during different Time Periods

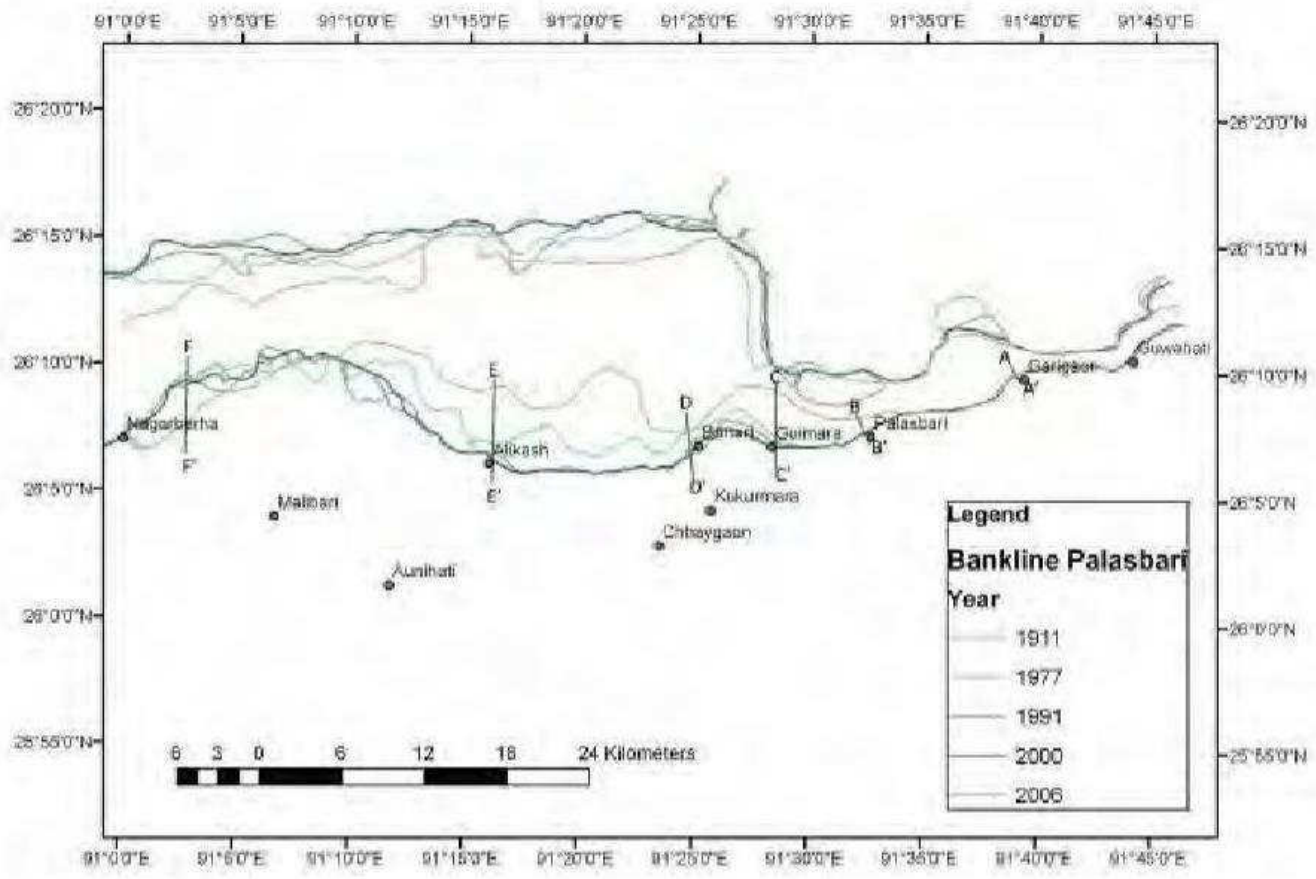


Table 7: Rates of Bankline Migration (in m) at Selected Cross-sections in the Palasbari Reach during Different Time Periods

Cross-Section				
	1911 – 1977	1977 - 1991	1991 – 2000	2000 - 2007
AA	53	-81	42	-55
BB	-1215	-55	23	-58
CC	-3430	-354	-321	-23
DD	-113	-1691	-137	-580
EE	-4128	-710	-415	4
FF	2770	821	-521	-298
Total	-6062	-2070	-1329	-1010

4.2.4. Flooding Behavior

The two segments of the subproject site - east of Dakhala Hill and west of Dakhala Hill are exposed to mainstream flooding from the Brahmaputra River, tributary flooding from both Deepar Beel (to the east of Dakhala Hill), and from the Kulsi-Deosila System (to the west of Dakhala Hill), and to local flooding from heavy rains.[10] These three types of flooding behavior, which can occur separately or in conjunction, can interact to exacerbate flooding impacts. Obviously, high water levels in the Brahmaputra serve to increase the level and duration of tributary flooding in Deepar Beel and in the Kulsi-Deosila River. It is noted that the outlet sluice on Deepar Beel is non-functional during Brahmaputra flooding, which raises the level and extends the duration of tributary flooding along this waterway, a situation that will be further exacerbated by local flooding. It is also noted that drainage congestion is widespread around the lower reaches of the Kulsi-Deosila system, a situation that will again be exacerbated by local flooding.

It has not been possible to obtain details of flooding behavior along the Palasbari Reach, although recent flooding experiences of two villages in the Palasbari Sub-project area are reported in 'Volume 1, Flooding in the Brahmaputra Valley of Assam' (NEIFRERM Project, July 2008). In 2008, several major floods occurred in Kamrup District. In mid-August, some 708 villages in the Kamrup Rural Sub-division and some 70 villages in the Kamrup Metro Sub-division were affected by flooding. The cause of this flooding is not stated but given its widespread nature it was presumably mainstream or a combination of mainstream and tributaryflooding. It is not known how many of these villages were in the Palasbari Reach. In Septembe 2008, major flooding occurred in the Hajo and Rangiya Sub-Divisions of Kamrup (to the north of the2Bramaputra) caused by tributary flooding when the Puthimari River (catchment area 1,790 km) breached embankments at a number of locations. Some 20,000 people in the Hojo Sub-division and a further 80,000 people in the Rangiya Sub-division were affected.National Highway NH-31 was cut for several days by floodwaters from the Puthimari River. Again, it is not known what occurred, if anything, along the Palasbari Reach tributary flooding in Deepar Beel and in the Kulsi-Deosila River. It is noted that the outlet sluice on Deepar Beel is non-functional during Brahmaputra flooding, which raises the level and extends the duration of tributary flooding along this waterway, a situation that will be further exacerbated by local flooding. It is also noted that drainage congestion is widespread around the lower reaches of the Kulsi-Deosila system, a situation that will again be exacerbated by local flooding.

4.2.4.1. Groundwater Quality

96. The entire Brahmaputra Valley especially its floodplain zone underlain by unconsolidated alluvial materials is a vast reservoir of groundwater. The dynamic resource of groundwater in the Brahmaputra valley is estimated to be of the order of 2.79 million ha m. In the floodplain zone 96. the depth of water is shallow, normally within 5 m below ground level. During the post monsoon period, in almost the entire flood plain area of the Brahmaputra Valley, the water table lies within 2 m below the ground surface, caused mainly by the impact of monsoon rains and recharge to the groundwater aquifers. This situation leads to water logging in large areas of the floodplain.

97. Groundwater quality of sample taken from Palasbari New Market Area reveals that the quality within permissible limits based on drinking water quality standards under IS 10500:1991 and meets all the desirable requirements. The analysis of the groundwater quality is represented in Table 8.

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[10] Interviews with villagers from Panikhaity and Jahirpu Villages, both in the Palasbari Sub-project area, indicated that tributary floods from the Kulsi River were less deep than mainstream floods from the Brahmaputra (see 'Volume 1, Flooding in the Brahmaputra Valley of Assam', NEIFRERM Project).

98. The Brahmaputra Valley is formed during the Pleistocene dating back to approximately 2 98. million years based from sediments derived from the Himalayas in the north, the Assam plateau in the south, and brought down by the Brahmaputra River and its tributaries. It is considered to be a tectono-sedimentary basin, 720 km long and 80–90 km wide, underlain by recent alluvium 98. approximately 200-300 m thick consisting of clay, sand and pebble. Most of the basin is underlain by very young and unweathered sedimentary formations with the result that the river carries mainly fine sand and silt with very little clay. The continuity of the flood plain is interrupted by some isolated hillocks of Archaean origin like the Dakhala Hill situated near Palasbari Reach. A dominant feature of the riverine landscape of the Brahmaputra is the large number of sandbars of varying shapes and

sizes locally known as Chars that develop on the sandy bed of the braided channel. Although mostly transitory in nature, some of these chars are more or less permanent with a veneer of fertile soil on the top that support vegetation, crops and settlements. Geo morphology of Palasbari reach in map-23.

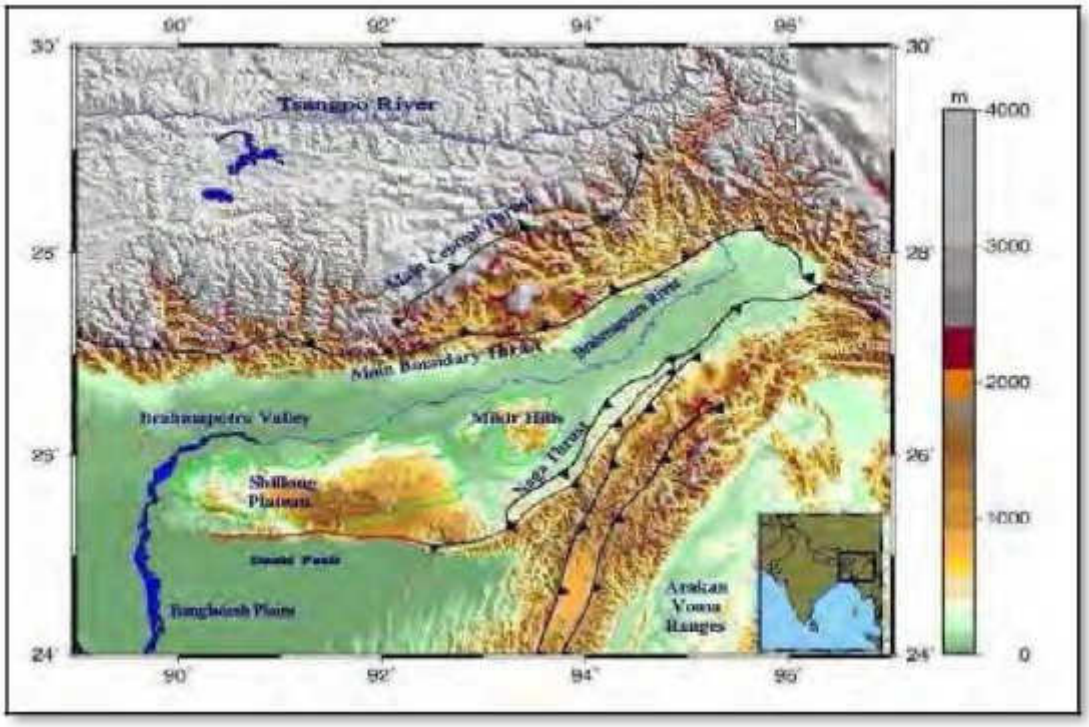
Table 8: Groundwater Quality

Sl.no	Parameter	Test Method	Palasbari	Units
1	pH Value	IS 3025 P-11	6.5	--
2	Appearance		Clear	
3	Temperature	IS 3025 P-9	19	°C
4	T. Hardness ($CaCO_3$)	IS 3025 P-21	154	mg/l
5	Chlorides (as Cl)	IS 3025 P-32	12	mg/l
6	Turbidity	IS 3025 P-10	05	mg/l
7	Total Iron (as Fe)	IS 3025 P-53	0.4	mg/l
8	Total Alkalinity		180	
9	Calcium		80	
10	Arsenic (as As)	IS 3025 P-37	0.00030	mg/l
11	Nitrate NO_3		0.15	
12	Fluoride		0.59	mg/l
13	Sulfate as So_4	IS 3025 P-24	82	mg/l
14	Total Coliform	IS 1622	Absent	MPN/100ml
15	F. Coliform	IS 1622	Absent	--
16	Lead (as Pb)	IS 3025 P-47	BDL	mg/l
17	BOD		1.6	mg/l

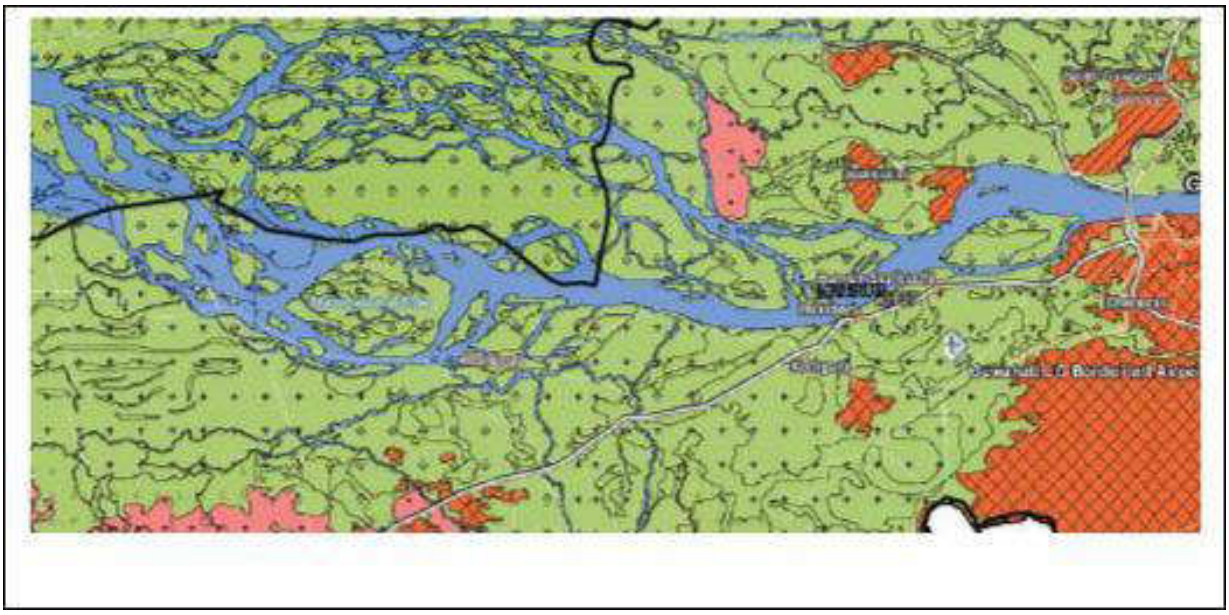
Source: Primary Analysis. Test carried out on 9.12.2015 by Greenviron

4.2.5. **Geology**

Map 22: **Geotectonic map of the region**



Map 23: Geomorphology of the Palasbari Reach



Source: Bhuban, ISRO

4.2.6. Seismology

99. Due to their strategic location in regard to colliding Eurasia (Chinese), Indian and Burmese tectonic plate boundaries, the Brahmaputra valley and its adjoining hill ranges are seismically very unstable. The earthquakes have caused extensive landslips and rockfalls on the hill slopes, subsidence and fissuring of ground in the valley, and changes in the course and configuration of several tributary rivers as well as the mainstream. The geo-tectonic map of the Brahmaputra valley and its adjoining highlands is presented in Map 24.

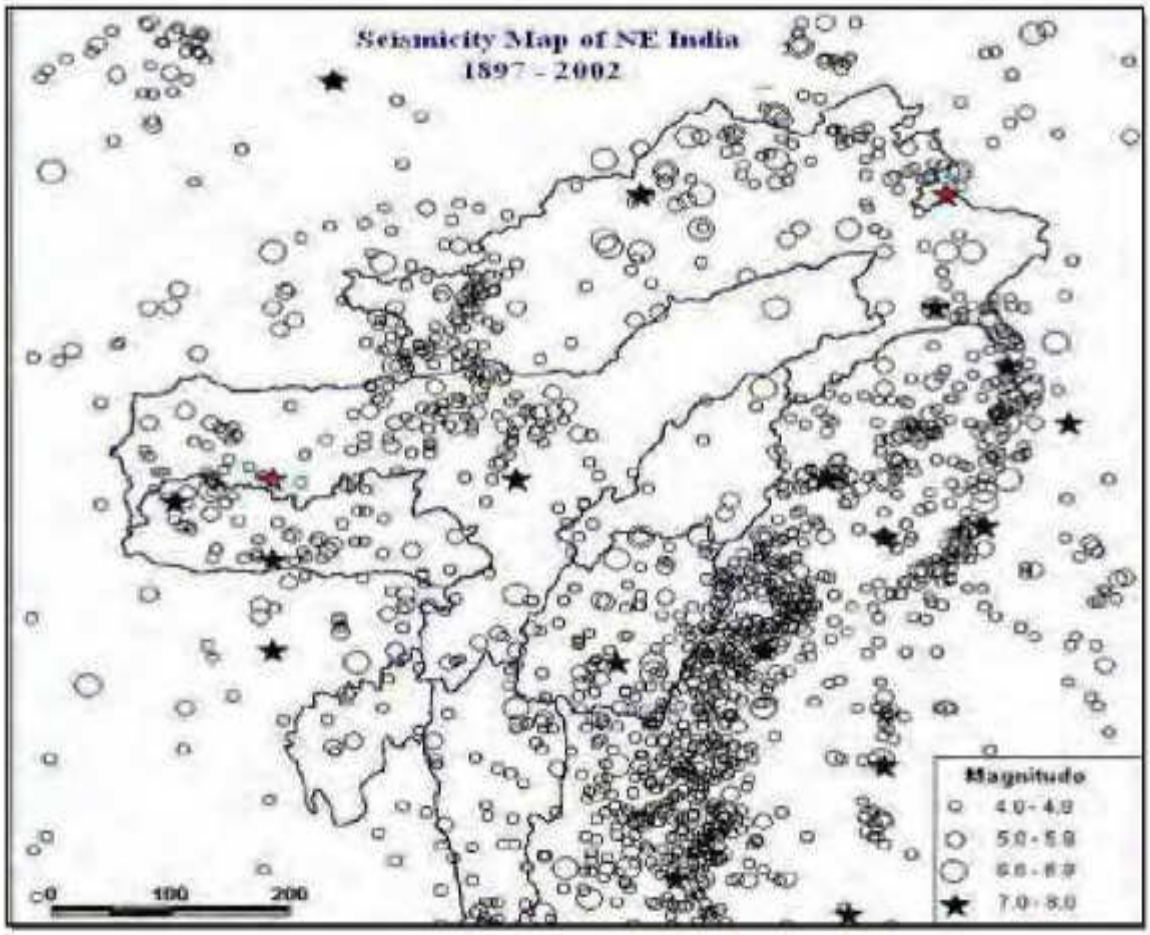
100. There appears to be phases of rapid aggradation of the Brahmaputra River associated with earthquakes, mainly as a result of deposition of sediments received from landslides, followed by relatively slower removal of accumulated debris over longer time periods. Active seismicity of the NE region has a very significant impact on the hydrologic regime and morphology of the Brahmaputra River including its host of tributaries and other water bodies (e.g. wetlands) strewn over the floodplains. Occurrence of these episodic events led to intensification of flood hazards, especially in the aftermath of the two great earthquakes of 1897 and 1950.

101. Based on the seismic zoning map of India, the entire project area falls in Zone V (very severe seismic intensity zone, Map-25). The distribution of major earthquakes (above Richter magnitude 7.0) in the NE region since the 1897 Shillong earthquake is shown in Table 9. The seismicity map of Northeast India with respect to the magnitude of earthquakes is shown in Map

Table 9: Major Earthquakes in Northeastern India and Adjoining Regions since 1897

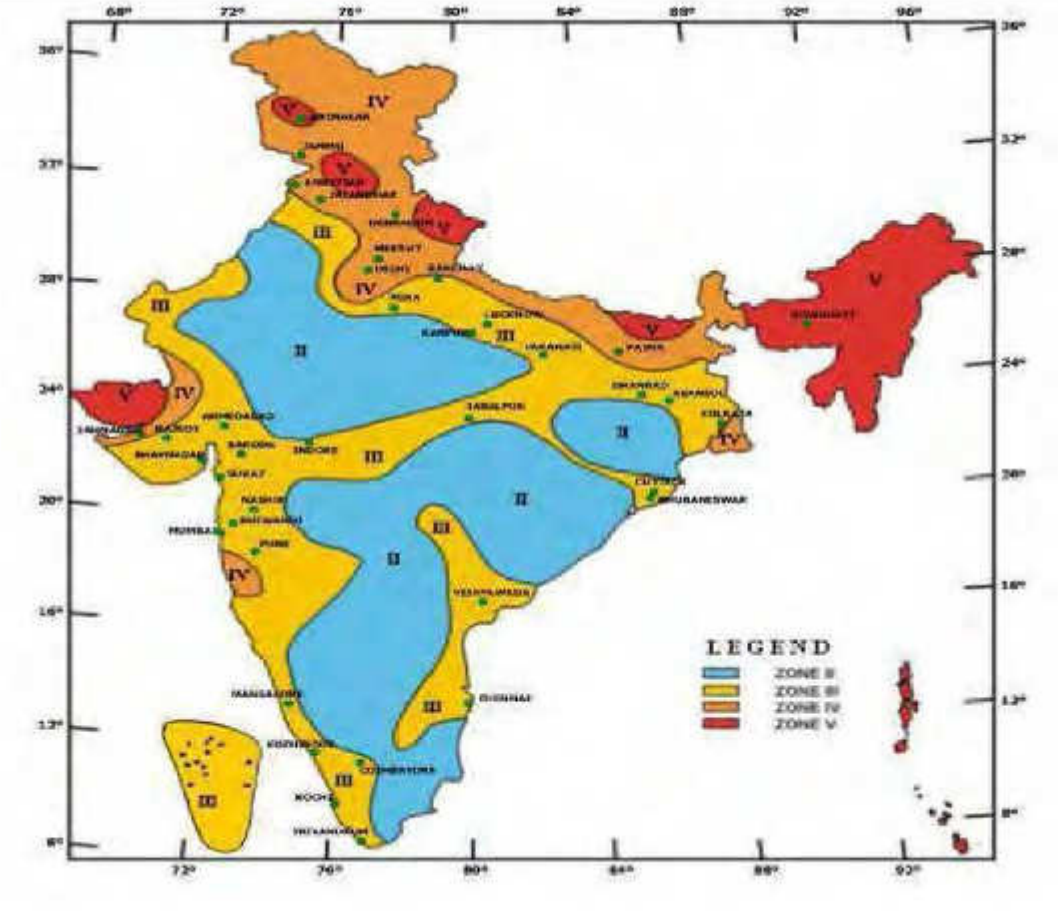
Date	Epicenteral Area	Lat (°N)	Long. (°E)	Magnitude
12-06-1897	Shilong, Meghalaya	26°00'	91°00'	8.7
31-08-1906	India-Burma Border	27°00'	97°00'	7.0
12-12-1908	Kachim,Burma	26°30'	97°00'	7.0
09-09-1923	Jankaria,Meghalaya	25°12'	91°00'	7.1
02-07-1930	Dhubri,Assam	25°30'	90°00'	7.1
27-01-1931	Kachin,Burma	25°36	96°48'	7.6
04-08-1932	India-Burma Border	26°00'	95°30'	7.0
23-10-1943	Hojai,Assam	26°00'	93°00'	7.2
29-07-1947	Tammu,Arunachal Pradesh	28°30'	94°00'	7.8
15-08-1950	India-Burma-China Border	28°50'	96°30'	8.7
06-08-1988	Manipur-Burma-Border	25°14'	95°12'	7.2

Map 24: Seismicity Map of Northeast India (1897 - 2002)

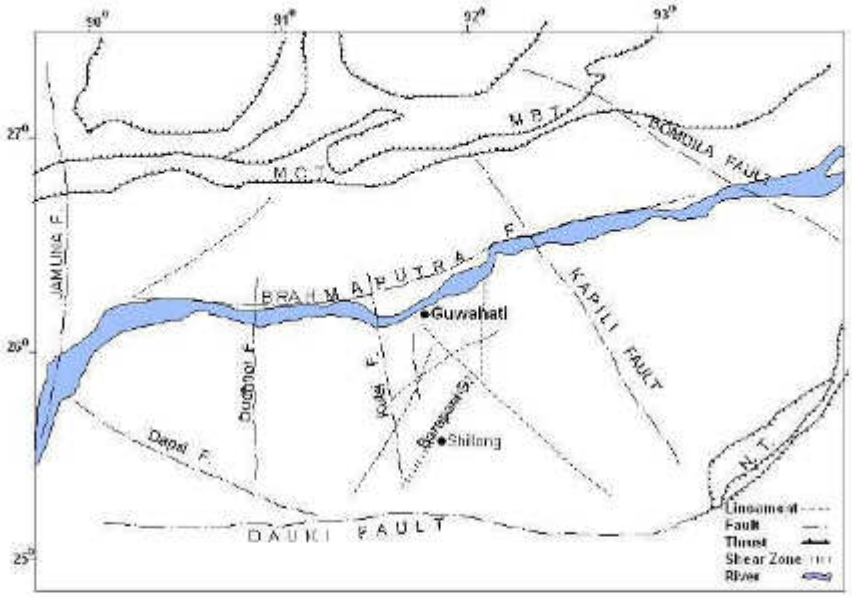


102. As reported by Oldham (1899), the great Shillong earthquake of 1897 had several impacts on the hydrology of the Kulsi River causing severe floods after the earthquake leading to aggradation of the river bed thereby changing the river from one with deep pools to one with a shallow sandy bed.[11] The bed level of the river was reported to have gone up by more than three meters due to which several tributaries had been blocked leading thereby to inundation of adjoining areas. Subsidence of the ground near the Brahmaputra River created a number of depressed areas now occupied by swamps. The tectonic sensitivity of the south Kamrup region including the Palasbari is indicated by the distribution of major faults in the area in Map 26.

[11] Oldham, D. 1899**.***The Great Earthquake of 1897*. Geological Survey of India Memoir 29.



Map 25: Seismic Zoning Map of India

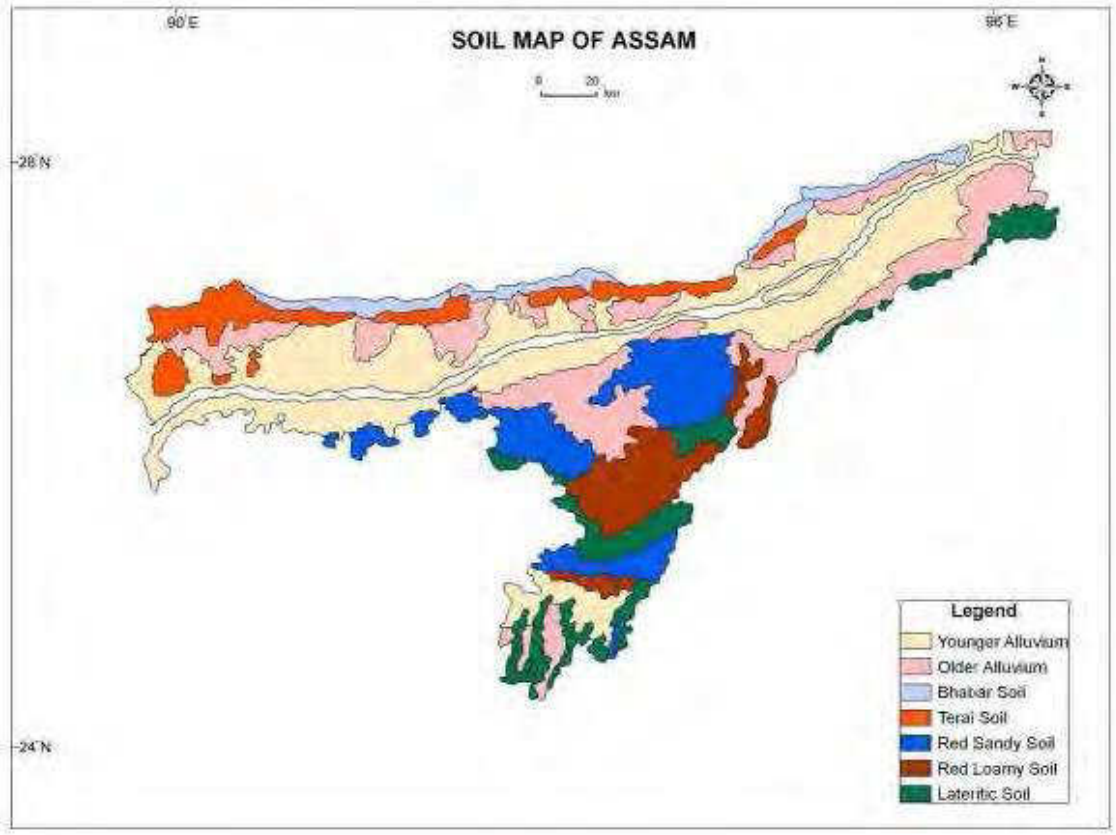


Map 26: Tectonic Map showing Major Faults in South Kamrup Region including Palasbari Reach

4.2.7. Soil

103. The project area is almost entirely made up of alluvial soils formed on recent river deposits called new alluvium, which are also termed as Fluvisols or Fluvents. These are mostly composed of sandy to silty loams and are neutral to slightly acidic in reaction. In limited upland areas within the valley and in the foothill region, there are few isolated pockets of deeply weathered Pleistocene deposits of older alluvium. A study of the lithological of the quaternary sediments of the Brahmaputra valley exten0ding down to more than 100 m reveals repeated sequence of clay, pebbles, and boulders.[12] In the hill areas, especially to the south of the Brahmaputra River, laterites and red loams are found. In the Palasbari Reach, besides the new alluvium, there are red ferruginous soils in the upland areas close to the southern hills and marshy soils in the perennially water-logged areas. The distribution of soil types in Assam is shown in Map 27.

Map 27: Soil Map of Assam



104. The soil quality of the project area was sampled and analyzed for two locations, namely Gumi and Palasbari. The sampling locations are shown in Map 16 and the soil quality at selected locations in Majirgaon-Nagarbera Reach is given in Table 10.

[12] GSI. 1977. Contributions of geomorphology and geohydrology of the Brahmaputra Valley. Miscellaneous Pub. 32.

Table 10: Soil Quality in the Study Area

Parameters		Gumi	Palasbari
Organic carbon	%	0.25	0.35
Available Nitrogen	Ppm	18.71	21.7
Available Phosphorus	Ppm	0.052	0.006
Iron	Ppm	0.054	0.040
Copper	Ppm	0.014	0.004
Manganese	Ppm	BDL	BDL
Lead	Ppm	BDL	BDL
Chromium	Ppm	BDL	BDL
Zinc	Ppm	0.018	0.002
Mercury	Ppm	BDL	BDL
Arsenic	Ppm	0.002	0.004
Potassium	Ppm	52	78
CEC		1.75	DBL
Textural Classes		Clay	Clay
Clay	%	55	37
Silt	%	28	33
Sand	%	17	30
Bulk Density	g/cc	1.59	3.17
Water holding capacity	%	29.36	33.31
Pore space	%	42.5	43.4
Specific gravity	%	1.14	1.03
Electrical conductivity	dS/m	3.6	3.0

(Source: Field monitoring and analysis by Environmental Science Department, Gauhati University, 2014)

105. The soil quality in the Palasbari Reach shows low organic carbon, low available nitrogen, low available phosphorous and medium available potassium.

4.2.8. Land Use

106. The current land use pattern in the area is examined in three different scales and space dimensions keeping in view the nature and intensity of the potential impact of the different project elements. On a broader scale, an 8 km buffer around the line of intervention i.e. the embankment is chosen and the land use pattern within the zone is delineated from satellite images using GIS. The size of the buffer is decided based on the consideration of topography (up to the edge of the hilly region in the south) and the location of the major wetlands of the area specially the Deepar Beel, the outlet of which joins the Brahmaputra in the eastern extremity of the reach. The land use map of the buffer zone is presented in Map 28, 29, 30, 31 and the area covered by different categories of land use is presented in Tables 11, 12, 13, 14.

Map 28: Palasbari Reach 10 km on both side (Image 2016)

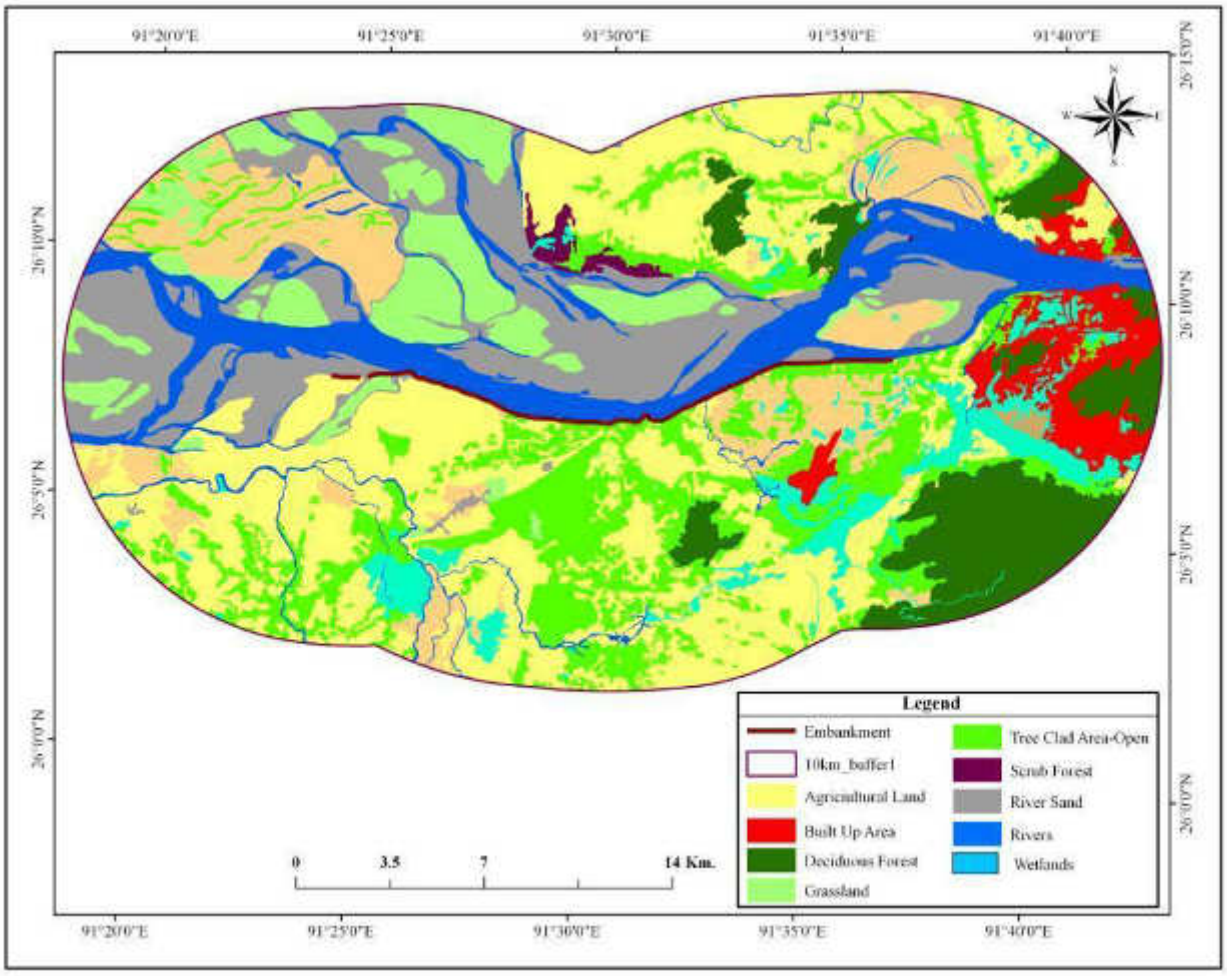


Table 11: Land use in the Study Area

Land Use Class	Area in km^2	%
Agricultural Land	221	29.55
Built-up Area	30	4.01
Deciduous Forest	87	11.63
Grassland	45	6.02
Tree Clade Area Open	95	12.70
Scrub Forest	15	2.01
River Sand	101	13.50
Rivers / Waterbodies	123	16.44
Wetlands	31	4.14
Total Area	**748**	100.00

Map 29: Palasbari Reach 5 km on both side (Image 2016)

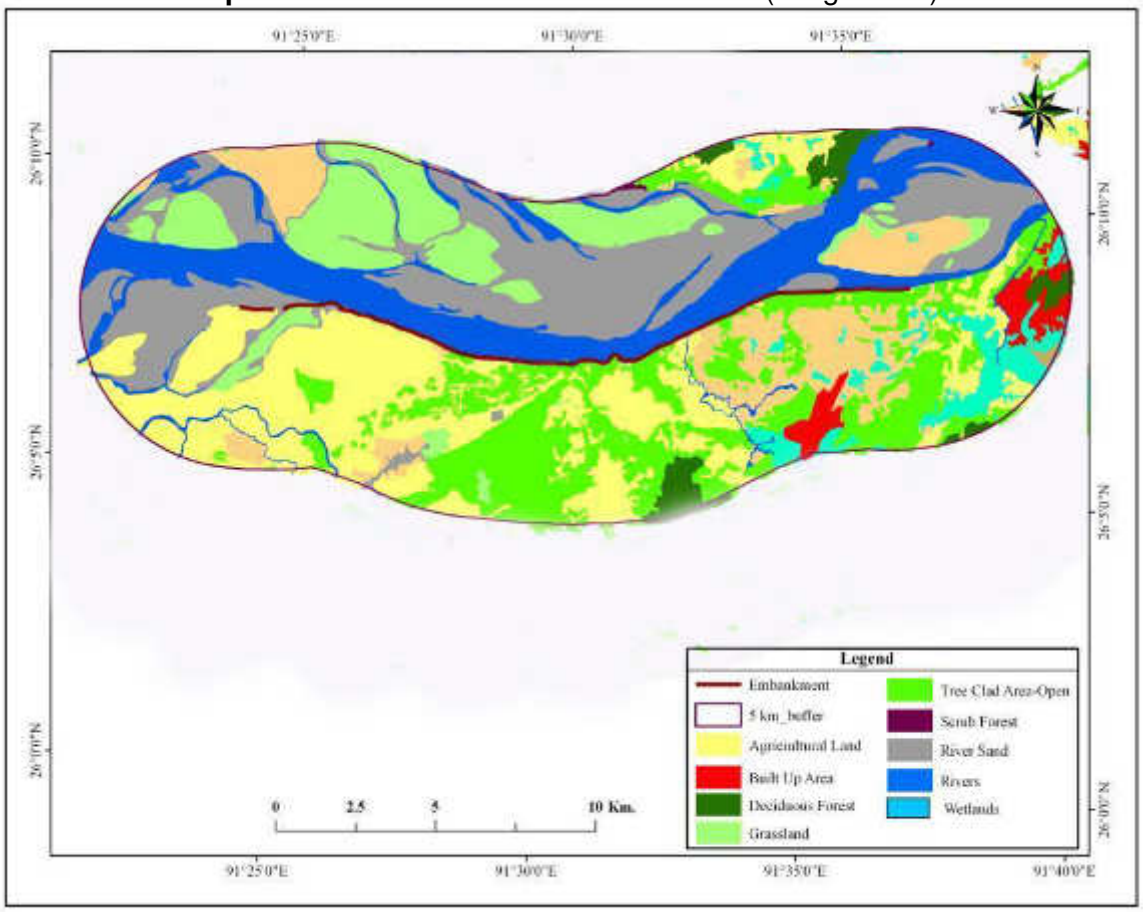


Table 12: Land use in the Study Area

Land Use Class	Area in km^2	%
Agricultural Land	95.0	28.20
Built-up Area	12.0	3.56
Deciduous Forest	34.0	10.09
Grassland	23.0	6.83
Tree Clade Area Open	28.0	8.31
Scrub Forest	5.0	1.48
River Sand	59.0	17.51
Rivers / Waterbodies	65.0	19.29
Wetlands	15.9	4.72
Total Area	**336.9**	100.00

Map 30: Gumi Reach 10 km on both side (Image 2016)

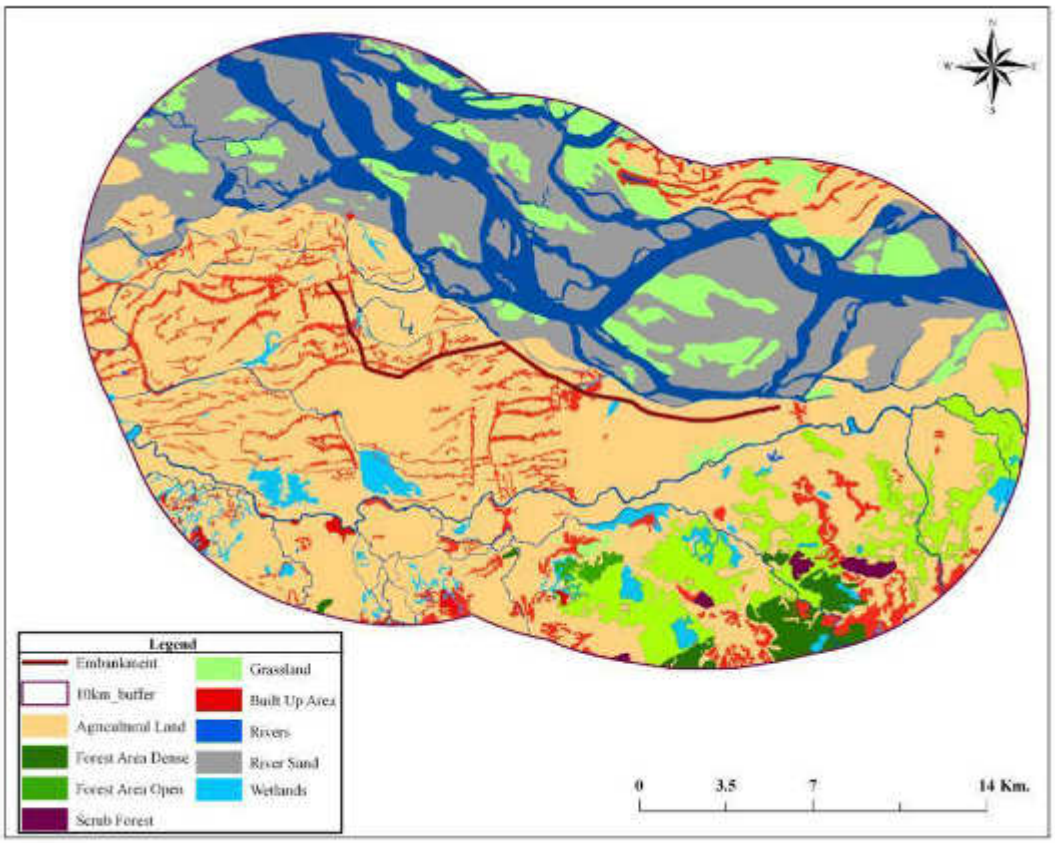


Table 13: Land use in the Study Area

Land Use Class	Area in km^2	%
Agricultural Land	166	22.43
Forest Dense	132	17.84
Forest Open	123	16.62
Scrub Forest	56	7.57
Grassland	65	8.78
Built-up Area	23	3.11
Rivers	65	8.78
River Sand	76	10.27
Wetland	34	4.59
Total Area	**740**	100.00

Map 31: Gumi Reach 5 km on both side (Image 2016)

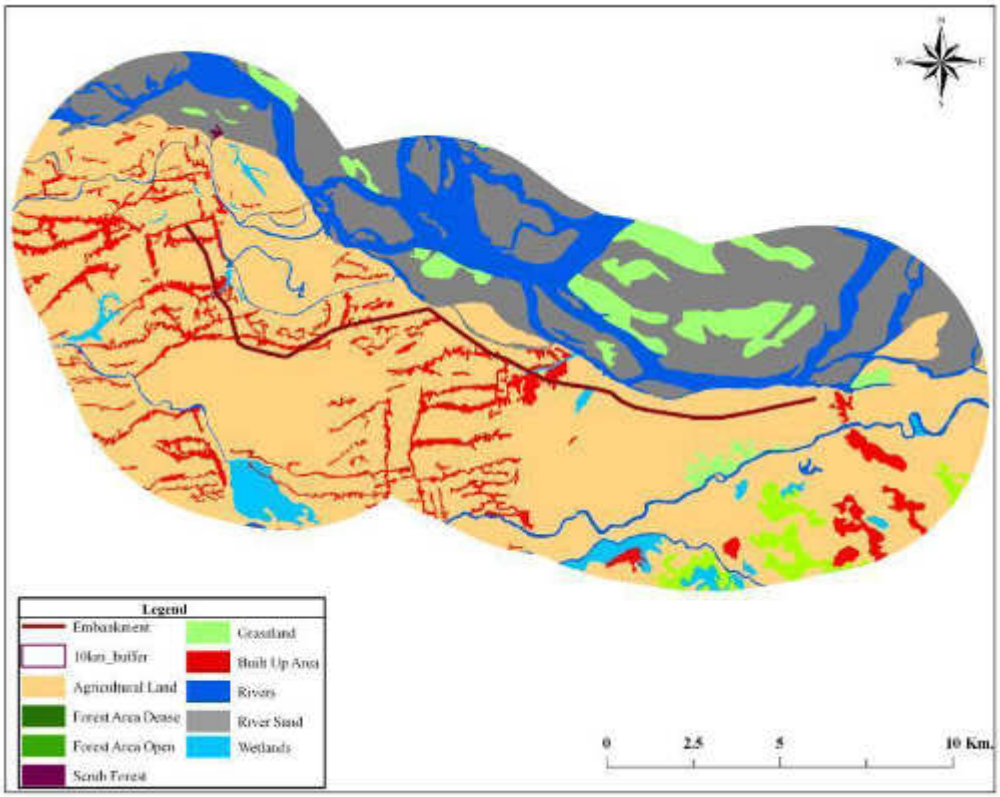


Table 14: Land use in the Study Area

Land Use Class	Area in km^2	%
Agricultural Land	97	33.45
Forest Dense	32	11.03
Forest Open	27	9.31
Scrub Forest	12	4.14
Grassland	23	7.93
Built-up Area	12	4.14
Rivers	43	14.83
River Sand	32	11.03
Wetland	12	4.14
Total Area	**290**	100.00

107. Out of the total study area of 748 km^2 area, agricultural land occupies 221 km^2 accounting for 29.55% area in Palasbari reach and out of 740 km^2, agriculture is practiced in 166 km^2 (22.43 %) in Gumi reach

108. The project area, especially towards the country side of the embankment is dotted with a large number of wetlands. These are mostly formed from abandoned channels of the Kulsi and other rivers. Few of these are created due to course truncation of the Kulsi River as a result of construction of the dyke system in 1974. The total area covered by river channels including Brahmaputra River, Kulsi River, and its tributaries in the country side of the embankment are about 11,398.3 ha whereas other water bodies including wetlands occupy about 1191.6 ha area (0.9%) of the 8 km buffer up to the foothills of the Meghalaya plateau. The sandbars (chars) on the river side of buffer zone occupy another 19,610.5 ha of the buffer.

109. Land use pattern is also examined in a 500 m direct impact zone on either side of the embankment using satellite remote sensing and GIS. The dimension of the direct impact zone is decided based on field observations as well as discussions with technical and administrative officials of the Government. The 500 m direct impact zone for the entire reach is shown in Table 12. The land use data for the direct impact zone is presented in Map 29. It indicates that the agricultural lands occupy highest portion of the area followed by tree cover areas, water bodies, sandbars, sandy areas, grass land, etc.

Map 32: Land use Map of Palasbari Reach (500 m buffer around embankment)

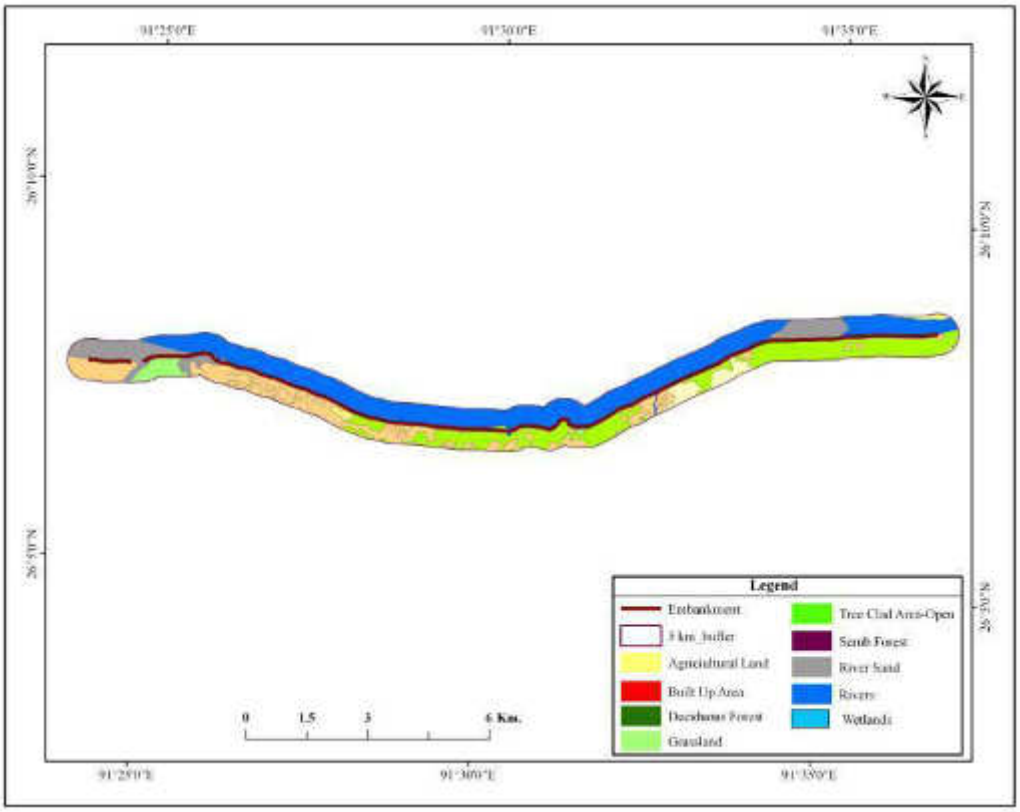


Table 15: Land use of Palasbari Reach (500 m buffer around embankment)

Land Use Class	Area in km^2	%
Agricultural Land	5	16.13
Built-up Area	1	3.23
Deciduous Forest	5	16.13
Grassland	3	9.68
Tree Clade Area Open	6	19.35
Scrub Forest	2	6.45
River Sand	2	6.45
Rivers / Waterbodies	4	12.90
Wetlands	3	9.68
Total Area	**31**	100.00

110. The land use pattern in the zone lying between the bank and the embankment was also mapped using satellite data and GIS. The result of this analysis is shown in Map 33. The land use data of the zone presented in Table 16 show that agricultural land dominates the land use accounting for more than 69% of the total area followed by homestead plantations (26%).

Map 33: Land use Map of Gumi Reach (500m buffer)

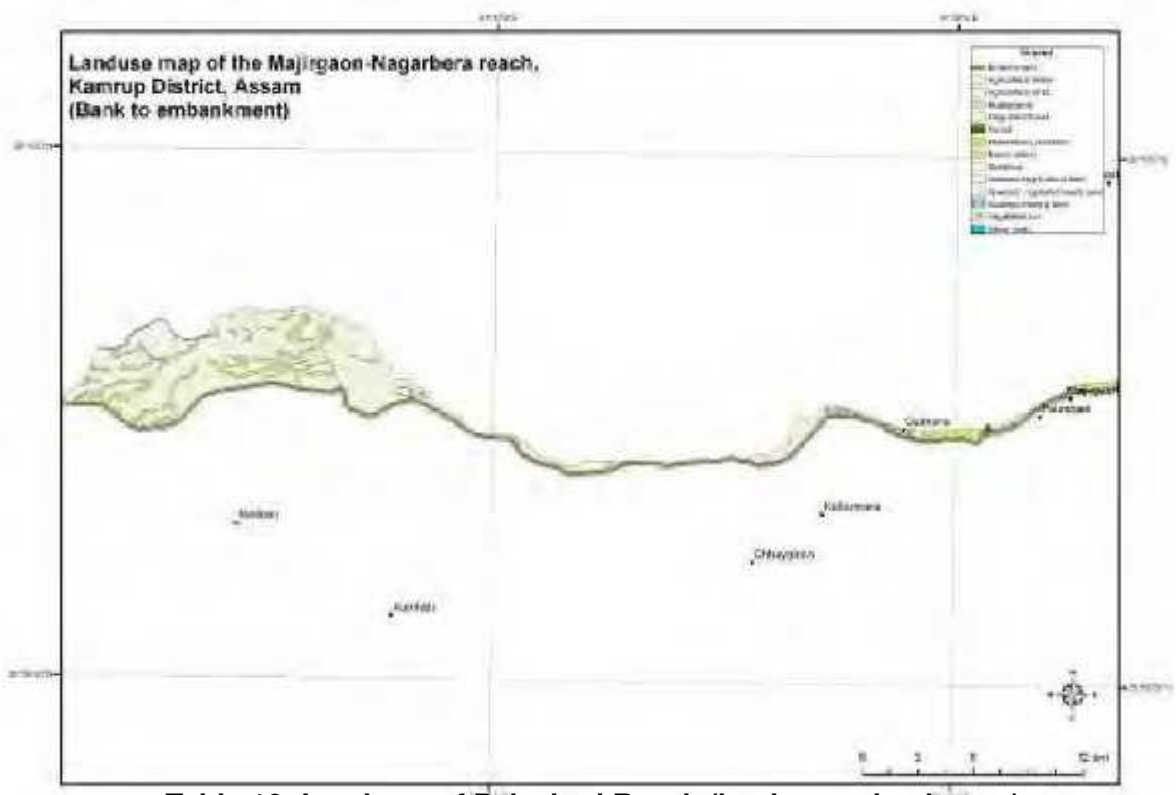


Table 16: Land use of Palasbari Reach (bank to embankment)

Land Use Class	Area in km^2	%
Agricultural Land	4.0	14.49
Forest Dense	3.0	10.87
Forest Open	3.0	10.87
Scrub Forest	1.0	3.62
Grassland	2.0	7.25
Built-up Area	2.0	7.25
Rivers	4.8	17.39
River Sand	4.8	17.39
Wetland	3.0	10.87
Total Area	**27.6**	100.00

4.2.9. Air Environment

111. The Palasbari reach being rural in character with limited economic development and infrastructure, the ambient air environment is relatively undisturbed. However, in order to scientifically establish the baseline air quality status as required in this assessment and in view of its future relevance, ambient air quality was monitored at two locations in the field as indicated in Map 16. The results of ambient air quality monitoring in the reach are presented in Table 17. The ambient air quality results have also been compared with the National Ambient Air Quality Standards (NAAQS) for Residential and Rural Areas in India.

Table 17: Ambient Air Quality

S. No.	Parameter	Unit	NAAQS for Residential and Rural Areas	Majir Gaon Initial EIA	Khanajan initial EIA	Palasbari*(May, June 2014) (Tranche 1 site/ Tranche 2 site)	Gumi*, (May June 2014) (Tranche 1 site/ Tranche 2 site)
1.	Suspended Particulate Matter(SPM)	pg/m^3	200	66.3	71.3		
2.	Respirable Suspended Particulate Matter (RSPM)	pg/m^3	100	47.5	56.0	56 / 37	54 / 26
3.	Oxides of Nitrogen (NOx)	pg/m^3	80	4.5	7.8	33 / 21	27 / 14
4.	Sulphur Dioxide (SO2)	pg/m^3	80	3.6	3.2	13 / 6	14 / 12
5.	Lead (Pb)	pg/m^3	1.0	0.045	0.062	0.049 / 0.044	0.056 / 0.043
6.	Carbon Monoxide (CO)	pg/m^3	2000	120	174		
7.	Hydrocarbons (HC)	pg/m^3	-	1250	870		

Source: Field monitoring, Dept. of Env. Science, Gauhati University, *Pollution Control Board, Assam during Tranche -1, results are from the work sites and from Trance 2 sites)

112. It is evident from the comparison that all the air quality parameters are found well within the permissible limits as per the NAAQS for residential and rural areas. The National Ambient Air Quality Standards in India are shown as Appendix 3.

4.2.10. Noise Environment

113. Ambient noise levels along the Palasbari Reach have been monitored at Gumi, Palasbari, Majirgaon and Khanajan during day and nighttime. In the absence of any major source of noise pollution in the immediate vicinity of the impact corridor, the noise levels observed were well within the standards for residential areas. The ambient noise levels during day and nighttime are presented in Table 18. The National Ambient Air Quality Standards in respect of noise are shown as Appendix 4.

Table 18: Ambient Noise Levels in the Study Area

Location	AAQS in respect of Noise for Residential		Day Time [dB(A)]			Night Time [dB(A)]		
	Leq(day)	Leq(night)	Lmax	Lmin	Leq(day	Lmax	Lmin	Leq(night
Gumi	55	45	58	42	47	56	37	45
Palasbari			52	37	45	52	41	43
Majirgaon			55	48	51	53	37	42
Khanajan			57	48	51	55	32	44
Palasbari (at tranche 1 site) (June, 2014)(Tranche 1 site/ Tranche 2 site)			47.2 / 47					
Gumi (at tranche 1 site) (June 2014)(Tranche 1 site/ Tranche 2 site)			48.1 / 49.3					

(Source: Monitoring done by Dept. of Env. Science, Gauhati University, *Pollution Control Board, Assam during Tranche -1, results are from the work sites and from Trance 2 sites)

4.3. Terrestrial Ecology

114. The Brahmaputra River has structured the terrestrial and aquatic ecosystem of the floodplain zones. People living in the floodplain of the river depend on the ecological supports of the Brahmaputra River and its monsoon flood. Almost every year, river water inundates the entire low-lying areas of the floodplains and thus rejuvenates the land with natural fertilizer and biodiversity components.

115. The river has created large numbers of wetlands in the floodplain within a range of 10 km distance from the major river system. These wetlands have supported numerous aquatic biodiversity resources including ecologically and commercially important butterflies, moths, fishes, amphibian, reptiles, mammals, birds and economically important aquatic plants, ornamental plants, medicinal plants etc.[13] and created life support systems of the traditional peoples living in the floodplains. The major human dependable biodiversity resources, which have regularly been supported the human livelihood management of the rural folks are supported by the river created wetland ecosystems. These wetlands were formed due to continuous interaction of land and water, so without water sources, no wetland ecosystem would exist in the floodplain zones.

4.3.1. Methodology of Baseline Data Collection

116. To collect the baseline data for the Palasbari Reach from the mouth of Khanajan River through Sontoli Bazzar and village Nagarbera near Jaljali river outfall (total length around 74.10 km) area was divided into two basic zones, based on the investment project design:, (1) from

[13] Saikia, P. K. and P. C. Bhattacharjee 1995. Status, and decline of water birds in Brahmaputra Valley, Assam, India. Pp. 20-27, in Verghese, A. S., Sridharand, A. Chakravarty, K. [ED.]. Proceedings: Published by Zafar Futhehaly, Bird Conservation Strategies for the Nineties & Beyond. OSI, OSI Liaison Officer, No. 10.Vishnuchittam, Sirur Park Road, Seshadripuram, Banglore-560020, India., Mani, M. S. 1986. Butterflies of the Himalaya. Oxford & IBH Publishing Co., New Delhi. & Mani, M. S. 1974. Ecology and Biogeography in India. Dr. W. Junk B.V. Publishers, The Hague

Ch. 0.0 km to Ch. 2.4 km (Khanajan river mouth to Dakhola hill), and (2) from the downstream of Dokhola Hill up to Nagarbera Hill near Jaljali River outfall ch 60.0 Km.[14] In many places, the embankment was found to be obliterated by the people through the activities like earth cutting and house constructions beyond Sontoli Bazaar up to Nagarbera village.

117. The Sub-zone (A) covers the countryside from the embankment. The width of this zone was fixed at 100 m where impacts may occur during embankment project. The Sub-Zone (B) covers the 100 m or less (as per the existence of terrestrial zones near riverside) between the embankment and Brahmaputra River. The assessment was carried out from 11 February 2008 and continued till April 2008**.** During field survey, the available primary information was collected by direct sighting method and the secondary information was collected from field during survey based on the interrogation with the local inhabitant and published materials to gather the additional data. Also, the present threats of the terrestrial and aquatic ecosystems were monitored, and the mitigation measures were analyzed.

4.3.2. Terrestrial Flora

118. The vegetation compositions along the Palasbari and Gumi reach were comprises of Ajar- *Lagerstroemia flosrganae*, Ahot Goch -*Ficus religiosa*, Bor Goch-*Ficus bengalensis*, *Tamarixdioica*, *Orozylum indicum*, Atlas-*Annona squamosa*, Buwal-*Cordia dichotoma*, Bogori-*Zizyphus mauriciana*, Bhimkol-*Musa balbasiana*, Bholuka Banh-*Bambusa balcooa*, Bijuli Banh-*Bambusa pallida*, Dewa Cham-*Artocarpus lacusha*, Satiana or Devil tree-*Alstonia scolaris*, Dimoru-*Ficus glomarata*, Khohota Dimoru-*Ficus lipidosa*, Gamari-*Gmelina arborea*, Helos-*Antidesma ghaesembilla*, Jati Banh-*Bambusa tulda* (trees were categorized based on height; e.g. >15 feet),Jamuk-*Syzygium fruiticosum*, Khokon-*Duabhanga grandifolia*, Katia Khongal Dimoru-*Ficus tinctoria*, Kathal-*Artocarpus heterophylus*, Karas-*Pungamia pinnata*, Krishnasura-*Delonix regia*,Kadam-*Anthocephalus cadamba*, Kolajamun-*Syzygium cumini*, Moder-*Erythrina indica*, Mokal banh-*Bambusa pallida*, *Bauhinia spp*, Mango-*Mengifera indica*, Narikol-*Cocos nucifera*, Owtenga-*Dillenia indica*, Palas-*Butea monosperma*, Poma-*Toona cialita*, Cascabela thevetia, Pakori-*Ficus rumphii*, Purakol-*Musa spp,* Simul-*Bombax ceiba*, Siris-*Albizzia lebbek*, Sisso-*Delbergia sisso*, Sonaru-*Cassia fistula*, Segun-*Tectona grandis*, Suwalu-*Litsea monopetala*,Soom-*Persea bombiciana*, Silikha-*Terminalia chebula*, Tamul-*Areca catechus*, Tora Goch-*Alpinia allughas*, Tambul- *Areca catechu*, Velew -*Trtramelos nudiflora* etc.

119. The other important terrestrial plants included *viz*., Jati Bet- *Calamus erectus*, Dubari ~~Ban- *Cynodon dactylon*, Loc~~osa Ghanh- *Hemarthia compressa*, Birina- *Vetiveria zizanoides*, Ekora- *Saccharum ravanae*, Khagori- *Phragmites karka*, Ulukher- *Imperata cylindrica*, Hankher-*Pollinia ciliata*, Kahua- *Saccharum sponteneum* and Borota Kher- *Saccharum elephantinus* etc. Other important plant species of the area have been eliminated due to regular flood and changing scenario of soil characteristics. The major climber species comprises *Stephania harnondifolia* (Tubuki lata), *Zanthoxylum hamiltonianum* (Tej-muri), *Cuscuta reflexa* (Akashi Lata), *Illegeriakhasiana* (Kerkeri lata), *Dioscorea hamilttoni* (Bonoria alu), *Smilax macrophylla* (Tikoni boral), *Calamus erectus* (Jati bet), *C. gracilis* (Wahing bet), *C. latifolius* (Motha bet), *Pinaga gracitis* (Raidang Bet), *Pothos cathcartii* (Hati-poita) and *P. scandens* (Kawri Lata) etc.

[14] In Ch. 60.0 km at Nagarbera hills, the local People have illegally demoralized the hills and its peripheral zones by collecting big boulders and stones for commercial purposes. The people also collected boulders that laid for the bank erosion management purposes

Table 19: Trees to be affected in Tranche 2 site under Palasbari sub project

Palasbari Reach				
	Trees	Fruting	Timber	Timbers used for making furniture
Dakhala	623	172	387	64
Bholapara	233	56	171	6
Satarapara	149	54	86	9
Guimara	1123	861	254	8
Simina	134	87	47	0
Mokadhuj	31	24	7	0
	2293			
Gumi Reach				
	Trees	Fruting	Timber	Timbers used for making furniture
Asalpara	1387	283	1084	20
Baghmara	913	546	272	95
Taparpathar	810	350	423	37
Borbhita	650	300	200	150
	3760			

120. The vegetables/ pulses /jutes etc. available in the project sites are Paleng, Mithi, Dhania, Lai Sak, Khesari, Podina, Potatoo, Bhendi, Bengena, Bilahi, Jolokia, Phulkabi-*Brassica oleraceavar,* Morapat-*Corchorus capsularis,* Amita-*Carica papaya,* Ghehu-*Triticum aestivum* and Rice etc. Study revealed the presence of 223 avian fauna, 19 mammalian fauna, 32 reptilian fauna from Khonajan Ch. 0.0 km to Palasbari Ch. 0.0km, Majirgaon 0.0 km to Dokhola hill 4.9 km, Dokhola hill Ch. 0.0 km to Gumi Ch. 22.0km, Ch 22.0 km to Ch. 60.0 km (Nagarbera village and hills) (Appendix 5, Appendix 6, and Appendix 7).

121. The study has reported altogether 11 amphibian fauna in Majirgaon -Nagarbera embankment site which include: Rana tytlery**,** *Rana typiensis, Haplobtrachus tigerina, Ranasyanophylectes, Rana leptoglosus,* Fezerzerya pieri**,** *F. synhendrense, F. terai, Mycrohyla ornate, Polypedatus leucomystes and Buffo melanostictus* (Table 20).

Table 20: Amphibian Fauna Reported in Majirgaon-Nagarbera Project Sites (based on present absent data)

Amphibian Species	Present absent data/Sample sites													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rana tytlery	1	1	0	0	0	0	0	0	0	0	1	1	1	1

Amphibian Species	Present absent data/Sample sites													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rana typiensis	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haplobtrachus tigerina	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rana syanophylectes	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rana leptoglosus	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fezerzerya pieri	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F. synhendrense	1	1	1	1	1	1	1	1	1	1	1	1	1	1
F. terai	1	1	1	0	0	0	0	0	0	0	0	1	1	1
Mycrohyla ornata	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Polypedatus leucomystes	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Buffo melanostictus	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Abbreviation: 1: (0 point): Dharapur; 2: Darapur; 3: Jangrabari; 4: Alutalibari; 5: DBHcm; 6: DBH; 7: DBH; 8: DBHin; 9: Spur 7th; 10: Majguri; 11: Goroimarialikash; 12: Borakhat; 13: Bejisuti-Kalidas; 14: Nagarbera Hillside (1: Present;0: Absent).

122. Diversity Index[14] and Species Richness[15] of Amphibian Fauna, Reptilian Species, Avian Fauna and Mammalian Fauna have been given in Appendix 8.

123. Rarefaction analysis of species richness of Amphibian Fauna shows higher richness in Gumi Reach at Spur 7th (Ch. 22.3 km), Majgur (Ch. 24.0 km), Goroimari Alikash (Ch. 26.0 km to 0 km), Borakhat, Bejisuti, Kalidas Beel area (Ch. 37.0 km to 42 km) and Nagarbera hillside (Ch. 58.0 km to 60.0 km), where richness value was 11.0.

124. Rarefaction analysis of species richness of Reptilian Species shows higher richness in Khonajan "0" point to Dhuptala Bazar (Ch. 0.0 km - Ch. 2.4 km); Gumi reaches at Spur7th (Ch. 3 km), Majguri (Ch. 24.0 km), Goroimari alikash (Ch. 26.0 km to Ch. 37 km), Borakhat, Bejisuti, Kalidas beel area (Ch. 37 km to 42 km) and Nagarbera hillside (Ch. 58.0 km to Ch. 60.0km) than the others.

125. The area is rich in avifaunal point of view. Study of avian species in Palasbari Reach exposed the subsistence of 223 avian species belong to 43 different families. The aquatic migratory birds have been observed from the Khonajan (Ch. 0.0 km to Ch. 2.4 km; Ch. 2.4 km to Ch. 9.5 km); from Majirgaon (Ch. 0.0 km) to Dokhola hill (Ch. 4.9 km and up to Ch. 19.5 km). The area ranging from Gumi (Ch. 22.0 km) to Nagarbera (Ch. 60.0 km) has no migratory waterfowl available owing to very shallow river channels and the riverbank was running comparably longer distance from the existing Brahmaputra Dyke. People reside in those areas have regularly been capturing the migratory birds for commercial purposes. Rarefaction analysis of species richness also shows higher richness in inside the embankment than outside (Richness Value: Inside: 222.9; Outside118.9).

126. Altogether 19 species of mammalian fauna have been recorded in the study site from Khonajan Ch. 0.0 km to Ch. 2.4 km; Ch. 2.4 km to Majirgaon 0.0 km; Majirgaon Ch. 0.0 km to

Dokhola Hill Ch. 4.9 km; Satrapara to Land Spur No. 7 (Ch. 4.5 km to Ch. 19.3 km); Ch.20.0 km to Ch. 60.0 km.

4.3.3. Faunal Behavior Pattern and their Land River Interface

127. There were altogether two river confluences found in the project site, one at Dharapur "0" point and other at Palasbari Boat ghat area. In the river confluence of Khonajan - Brahmaputra (near Dharapur "0" point) and Palasbari outlet Channel-Brahmaputra (near Palasbari boat ghat; Coordinates: 26 07′88″N-91 35′24″E) dolphins were came to forage and playing during winter and monsoon. It is a deep channel even during dry season. The other land river interfaces were completely blocked during 1974 embankment from Ch. 20.0 km - Ch. 60.0 km Gumi - Nagarbera site.

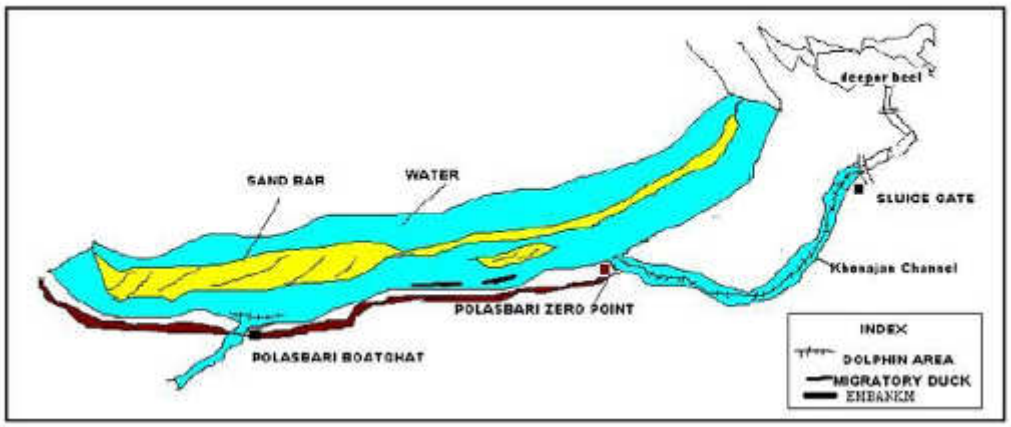
4.3.4. Migratory Route of Terrestrial Fauna

128. There is no live migratory route of terrestrial fauna in the Palasbari Reach, however, one wild elephant was reported to have reached the riverside habitat near Dharapur "0" Point (Latitude 26 09′49″N & Longitude 91 39′01″E), but it could not be marked as a migratory route.

4.3.5. Dolphin and its Behavior Patterns

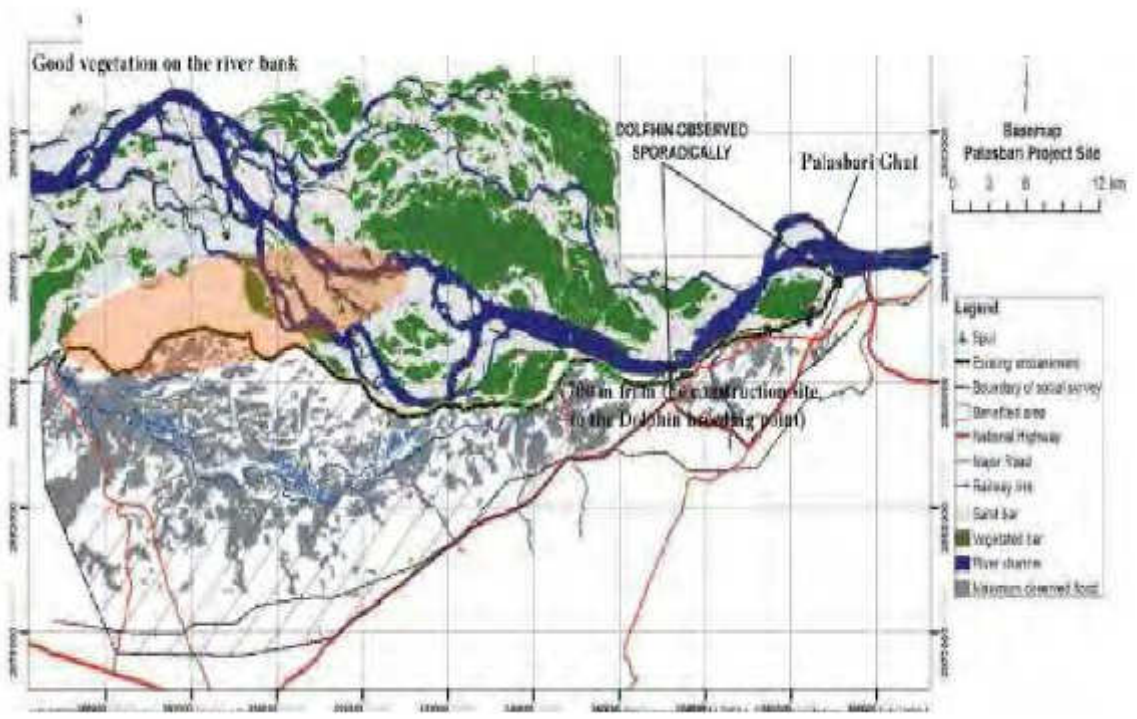
129. River Dolphins came to the embankment site throughout the deep water channels during Monsoon season, but the most important areas are the Palasbari boat ghat Ch. 0.0 - 4.9 km (26 07′88″N-91 35′24″E) and Dharapur "0" Point Ch. 0.0 km (Coordinates: 26 09′49″N-91 39′01″E) up to sluice gate, in which the Dolphins were frequently visited for playing, breeding and foraging purposes (Ref Map 34). Earlier, the Dolphins extended their range up to Deepar beel,[15] which is connected by the Khonajan River from Brahmaputra. But the Sluice gate is the main barrier of this species extended up to Deepar beel (3 km distance from the Dharapur "0"point).

Map 34: Important Dolphin Areas in Palasbari Reach



[15] In ecology, diversity index is a statistic which is intended to measure the biodiversity of an ecosystem. The species richness is the number of species present in an ecosystem

Map 35: Distance of Dolphin Breeding point from the Embankment



130. Deepar beel is the only Ramsar site of Assam, situated about 3 km Arial distances from the Khonajan mouth. Khonajan is the only outlet of this important wetland of Kamrup district. Although it has connection with river Brahmaputra, the embankment did not hamper the beel, as the proposed embankment did not harm the connection of Khonajan. The garbhanga RF is adjoined with the Deepar beel, but it is far away from the embankment and is a different strand of south bank ecosystem.

131. However, the Dolphins were not seen during winter when water level recedes. Nonetheless dolphins were still sighted at 'Dharapur "0" point' area outside the embankment (Ref Map 30). Therefore, there will be no effect on Dolphin by this embankment. Also, the migratory waterfowls were seen from Dharapur "0" point' to Majirgaon Ch. 0.0km during winter season. This area is important for the migratory waterfowl.

4.3.6. Identification of Areas of Eco-Sensitivity

132. The area near Khonajan "0" point Ch. 0.0 km of Dharapur project site and the Khanajan channel up to Sluice gate is the eco-sensitive area (Lat/Long. 26 09′49″N - 91 39′01″E). Bird nests holes were also observed in this point. The Brahmaputra river channels from the Dharapur "0" point up to Dhuptala bazaar Ch. 2.4 (Coordination: 26 09′49″N-91 39′01″E to 26 08′38″N-91 37′28″E) is the important site for migratory waterfowl during winter season. Also, the area near Palasbari Ghat (Latitude 26 07′88″N & Longitude 91 35′24″E) (Ch. 0.0 to Ch. 4.9 km up to Dokhola hill) is the most important eco-sensitive area for River Dolphin (mammal) and *Bagarius bagaris* (fish species) particularly during monsoon. Both the species reported to breed and playing in this site.

4.3.7. Changes in River Ecology from Last Few Years & Its Effect on Terrestrial Ecology

133. In Palasbari Reach, a large stretch of terrestrial ecosystem had merged into the river water near Majirgaon Ch. 0.0 km to Ch 4.9 km area and Dokhola hill Ch. 0.0 km to Ch. 20.0 km. In last 40 years, an area of approximately 5 kilometers width of land has been lost from downstream of Majirgaon (from Palasbari) to Gumi Spur no. 1 due to soil erosion both during pre- and post-flood season. There was around 3 kilometers width of terrestrial ecosystem, which has been lost along the sides of Dharapur-Palasbari-Semina -Guimara area in last 20 years. During late 90's, a dense forest patch and potential biodiversity area exists from Dokhola Pahar area to Guimara, but after 17-18 year, this area has been lost to soil erosion.

134. The river ecology also has changed tremendously in Gumi Ch. 19.5 km from 7th No. Spur to Kalidas beel area due to blockage of natural river during 1974. Extensive deposition of river sands and reduction of wetland encourage reducing ground water level that hampers the terrestrial ecosystem.

4.3.8. Wetlands around Project Sites

~~135. There are very few p~~erennial wetlands available near Palasbari Reach. The existing wetlands are Deepar Beel,[16] Mora Kulsi (near Ch. 21.0 km), Jahirpur, Alikash, and Bejisuti-Kalidas Beels. The Deepar beel wetland is situated about three kilometers south-east from the Khonajan (Ch. 0.0) area. Although, the Deepar beel ecosystem has a direct connection with the

[16] Deepar beel is a large natural wetland having great biological and environmental importance besides being the only major storm water storage basin for the Guwahati city. The beel is endowed with rich floral and faunal diversity. In addition to huge congregation of residential water birds, the Deepar ecosystem harbors large number of migratory waterfowl each year. Deepar beel has been designated as a Ramsar Site in November 2002. It supports threatened species of birds like spot billed pelican, lesser adjutant stork, greater adjutant stork, black necked stork, and large whistling teal. The lake is one of the staging grounds on the migratory flyways for several species. The diversity and concentration of indigenous freshwater fish species is very high. Natural breeding of some of these species takes place within the beel itself. Phytoplankton is one of the major components of the lowest level of the producers in the Deepar beel ecosystem. The dominant species are represented by Oscilatoria sp and Microcystis sp. A total of 18 genera of phytoplankton are reported only from the core area of the Deepar beel ecosystem. The dominant aquatic plants include Eichhornia crassipes, Pistia stratiotes, Ottelia alismoides, Lemna minor, Potamogeton crispus, Vallisneria spiralis, Hydrilla verticillata, Ipomoea reptans, Azolla pinnata, Spirodela polyrhiza, Eleocharis plantaginea, Nymphaea albea, N.rubra and Sagittaria sagittifolia. The giant water lily Euryale ferox also grows here. The lake shore vegetation includes Eupatorium adoratum, Achyranthes aspera, Cyperus esculoentus, Phragmites karka, Vitex trifolia, Accium basilium, Saccharum spontaneum and Imperata arundinacea. Dominant tree species in the nearby deciduous forests include Tectona grandis, Ficus bengalensis and Bombax malabaricum. Altogether 21 genera of zooplanktons were identified in Deepar beel, the dominant species were from the groups of Cladoceran, Copepod, Rotifers and Protozoans, such as, Paramecium sp. The important benthic fauna in the Deepar beel ecosystem includes Tubifex sp., Nais sp., Pheritima sp., Dero sp., Limnodrillus sp., Chironomus sp., Bellemya sp., Bortia sp., Chaoborous sp., Culicoids sp., Dragon flylarvae, Cybister larvae, Pila globosa, Unio sp., etc. Wild Asian elephants (Elephas maximus) still visit the beel despite its proximity to Guwahati. Preliminary surveys have revealed the presence of at least 20 amphibians, 12 lizards, 18 snakes and 6 turtle and tortoise species in Deepar beel. Deepar beel harbors a large number of terrestrial and aquatic birds' species, most of which are either endemic, threatened or endangered. Altogether 219 bird species have been recorded, of which 70 species are waterfowl.

river Brahmaputra by Khonajan channel, this Khonajan channel is located outside the project boundary and has a sluice gate near Dharapur-Garigoan area. Also, from Gumi to Nagarbera project site, the wetlands are found along the stretches of land outside the embankment. Kalidas Beel (26°07'58" N and 91°01'04") support large number of fish and amphibian species, which breeds during pre-monsoon and monsoon season

4.4. Aquatic Biology

4.4.1. Identification of Aquatic Fauna

136. All the aquatic fauna were collected from 12 different study zones. The whole stretch of river bandh was surveyed in these 12 different points *viz.* Khanamukh (9.5 km-upstream), Palasbari-Majirgaon (Ch. 0.0 Km), Gumi (Ch 22.0 Km), Last 7 spur (Ch. 11.70 Km), Majgumi (Ch0 Km), Zahirpar (Ch 32.0 Km), Alikash-Taparpathar (Ch 37.0 Km), Asalpara Bara khat (Ch 39.0 Km), Bejisuta-Kalidas beel (Ch 40.0 Km), Sontoli (Ch 42.0km), Hill side (Ch 57.0 Km), Nagarbera (Ch 60.0 Km) were selected randomly for detailed observation. The details of survey points are given in Table 25. Some of the points were adjacent to fishing communities. The variability and number of each species in all study zones are found to be varied based on the ecological variations in these areas. As these areas are flood prone, tremendous scope of diversity of aquatic fauna is expected. The major fisheries of these areas are *Gudusia chapra, Hilsa ilisha, Salmophasia bacaila, Barilius spp etc.* Migratory fishes like *Hilsa (Tenualosa) ilisha* and *Anguilla bengalensis*, an endangered species is also encountered in the Palasbari Reach.

Table 21: **Survey Points of Aquatic Ecology**

S. No.	Survey Points	GPS Position	S. No.	Survey Points	GPS Position
1.	Khanamukh (9.5 km-upstream)		2.	Palasbari-Majirgaon (Ch. 0.0 Km)	
3.	Last spur 7 (Ch. 11.70 Km)	N: 26°05'48" E: 91°20'52"	4.	Gumi (Ch 22.0 Km)	N: 26°05'59" E: 91°22'12"
5.	Majgumi (Ch 26.0 Km)	N: 26°05'42" E: 91°19'34"	6.	Zahirpar (Ch 32.0 Km)	N: 26°05'31" E: 91°18'36"
7.	Alikash-aparpathar (Ch 37.0 Km)	N: 21°05'58" E: 91°16'25"	8.	Asalpara Barakhat (Ch 39.0 Km)	N: 26°05'38" E: 91°14'52"
9.	Bejisuta-Kalidas beel (Ch 40.0 Km)	N: 26°07'58" E: 91°01'04"	10.	Sontoli (Ch 42.0km)	N: 26°07'58" E: 91°20'52"
11.	Hill side (Ch 57.0 Km)	N: 26°05'25" E: 91°01'12"	12.	Nagarbera (Ch 60.0 Km)	N: 26°06'54" E: 91°00'40"

137. In these areas some of the benthos e.g. Tubifex, Chironomus etc. are also found during the investigation. Presence of turtle like *Kachuga sylhetensis*, *Aspideretes gangeticus* has also been observed. Dolphins are reported to be frequently seen by the local villagers and fishermen. Besides that, Dolphins were frequently encountered at several points Including Palasbari, Gumi, Majgumi, and Jaljali River. Surfacing of Dolphins was observed in the main channel of the river.

138. The sluice gate of the Khanajan is serving the flood control measure without destroying the habitat. The Khanajan river mouth is found to be very important for fish richness and local migration of fish for breeding in the Deepar beel areas. Because of fish richness the river Dolphin[17] used to come either for foraging or breeding.

4.4.2. Aquatic or Macro-Invertebrates Ecology

139. The aquatic fauna under macro-invertebrates, such as crabs, mollusks, snails, lizards, amphibians and other aquatic mammals (River Dolphin & Otter) gives a rich diversity in the project area. Besides this phytoplankton, zooplanktons were also found in abundance. The details of Fish Species, Macro-Invertebrates, Crabs, Turtles & Tortoises, Lizards, Snakes, Mammals, Plankton, Chlorophyceae, Myxophyceae, Zooplankton and Benthos observed in Palasbari Reach have been given in Appendix 9.

4.4.3. Fish Species Diversity

140. Total 65 species of fish belonging to 23 families has been identified in the study area. Diversity of fishes in different sites gives different results. *Salmostoma, Garra, Gadusia* etc. species are predominant in the Palasbari Reach. Hilsa is found to be more dominant in the flood seasons because it migrates through main channel of the Brahmaputra River. In winter season also Hilsa is found to migrate in a lesser number. Other fish species like minnows are found to be less in diversity in some points.

4.4.4. Faunal Behavior Pattern

141. The existing wetland at Deepar Beel at Khanamukh area, having direct connection with the Brahmaputra River, has given a rich commercial fishery in and around the Palasbari area. Kalidas Beel also supports large number of fish and amphibian species, which breeds during pre-monsoon and monsoon season. The river Dolphins[18] also breed and play in the river water adjacent to all sites. Dolphins used to come to the connecting channels for feeding the fish where fishes are found in plenty. Other species like turtles and tortoises prefer to breed only in sandy ground near bank of the river having land river interface.

4.4.5. Migratory Route of Aquatic Fauna

142. The migratory fish species like Hilsa and Anguilla, which have been encountered show anadromous and catadromous migratory behavior, respectively, migrating through the main channel of the river to the deeper zones of the river. Therefore, the proposed dyke construction

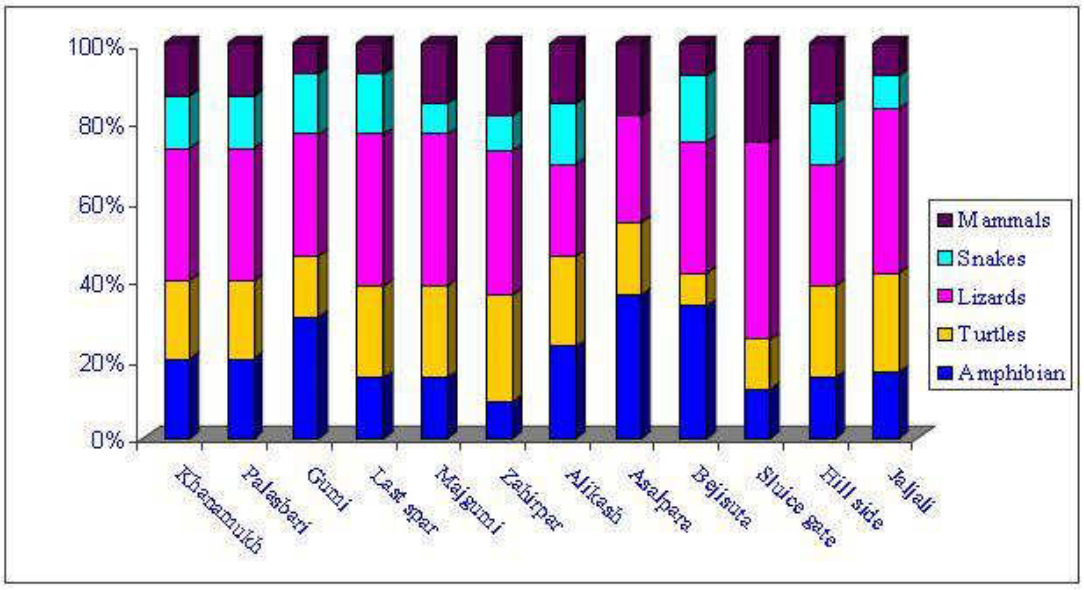
[17] The Gangetic Dolphin (*Platanista gangetica)*, an extremely docile and graceful creature is an endemic species of the Brahmaputra river. Commonly known as 'Shihu' in Assam, the Gangetic Dolphins are among the four freshwater Dolphins found in the world - the other three are the Baiji found in the Yangtze River in the People's Republic of China, the Bhulan of the Indus in Pakistan and the Buto of the river Amazon in Latin America. The presence of river dolphin in a river system signifies a healthy ecosystem. Since the river dolphin is at the apex of the aquatic food chain, its presence in adequate numbers symbolizes greater bio diversity in the river system. IUCN declared river dolphins as endangered in 1996, following which the Ganges river dolphin has been included in the Schedule - I of the Indian Wildlife Protection Act, 1972.

~~will not have adverse effects~~ on the migratory route. Other fish species like *Crossocheilius,* and *Tor* show only local migration from upper to lower reaches of the river.

4.4.6. Areas of Eco-sensitivity/ Protected Area/ Restricted Area/ Legislative and Others:

143. No such eco-sensitivity areas, protected area, restricted area, and legislative areas were found in the project sites but the areas between coordination of 26°07'58" N, 91°01'04" E and 26°07'58" N, 91°20'52" E supports comparatively very good vegetation types on the bank of the proposed project areas. Therefore, the bank of the river having sandy beds should not be disturbed during the project intervention. Special care should be taken to keep the breeding habitats in their natural conditions.

Figure 6: Abundance of Different Aquatic Vertebrates other than Fish



(Source: Field Survey)

4.4.7. Identification of Endemic/ Threatened and Endangered Species

144. Four fish species are found under endangered category, namely *Anguilla bengalensis, Tortor, Garra gotyla stenorhynchus, and Laguvia shawi. Be*sides fish, Turtles, few amphibians, and dolphins are also under Schedule-I endangered species.

4.5. Socio-Economic Environment

4.5.1. Demography

145. Palasbari sub project area lies in Kamrup district. It is located in the south west part of Assam state with 14 revenue circles and 17 blocks (Map-36). There are 1393 villages in the district and out of which 332 villages were located in the sub project area. The Palasbari reach falls in 6 Revenue Circles as per the land records, namely, Goroimari, Chaygaon, Chamaria, Nagarberra, Boko, and Palasbari. These circles consist of a total of 332 villages along the reach in the core and buffer zones. The structural measures are concentrated in two blocks. The general details of demography of the Palasbari reach are given in Table 22.

Map 36: Revenue circles and blocks under Kamrup district

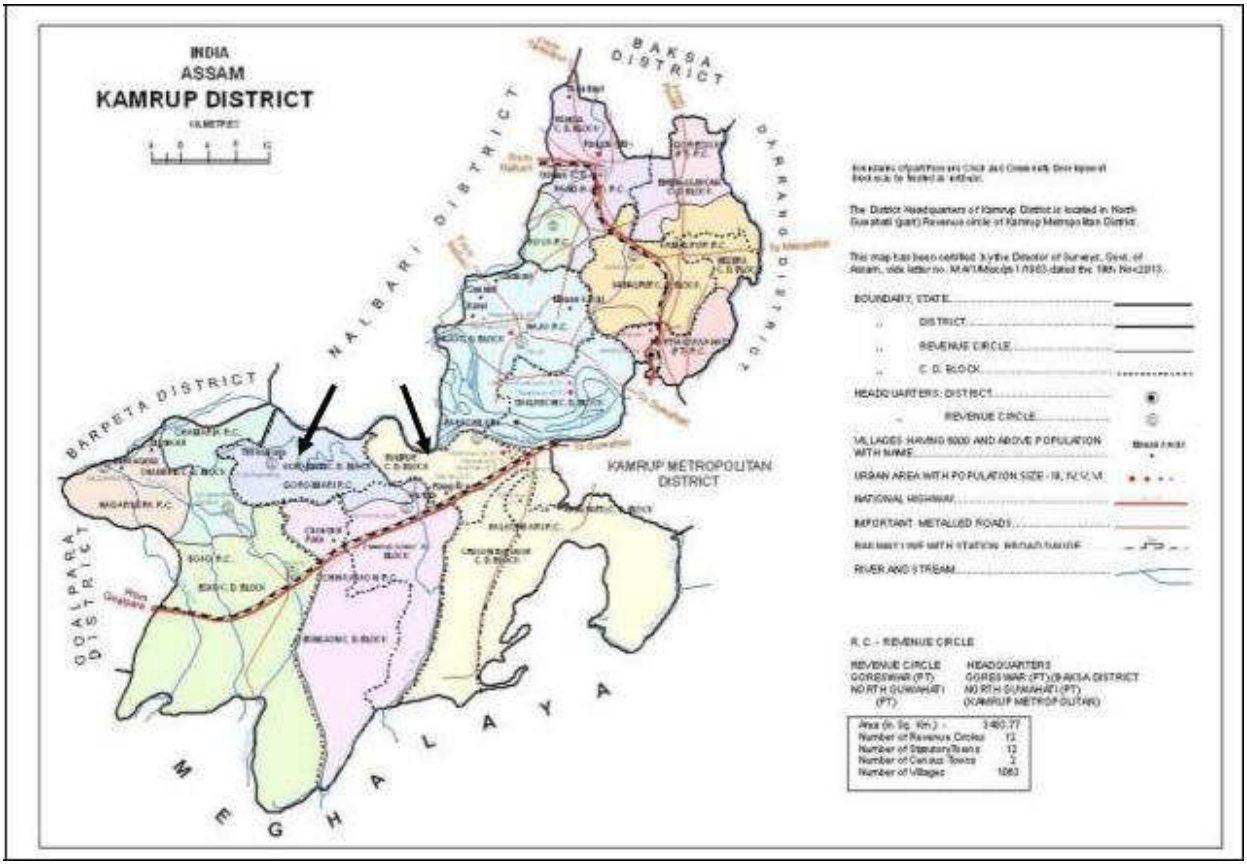


Table 22: Palasbari block Details

Block	Total / Urban / Rural	Area in Km²	Number of household	Total Person	Male	Female
Rampur	Total	128.16	20150	97709	50071	47638
	Rural	116.45	14528	70427	36040	34387
	Urban	11.71	5622	27282	14031	13251
Goroimari	Total	162.73	21741	122082	62107	59975
	Rural	162.73	21741	122082	62107	59975
	Urban	0.0	0	0	0	0

146. In the subproject areas, people are always vulnerable to physical risks - i.e., displacement by erosion and flooding, which further produces social and economic vulnerability. As a result, the subproject areas have more BPL houses (compared to national average of 26%). Then there are cases of female-headed households and elderly. In the context of erosion, many households fall within the multiple vulnerability category. The subproject location is marked by the presence of the people belonging to General, OBC, SC and ST categories. Nearly 50% of those surveyed are either landless or marginal farmers due to loss of land to the river. Around 25% live on daily wages, including those who earn a living as migrant worker (i.e., *hajira*) and others are dependent on agriculture and livestock.

152. The economy of Kamrup district and sub project area was mainly agriculture, livestock and timber market. As revealed by the dataset in the succeeding Table, the population density in the revenue block ranges from 762 persons per km^2 in Rampur to 750 persons per km^2 in Goroimari

Block. The average population density in the study area is 755 persons per km2. The population profile of the revenue circles along the Palasbari reach with respect to male, female, schedule castes (male and female), schedule tribe (male and female) have been given in Table 23.

Table 23: Palasbari: Population Profile

Name of the block	Total / Urban / Rural	Total Population	Schedule cast	Schedule Tribe	% of schedule cast	% of schedule tribe
Rampur	Total	97709	10216	450	10.46	0.46
	Rural	70427	8348	376		
	Urban	27282	1888	74		
Goroimari	Total	122082	1821	86	1.49	0.07
	Rural	122082	1821	86		
	Urban	0	0	0		

4.5.2. Education

147. Based on 2011, 75.55% population was literate in the district, ahead of Assam state average of 72.19%. Male literacy rate is 81.3 % and female literacy rate is 69.47%. The education facilities in the region are distributed mainly in the form of Primary, Middle, Secondary and Senior Secondary schools mainly. Out of 332 villages, 296 villages have any form of educational facility within their boundary. As many as 6 Colleges, 12 Adult Literacy Centers and 12 other education facilities are also available in the region. The details of education facilities in the revenue circles have been presented in Table 24. The pattern of distribution of these facilities, revenue circle-wise, is illustrated in Figure 7.

Table 24: Education Facilities in the Palasbari Reach

Revenue Circle	Villages with Educ. Facility	No. of 1° School	No. of Middle School	2° School	Sr. 2° School	College	No. Adult Literacy Class/ Centers	Other Educ. Facilities
Goroimari	59	127	33	16	1	1	0	0
Chaygaon	50	97	25	13	2	1	0	0
Chamaria	53	89	27	5	0	2	11	11
Nagarbera	27	84	24	7	1	0	11	0
Boko	62	101	34	13	0	2	00	
Palasbari	45	98	29	14	3	0	0	0
Total	296	596	172	68	7	6	12	12

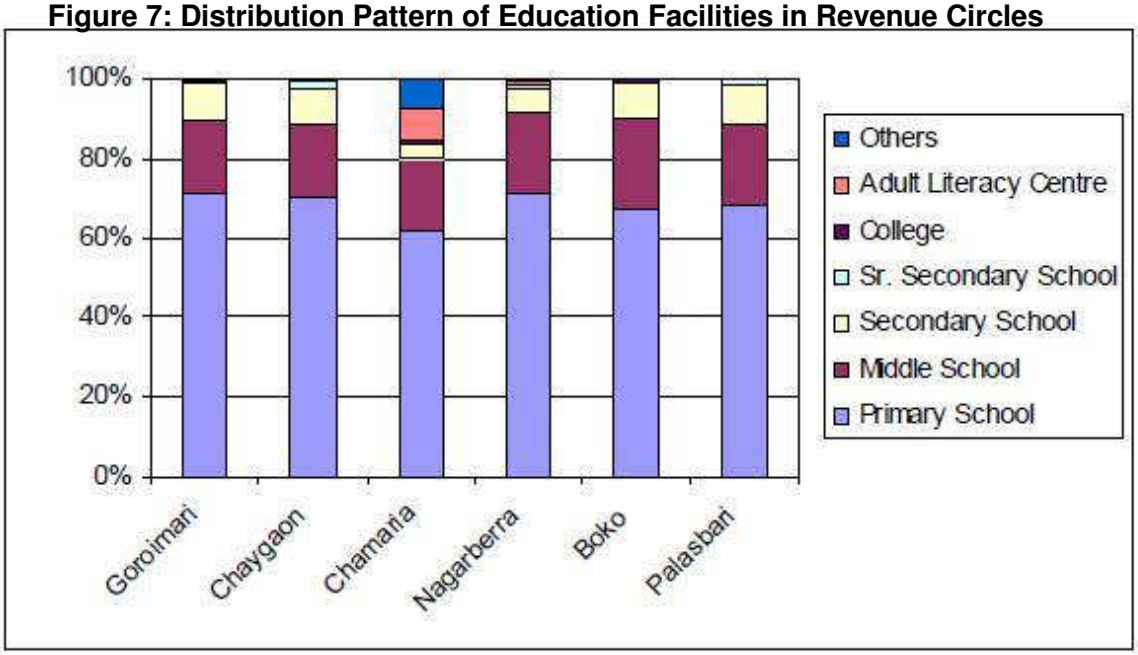
(Source: Census of India)

Table 25: Block wise literacy rate of the Palasbari Reach

Block		Total Population	Literate	Male	Female	Literate %	Male Literate %	Female Literate %
Rampur	Total	97709	65547	36130	29417	67.08	72.16	61.75
	Rural	70427	44872	24822	20050	63.71	68.87	58.31
	Urban	27282	20675	11308	9367	75.78	80.59	70.69
Goroimari	Total	122082	45912	26992	18920	37.61	43.46	31.55
	Rural	122082	45912	26992	18920	37.61	43.46	31.55
	Urban	0	0	0	0	0.00	0.00	0.00

Source: Census of India 2011

Figure 7: Distribution Pattern of Education Facilities in Revenue Circles



4.5.3. Peoples Dependence on Aquatic Fauna

148. Almost 55% people are dependent on fishing in the surrounding areas of Gumi, Majgumi, Alikah, and Bejikhuta. There are several beels used for fishery activity. Most of the households maintain their own fish ponds and almost one third of the households are involved in fishery activity. Besides fishing most people depend on the river Brahmaputra for bathing and irrigation in paddy field.

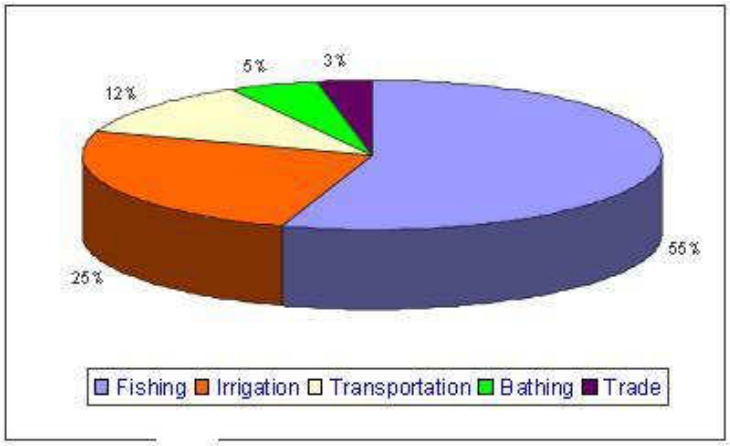
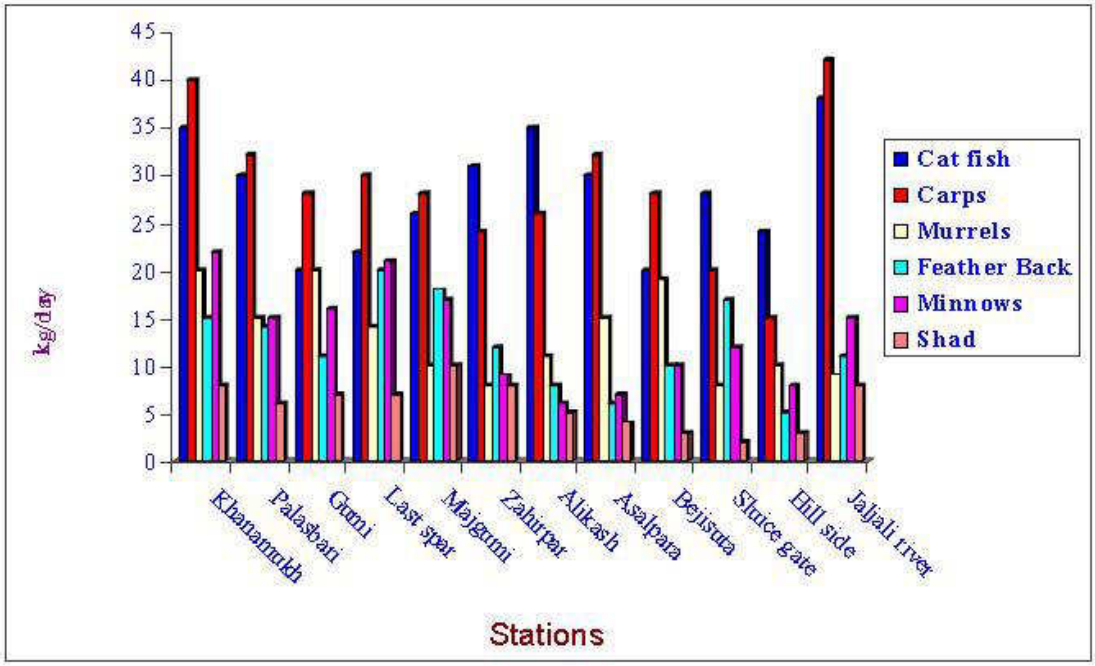


Figure 8: Dependency on Aquatic Fauna



(Source: Market Survey)

Figure 9: Average Fish Landing in Different Temporary Stations along the Palasbari Gumi Reach

4.5.4. Industries

149. The entire area along the Palasbari reach does not have any major industry. People are mainly dependent on fishing and agricultural activities for their livelihood. A few small scale/ household industries are present in the area, which are mainly focused on manufacturing of Gunny Bags, Jute Products, Bricks, Pat Muga, and production of Species and Mustard Oil. The distributions of these industries in various revenue circles along the Palasbari reach are given in Table 26.

156. Timber furniture was popular activity in the area with huge market potential in Guwahati and nearby urban areas.

Table 26: Palasbari Reach: Industrial Profile

Revenue Circle	Gunny Bags	Jute products	Spices	Mustard oil	Bricks	Pat Muga	Others
Goroimari	0	0	0	0	0	0	0
Chaygaon	0	0	0	0	0	0	0
Chamaria	9	10	0	1	0	0	20
Nagarberra	0	6	1	0	0	0	7
Boko	0	0	0	0	0	0	0
Palasbari	0	0	0	0	1	1	2
Total	9	16	1	1	1	1	29

Source: Census of India

4.5.5. Connectivity

150. The villages in the 6 Revenue Circles are mostly connected through paved roads. Also, the connectivity is through unpaved (mud) roads, footpaths, navigable river as well as waterways other than river. Poor accessibility from village settlements to the amenities and facilities was experienced in every rainy season due to the water stagnation and flooding for at least four months. The details of the connectivity are shown in Table 27.

Table 27: **Palasbari Reach: Connectivity**

Revenue Circles	Total No. of Villages	Approach Paved Road	Approach Mud Road	Approach Footpath	Approach Navigable River	Approach Waterway other than River
Goroimari	75	60	71	0	0	0
Chaygaon	53	52	53	6	0	0
Chamaria	60	53	21	1	7	1
Nagarberra	28	17	24	0	14	2
Boko	64	59	61	0	0	0
Palasbari	52	36	47	3	4	2
Total	332	277	277	10	25	5

4.5.6. Power Facilities

151. Power facility in the Palasbari Reach area is not available in all the villages. Only 73.5% villages have electrical connections. Mostly, power is available only for domestic usage. Only in 4 villages, power is also available for agricultural activities.

Table 28: Palasbari Reach: Power Facilities (villages)

Revenue Circle	Total Number of Villages	Villages having Power Supply	Villages with Power for Domestic Use	Villages with Power for Agricultural Use	Villages with Power for Other Uses
Goroimari	75	40	37	0	0
Chaygaon	53	45	42	0	1
Chamaria	60	40	40	3	0
Nagarberra	28	15	15	1	1
Boko	64	57	57	0	0
Palasbari	52	47	47	0	3
Total	332	244	238	4	5

Source: Census of India

4.5.7. Drinking Water Supply

152. Main source of drinking water in the entire Palasbari reach is groundwater. Water is available through wells, tube wells, hand pumps, and river. An inventory of the drinking water facilities throughout the year in the villages of Palasbari Reach are given in Table 29.

Table 29: Drinking Water Facility

Total/ Rural/ Urban	Total Number of household	Sources of drinking water								
		Tap water from Treated source	Tap water from un Treated source	Covered well	Uncovered well	Handpump	Tube well/ Bore well	Spring	River/ cannel	Tank/ pond/lake
Total	**50232**	**1522**	**377**	**703**	**8570**	**35982**	**704**	**963**	**630**	**38**
Rural	**38186**	**892**	**321**	**366**	**8201**	**25872**	**424**	**926**	**627**	**28**
Urban	**12046**	**630**	**56**	**337**	**369**	**10110**	**280**	**37**	**3**	**10**

Source: Census report 2011

153. During summer season, out of 332 villages, drinking water is available from tube wells, hand pumps and wells in 107, 80 and 87 villages, respectively. Tap water is available only in 9% villages.

4.5.8. Sanitation

154. There are public water supply schemes in some villages. The local bodies are operating the schemes. In town areas, about 50% households have latrines. The villages and other urban settlers however, practicing open defecation. There is no formal drainage system in the villages.

Table 30: Sanitation facility in Palasbari Circle

	Flush / Pour Latrine			Pit Latrine		Night soil disposed in open drain	Service Latrine		No latrine within premises	
	Piped sewer system	Septic tank	Other System	With Slab/Ventilated Imported Pit	Without Slab/ Open pit		Night soil removed by Human	Night soil removed by animals	Public Latrine	Open
Total	2988	8872	2638	7775	4312	153	358	171	631	22334
Rural	1590	5820	1976	4875	3172	93	247	162	341	19910
Urban	1398	3052	662	2900	1140	60	111	9	290	2424

Data Source: Census of India, 2011

4.5.9. Medical and Health Facilities

155. Illness such as skin diseases, malaria, diarrhea, and dysentery were prevalent in the subproject area. Skin diseases were reported as major concern as it stricken almost every household member in all villages. In case of illness, most of the households consult faith healer available in the village. Some households consult Ayurvedic doctor in the village in nearby places. If the illness is not remedied by the local faith healers or Ayurvedic doctors, the patient then avails of services of local health centers about 2–5 km from the villages.

156. The primary medical facility is available in most of the villages falling in the study area along the Palasbari Reach. The details of the health care facilities are given in Table 31.

Table 31: Medical Facilities

Revenue Circle	AD	AyD	MCW	MH	CWC	HC	PHCs	PHsC	FWC
Goroimari	0	0	0	0	0	0	0	6	13
Chaygaon	2	0	0	0	16	0	3	9	7
Chamaria	1	0	10	0	9	0	1	6	3
Nagarberra	2	0	0	0	2	0	2	6	6
Boko	7	1	3	1	10	0	3	9	7
Palasbari	7	0	0	0	1	0	6	2	9
Total	19	1	13	1	38	0	15	38	45

Note: AD- Allopathic Dispensaries MCWC - Maternity and Child Welfare Center CWC - Child Welfare Centers PHC - Primary Health Centers FWC - Family Welfare Center Source: Census of India 2001

AyD - Ayuverdic Dispensaries MH - Maternity Homes HC - Health Centers PHCs -Primary Health Sub-Centers

157. Due to widespread impact of floods on amenities such as sanitation and water, the communities often experience outbreak of diseases such as malaria, diarrhea, cholera, jaundice and other water borne diseases. During the floods, accessing medical facilities become very

difficult due to the unavailability of means of transport. Also, with lack of work (during floods, as shared above) many people don't go to the doctor for treatment due to the unavailability of money. Within the Government organized flood camps, much medical facilities are not available. In the past, many people used to die of diseases post-flood in the area, but with better medical facilities while the situation has improved it still needs to be catered to. The community shared that in instances of child birth, local "dais" (midwives) carry out the delivery during the flood times on the raised platform called "*saang.*

4.5.10. Land use

158. As per the revenue records, the areas under different land use categories in the villages falling under the core/ buffer zone of Palasbari reach are given in Table 32.

Table 32: Land use

LULC Class	Area (km^2)	LULC Class	Area (km^2)
Built-up, Urban	134.01	Built-up, Mining	0.03
Agriculture, Crop land	1579.38	Agriculture, Plantation	21.72
Agriculture, Fallow	17.86	Agriculture, Current Shifting Cultivation	0.02
Forest, Deciduous	1790.95	Forest, Scrub Forest	219.22
Grass/Grazing	88.03	Barren/unculturable/ Wastelands, Scrub land	9.24
Wetlands/Water Bodies, Inland Wetland	161.66	Wetlands/Water Bodies, River/Stream/canals	314.08
Wetlands/Water Bodies, Reservoir/Lakes/Ponds	8.78		
Total			**4345.00**

159. The pattern of land use is further illustrated with the help of pie graph in Figure 8. It shows that the land without any irrigation facilities occupy about 56% of the geographical area.

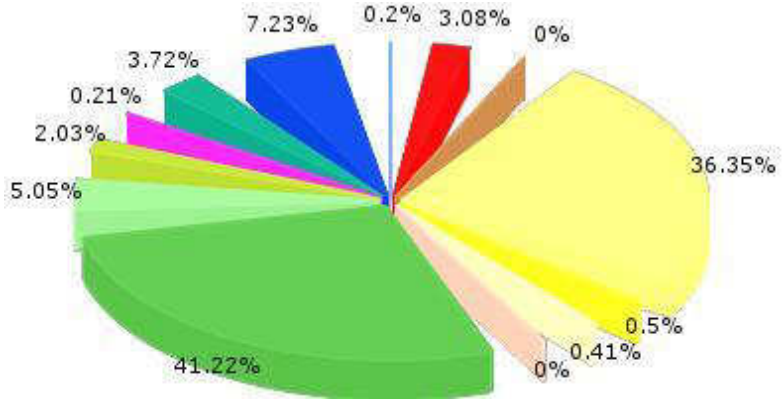


Figure 10: Distribution of Land use

160. The locations of various types of educational, social, religious and other institutions of social importance within the 100 m direct impact corridor around the embankment were obtained using a handheld GPC and the data were subsequently plotted on the satellite image of the tract with the help of GIS. The distribution of the institutions is shown in Figure 15, while the data are presented in Table 33.

Table 33: Establishments Located within 100 m Impact Zone

Facility	Majirgaon-Dakhala		Dakhala hill-Gumi		Gumi-Nagarbera	
	CS	RS	CS	RS	CS	RS
Education Facility						
L.P.school	2	Nil	2	Nil	9	1
M.E.school	1	Nil	Nil	Nil	4	Nil
High School	1	Nil	2	Nil	4	Nil
Madrassa	Nil	Nil	Nil	Nil	3	Nil
Relegious and Cultural Heritage Facilities						
Temple	3	Nil	2	Nil	Nil	Nil
Namghar(prayer Hall)	2	Nil	2	Nil	1	Nil
Mosque	Nil	Nil	2	Nil	9	1
Graveyard	Nil	Nil	Nil	Nil	1	Nil
Cremation ground	1	Nil	Nil	Nil	Nil	Nil
Id-gah maidan	Nil	Nil	Nil		1	Nil

Source: Field Survey

4.5.11. Distribution of Land use

161. The baseline survey which covered 10% of the villages in the Palasbari Reach revealed the proportion of households in each of the land holding category. About 18% households have land holding above 2 ha while the remaining are either marginal holders or landless. Due to erosion, landowners are displaced which increases the number and proportion of marginal and landless households. About 600 hectares is loss due to erosion annually in the Palasbari Reach.

Table 34: Distribution of Land Holding by Category: Palasbari Reach

Class	Land Holding Category	Category as defined by Government of India	% of households in each category
A	Large Land Holder	Land owned more that 7.01 ha.	1.64
B	Medium Land Holder	Land Owned 4.01 ha to 7.00 ha	6.09
C	Small Land Holder	Land Owned 2.01 to 4.00 ha.	10.77
D	Marginal Land Holder	Up to 2.00 ha	26.25
E	Land Less	Household without land holding	55.25

162. In the past years, WRD built embankments for flood control in the subproject area. Retired embankments had to be built due to breaches and/or failure of existing embankments during high floods. The embankments provided substantial benefits to the local communities in terms of protection against loss of crops, assets and displacement. However, those affected by land acquisition for flood control embankments did not receive compensation as provided in the Assam Land (Requisition and Acquisition) Act of 1964. Compensation remained an outstanding issue for households who lost land due to construction of embankments. In Palasbari subproject 8 major LA case are pending from 1984 to 2000, which is now being addressed by WRD in the context of preparing the subproject proposal under the FREMAA Assam. From the tranche 1 all land acquisition issues are dealt under The Land Acquisition and Rehabilitation and Resettlement Act, 2013 and similarly it will be followed I tranche 2 also.

4.5.12. Occupational Pattern

163. The baseline survey revealed that more than 50% households in the Palasbari Reach were involved in agriculture, livestock, and fishing activities in a small land holding that are not economically viable to feed a large size household. This indicates that at least one member of each household has migrated to Guwahati for day labor. This migration of workers is considered as a major source of household livelihood. It was also estimated based on the survey that about one third of the working population was engaged in service sector - job with government or private sector. Remaining households were involved in activities such as timber, marketing, business, transport and other artisan activities. 41.45% of the population are working. Out of that 27.76% are main worker and 13.69% are marginal workers (Table 35). Distribution of all the main workers under Rampur and Goroimari Block under Palasbari subproject are shown in Table 36.

Table 35: Distribution of Working Population

		Number	%
Total Worker (main and marginal)	Person	628,954	41.45
	Male	428,492	55.04
	Female	200,462	27.12
Main Worker	Person	421,244	27.76
	Male	346,863	44.56
	Female	74,381	10.06
Marginal Worker	Person	207,710	13.69
	Male	81,629	10.49
	Female	126,081	17.06
Non-Worker	Person	888,588	58.55
	Male	349,969	44.96
	Female	538,619	72.88

Source: Census Report 2011

Table 36: Distribution of Main workers in the district

Cultivator	Person	185,803	29.54
	Male	149,792	34.96
	Female	36,011	17.96
Agricultural labor	Person	99,522	15.82
	Male	55,369	12.92
	Female	44,153	22.03
Workers in household industry	Person	69,106	10.99
	Male	21,144	4.93
	Female	47,962	23.93
Other workers	Person	274,523	43.65
	Male	202,187	47.19
	Female	72,336	36.08

Table 37: Distribution of Main workers in Rampur and Goroimari block

		Main worker			Cultivator			Agricultural workers			Household industry			Others		
		Person	Male	Female	Person	Male	Female	Person	Male	Female	Person	Male	Female	Person	Male	Female
Garoimari	Total	33039	27530	5509	18688	16877	1811	4800	3208	1592	766	405	361	8785	7040	1745
	Rural	33039	27530	5509	18688	16877	1811	4800	3208	1592	766	405	361	8785	7040	1745
	Urban															
Rampur	Total	26284	22501	3783	6842	6326	516	1868	1654	214	1970	948	1022	15604	13573	2031
	Rural	19154	16259	2895	6384	5872	512	1614	1415	199	1492	678	814	9664	8294	1370
	Urban	7130	6242	888	458	454	4	254	239	15	478	270	208	5940	5279	661

164. Agriculture and wage/day labor are principal occupations in the area. While 52% are involved in agriculture, nearly 22% are engaged in daily labor activities. The incidence of landless is high in both the subproject locations. On an average, nearly 40% of the population in the households are now involved in doing "*haajira"* (wage labor) to meet their daily subsistence needs. However, during floods, the area is all flooded with water, with no means of transportation; people are not able to go to work and stay at home. Flood means no work for them, making it even more difficult for households to take care of household expenses and meet basic needs.

4.5.13. Primary Source of income

165. Table 38 enumerates the primary sources of income of the 135 AHHs village/ward wise. It is pertinent to note that none of the AHHs depend on agriculture for earning their primary source of income (Assessed for tranche 2).

Table 38: Ward/Village wise Distribution of Income Source

Source of Income	Dakhala	Bholapara	Satrapara	Guimara	Simina	Mokadhuj	Grand Total
Diary	0	0	0	0	0	0	0
Govt. Service	2	1	0	2	0	0	5
Non-Agriculture Labor	18	11	2	20	4	4	59
Profession	3	0	0	5	2	0	10
Pvt. Service	1	0	0	1	0	0	2
Trade/Business	8	1	0	4	0	0	13
Employment in Small Tea Stalls	0	0	0	0	0	1	1
Other (Agri Labor)	0	0	0	1	2	14	17
Absent	4	2	9	7	5	1	28
Grand Total	**36**	**15**	**11**	**40**	**13**	**20**	**135**

4.5.14. Total Annual Income

166. The resettlement Survey has brought forth that the annual income of majority of the total 135 AHHs surveyed is less than ₹45,000, i.e.- the majority of the affected households (AHHs). Only 4 AHHs of the 135 AHHs earn more than ₹1 lakh annually in the subproject location. Table 38 illustrates the distribution of annual income of the AHHs by their income (Assessed for tranche 2).

Table 39: Ward/Village wise Distribution of Annual Income

Income Source	Dakhala	Bholapara	Satrapara	Guimara	Simina	Mokadhuj	Grand Total
Less Than ₹25,000	3	0	0	3	0	0	6
₹25,001-45,000	14	4	2	17	6	14	57
₹45,001-65,000	9	7	0	10	0	5	31
₹65001-85000	4	1	0	2	2	0	9
₹85,001-1 Lakh	0	0	0	0	0	0	0
More than ₹1 Lakh	2	1	0	1	0	0	4
Absent	4	2	9	7	5	1	28
Grand Total	**36**	**15**	**11**	**40**	**13**	**20**	**135**

4.5.15. Common Property Resources

167. In every village there are some resources which belong to the community as a whole and are classified as Common Property Resources (CPRs). In the project area, 7 such CPRs would be affected as a result of the Project. Table 41 enumerates the village/ward wise distribution of the CPRs.

Table 40: Ward/Village wise Distribution of Common Property Resources

Name of Village	Temple	School	Hand Pump	Cremation Ground	Community Toilet	Grand Total
Dakhala	0	0	1	0	0	1
Bholapara	1	0	0	0	0	1
Satarapara	0	0	0	1	0	1
Guimara	0	0	1	1	1	3
Simina	0	1	0	0	0	1
Mokadhuj	0	0	0	0	0	0
Grand Total	**1**	**1**	**2**	**2**	**1**	**7**

5. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1. Potential Environmental Impacts

168. Environment Impact study has been carried to study the effect of the proposed embankment project on the physical, biological and social environment of the project area. Potential impacts are categorized into two category (i) impact during design & construction stage and (ii) impact during operation stage. Qualitative and quantitative techniques have been used for identification, assessment and evaluation of the potential impacts. Impacts based on their magnitude and significance are classified as insignificant, minor, moderate and major. The mitigation measures have been presented along with the impacts.

5.1.1. Land Use

5.1.1.1. Land Use Change due to Project Activities and Borrow Area

Design and Construction Phase

169. **Impacts**. The proposed project activities involve construction of Apron and Embankment works, construction of new sluice gate, Protection work along the southern bank of the river Brahmaputra at Barbhita and Taparpathar area. Following works will be executed under Palasbari and Gumi reach. Bank protection work Dokhola Hills to Makadhuj 6.4 km, Rehabilitation of existing spur at Chimina, Construction of Sluice gate at Kalbhog Channel, Bank Protection work at Borbhita reach 1.2 km, Bank Protection work at Taparpathar 5 km,.

170. Substantial quantity of the earth will be required for construction of the river embankment of about 5 m height above the ground level with a top width of 7.5 m and a side slope of 1:2 to 1:3 which is designed for 100-year flood return period. It is proposed that the demand for earth will be fulfilled by excavating borrow pits in the vicinity of the river embankment. The unplanned selection of borrow areas/ no rehabilitation of borrow areas may lead to loss of productive use of the land. The transportation of borrow earth may also cause air pollution, if transported in uncovered trucks. Due to such construction activities along the river bank, the land use of about 100 m buffer (37 m for embankment plus borrow areas towards country side) around the embankment is likely to be affected or changed. Based on satellite imagery and GIS interpretations, the Palasbari Reach has about 819.9 ha land (57.7%) of buffer area used as agricultural land and about 447.7 ha (31.5%) area as homestead plantation.

171. The access to the embankment construction site is mostly through the single lane rural roads (paved and unpaved both). These roads would require strengthening to sustain the heavy trucking load. In addition, four to five construction camps throughout the 74.1 km long Palasbari Reach are likely to be located at about 10–15 km apart, close to the embankment. This will also temporarily change the land use of the area.

172. Due to the proposed interventions, most of the agricultural land and homestead plantation around the embankment site and construction camp areas may be affected adversely. Loss of topsoil is one of the most potential impacts with respect to borrowing of earth from country side of the embankment. Besides this compaction of soil along the haulage route may also take place, if proper mitigation measures are not employed.

173. **Mitigation Measures**. Since the impact zone around the embankment covers productive land, which is used by the villagers for cultivation, diversion of land for project purposes shall be minimized to the maximum extend feasible. The option of backward shifting of embankment shall be preferred. Adjacent cultivable lands, shall not be occupied for storage and/or handling of construction materials. Construction camps shall preferably be located on uncultivated area. All requisite facilities (drinking water supply, sanitation, domestic solid waste collection &disposal, fuel supply) shall be provided at these camps. The land used for construction camp shall be made reusable/cultivable after closure of construction camp. No construction debris shall be

deposited on agricultural land. Loss of crops for construction camp area shall be compensated to the landowners.

174. **Borrow Area Location and Rehabilitation:** The borrow pits shall be on river side since borrow pits on the river-side to get silted up in the course of time whereas on the country-side remain a permanent disfiguration. Further the borrow pits next to embankment on the country side can be a cause of inducing seepage to the foundations. Borrow pits on the country side away from embankment shall be preferable even at the expense of comparatively long hauls. If sourcing earth from country side is unavoidable, the preference to be given for the following options:

(i) Waste land or excavating or enlarging existing lank or any humps above general ground level
(ii) Waste land or excavating or enlarging existing lank or any humps above general ground level
(iii) Earth from retired embankment.
(iv) Land which farmers wants to either convert into a fish pond or lowering the agriculture field level to increase its water retention capacity
(v) No land acquisition shall be made for borrow areas
(vi) Exploring the suitability of using dredge material from river Kulsi/Jaljali- which otherwise also require desiltation to increase its water carrying capacity
(vii) Exploring the option of using combination of soil and sand in embankment construction. Means using soil as outer cover and sand as filler in between.
(viii) Exploring technical feasibility of using soil from sandbars existing away from the bank.
(ix) Follow the WRD guidelines for locating borrow pits close to the embankment if at all it is to be located next to embankment. All efforts shall be made that no tree loss takes place due to borrowing. The trucks shall be covered while transporting the earth.
(x) Prior environmental clearance shall be obtained from SEIAA for borrow areas.

175. While borrowing the earth top soil shall be preserved. The Borrow pits shall be rehabilitated after borrowing. The WRD guidelines for locating/rehabilitation of the pits shall be strictly followed. The Indian Road Congress (IRC):10-1961 guideline may also be referred for selection of borrow pits. In all cases good engineering and construction practices shall be followed. The construction contractor or DPR consultant shall submit the borrow area identification details along with borrow area rehabilitation plan in advance.

176. WRD Guidelines with respect to borrow area location and rehabilitation:

(i) For high embankments no excavation shall be done within 45 m of the river side toe of the embankment. From 45 m to 60 m the borrow pits must not be more than 1.8 m deep and from 60 m to 90 m not more than 2.4 m deep and beyond 90 m they can be of 3 m depth.
(ii) If earth is to be taken from land-side of the embankment, no borrow pits shall be excavated within 24 m of the land-side toe of the embankment. The depth of excavation in 24 m to 36 m shall not be more than 0.6 m.
(iii) For low embankments the borrow pits on the river-side and on the land-side shall not be located at less than 24 m from the toe.
(iv) The borrow pits shall be staggered and on undisturbed ground 6 m wide left at regular intervals to prevent the velocity of flow through the river-side borrow pits. The staggering will also help in inducing silting and filling up of these borrow pits.
(v) On the country-side the water-logged areas (bandhis) shall be cut and interconnected to permit ordinary drainage. These shall be connected to the nearest drainage channel so as to carry away the drainage water.

(vi) The borrow areas selected for taking earth shall be cleared of all trees, shrubs, grass and vegetation mounds.
(vii) No borrow pits shall be made on roads, village tracks, graveyards, canals or embankments.

177. The Indian Road Congress (IRC):10-1961 guidelines for selection of borrow pits and amount that can be borrowed is summarized below:

(i) Borrow areas shall not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth shall not exceed
(ii) Borrow areas shall not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth shall not exceed
(iii) 45 cm. The topsoil to a depth of 15cm shall be stripped and set aside for its later use for the purpose of turfing on slopes of the embankments. Thereafter, soil may be dug out to a further depth not exceeding 30 cm and used in forming the embankment.
(iv) Borrow pit shall be selected from wasteland;
(v) Priority shall be given to the borrowing from humps above the general ground level within the road land;
(vi) Priority shall be given to the borrowing by excavating/enlarging existing tanks;
(vii) Borrowing shall be from land acquired temporarily and located at least 500m away from the road;
(viii) Borrowing shall be from mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the road;
(ix) In case of settlements, borrow pits shall not be selected within a distance 800 m from towns or villages. If unavoidable, earth excavation shall not exceed 30cm in depth;
(x) The haulage distance from site shall not be too far.

Operation Phase[18]

178. **Impacts.** Encroachment on embankment for habitation and cultivation purpose may affect embankment stability. Villagers also cut the embankment to create approach to river side for their movement for toileting, cattle grazing, and farming. Borrow areas, if not rehabilitated may have landscape and accidental hazards. Also, if the borrow areas are not rehabilitated based on the intended end use of the owner,

179. **Mitigation Measures**. Provision shall be made in the embankment design for providing Access[20] to the river bank close to the habitated areas. The construction contractor shall ensure rehabilitation of borrow area before handing over the project.

5.1.1.2 Land use Change due to construction material sourcing (Quarrying)

Design and Construction Phase

180. **Impacts.** A project of this magnitude would require significant amount of construction material. Illegal quarrying may lead to land use change, unstable rock formation, air and noise pollution. The aggregate demand for construction of river embankment with paved road on the top in Palasbari Reach will be met through approved Bamunigaon and Rani quarry located at distance of about 30-40 km from the reach. The environmental aspects and control of pollution due to quarrying operation of these approved quarries are controlled and monitored by SPCB. Thus, adverse impacts as a result of quarrying operations are not envisaged in the proposed project.

[18] Operation phase in this section means post-construction use period.

181. **Mitigation Measures**. Aggregates required for construction of embankment and roads shall be procured from quarries approved by State Pollution Control Board. Air and noise emissions from quarry shall be well within the prescribed limits. Setting up of stone crushers, if required, shall be done only after obtaining consent from State Pollution Control Board and taking adequate measures for air pollution control. While finalizing the site, proper land use assessment shall be done. The land to be earmarked for dumping construction waste if any shall be free from any social or R & R issue.

5.1.2. Soil Environment

5.1.2.1 Soil Erosion

Design and Construction Phase

182. **Impacts.** Soil erosion potential of an area depends on its topography, geological structure, rainfall, soil type and land use/land cover. In the Palasbari Reach, the topography of the terrain covering the alluvial plain is nearly flat with a gentle gradient towards south west, except few occasional hillocks that rise steeply above the plain. Except the upper reaches of tributary rivers originating from the Meghalaya plateau including the Kulsi where slopes are steep, the soils are easily eroded and if rainfall is heavy, the rivers in the valley part of the basin show more of a depositional character due to their greatly reduced slope, transport of higher sediment load from upstream areas and congestion of drainage. Possibility of occurrence of gully and rill erosion is expected in the uncovered side slopes of embankments and other freshly cut or deposited areas.

183. **Mitigation Measures**. Following mitigation measures can prevent the soil erosion:

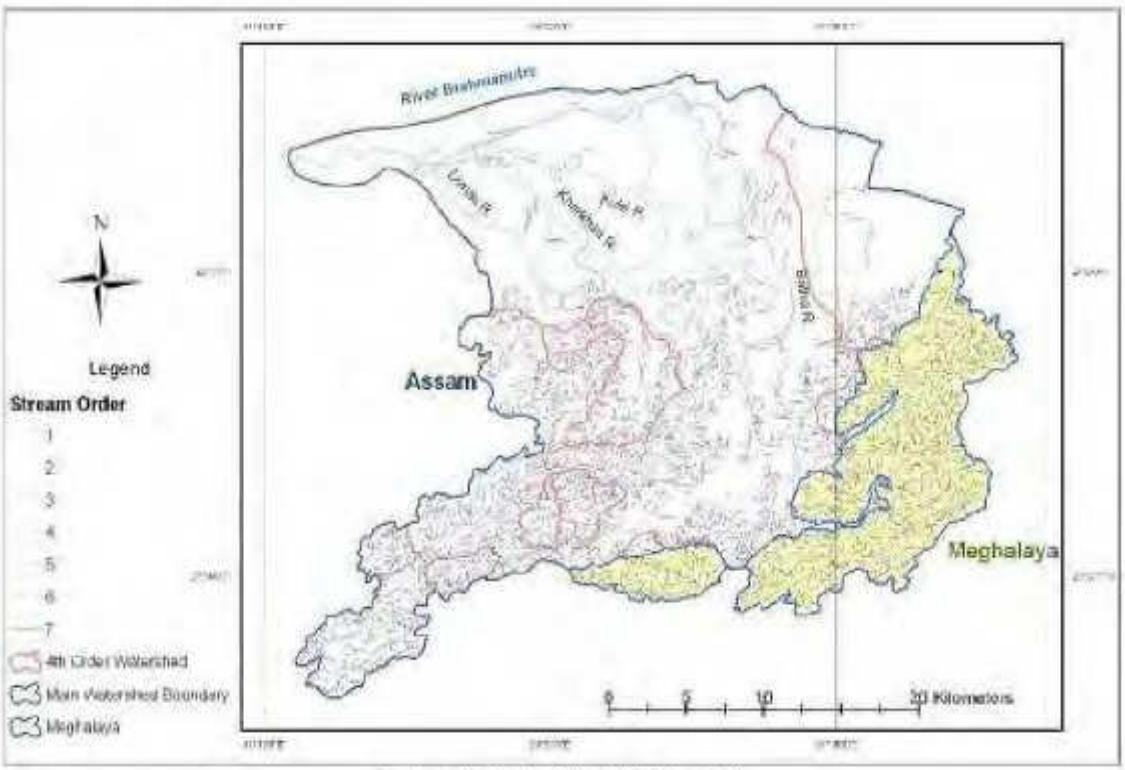
(i) Construction shall be scheduled such that large areas of soil particularly at borrow areas near the embankment are not laid bare during the monsoon.
(ii) Exposed surface shall be resurfaced and stabilized as soon as possible. This shall also be covered by straw or mulch to avoid soil loss in the intervening period. Ground disturbances shall be phased so that it is limited to workable size.
(iii) Stabilizations of soil around approach roads/slopes shall be done by turfing and tree plantation in ROW.
(iv) Other slope stabilization measures like selection of less eroding materials around water bodies/water streams shall be adopted.
(v) The embankment and road design shall incorporate adequate engineering measures so that the construction could withstand the earthquake magnitude of more than 6 Mb.
(vi) Soil conservation measures like contour bunding, terracing, afforestation in the hill slopes of the upper watershed and agro-forestry, agro-horticulture along with appropriate structural methods in the plain areas is required to mitigate gully sheet and rill erosion. However, this activity is beyond the scope of proposed project activity and is suggested to be initiated by WRD with concerned other agencies.
(vii) Soil erosion shall be visually checked on potential erosion zones during construction phase. In case soils erosion is found, suitable measures shall be taken to control the same.

During field visit, it has been noticed that people cut the earthen embankment at various places between Gumi village (Ch. 21.0 km) and Nagarbera hill (Ch. 58.0 km) for trespassing buffalo cart to carry resources from river side of the embankment to the countryside.

Operation Phase

184. **Impacts.** Due to bank erosion, the bank line at various sections throughout the reach has shifted up to 7.6 km during the study period of 1911-1988. A total of 16,119.83 ha land was eroded between year 1911–2008 in the entire stretch of 74.1 km of Palasbari Reach. The proposed project will have net benefits in terms of soil erosion and preventing progression of land loss which is about 90.1 ha per year (considering reduced scope of the Palasbari sub-project as 25 km length of river running) at present in the Palasbari Reach. Soil erosion may still occur during the operation phase and early detection and remedial measures shall need to be taken for safety of the embankment and roads. Most part of flood plain of Brahmaputra in Palasbari sub-project area is covered by lower watershed of Kulsi River and a number of tributaries join it in this region (Map 34). Any attempt to prevent flooding and erosion in this part will necessitate the management of the Kulsi watershed in a holistic manner in order to derive sustainable benefit out of the proposed project. The current land use pattern in the watershed as depicted in the land use/land cover map (Map 35) based on interpretation of satellite data using a GIS platform shows the highland-lowland interactive nature of the physical as well as cultural landscape of the region with the project area covering the southern most part adjoining the Brahmaputra river. The environmental setting of the watershed *vis-à-vis* the benefiting area of the project therefore warrants an integrated approach of management for the entire watershed.

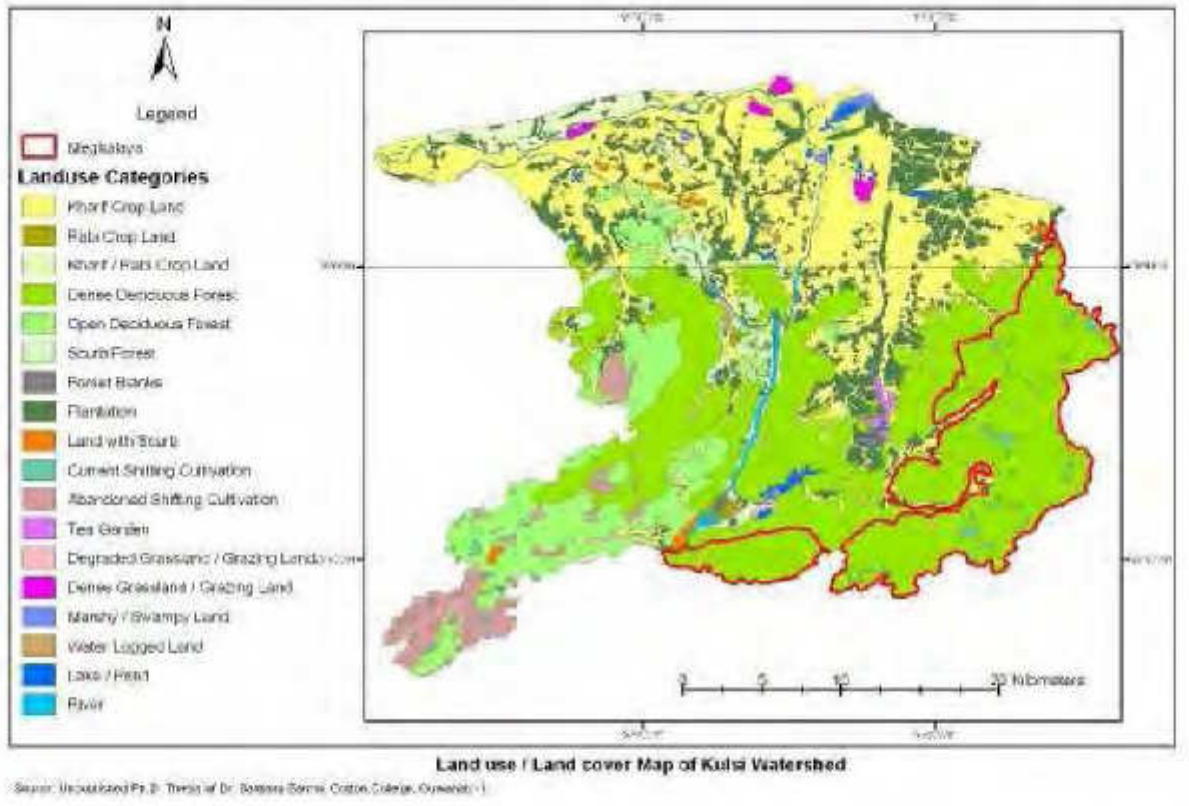
Map 37: Drainage Network of the Kulsi Watershed



Drainage Network of the Kulsi Watershed

Source: Unpublished Ph.D. Thesis of Dr. Sanjeev Barua, Cotton College, Guwahati -1

185. **Mitigation Measures**. Periodic checking shall be carried out to assess the effectiveness of stabilization measures. A detailed study to assess the location, reasons of soil erosion along the embankment during third year of the operation phase shall be undertaken. Suitable strengthening measures shall be implemented to prevent reoccurrence of soil erosion at existing erosion prone locations and prevent erosion at newer locations. To combat the menace of soil erosion and to ensure its conservation on a sustainable basis, efforts shall be made to develop watershed management plans jointly by Assam Government and Meghalaya Government under the aegis of the North Eastern Council for the Kulsi River system of the reach where both water as well as soil will receive adequate emphasis.



Map 38: Land use/ Land Cover Map of Kulsi Watershed

5.1.2.2. Soil Compaction and Contamination

Design and Construction Phase

186. Impacts. Soil around construction site, haulage road, construction camp, and workshop, will get compacted due to transportation of man, machine and materials. Considering about 57.7% of land in the closed vicinity of river embankment is used for agricultural purposes in Palasbari Reach, and construction period is for 6 years, the agricultural yield will be reduced substantially due to soil compaction. Soil may also get contaminated around construction site, machine maintenance area, fueling station, construction camp, hot mix plant site, and haulage road.

187. **Mitigation Measures**. The movement of construction vehicles, machinery and equipment shall be restricted to the embankment site and pre-defined haulage road. Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and

machineries shall be made to avoid damage to existing village roads, crop lands and settlement areas. The non-usable, non-saleable, non-hazardous construction waste shall be dispose of in the properly delineated places. Usable or saleable waste shall not be disposed of to landfill.

188. All efforts shall be made to prevent soil contaminations. Following measures shall be taken to prevent the same:

(i) The construction vehicle shall be fueled or repaired/serviced at the designated place with proper arrangement of waste collection and disposal. The arrangement shall include cemented floor with dyke around for fuel storage and filling as well repairing of construction equipment. To avoid the soil contamination at the wash down and re-fueling areas, "oil interceptors" shall be provided.
(ii) The demolition waste if any shall also be used to the extent feasible for construction.
(iii) Oil and grease spill and oil-soaked materials shall be sold off to State Pollution Control Board (SPCB)/ MoEF authorized vendors.
(iv) Oil spill kits should be available at the site to minimize the damage to soil quality in case of spillage
(v) Fuel and waste oil should be stored in isolated locations on paved areas only to minimize the soil contamination. These areas should be provided with the garland drains provided with the oil interceptors

Operation Phase

189. **Impacts**. During the operation phase, contamination of soil is not likely to happen other than due to accidental spillage from vehicle movement.

190. **Mitigation Measures**. Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

5.1.3. Hydrology and Morphology

Design and Construction Phase

191. **Proposed Works**. The proposed project works at Palasbari will be implemented in two tranches and consist of retirement of portions of the existing Brahmaputra embankment in the area of Palasbari (around 5 km), construction of two new sluices, together with around 19 km of riverbank protection in different places consisting of revetment and anti-erosion works near Gumi. The work under Tranche 2, to be implemented from year 2 (2015-2016) of the project is at this moment tentative and subject to future confirmation depending on the morphological development.

192. **Impacts.** No impact is envisaged during this phase. The aspects associated with design and construction of various project components associated with hydrology and morphology have been addressed under land use, soil, flora and fauna, air and noise and water quality section. The impacts associated with the operation stage are presented under various sub- sections below.

5.1.3.1 External Effects on Morphology - Upstream and Downstream Impacts

Operation Phase

193. **Impacts**. The impact of the planned flood protection measures along the Brahmaputra is considered negligible, as they focus on strengthening existing embankments. The proposed

bank protection measures will confirm and stabilize the present bank line; the pro-siltation measures will have no discernible effect on general bed levels. In summary, the proposed works are expected to have no adverse effects on the dynamic river morphology.

194. The construction of riverbank protection works leads to a river response, commonly a deepening of the channel alongside the protection work. This is a consequence of flow concentration and/or a reduction of sediment entrainment from eroding bank. It is commonly believed that the Brahmaputra instability is largely associated with excessive sediment transport. The proposed interventions, revetments and anti-erosion measures, reduce the sediment. Both measures further reduce turbulence and the impact of currents, as opposed to spurs, which actively deflect the currents, and therefore minimize negative effects. The reduced sediment entrainment alongside the protected reach has the tendency of encouraging more pronounced and stable channels without affecting the opposite bank or the upstream area. In order to avoid downstream riverbank erosion, the project places the downstream termination with a slight curvature away from the existing bank, which results in passive protection of a certain downstream length. This does not alter the dynamic pattern of constantly changing in-stream channel bars, locally called, chars or chaporis.

195. The project will not build new river training works, namely spurs. In some cases, existing spurs will be rehabilitated, not changing their length or orientation, but concentrating on repairing local damages. As the existing spurs are long established, limited rehabilitation under the Project will inflict no change on their impact on the dynamic river and char system.

196. A number of charlands in the project area are used for seasonal cropping and other uses. It is expected that the current adaptive land use patterns of these charlands will continue into future to ensure their beneficial use. Charland in the immediate vicinity of the project sites does not have permanent settlements.

197. **Mitigation Measures**. The project envisages a process of systematic annual analysis and prediction of sedimentation and erosion behavior, which includes the analysis of the structural response to riverbank protection work. The analytical tools consist of (i) low-water satellite imagery based large-scale morphological analysis of Brahmaputra reaches, supported with (ii) large-scale bathymetric surveys covering the near bank channel pattern starting from several kilometers upstream of locations of interventions and typically ending around 10 km downstream, and (iii) near-bank surveys, providing a detailed picture of the river response and structural performance. In case unexpected downstream effects are observed, the Project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies.

5.1.3.2 External Impacts on Flood and Drainage

Operation Phase

198. Impacts. The proposed structural flood protection works consist of retirement inland of existing lengths of the Brahmaputra dyke. No new embankments are proposed. The proposed works will essentially confirm existing flooding behavior and provide better protection from mainstream flooding to flood-liable areas behind the embankments. The proposed ant-erosion and pro-siltation works will not significantly affect flood behavior, gross cross-section-wide sediment behavior of river morphology. Embankments are to be retired only 50-100 m from their present position, so there is no significant change in floodplain storage or cross-section conveyance. No discernible change in downstream flood levels will occur. The proposed bank protection measures will stabilize the banks and have no discernable effect on flood behavior. . It is also to be noted that the proposed works include construction of two gated drainage sluices

to mitigate drainage congestion within the protected areas either side of Dakhala Hill. (The nature and extent of these sluices will be determined during the project implementation).

199. **Mitigation Measures**. Under the project, it is proposed to develop and use a numerical hydraulic model to investigate flooding and drainage behavior, both within and outside the protected areas, associated with mainstream, tributary and local flooding. This model will be used to ensure that there is adequate freeboard against embankment overtopping and that adequate provision has been made for sluice gates to facilitate drainage from the protected areas. Natural drainage systems shall be left undisturbed to the greatest extent possible; the flooding behavior of beels and wetlands will be assessed and where possible improved and/or preserved. Adequate provisions shall be made in designing embankments to withstand extreme meteorological and other geophysical events.

5.1.3.3 Changes in Water Levels

Operation Phase

200. Impacts. The conveyance capacity of the Brahmaputra opposite the Palasbari Reach is enormous - and will remain unchanged by the proposed works on the southern bank. Accordingly, the proposed works will have no discernable effect on river water levels. Changes in channel conveyance brought about by the natural processes of riverbank erosion, accretion and channel avulsion will play a much greater role in any future change in water levels. An improved embankment network will reduce the risk of sudden devastating flooding and as such provide more predictable and stable water levels on the flood plains (especially from temporary local inundation during the flood season).

201. **Mitigation Measures**. Changes in cross-section will be monitored at regular intervals to detect any changes and initiate corrective measures. The Project concept allows later rectification within the concept of adaptive approach. To this end, the project has substantial contingencies. Under the Project, the numerical hydraulic model of the sub-project area will be used to identify low lying areas with a potential risk of deep inundation when major floods occur. The option of providing raised flood refuge platforms in appropriate locations will be explored.

5.1.3.4 Effect on Flow Velocity/ Discharge Intensities

Operation Phase

202. **Impacts.** The proposed interventions are not expected to have any significant effect on the overall velocity profile of the river as the works are limited to the bank or near shore areas of the river and a combination of largely passive river training and flow regulating measures will be taken up to provide an optimum flow velocity in the section. Recognizing instability and unpredictability of the Brahmaputra River, clearly two different scales need to be distinguished for studying effects of flow velocity and discharge changes: (i) the total river cross section, many kilometers in width, and (ii) the cross section of the near bank channel, typically below one kilometer in width. Limited interventions along the bank do not change the cross section average flow velocities in alluvial rivers. Areas of faster flow are compensated through areas of slower flow and lower discharges, which on average even out. The average flow velocity and discharge is affected by different river stages with increasing discharges resulting in increasing flow velocities. The lack of systematic measurements limits the present ability of quantifying this satisfactorily.

203. The magnitude and variation of discharge in the Brahmaputra River undergoes drastic changes on seasonal as well as annual basis due to the unique hydro-meteorological and geophysical characteristics of its basin. The potential increase of these natural perturbations in

the river hydrograph in the wake of unfolding climate change scenario appears to be more significant compared to any minor change that may be introduced as a result of the proposed activities on or near the river bank. The river being very wide with appreciable channel roughness due the presence of multitudes of sandbars and bed forms, transmission of any minor disturbance in the flow close to the bank to areas midstream or across the channel to the other bank appears quite unlikely. Only major proactive river training interventions like spurs protruding into the river may have direct impact on the flow pattern and channel configuration affecting it significantly.

204. **Mitigation** Measures. Flow velocity changes along the bankline will be systematically monitored as part of the near-bank surveys. This includes establishing systematic records of discharges and flow velocities during the hydrological cycle. It is expected that this monitoring will contribute to a better understanding and a gradual optimization of the layout of structural flood and erosion countermeasures. Open revetments, such as dumped stone (rip-rap) placed on geotextile filters or multi-layers of sand-filled geotextile bags shall be preferred. Impermeable bituminous or interlocked revetments shall not be preferred as they have impact on the natural environment by interrupting exchange between flowing water and ground water. Any of the eco-friendly local resource-based methods may be used in preference to the impermeable surfaces like bituminous or cement slab.

5.1.3.5 Impacts of Development Works in Upstream Catchments

205. **Impacts.** A large number of hydroelectric projects (57 since February 2008 with a total generation capacity of 15,000 MW) are under various stages to implementation in the upstream parts of the Brahmaputra basin in India. It is likely that these projects will have impacts on flood behavior in the subproject areas. The upstream dams, albeit mostly run-of-the-river schemes, would reduce flood peaks while acting as sediment traps that will lessen the outflow of sediments (until these reservoirs are filled up over the years).[19] Likewise, improved watershed management pursued in upstream catchment will contribute to reduction of flood peaks and sediment transport over the long term. Any effect of this reduction in sediment inflows on the Brahmaputra main stream channel cross sections and flood behaviors is difficult to predict, but any effects are likely to lead to a reduction in flood levels and aggradation, since reduced sediment loads supports a more stable channel pattern with deeper channels characterized by higher conveyance.

206. **Mitigation Measures.** Systematic monitoring and analysis of hydrological and geo-morphological parameters will help identify any measures that may have to be considered to adapt to any unexpected changes over the longer term. The project will also promote holistic catchment management through state wide planning and coordinated implementation.

5.1.3.6 Impact on Silt Deposition and Bed Level Change

Operation Phase

207. **Impacts.** The Brahmaputra River carries the second highest sediment load of all major rivers in the world. The high amount of sediment is largely mobilized during the high flood season flows and often leads to dramatic changes of the platform (river appearance on maps). While the riverbed is largely formed by the coarser sediments especially sand and more upstream gravel, the floodplains are built from finer silts and clay. The latter constitute the wash load in the river, which means they are transported within the channels to the sea without

[19] Nevertheless, effective information network needs to be set up to inform the local population the sudden changes in discharge volumes in advance, to cope with abrupt water level rise in the tributaries.

settlement. Only after inundation and in areas without noticeable flow do the finer sediments settle. Part of this settlement has been cut-off through the construction of embankments in many places since minimum 25 years (the end of the major embankment construction program). It is noted that the inhibited deposition of the fertile finer clay and silt requires the use of alternative fertilizing methods to maintain overall soil fertility.

208. Problematic at this moment are breaches in the embankments, which result in high velocities in the breach area allowing the flowing water to transport coarser, infertile sand through the breached section. This sand gets deposited downstream where the area widens, and the flow velocities drop. The resulting sand carpets are disastrous for the overwhelmingly small and marginal farmers as they render the fertile floodplain land unusable and can only be removed at great cost

209. **Mitigation Measures**. The bank stabilization and retirement of the embankment system in the Palasbari Reach will reduce the risk of embankment breaches with associated deposition of infertile land in the breach. This will help in supporting agriculture and livelihood of the dominant small and marginal farmers. In general, about 35.5% of the land within an eight kilometers buffer behind the embankments is used for agricultural activities. The dynamic pattern of silt deposition in the river and areas adjacent to the bank, especially in the vicinity of anti-erosion and river training works, will be monitored at regular intervals to contribute to the knowledge base and understanding of the Brahmaputra morphology, and initiate necessary corrective measures if required.

5.1.3.7 Effect on Subproject Drainage System

Operation Phase

210. **Impacts**. The existing embankment system along the Brahmaputra impedes the present drainage channels of the area, including the Kulsi River, which has been truncated at several places near its earlier outfalls and forced to flow towards its present outfall along a joint channel with Jaljali River near Nagarbera. Moreover, the embankment acts as a barrier for the drainage of accumulating countryside water into the Brahmaputra during the wet season. The proposed works will have no additional adverse impacts on drainage. In fact, the incorporation of two gated sluices will relieve drainage congestion in key areas.

211. **Mitigation Measures**. Under the Project, the numerical hydraulic model will be used to undertake a comprehensive analysis of the existing natural drainage system to identify drainage behavior and problems, key drainage channels/ systems and drainage congestion areas. This model will be used to investigate the optimum location, size and method of operation of the sluice gates. The cost-effectiveness of various remedial measures will be assessed with the object of improving drainage conditions. As part of this investigation, the preservation and/or improvement of the environmental flooding regime of wetlands and beels will be investigated.

5.1.3.8 Effect on Wetlands/ Beels within the Subproject

Operation Phase

212. Impacts. Deepar Beel is the only wetland which has direct connection with the River Brahmaputra along the Palasbari Reach. However, it is situated about 3 km aerial distance from the Khanajan mouth (which is the only outlet of this important wetland). The retired embankments will not impede the functioning of the beel, as they are not impeding the connection between the beel and the Khanajan River. The Garbhanga Reserved Forest is adjoined with the Deepar beel, but it is far away from the embankment and is a different strand

of south bank ecosystem. The other wetlands located in the study area are fed by Kulsi River and will not be affected by the proposed project activities.

213. With the flood protection measures in place, farmers may use more fertilizers and grow more crops in the fields. The fertilizers and pesticides could reach the wetland as the land slopes towards the latter. This increases the tendency of eutrophication in the wetlands. The flood water is essential to the wetlands for flushing the pollutants in the wetlands.

214. Mitigation Measures. Since, various terrestrial and aquatic wildlife species depend on these wetlands, due care shall be taken to ensure that no direct or indirect impact like siltation or flow of waste/debris is caused to any wetland located in the close vicinity of project construction activities.

5.1.3.9 Water Quality

Design and Construction Phase

215. **Impacts**. The major source of surface water pollution during project construction phase will be sewage and wastewater generated from labor camp/ colonies as well as workshop areas. The project construction is likely to last for a period of 6 years. Most of the laborers would come from nearby areas. About 50-60 labor families (total population 250 to 300) are likely to stay in each const3ruction camp. The domestic water requirements in each construction camp will be about 45 m /day. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 36 m3/day. However, it may pollute land and other nearby water bodies if discharged untreated, especially during the low flow season.

216. No arsenic pollution is noticed either in river water or ground water in this area. Hence no impact of arsenic is anticipated in this area which is otherwise prevalent problem in West Bengal and adjoining areas.

217. As significant quantity of groundwater is not likely to be extracted as part of this project, any appreciable quantitative impact on ground water because of the construction activities is also ruled out. In addition to that ground water is easily available in 5 m BGL even during the lean periods. Impact on ground water quality is not likely due to the project activities as the wastewater generated from the project will be trapped for treatment before it will discharge/ percolate from the project sites.

218. **Mitigation Measures**. Septic tanks shall be provided in each camp to treat the domestic sewage. Provision of mobile toilets may also be considered with the provision of channeling the sewage to septic tank in a closed loop system. Discharge of untreated domestic sewage to the Brahmaputra River or to any natural waters will not be permitted. No debris shall be dumped in the water bodies.

Operation Phase

219. **Impacts.** No impact is anticipated due to the project in this phase.

5.1.4. Climate

Design and Construction Phase

220. **Impacts.** Short term impact in terms of minor increase in temperature may happen in the immediate vicinity of the embankment due to cutting of large number of trees located within the

project intervention zone. However, these trees are of fast growing species like Bamboo, Simul, and the like.

221. The impact of climate change screening is based on the Aware™ geographic data set, compiled from the latest scientific information on current geological, climate and related hazards together with projected changes for the future where available. These data are combined with the project's sensitivities to hazard variables, returning information on the current and potential future risks is 'medium'. High flood is expected in future.

222. **Mitigation Measures**. The maximum possible efforts must be made for minimizing cutting of the trees while designing the embankments. Compensatory tree plantation to be undertaken based on 3 trees plantation against each tree cut as per the state government policy.[20] Special design consideration were made keeping water level rise due to climate change

Operation Phase

223. **Impacts.** No direct impact is anticipated on the climate of the study area due to the proposed project. However, changes in the catchments area of the river and extreme events due to possible climate change (global warming) can have indirect impacts on project and project area. With respect to the proposed project, climate change can play a major role due to its implications on water resources, water availability, and inland/ fresh water wetlands. The climate change impacts on water resources for throughout the country were studied as part of India's Initial National Communication (Natcom 1) Project. The study revealed that climate change impacts on the inland wetlands would be a complex issue dependent on several variables, including temperature increase, rate of evaporation, changes in precipitation on the catchment, changes in nutrient cycling and the responses of a variety of aquatic species. Although tropical lakes are less likely to be impacted by climate change as compared to temperate lakes, an increase in temperature would alter the thermal cycles of lakes, oxygen solubility and other compounds, and affect the ecosystem. Shallow-water marshes and swamps would be even more vulnerable to increased temperatures and lower precipitation. The increased evaporation of water and reduced inflow from rainfall could desiccate the marshes, swamps and shallow lakes.

224. GCM model projections (by HadCM2) for India indicate an increase in precipitation by up to 30% for the north-eastern region in addition to a relatively moderate increase in temperature of about 2°C by the period 2041-2060. This could increase the incidence of flooding in the Brahmaputra basin. Since, there are divergent views on the above findings; these can not be taken into consideration for any design change at this stage till more specific and dependable information related to climate change effect on river hydrology in this region is available.

225. **Mitigation Measures**. The likely impact framework shown above is generalized. However, more information must be collected based on newer studies and monitoring data. Further action on this account can be considered only in the following phases of the project. The flood pattern needs to be closely analyzed during proposed life span of the embankment and take appropriate timely protective measures in case the flood levels increase earlier than the projected levels for 2041-2060 due to climatic changes.[21]

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[20] The rate of compensatory afforestation mentioned here is as per the consultation with Chief Conservator of Forests, Forest Department, and as per Assam Government's Guidelines for Compensatory Afforestation, 2000.

[21] The SWAT water balance model has been used in this study for the river basins to carry out the hydrologic modelling of the country. The SWAT model has been used on each of the river basins separately using daily weather generated by the HadRM2 control climate scenario (1981-2000). The model has been run using climate

5.1.5. Air Environment

5.1.5.1 Design and Construction Phase

226. **Impacts**. The ambient air quality of the area is good. The level of SPM, RSPM, NOx, SO_2, Pb, CO, is much lower at both the locations monitored (Majirgaon and Khanajan) than the prescribed National Ambient Air Quality Standards for rural areas (Refer Table 14). While various construction activities will increase the ambient air quality, but the level is likely to remain within the prescribed standards.

227. During the construction phase, there will be two main sources of air emissions, i.e. mobile sources and stationary sources. Mobile sources are mostly vehicles involved in construction activities, whereas emissions from stationary sources include construction equipment & machinery, diesel generator sets, excavation/ grading activities etc. Hot mix plant will not be used for road construction since all roads will be gravel roads. In addition to these, fugitive emissions will also form a major proportion of air pollution in the form of particulate matter from storage and handling of construction material.

228. Fugitive dust sources associated with construction phase include vehicular traffic generating fugitive dust on paved and unpaved roads, aggregate material handling, and other aggregate processing operations. Fugitive dust generated from these activities may range from 0.1 m to more than 300 m in aerodynamic diameter.

229. The emission of particulate matter during the construction phase will be generated from the activities like receipt, transfer and screening of aggregate, crushing activity, road dust emissions. The likely emission levels from these sources are indicated at Appendix 10. In addition to that emissions from various construction machinery fueled by diesel and from mobile source will be in the form of PM_{10}, VOC, CO, NOx and SO_2. The emissions from stationary and mobile diesel engines with respect to their working/ movement are presented in Table 41:

Table 41: Exhaust Emissions for Stationary and Mobile Machinery

Source	PM10	VOC	CO	NO_x	SO2
Diesel exhaust emissions (idle)	0.043 g/min	0.208 g/min	1.57g/min	0.917 g/min	18.8 S g/l
Diesel exhaust emissions (moving)	0.4 g/mile	3.18 g/mile	18.82 g/mile	8.5 g/mile	18.8 S g/l

230. **Mitigation Measures**. Hot mix plants should be located away from the populated areas and be fitted with the air pollution control devices, the emission shall meet National/ State Pollution Control Board standards. Further, the hot mix plants must be sited at least 1 km in the downwind direction from the nearest human settlement.

scenarios for the period 2041 to 2060, without changing the land use pattern. The outputs of these two scenarios have been analyzed with respect to the possible impacts on the run-off, soil moisture and actual evapotranspiration.

231. It shall be ensured that the dust emissions from the crusher and vibrating screen of the stone quarries do not exceed the standards.

232. Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing road. Water may be sprayed on earthworks, on a regular basis. During and after compaction of the sub-grade, water will be sprayed at regular intervals to prevent dust generation.

233. The following mitigation measures will also be taken to mitigate the dust entrainment and fugitive emissions from the various sources in Palasbari Reach:

(i) Covering of loads in trucks, and the paving of access areas to unpaved lots or construction sites, are examples of preventive measures. Examples of mitigation controls include water flushing, and broom sweeping and flushing.
(ii) Redistribution of loose material onto the travel lanes will produce a short-term increase in the emissions. In general, preventive controls are usually more cost effective than mitigation controls.
(iii) Sprinkling water will control fugitive dust entrainment.
(iv) Sprinkling of water on the dust prone areas and construction yard.
(v) Regular maintenance of machinery and equipment will be carried out.
(vi) Ambient air quality monitoring should be carried out during construction phase. If monitored parameters are above the prescribed limits, suitable control measures must be taken.
(vii) Care shall be taken to keep all material storages adequately covered and contained so that they are not exposed to situations, where winds on site could lead to dust/ particulate emissions.
(viii) Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust from the material stores/ warehouses.
(ix) Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled materials do not become a source of fugitive emission.
(x) Spilled concrete slurries or liquid wastes shall be contained/ cleaned up immediately before they can infiltrate into the soil/ ground or runoff in nearby areas.
(xi) All slopes and embankments will be turfed as per best engineering practices to help minimize the dust generation during operation of the road. Plantation along the embankment should be maintained.
(xii) Ambient air quality monitoring should be done for the first 3 years of the operation phase. If monitored parameters are above the prescribed limits, suitable control measures must be taken.
(xiii) A wide variety of options exist to control emissions from unpaved roads in the form of: Vehicle restrictions that limit the speed, weight or number of vehicles on the road;
(xiv) Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
(xv) Surface treatment, such as watering or treatment with chemical dust suppressants.

Operation Phase

234. **Impacts.** The prime source for air pollution during operation phase will be the vehicular movement on the paved road on top of the embankment, which will be used for transportation as well as maintenance of the embankment. However, during the operation phase, the embankment will be strengthened and will be covered with turf and construction of paved roads

will reduce the fugitive emissions. Due to all these developments, impact on air quality during operation phase will beneficial.

235. **Mitigation Measures**. Plantation along the embankment and turfing on the embankment slopes should be maintained, and their survival rates should be monitored. In addition to that regular maintenance of the road on the top of embankment as well as connecting roads shall be done for reducing fugitive emissions.

5.1.6. Noise

Design and Construction Phase

236. **Impacts.** During construction phase, noise will be generated from various activities such as site clearing, excavation, erection, finishing etc. The general noise levels during construction phase such as due to working of heavy earth moving equipment[22] and machineries installation may sometimes go up to 100 dB(A) or more at the work sites. As per the proposed plan, manual labor is likely to be preferred with limited use of machinery.

237. As a worst-case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point. The increase in noise levels[23] due to operation of various construction equipment is expected to increase the noise level from 100.3 dB (A) at a distance of 1 m to 52.4 dB (A) at a distance of 250 m from the sources. The predicted levels are presented at Table 42.

Table 42: Increase in Noise Levels due to Operation of various Construction Equipment

Distance (m)	Ambient Noise Levels dB (A)	Increase in Noise Level dB (A)	Increase in Ambient Noise Level dB (A)
1	51.0	100.3	49.3
10		80.3	29.3
50		66.3	15.3
100		60.3	9.3
150		56.8	5.8
200		54.3	3.3
250		52.4	1.4

238. In addition to the above, there will be significant increase in vehicular movement for transportation of construction material. At present, vehicular movement near the project site is of

[22] In absence of the data on actual location of various construction equipment and machinery, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. However, the noise levels shall attenuate as the sound wave passes through a barrier. The transmission loss values for common construction materials like brick, light concrete, dense concrete, concrete block with a thickness of 4 to 6 inches vary in the range of 30 to 40 dB(A). Thus, the walls of various houses will attenuate at least 30 dB(A) of noise. In addition, there will be attenuation due to Air absorption, atmospheric in homogeneities, vegetal cover.

the order of 5 to 10 vehicles/ hour. During construction phase, the increase in vehicular movement is expected to increase up to a maximum of 40 to 50 trucks/ hour.

239. As a part of the EIA study, impact on noise level due to increased vehicular movement was studied using Federal Highway Administration Model. The results of modeling are outlined in Table 43:

Table 43: Increase in Noise Levels due to Increased Vehicular Movement

Distance (m)	Ambient Noise Levels dB (A)	Increase in Noise Level dB (A)	Increase in Ambient Noise Level dB (A)
10		72	21
20		67	16
50	51	61	10
100		57	6
200		52	1

240. Hence, during construction phase, increase in noise level is expected to be between 25% to 30%. However, the increase in noise levels will be localized, temporary in nature and mostly will be during daytime only.

241. **Mitigation Measures**. Following noise control measures shall be adopted, and included in the civil work contracts:

(i) Site Controls: Stationary equipment shall be placed along un-inhabited stretches meeting the National Noise Quality standard, particularly for residential areas (Category C) and silence zones (Category D: hospitals, educational institutions, courts, religious places, etc.), keeping the distance at least 150m (Category C) and 250m (Category D), to minimize objectionable noise impacts. In the event potential nose sensitive receptors are identified who will fact higher noise due to construction, appropriate temporary noise barriers will be established.

(ii) Scheduling of Project Activities: Operations will be scheduled to when people would be least likely to be affected. Construction activities shall be restricted between 10 P.M. and 6 A.M. near residential areas.

(iii) Protection devices (ear plugs or ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines.

(iv) Construction equipment and machinery shall be fitted with silencers and maintained properly.

(v) Noise measurements shall be carried out along the reach as well as in nearby villages, to ensure the effectiveness of mitigation measures.

(vi) Use of manual labor

Operation Phase

242. **Impacts**. The prime source of noise pollution during operation phase will be the vehicular movement. However, as the roads will be paved and will provide smooth traffic movement, the impact due to vehicular movement will be less significant.

243. **Mitigation Measures**. Adequate signage shall be provided restricting the use of pressure horn particularly in near noise sensitive locations e.g. schools, hospitals and populated areas. Noise measurements shall be carried out along the road to ensure the effectiveness of mitigation measures. Tree barriers between the road and village, semi urban and urban area shall be developed in a layered manner as suggested under air environment mitigation measures.

5.1.7. Terrestrial Ecology

5.1.7.1 Disturbance to Vegetation

Design and Construction Phase

244. **Impacts**. There would be no major impact on terrestrial flora except cutting of trees during project intervention in the Palasbari reach, as there is no protected forest, reserved forest or sanctuary etc. present in this area. The natural terrestrial ecosystem (bio-diversity) has already been damaged by the heavy floods and erosions in the past in this area. The present vegetation is the cultural one which can always be compensated by afforestation program. The proposed project will help to improve the terrestrial biodiversity of the area.

245. The baseline survey along the Palasbari Reach taking into consideration of the project implementation area 1209 trees will be cut in Palasbari reach and 1,450 trees will be cut in Gumi reach. Total 2659 trees will be affected due to tranche 2 works.

Table 44: Trees to be affected in Tranche 2 site under Palasbari sub project

Palasbari Reach			
	Trees	Fruiting	Timber
Dakhala	**1209**	**334**	**738**
Bholapara			
Satarapara			
Guimara			
Simina			
Mokadhuj			
Gumi Reach			
	Trees	Fruting	Timber
Asalpara	**1450**	**805**	**1116**
Baghmara			
Taparpathar			
Borbhita			

246. **Mitigation Measures**. Efforts shall be made to minimize the tree loss. Provision shall be made for planting three trees for every tree cut. Plantation programme shall be initiated parallel to construction activity. The native and existing vegetation profile shall be maintained during plantation programme, so that local inhabitants can utilize their resources. Indigenous plants namely Jati-bet- Calamus erectus, Bamboo- Bambusa balcooa, Bamboosa tulda, Delbergia sisso, Artocarpus heterophylus, Dimoru-Ficus lipidosa and Ahot-Ficus religiosa shall be

preferred. Afforestation shall be undertaken with community participation. Communities affected shall be invited to participate in the planting and maintenance to ensure high survival rate.

Operation Phase

247. **Impacts.** No direct impact is anticipated during operation stage except accidental damages or absence of tree management.

248. **Mitigation Measures**. Arrangement shall be made for effective tree management to ensure survivability of the tree plantation. The Department of Environment and Forest - Social Forestry Wing may be consulted or involved in this programme. The tree survivability audit shall also be conducted at least once in a year to assess the effectiveness of the programme.

5.1.7.2 Habitat Fragmentation and Destruction

Design and Construction Phase

249. **Impacts.** No habitat fragmentation and destruction are envisaged due to the project activities in the reach. However, provision of construction of drainage sluices will help in improving the re-colonization of aquatic bio diversity.

250. **Mitigation Measures**. Awareness program shall be initiated to inform the people about the usefulness of the sluice gate and remove the fear of increased flood due to such opening.

Operation Phase

251. **Impacts**. Inappropriate opening of the sluice gate may have substantial damage to theca system.

252. **Mitigation Measures**. Appropriate management will have to be made for the operation of the sluice gate as resident around are not very favorable to this gate due to the fear of increased flood from Brahmaputra. The purpose is that the water connection is available between the lake and river Brahmaputra for the movement of the aquatic life between river and lake.

5.1.7.3 Animal Distribution/Migratory Route

Design and Construction Phase

253. **Impacts.** There is no migratory route of wildlife species in entire Palasbari Reach area; hence there is no possibility of impact on animal distribution. There are two dolphin breeding sites located at Dharapur-Khonajan mouth and Palasbari Boat ghat area (Coordinates: 26 07′88″N - 91 35′24″E). The Dolphin breed during monsoon period between (May to August). Dolphin is sensitive to polluted water and any obstruction of the channels at this stage may disturb the breeding activities.

254. **Mitigation Measures**. The construction activity should be restricted during the breeding period of May to August at these two Dolphin breeding sites. About 2km section around the identified Dolphin breeding site will be designated as sensitive area. All care shall be taken to ensure that construction waste does not find its way to water in this area and pollute it. Care shall also be taken to ensure that channel is not obstructed in any way. Civil work contract documents will specify these requirements, including the regular monitoring by an environment expert from the subproject implementation office.

Operation Phase

255. **Impacts.** No impact is anticipated during operation stage with regards to animal distribution and migration.

5.1.7.4 Endangered Species

Design and Construction Phase

256. **Impacts.** No impact is anticipated on any endangered species since these are not found in this area currently. As per the information, 9 Reptilian Fauna, 17 Avian Fauna and 1 Amphibian Fauna, and Gangetic dolphin which are categorized as endangered species have reached this area. The reptile fauna is still found some time in this area. However, no impact on any endangered species due to project intervention is envisaged.

5.1.8. Aquatic Ecology

5.1.8.1 Effect on Fishing Activities/productivity

Design and Construction Phase

257. **Impacts.** Palasbari Boat Ghat (Co-ordinates: 26°07'88" N, 91°35'24" E) and Majgumi (Ch. 26.0 km) (Co-ordinates: 26°05'42" N, 91°19'34" E) are the two major fish landing sites in the Palasbari Reach where the bulk selling and buying of the catch is done mostly on wholesale basis and are important facility for transportation of fish catch. These fish landing sites are not within the tranche 2 proposed work location and hence will not be disturbed during the project implementation period. There are few temporary minor fish landing sites in the reach. Temporary flushing of the fish species towards the deeper part of the river may happen during construction of bank line protection measures. The construction work will not affect the fish activity in the river as they move with the river current. The construction activity may increase the turbidity on the bank temporarily.

258. **Mitigation Measures**. Adequate provision shall be made in the design to ensure access to the temporary fish landing site/Boat ghat. Adequate requisite facilities shall be restored or maintained for undisturbed movement of the fisherman. During the construction, the contractors must provide a clear signage to guide which areas that fishing boat should not pass by or make a temporary landing.

Operation Phase

259. **Impacts.** No impact is anticipated during operation stage with regards to fish activities.

5.1.8.2 Migratory Routes

Design and Construction Phase

260. **Impacts.** There is no migratory route of fish in the Palasbari Reach, which can be affected due to the proposed project. The migratory fish species like Hilsa (anadromous[23][24]) and Anguilla (catadromous[24][25]) migrate through the main channel of the river i.e. through the deeper zones of the river. Therefore, project will not have any impact on the migratory route of these fishes. Other fish species like *Crossocheilius, Tor* also show only local migration from upper to lower reaches of the river, but these also migrate in the deeper zone of the river. The construction of the dyke and revetment measures will not have any effect on the migratory routes.

[23] Migration of fish from sea to fresh water for breeding.

[24] Fish that lives in fresh water and breeds in sea.

5.1.8.3 Effect on Spawning and Breeding Grounds

Design and Construction Phase

261. **Impacts**. Along the whole stretch of Palasbari Reach, there are few breeding grounds as well as spawning grounds for fish. It has been observed that all fish species do not breed in same place. Breeding grounds varies from fish to fish as well as location. It has been observed that most of the riverine fish species, e.g. *Baralius, Salmostoma, Danio, Gara* etc., prefer the shallow courses of river for breeding and spawning. For other fish species like *Minnows, Channa, Labeo* and the like prefer beel for breeding. Fish spawning seasons also vary from fish to fish. However, most normal seasons for almost 80% of fish species starts from April and ends in August (i.e. during pre-monsoon and monsoon seasons).

262. At Ch. 0.0 km of Palasbari Reach, Last Spur No. 7 (Ch. 11.7 km) (Co-ordinates: 26° 05' 48" N, 91° 20' 52" E), small channels of the River Brahmaputra flows here. Due to the spur the river channel shifted to other direction. During the flood seasons many fishes come here for breeding and playing. Increase in siltation due to construction activity in this area particularly during the breeding season, may disturb the breeding activities.

263. **Mitigation Measures**. The construction activity should be restricted during the breeding period of April to August at above breeding sites. All care shall be taken to ensure that construction waste does not find its way to water in this area and pollute it. These will be included in the civil work contracts with the designation of the sensitive areas where construction works will be restricted during the specified period.

Operation Phase

264. **Impacts.** No impact is anticipated during operation stage with regards to fish activities.

5.1.8.4 Effect on Pond Fisheries

Design and Construction Phase

265. **Impacts**. No pond fisheries activities are found along the existing embankment. However, pond fisheries are found in the study areas. The current productivity of these places is low. Once flood scenario is stabilized, siltation problems will be minimized, and the fish productivity of these areas will be improved.

266. **Mitigation Measures**. The fish productivity can be improved substantially with use of better fish culture and increasing the capacity of fish ponds as well institutional strengthening support. Fish productivity audit may also be undertaken to assess the effect of institutional support.

5.1.9. Socio Economic

5.1.9.1 Social conflict

Design and Construction Phase

267. **Impacts.** Owing to the proposed project, there will be establishment of construction camps that will add to the population of the study area temporarily. Most of the workers will be from the local villages. Migrant workers will have the very little impacts in this project as number will be very small and may of conflicting culture and lifestyle; compete with local laborers over job opportunities, and potential health issues such as HIV/AIDS. This shall also exert pressure on the natural resources in the project area. However, this will only be a temporary phase lasting only during the construction period.

268. **Mitigation Measures**. Early consultations will be made by the contractor with the local communities to determine the appropriate location of work camp sites with the encouragement that local people are given preference in employment when they meet basic job requirements. All migrant workers will undergo workshop/briefings to sensitize them on local culture and lifestyle awareness.

5.1.9.2 Establishments

Design and Construction Phase

269. **Impacts**. Good number of houses and establishments are located close to the existing embankment. Even some of the habitats have their hutments on the embankment itself. The households likely to be affected will be covered under the RAP report. The household likely to be affected by project intervention will receive compensation and assistance as per the RAP, to be prepared based on ADB policy on IR, National Policy on R&R and Assam state laws. Various educational, physical or cultural heritage facilities viz., temples, prayer halls, mosque, graveyard, cremation ground, Idgah Maidan, etc., are located close to the embankment which may affected partially or due to construction Noise and Air pollution. The details of such facilities are presented in Table 45:

Table 45: Establishments Located within 100 m impact zone

Facility	Majirgaon-Dakhala		Dakhala hill- Gumi		Gumi-Nagarbera	
	CS	RS	CS	RS	CS	RS
Education Facility						
L.P.school	2	Nil	2	Nil	9	1
M.E.school	1	Nil	Nil	Nil	4	Nil
High School	1	Nil	2	Nil	4	Nil
Madrassa	Nil	Nil	Nil	Nil	3	Nil
Religious and Cultural Heritage Facilities						
Temple	3	Nil	2	Nil	Nil	Nil
Namghar(prayer Hall)	2	Nil	2	Nil	1	Nil
Mosque	Nil	Nil	2	Nil	9	1
Graveyard	Nil	Nil	Nil	Nil	1	Nil
Cremation ground	1	Nil	Nil	Nil	Nil	Nil
Id-gah maidan	Nil	Nil	Nil		1	Nil

270. **Mitigation Measures**. Efforts shall be made to prevent any relocation or demolition of these establishments. Where required, the social infrastructure shall be rehabilitated taking account of social and cultural values. Temporary Noise Barrier will be installed close to school and place of worship during the construction stage. Thick plantation shall be made close to these establishments

5.1.9.3. Archaeological Sites to be impacted

271. **Impacts.** No archaeological sites will be impacted due to the proposed construction of river embankment along the Palasbari Reach

5.1.9.4. Places of Pilgrimage and Tourism to be impacted

272. **Impacts.** There is no pilgrimage or tourist spot along the Palasbari Reach. Hence, no impact to this valuable component is expected. In fact, with the strengthening of embankment and improvement of roads will have positive impact on the accessibility of the villages along the reach.

5.1.9.5 Water Supply and Sanitation

Design and Construction Phase

273. **Impacts**. Local residents are dependent on ground water for meeting their drinking water supply. The quality of ground water in this reach was found fit for drinking purposes. The proposed sub-project activities are not likely to affect the water supply of the area.

274. Sanitation facilities are poor in the area. People residing near the embankments usually go to river bank for their daily needs. Many places in the embankment have been damaged to create access to the river. Drinking water and sanitation becomes one of the major problems during floods. Another problem in the embankment construction is that it complicates the disposal of sewage and runoff water from the countryside to the riverside. Open drainage canal

that drains individual houses usually runs almost parallel to the embankment for some distance until a creek or river intercepts and drains towards Brahmaputra River. The extended open drainage canals are usually not maintained and poses serious health hazard. Several points along the embankment are also used as disposal site for municipal solid wastes. The need for disposal sites should be considered in the design of the embankment.

275. **Mitigation Measures**. Access should be provided to river near intensive settlement areas. Awareness should be created among the residents about the upkeep of the embankment. Garbage shall be collected at designated locations. The promotion against the disposal of untreated sewage (through septic tanks) shall be conducted under the sub-project.

Operation Phase

276. **Impacts**. Unplanned development, encroachment, and tree plantation may affect the stability of the embankment.

277. **Mitigation Measures**. Uncontrolled and unplanned development should be prevented. Awareness shall be created amongst the people for the upkeep of the embankment.

5.1.10. Land Use

Design and Construction Phase

278. **Impacts**. A large number of households are affected by flood and erosion. In the Palasbari Reach alone, about 78.61 % of households surveyed by socio-economic team under this TA are affected due to flood and erosion. The proposed project will bring relief to the entire population in this area. The project will also provide employment to a large number of people for about 2 years in tranche 2. The project will boost the local economy as small businessmen and entrepreneurs will provide the daily needs of the workers and officers of the proposed project.

279. With the stabilization of the area and prevention of land loss due to erosion every year (about 1 ha/year) land availability for multiple crops will increase bringing positive impact on the local economy.

280. Nevertheless, some of the subproject infrastructure would require land acquisition and resettlement, including the construction of embankment, as well as renovation of existing embankments. The embankment retirement would require the acquisition of land for the shifting of the embankments, which will be assessed after embankment alignments can be fixed following the bank line stabilization through riverbank protection works. In addition, strengthening of the existing embankments, riverbank protection, sluice gates, and associated structures will also require certain amount of land acquisition and resettlement, including the embankment informal dwellers.

281. The subproject area also has existing embankments and associated structures of which land acquisition process has not been completed. It is a demand of concerned local population that the past dues of the land acquisition and resettlement payments should be provided in association with the improvements of the concerned infrastructure.

282. There are twelve fish landing stations in this reach. The average fish collection at these centers is of the order of 100 to 150 kg per day. These stations may get disturbed during construction stage.

283. **Mitigation Measures**. The resettlement activities will be implemented in accordance with ADB's voluntary resettlement and other social safeguards policies, as well as the applicable laws

and regulations of the Government of India and the Assam State. In the context of the project, a resettlement framework was prepared to cover Palasbari-Gumi subproject, Palas, for which specific scopes will be finalized following the detailed design and prior to the tendering of the concerned infrastructure works.

284. Regarding the pending compensation of past structure works, if any subproject sections to be covered by the proposed project have any outstanding grievances from past acquisition for embankments that are being strengthened and/or improved, a due diligence would be undertaken to assess the scope of the problem with detailed recommendations to address the grievances prior to launching the subproject work.

285. It is recommended that the project affected peoples (PAPs) are given preference as daily wage laborers. Farmers can also consider switching over to shallow water rice cultivation means from anaerobic verity to aerobic verity of rice cultivation. Farmers will be able to get three crops which are otherwise mostly limited to two crops.

286. Appropriate provision shall be made to provide alternate fish landing stations for the temporary fish landing sites, so that economic activities of the fishermen are not disturbed due to project activities.

5.1.11. Accidents and Safety

Design and Construction Phase

287. **Impacts.** The risks associated with the proposed project are minimal. However, roads being narrow, efforts shall be made that no hazardous traffic conditions are created due to construction vehicle movement. Local people may encroach to construction area and get hurt.

288. **Mitigation Measures**. Adequate lighting and fluorescent signage shall be provided at the construction sites. Signage shall be made in local language.

289. The workers shall be provided with necessary personal protective equipment and a first aid unit including adequate supply of dressing materials, transport means, nursing staff and an attending doctor, shall be available at each construction site. Health checkup camps shall also be organized every year.

Operation Phase

290. **Impacts.** Due to improved road condition, drivers may have tendency to drive fast on embankment road resulting in accidents.

291. **Mitigation Measures**, Speed limits shall be prescribed for vehicular movement on the embankment road to avert the accidents. Adequate signage and light reflectors shall be placed along the road side.

5.1.12. Navigation

Design and Construction Phase

292. **Impacts.** This river section is navigated by people for moving from one place to another located at river bank and moving to char lands for fishing & farming. They use small motor boats and fish landing sites or boat Ghats for these movements. There are various fish landing sites in this sub project area. Palasbari Boat Ghat and Majgumi are the big sites where fishes are traded

in whole sale. These landing sites/boat ghats could be temporarily disturbed due to project activities. However, there will not be any impact on the general navigability of the river due to the project since project activities are limited to river bank and beyond.

293. **Mitigation Measures**. During construction, contractors are asked to provide alternate landing sites (ghats) with similar berthing facilities, access, and other common infrastructure, as part of the tender documents. In places the riverbank protection will provide steps to facilitate landing of local boats in support of trade and river crossings. The project design has additional provisions to closely monitor the general river behavior as well as its response to the new works and, within the concept of adaptive approach, to mitigate any negative impacts (through phased implementation).

5.2. Summary of Impacts

294. Almost all the impacts are occurred during the construction period and the physical intervention associated with the civil works are not significant, therefore, the environmental impacts are temporary and reversible. With implementation of proposed mitigation measures, most of the impacts will be minimized, and no residual and cumulative impact is expected.

6. ANALYSIS OF ALTERNATIVES

6.1. Introduction

295. The analysis of alternative is an effective tool to examine the number of options (locational & technological) and establishing most environmentally favorable alternative which cause minimum environmental loss to the natural and social environment. However, since the subproject is site specific, i.e., aims to sustain the functions of the existing flood embankment systems protecting a large number of people and landmass from frequent devastating flooding and riverbank erosion of the Brahmaputra River, the scope for assessing alternatives to the project is limited. The Palasbari subproject was divided into two reaches – Palasbari and Gumi. Under Palasbari reach there are three project components: (i) bank protection works from Dokhola Hills to Makadhuj for a reach of 6.4 km.(ii) Rehabilitation of existing spur at Chimina and (iii) construction of sluice gate on Kalbhog River. Under Gumi reach there are three components. (i) bank protection works, between these deflectors, (ii) bank protection works, at Borbhita Area, over a length of 1.20 km, and (iii) bank protection works along southern bank of river Brahmaputra, at Taparpathar area, over a length of 5 km.

6.1.1. 'Without Project' Option

296. **Physical Environment**. In the 'without project' scenario, loss of precious land at the rate of about 90.1 ha/year will continue due to river bank erosion. Average erosion 17 m/year. Siltation of land due to flood will result to reduced productivity or loss of single crop. No effect on ambient air and noise quality is anticipated. The sedimentation level in wetlands and river bank may continue to increase due to erosion or flood.

297. **Biological Environment**. In the 'without project' scenario, the present species composition of the vegetation, fisheries and wildlife is expected to remain unchanged. In normal conditions (no flood scenario), no change is anticipated in fish productivity of wetlands, pond fisheries, or productivity of agricultural land. However, loss of vegetation or loss of agricultural productivity, loss of pond fisheries productivity would be high during floods.

298. **Socio-economic Environment**. Without the project, large number of population will remain vulnerable to flood effect. Even the current rate of erosion to the tune of about 90.1 ha every year is a big loss of agricultural land and settlement areas. Flood also causes many linked socio-economic and health problems.

6.1.2. 'With Project' Option

299. **Physical Environment**. In the 'with project' scenario, no change is expected in air, soil and water conditions. The air pollution and noise levels are likely to increase during construction phase but will be confined within the close vicinity of construction sites and will be temporary in nature. The bank protection measures will prevent loss of about 90.1 ha/year of productive land and will prevent increase of sedimentation load to river equal to 53.82 ha/year of land area.

300. **Biological Environment** In the 'with project' scenario, there is likelihood of improved fish productivity from wetland and pond fisheries. No significant impact is expected in terms of increase in sedimentation level or fish productivity during construction stage. With the implementation of mitigation measures the overall impact of the project is likely to be nil or positive on the biological environment except in terms of loss of trees which will be minimized and regenerate over a period due to proposed tree plantation program. The project also entails cutting of about 2659 trees in Palasbari Reach due to renovation/construction of new dyke and other project activities. Needless to say, trees play an important role in the environment as

oxygen purification, checking soil erosion, habitat of numerous different fauna etc. The Bamboo and Simul trees are found in maximum quantity in all the subproject areas. The maturity period of Bamboo tree is about 3 years and Simul is about 10 years which means most of the trees are fast growing. The economic benefit has been worked out based on direct sale value of a matured tree. The average value of a Simul tree is ₹2,500/tree and that of Bamboo is ₹4,000/ bunch. For calculation purposes 60% tree are considered as Bamboo and 40% as Simul. On this basis the cost of tree loss is calculated as ₹39.6 million.

301. **Mitigation Cost:** With regards to mitigation measures, it is planned to plant three times the tree cut. Means a total of 7,977 trees are to be planted. The cost of plantation and 5 years of maintenance is estimates as ₹2.34 million. Additionally, the cost of monitoring and additional tree plantation is estimates as ₹0.075 million.

302. **Net Benefit:** Against the ecological loss of ₹39.6 million and mitigation cost including monitoring of ₹2.415 Million, an ecological gain of ₹108.0 million is expected. The net ecological benefit from the proposed mitigation measures is thus ₹65.99 million.

303. **Socio-economic Environment**. The 'with project' scenario is also likely to bring stability to the economy of the area. It will facilitate conservation of large area from erosion (90.1 ha/year), which means increased agricultural produce. Farmers will be able to plant three crops, instead of two crops in a year. Wetlands and pond fisheries productivity will improve due to reduce siltation load and improved fishery practices. The project will also provide better commuting opportunities to fishermen and people of the area through the paved road on the embankment, which means reduced commuting time to reach the markets. The flood protected environment may also promote agro-based industries in the area. The post-project scenario will enhance overall economy of the area. As per socioeconomic study, based on land use record of State Government of Assam, majority of the land in the subproject benefit area is agriculture which is about 62%. The major crops grown are rice, rabi, kharif, mustard and tea with rice crop accounting for 66%. Considering the land use and existing cropping pattern, a total benefit of ₹4.65 mn per annum or $0.12 mn for Palasbari reach can be achieved (Refer Table 45 for calculation basis). These benefits can further improve with improved cropping pattern and use of HYV seeds. With availability of land, even non-polluting industries as agro-based and cottage industries may also be promoted in the area. Currently the fish productivity from pond fisheries and beel is of the order of average 100 to 120 kg/ha/year (It varies though from 10 kg/ha to 250 kg/ha). This productivity can be doubled with proper institutional support. The area under fisheries in Palasbari reach is of the order of 1,191 ha. This means a total gain of fish productivity of about 142,920 kg per annum (@ increase of fish productivity of about 120 kg/ha/annum). Considering a very average rate of ₹50/kg the total gain works out to be ₹7.15 Million

6.1.3. 'Repeated Embankment Retirement' Option

304. **Physical Environment.** This option involves the retirement of flood embankments in response to the riverbank erosion process, with the acquisition of land and compensation to the affected people. In this scenario, loss of land at the rate of about 90.1 ha/year (reaching 2,703 ha in 30 years) will continue due to riverbank erosion. There is also a possibility of frequent flood inundation in the subproject area, unless the retired embankment can be constructed before the existing embankment is breached due to the river bank erosion.

305. **Biological Environment.** In this option, the eroded land will turn into a river channel turning into an aquatic environment. The environment of floodplain and wetlands during the monsoon season will depend on the timing of constructing the retired embankment against the

breach of existing embankment due to erosion. For other seasons, no change is anticipated in fish productivity of wetlands, or productivity of agricultural land.

306. **Socioeconomic Environment.** Since this option involves continuous river erosion, there will be displacement of people associated with 2,703 ha of land in 30 years to be lost due to river erosion, of which agriculture productivity will be lost. The similar economic benefits may be delivered in case of timely construction of retired embankment prior to the breach of existing embankment due to river erosion. However, there is a risk of failure given the lengthy procedures for land acquisition and opposition from the concerned population in the subproject areas (when compared with the 'with-project' option), in which case there will be repeated flood damages, affecting the confidence of local population on the reliability and effectiveness of FRERM systems leading to much less positive socio-economic impacts as compared with the 'with-project' option.

7. INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

7.1. Public Consultation and Participation

307. Meaningful consultation with affected peoples were carried out, and the consultation processes are appropriately documented in the updated EIA. The team pays special attention to ensure that vulnerable groups have sufficient opportunities to participate in consultations. The projects classified as 'category A' for environment, the project team participates in consultations to understand the main concerns of the project-affected people so that these concerns and recommendations can be adequately addressed in project design and safeguard plans.

308. To hold public consultation, following principles were followed (i) affected people were invited; (ii) project implementation schedule and matrix EMP were distributed; (iii) the team from WRD, district administration, PMC and FREMAA explained about the project and potential impacts as well as how the project will handle the impacts: and (iv) names of contact person, and contact number of PMU staff who will be acting as the grievance redress mechanism officer, to the participants were given (in this case SIO, the local WRD officer) and let them know, in case, they have concerns about the project to contact this PMU staff. Local people were also consulted from different socio- economic backgrounds in the villages along the Palasbari reach.

309. For the preparation of the EIA report 2009, three state level workshops were conducted. The first workshop was held in December 2007 on the interim progress of project preparation, and the second workshop in June 2008 on the draft findings of the study. Stakeholder consultations and socio-economic and poverty surveys were done in 4 villages in the first phase up to September 2007, followed by more detailed surveys in 33 sample villages out of 333 villages in the subproject area, along with 1 village in char land and another village outside of the subproject area using focus group meetings (FGMs) and participatory rural appraisal techniques. Furthermore, surveys on most vulnerable people were conducted in 18 villages through FGMs. Group discussions with women facilitated by Women Enumerators on impact of disaster on their livelihood and their present coping mechanism were held in each village surveyed.

310. In addition, two state level workshops were conducted. The first workshop was held in December 2007 on the interim progress of project preparation, and the second workshop in June 2008 on the draft findings of the study.

311. For updating EIA as part of preparation of tranche 2, public consultations were carried out at least two times, on 12 and 13 February, July and 4 November 2015 in Gumi and in 5 November 2015 in Palasbari. The consultations with villagers in the fringe of Palasbari and Gumi reach discussed about potential environmental and social impacts including potential physical displacement of people living in the embankment as part of preparation of resettlement plan. In between these 2 consultation dates, several visits were made in the fringe villages to assess the implication of programme on social and environment aspects in the month of July 2015. The official public consultation that address only for updating EIA were carried out in the affected villages in Palasbari subproject reach on 4 and 5 November 2015 and on 10 November 2016 at Palasbari.

312. As part of implementation of EIA, future public consultations are also envisaged in the implementation stage. The EMP provides for monitoring the effectiveness of the mitigation measures proposed, gathering feedback from the public and NGOs, and taking corrective actions. Provision has also been made for regular information dissemination and an awareness program during the construction and operations phases. The specific environmental impacts observed, mitigation measures adopted, and the prospects for impacts on further structural works will also be consulted and reported at the time of the processing of the second tranche of the Program.

7.2. Information Disclosed

313. The EIA report 2009 has been disclosed in ADB website, and the hard copy has been placed in the offices of FREMA, SIO Palasbari and SIO Gumi to make the report available for interested parties. The EIA report 2009 was also being submitted to obtain environmental clearance.

314. The discussions were primarily focused on receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. Issues were discussed in depth with the government officials and NGOs while in case of the villagers those issues were touched upon which are relevant to them. To begin with, they were given a brief outline of the project's objectives, type and components of the project in a simplified manner and in their native language. A set of pre-determined common questions were provided to the stakeholders to seek their perception of the proposed subproject.

315. The discussions with the stakeholders were focused mainly on the following points:

(i) Problem(s) related to environment as result(s) of flood and erosion of the Brahmaputra River;
(ii) Whether the proposed project will help in providing safety to the people, their property and environment of the area;
(iii) Any significant negative impact of the project on the overall environment of the area;
(iv) Possible impacts of the project on agriculture, wetlands, drinking water facilities, and local economy;
(v) Grievance Redressal Mechanism; and
(vi) Cooperation during execution of the work

316. Impact on the flora and fauna was mainly discussed with the officers of the Kamrup west DFO office and range offices of the forest department. The effect of air and noise pollution due to the project (during the design and construction stage) and disturbance in river water was discussed at length.

317. The consultation process was undertaken after studying the project design and identifying the possible impacts due to the project execution and commissioning. The impact assessment study focused mainly on the findings of the assessment and acceptability of the proposed mitigation measures. Issues of tree cutting, impact on physical environment, disturbance on fishing activities and fish productivity, productivity of beels in the study area and proposed mitigation measures were discussed at length.

318. For the state-level workshop, the executive summaries of the study findings were shared in advance with the invited participants including the NGOs. The first workshop presented and discussed the interim findings of the project preparatory studies, including the problems and issues related flooding and riverbank erosion in Assam including lessons, key strategic elements for integrated FRERM, and peoples' perspectives on living conditions and aspirations. The second workshop presented the draft final findings, including the rationale and preliminary objective and scope of the IFRERM Assam, social impact assessment and safeguards, and environmental impact assessments. After the workshops, press briefings were organized with the circulation of the executive summaries. The presented materials at the workshops are posted in the following ADB websites on the IFRERM-Assam:

(i) 1st Workshop held on 1 December 2007 at Administrative Staff College of India, Guwahati (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-IND-TACR.pdf)
(ii) 2nd Workshop on 25 June 2008 at the Institute of Engineers Conference Hall, Guwahati (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-01-IND-TACR.pdf)

(iii) 3rd Workshop held on 4 February 2009 at Brahmaputra Hotel, Guwahati (http://www.adb.org/Documents/Reports/Consultant/38412-IND/38412-02-IND-TACR.pdf).

7.3. Major Comments Received

319. While a wide range of people from different administrative, social and economic backgrounds were consulted, their concerns can be summarized in the following three categories of discussion of issues.

7.3.1. Concerns of Local stakeholders

320. The project received unanimous support and consent from all local people including those who will be rehabilitated, provided adequate compensation is paid. Environmental awareness and likewise concern were found low and issues such as probable reduction in fish catch also did not raise any significant concern amongst the fishermen. The only concern of the villagers was pertaining to compensation against loss of land and the mode of payment. People are looking forward for quick compensation and early start of the project.

321. People welcomed the initiative of the State Government of Assam for strengthening of embankment and providing revetment to the riverbank, as many of them were inundated during 2004 flood and recently in 2015. Condition of the Panchayat Bundh has emerged as the major area of concern for the local people. They were looking forward for enhancement of ghat facilities and environment around it.

322. The local stakeholders were especially supportive of the project as it can reduce the flood inundation scenario as well as protect the land from erosion, which will result in significant safety scenario as well as socio-economic development of the region. The local people did not perceive any adverse impact due to the proposed project. A few people told that the present embankment is very weak and because of which flood water enters their houses and paddy fields. They want boat ghat in appropriate location in Palasbari area.

323. The potential project affected people repeatedly stated their resettlement and compensation worries and on being informed of increased air and noise pollution from induced traffic and construction activities, remarked that it does not concern them much.

7.3.2. NGOs' Comments

324. There are limited NGOs active in the study area and directly dealing with environmental issues. All the NGOs' consulted had welcomed the flood control project and said that it will help in protection of agricultural land, domestic animals, fishermen communities etc. They also highlighted the importance of maintaining the natural drainage system along the project sites. The NGOs during interaction also highlighted the relief work they are carrying out during the flood situations. They also suggested increasing forest cover through afforestation program. Dr. Sanjay Hazarika of CE-NES also indicated the need of enhancing institutional capacity and strengthening review mechanism. He also emphasized on the following:

(i) Prevent any change to natural drainage,
(ii) Consider provision of alternate platform then only attached to embankment for use by animals and people during flood, and
(iii) Protection of the fish spawning grounds during construction and operation.

7.3.4. Local Officers' Comments

325. Dr. Baruwa from Environmental Council of Assam had raised concern of leaching of arsenic into groundwater which is generally used for drinking water supply from the river bank filtration wells in the floodplains of Brahmaputra River and asked about the possibility of integration of drinking water and irrigation projects. The analysis of water quality of surface and groundwater samples taken in Palasbari reach revealed very low arsenic content in river water as well as groundwater and the water quality well within the desirable standards as per IS 10500:1991.

326. Mr. Biren Thaukuria (RTD EE, WRD) has highlighted the importance of study for impact on fish productivity due to reduced siltation, which can emerge as a benefit to local fishermen. Mr. B. B. Hagjer (Secretary, Department of Environment and Forests) has pointed out requirement of study of impact downstream and upstream of the reach which can be affected after protection of the reach.

327. During the interaction, Mrs. E. Choudhary (Principal Secretary, Soil Conservation) raised the issues of bed level raising, seepage of embankment/ softening of embankment, erosion and increase in sedimentation as well as the requirement of catchments area treatment plan. She also revealed the requirement of soil conservation, study of earthquakes and its effect on siltation in the river.

328. The interaction with Department of Minority Welfare and Charland Development Directorate revealed that most of the chars in Brahmaputra are semi-permanent and as per their record there are 2,251 char villages. Drinking water is mainly supplied from the hand pumps and tube wells. The department also supports in the form of seed distribution, construction of raised platforms with and without sheds, repairing of schools, vocational training to local villagers,

329. The interaction with Chief Conservator of Forests, Forest Development Department and Head Assistant of the CCF office on 19 May 2008 has provided the useful comments and suggestions on possible intervention of proposed project on Forest and Wildlife. No specific suggestion or comment was made with respect to Palasbari reach as no protected area is in the project area. However, prior permission is needed from the Chief Conservator of Forests (Wildlife) for cutting of trees within the boundary demarcated as wildlife sanctuaries and national parks. If land is outside the protected areas, then the permission is not necessary from CCF or Forest Department. However, afforestation is needed if there is any loss of tree species during project intervention. At least three plants must be planted in place of one such tree cut during project intervention. For afforestation program, bamboo, simul trees and banana plants must be planted along the side of embankment. These trees have no side roots to destroy the embankments. Again, in the borrowing sites water resistant plants such as Salix tetrasperma, Buwal and Pani hizol should be planted.

330. The detail of formal and informal consultation held with various stakeholders with outcome is summarized at Table 44. Attendance sheets are given in Appendix 11.

7.4. State Level Workshops

331. Public consultation was also held with the stakeholders during the two state workshops, which were held in the months of December 2007 and June 2008 in Guwahati. Taking into consideration the environmental importance of the project, a number of environmental NGOs

were invited during these state workshops. However, only a few had turned up.

332. During the workshops most of the delegates and NGOs present in the workshops have supported the project. While similar comments as recorded for individual meetings were received, key recommendations in the workshops included (i) wider implications beyond the subproject areas should be assessed including downstream hydrology and sediment transport, impacts of global climate change, etc.; (ii) interventions should be carefully defined considering the data unavailability and unreliability, for which progressive knowledge development and adaptive approach learning lessons are critical; (iii) performance and lessons of FRERM (including its hydrological, social, and environmental implications) should be studied and reflected; (iv) livelihood implications of the poor should include those who live outside of the embankments and chars, and appropriate supporting measures should be included in the project design; (v) willingness of WRD to adopt people-centered approach as suggested by the team would remain a concern calling for serious pursuit; (vii) effective quality control and sustainability assurance measures should be put in place for FRERM structural measures with effective stakeholder participation; and (viii) details of the study finding should be made available to the local research organizations and interested groups.

7.5. Integration of comments

333. As observed from their responses, almost everyone interviewed was supportive of the project and believes that it will help provide the much-needed protection against the recurrent ravage of erosion and flood and bring prosperity to the region.

334. During discussions, notes were taken for any issue raised and suggestions made. These were then tabulated for a comprehensive analysis of the concerns raised. References have been taken from public opinion where no official data were available, while the officially available data have been extensively used for understanding of the study area characteristics. Each of the issue was then analyzed on practical and scientific basis and accorded a likewise importance in terms of their magnitude in Chapter 5: Anticipated Environmental Impacts and Mitigation Measures. For any significant concern, preventive or mitigative measures have been suggested drawing points from all the suggested measures.

Table 46: Summary of Outcome of Public Consultation

Date	Area	Topic of Discussion	Important Outcome
12.02.15 & 13.02.15	Palasbari Reach and Gumi Reach, WRD office, Circle Office	1.Regarding any specific problem(s) related to environment because of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the	During Economic assessment -No adverse impact visualized. Will help to protect the area from erosion and flood. -- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the Palasbari Town. Should be properly done. Benefits will be there.

		project on Agriculture, Wetlands, Drinking Water & Local Economy	
Month of February, 2015	Different villages under Palasbari Reach covering the affected villages on the south Bank	1.Regarding any specific problem(s) related to environment because of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy	During Economic assessment -No adverse impact visualized. Will help to protect the area from erosion and flood. -- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the Town Palasbari. Should be properly done. Benefits will be there both for peoples life and agrarian economy.
July 2015	Effected villages within the benefited area of Dibrugarh Reach on the south Bank	1.Regarding any specific problem(s) related to environment because of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy 5.Suggestion or comment on issues other than those discussed so far	RP Survey Government must be compensated for their land or alternative land should be allotted in nearby safe place. -Government should be very careful during the process of embankment and the actual value of the land should be given during land acquisition for embankment. -If Government gives proper compensation for land during the embankment project, and has no objection otherwise people will oppose the embankment. Because many people might loss their land during this project.
4 November 2015 and 5 November, 2015	4 Nov- People from different villages came to Gumi for public Hearing. Attended by Local MLA, School teachers, Circle officer, officers from the WRD, Bokakhat; FREMAA, PMC, Village headman, etc. 5tn Nov- Simina, Villagers, Head man of villages, Block level officers, WRD officers,	1.Regarding any specific problem(s) related to environment because of flood & erosion of the Brahmaputra 2.If the proposed project will help in providing safety to the people, their property and environment of the area 3. Any significant negative impact of the project on the overall environment of the area 4. Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy 5.Suggestion or comment on issues other than those discussed so far	- The work is necessary. It should be done urgently. No bad effect seen. Will benefit the people and the Palasbari town and villages. Should be properly done. Benefits will be there. -They highlighted the maintenance of water outlets. - Increase of forest cover by plantation -Suggested not to block any existing drainage - protection of the fish spawning grounds during construction and operation. - No adverse impact visualized. Will help to protect the area from erosion and flood. -Our agriculture productivity will improve. Land will be protected. Agricultural lands will be secured from erosion. - So far local people were

	(List of the participants with their signature is attached below)	6. Mitigation measures proposed by WRD were discussed 7. Grievance redressal Mechanism	satisfied with the plan of the mitigation measures - They also supported the grievance redressal mechanism.

8. GRIEVANCE REDRESSAL MECHANISM

335. Updated EIA for tranche-2 prepared and will be implemented in close consultation with the stakeholders and involve public for consultations, small group meetings, focus group discussions and meetings, particularly with the AHHs. This is a new section which is added in the update EIA 2017. A grievance redressal mechanism (GRM) developed for the programme will be followed in the tranche 2. The grievance redressal committee (GRC) for Environment and Social issues will be uniform under the project. GRC are formed at three levels (i) project level, (ii) district Level and (iii) executing agency level to receive, evaluate and facilitate the resolutions of the affected people's concern, complaints and grievances as per FREMAA notification No. FREMAA(P)/PROJ/209/2017/4 dated 28.08.2017.

336. This framework will be made available in local language(s) and will be distributed on the public meetings at the community level that will be carried out as part of public consultation during project implementation. The updated EIA report will be disclosed on ADB, WRD and FREMAA websites and consultation will continue throughout the project implementation period.

337. Detailed procedure for community complaint and grievance redressal on implementation of EMP or environment related issues during the project implementation stage will be redressed at the local level by a GRC in a consultative manner with the full participation of the affected households including women, or their representatives; the Executive Engineers, Assistant Engineers and representatives from the panchayats/ municipality, local NGO, and vulnerable groups. Grievance will be redressed within 2 to 4 weeks from the date of lodging the complaint. At the project site level, the SIO is the secretariat of the GRM. All costs incurred in resolving the complaints will be borne by the project. A comprehensive report will be maintained by the executing agency of all the grievance proceedings for future checking and/or auditing. This proposal was discussed during public consultation.

338. At district level under the Deputy Commissioner's Chairmanship grievances will be resolved if not resolved at project /local level. The GRC will meet regularly at least once a month on a prefixed date. Decisions of the District level GRC will be final, unless an appeal is preferred with the CEO, FREMAA. The PMU is the secretariat of the GRM at the state level

339. In addition to disputes/complaints relating to environmental safeguards will be resolved at SIO level. If not resolved will be referred District Level and later to state GRM in the PMU (FREMAA) under the CEO. However, the GRM is not substitute any Court of Law. While complaints files to the GRM of the project, complainant has its freedom to submit the case to the court.

Figure 11: Grievance Redressal Mechanism

9. ENVIRONMENTAL MANAGEMENT PLAN

9.1. Environmental Management Plan (EMP) and Monitoring Plan (EMoP)

340. The aim of the environmental management plan (EMP) is to ensure that the various adverse impacts associated with the project are properly mitigated; either by preventing the impacts or by mitigating those to reduce the effect to an acceptable level by adopting the most suitable techno-economic option (Economic Assessment- Appendix-12). The EMP also ensures that the positive impacts are conserved and enhanced.

9.2. The EMP

341. The EMP consists of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation stages of the project. The plan also includes the actions needed for implementation of these measures.

342. The major components of the EMP are:

(i) Mitigation of potentially adverse impacts;
(ii) Monitoring during project implementation and operation;
(iii) Institutional Capacity Building and Training;
(iv) Implementation Schedule and Environmental Cost Estimates; and
(v) Integration of EMP with project planning, design, construction and operation

343. The EMP is detailed at Appendix 12, and good practices Appendix 13.

344. The environmental monitoring plan (EMoP) is given in Appendix 14.

9.2.1. EMP Implementation Timetable

345. The mitigation measures shall be implemented depending on the nature and time of impact. The implementation schedule has been prepared considering 24 months of construction phase starting from year 2018 and ending on October 2020.

9.2.2. Authorities and Their Responsibilities for Implementation of the EMP

346. The authorities and responsibilities for the implementation of the environmental management plans shall be tiered based on the activity. The suggested hierarchy and information flow is given in at Figure-12.

347. All the policy decisions, including incorporation of the EMP requirements in compliance to loan covenants shall be the responsibility of the recommended FREMAA as the executing authority and will be registered under the Societies Act. The FREMAA composed of representatives from State: departments of water resources, agriculture, finance, fisheries, forest and environment, planning and coordination, public works, disaster management and revenue, rural development, soil conservation, and welfare of plain tribes and backward classes.

348. The current program management unit (PMU) will continue on behalf of FREMAA to take responsibilities to implement overall EMP. The PMU's social and environmental unit is expected to continue to have a senior environmental specialist seconded from the State Forestry and Environment Department, however, the option to engage environment specialist from outside the government employee will also be kept. The PMU will continue to be assisted by a multidisciplinary team of consultants for institutional strengthening and project management

(ISPM) for capacity development, quality control, and project management. The PMU-Social and Environmental Unit (SEU) will ensure that the environmental mitigation measures are being implemented by the subproject implementation offices (SIOs). The PMU will, among others ensure that the EIA reports comply with national and Bank guidelines, monitor the status of implementation, and preparation of monitoring reports.

349. In each subproject, there is SIO comprising technical team (SIO-T). As under Palasbari subproject there are two reaches Palasbari and Gumi, two separate SIO and their team will look after 2 reaches. The SIO will coordinate the implement or cause the implementation of the monitoring and mitigation measures under the supervision of the PMU. The Executive Engineer (EE) is responsible for day today activities with support from PMC. Assistant Engineers under the EE directly monitor and supervise field work and report to SIO. The head of the SIO under the Assam State Disaster Management Authority (ASDMA) is the District Commissioner of the respective district.

9.2.3. Mechanisms for Feedback and Adjustment

350. **Environmental Management Plan**. The implementation the EMP is guided by the EMP matrix in appendix 12 and good practice in appendix 13. All the EMP related with the construction work will be implemented by the contractor. The implementation of other aspects of EMP will be led by the PMU with support from PMC and ISC as well as SIO.

351. The contractor will report the implementation of EMP in its monthly report and the PMU will submit semiannual report on the implementation of overall EMP.

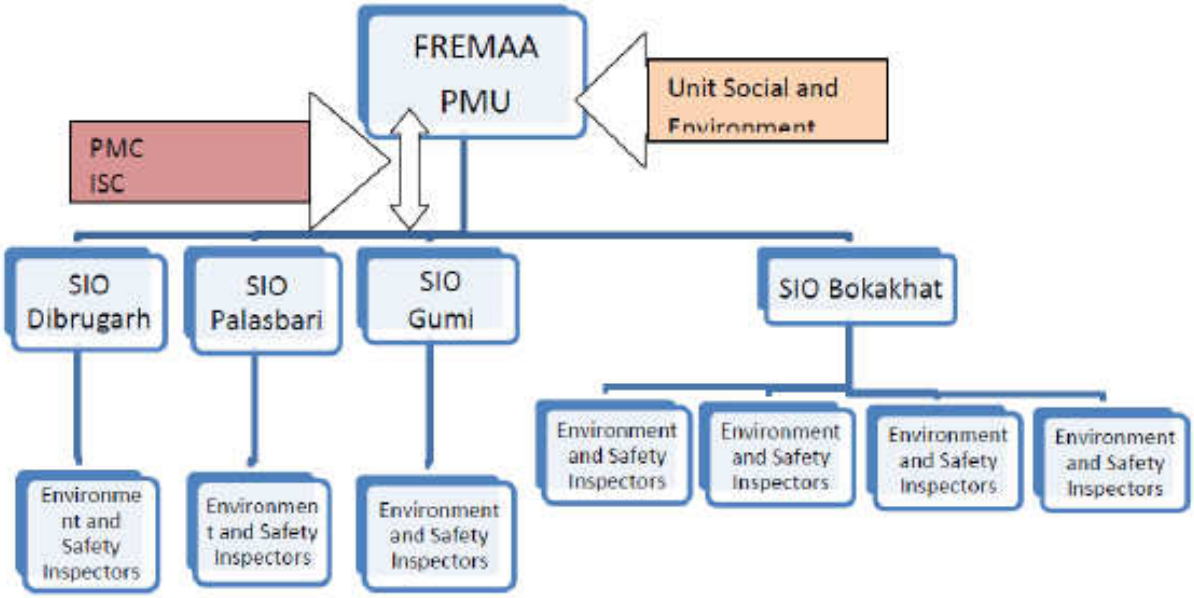
9.3. Environmental Monitoring Plan (EMoP)

352. The aim of EMoP during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards.

353. A monitoring schedule has been drawn up based on the environmental components that may be affected during the construction and operation of the project. Since project is likely to have impact on various components of environment, a comprehensive monitoring plan covering wildlife, fisheries, cropping pattern, soil erosion, drainage congestion, tree plantation, air quality, noise and vibration are provided as Appendix 14. Monitoring plan has been separately suggested for construction phase and operation phase. Monitoring points have been selected based on the sensitivity of the location with respect to sensitive receptors.

354. The proposed organization structure to implement the EMP in FREMAA is shown at Figure 12.

Figure 12: Proposed Organization Structure



9.4. Institution Strengthening Cost

355. To enhance the capacity of the project staff in implementing EMP for effective implementation of proposed mitigation measures and monitoring the resultant effect, some training programs are proposed. The detailed training plan is provided at Appendix 15.

356. The environmental budget has been worked out for the entire three projects for tranche 2 together since various costs are common in nature. However, summary table below highlights sub projects specific costs component. The mitigation cost, inclusive of monitoring cost and training during the project life cycle (construction and operation phase) amounts is estimated to be ₹31.9 million for all the subproject put together in tranche.

357. The mitigation cost including monitoring is estimated as ₹17.26 million during construction phase and operation phase. The costs of establishment and training are estimated as ₹11.84 million. The detailed break up is given at Appendix 16.

10. CONCLUSIONS AND RECOMMENDATIONS

358. The conclusions are based on Environmental Assessment carried out for the Palasbari reach, which is one of the three reaches identified as most vulnerable to flood and erosion of the Brahmaputra River in Assam. The subproject is needed to safeguard the people, property and environment from frequent and devastating floods of the Brahmaputra River.

359. The subproject at Palasbari was considered as environmental category B under ADB SPS 2009 and the findings of the update EIA study support this categorization as no significant impact are anticipated to be generated from the Palasbari and Gumi subproject. With the structural works focusing on sustaining the functions of the existing embankment systems through renovation of deteriorated embankments, provision of inner secondary embankment and sluice gates, and riverbank protection works, the present EIA indicates no significant adverse environmental impacts that are sensitive, diverse, or unprecedented, and affect an area broader than the site.

360. The EIA study was carried out from February 2015 to January 2016 (information collected till September 2017), and is based primarily on secondary data. However, primary data was also collected where secondary data was not available or not up to date. The environmental study covered the project area, as well as the area of direct and indirect impacts. The environmental assessment report was prepared in accordance with relevant applicable laws and regulations of the Government of India; and in conformity with the ADB's SPS.

10.1. Environmental Gains Due to Proposed Works Justifying Implementation

361. The project entails various impacts on the project setting. There are many impacts bearing benefits to the area against the limited number and magnitude of negative impacts. These include the following:

(i) The Brahmaputra River carries more water per unit area of basin than any other river in the world, The area experiences heavy rainfall during monsoon with annual rainfall of the order of 170 to 220 cm. The proposed project -through strengthening the reliability of the existing embankments and riverbank protection works- will prevent people from the impacts of devastating floods.

(ii) The reach is prone to extreme hazards of bank erosion, and embankment breaches. This results in loss of productive agriculture land, infrastructure and damage to ecology. The proposed project will result in protecting loss of precious agriculture productivity.

(iii) The project area does not pass through any protected area (reserved forests, wild life sanctuaries, national park) or ecologically sensitive areas. The afforestation will not only help in compensating losses of trees but also increase tree cover in the long run due to the compensatory afforestation at the rate of 1:3 as per the state government policy.

(iv) There are large number of wetlands, beels and other water bodies (fish ponds) in the study area, however these are not likely to be affected by the project intervention. The proposed project is likely to enhance the fish productivity in these water bodies due to protection from flooding and siltation under this project.

(v) The people are largely poor in the area, many of them depend on fisheries, agricultural activities and forest resources. The area is also vulnerable to the floods of the Kulsi River that joins the Brahmaputra in this reach. The economic gain is expected to be high.

10.2. Potential Impacts, Mitigation, Management and Monitoring

362. The project entails various impacts on the environmental setting of the area. While some are negative, there are many bearing benefits to the area as well. Provided that the recommended mitigation measures are implemented, no impact is anticipated on endangered species like river Dolphin due to project activities. Some of the trees along the embankment are likely to be cut. But, if the proposed compensatory afforestation plans are effectively implemented, and survival rate is monitored and sustained, the positive benefits are likely to be accrued. The project is likely to bring positive impact to wetlands, pond fisheries and agricultural productivity due to protection from flood and reduced sedimentation. Project activities are likely to generate some adverse environmental impacts during construction. However, these will be temporary. Implementation of the prescribed mitigation measures will minimize the adverse impacts. Moreover, the impacts shall be monitored continually by implementing and updating the EMP and EMoP.

363. The project is welcomed by all the stakeholders. The suggestion received from the public/stakeholders has been integrated while developing the mitigation measures and the EMP and EMoP.

364. There is a possibility that the subproject area may be affected by the impacts of climate change and other external events including major earthquakes and upstream development works such as hydropower development. While the impacts of these events may well extend beyond the economic life of the subproject investments (of 30 years), available study indicates the possible climate change impact of increased precipitation by up to 30% in the north-eastern region by 2040-60, although diverse anticipation still coexists. A large-scale earthquake (and landslides) may exacerbate the sediment loads of the Brahmaputra, whereas the hydropower dams upstream may reduce the sediment inflow. On these accounts, the systematic monitoring of the river dynamics to be strengthened under the project will facilitate the identification and implementation of necessary measures to adapt to any emerging changes in the construction and post-construction phase of the subproject.

365. During the construction stage, some trees along the embankment are likely to be cut, but if the proposed compensatory afforestation plans are effectively implemented, and survival rate is monitored and sustained, the positive benefits are likely to be accrued. Project activities are likely to generate other adverse environmental impacts during construction. However, these will be temporary. Implementation of the prescribed mitigation measures will minimize the adverse impacts, with the stipulated EMP and EMoP.

366. The project involves strip acquisition of land for strengthening the existing embankments and associated structural relocation. The concerned land acquisition and resettlement cases will be addressed following the Government's and the State Government of Assam's laws and regulations, and ADB's Involuntary Resettlement Policy, which has been stipulated in the resettlement framework, based on which resettlement plans are prepared and implemented to address all the cases. For tranche 2 works, extensive public consultation has been carried out, consistent with state guidelines. For affected people, support will be provided to improve, or at least restore, the pre-intervention income and livelihoods standards, and productive capacity. In addition, the subproject will provide construction labor opportunities and community development assistance to nearby communities and to landowners whose land will be acquired, or structures be affected, including non-title holders.

10.3. Irreplaceable Resources

367. Dolphin and other endangered species found in the Brahmaputra River and other nearby areas are not exclusive to the project site. No damage to the habitat of these species is anticipated. There are no other environmental sensitive resources found in the project area which is likely to be affected by the project.

10.4. Post EIA Surveillance and Monitoring

368. While an EIA is meant to provide a comprehensive understanding of the environment status of the area under the study, post EIA surveillance is the means to ensure that the significant impacts identified are adequately mitigated as per the proposed mitigation plan. A detailed monitoring plan has been provided as part of the EMP. Air, surface water quality, ground water quality, noise, soil erosion, drainage congestion and tree survival rate monitoring and reporting along with the follow up actions in case of deviation from the norms have been detailed. The frequency has been set in consideration of the likely impacts.

10.5. Public Consultations

369. The project received unanimous support and consent from all local people including those who will be rehabilitated, providing adequate compensation is paid. People welcomed the initiative of the state government for strengthening of embankment and providing revetment to the riverbank, as many of them were inundated during the 2004 flood. The subproject will result in significant safety as well as socio-economic development of the region. The local people did not perceive any adverse impact due to the proposed project. Environmental awareness and likewise concern were found generally low and issues such as probable reduction in fish catch also did not raise any significant concern amongst the fishermen.

370. Nevertheless, local stakeholders as well as NGOs emphasized the need to ensure the effectiveness of institutions and their program delivery mechanisms to implement the subproject structural and non-structural measures. Villagers were concerned on the compensation against loss of land and the mode of payment.All compensations payments under Tranche I have been completed in early 2018. . Capacities and willingness of the project organizations to adopt people-centered approach as suggested by the project also remains a constraint. The project has included necessary provisions to address these concerns, including the time-bound actions to address these institutional constraints with institutional reforms and capacity development support.

10.6. Recommendations

371. The EIA was carried out during feasibility study and consequently during preparation of DPR for tranche 2 it was updated. Therefore, the detailed engineering design was considered for the preparation of IEE. If any changes required in implementation stage, or any additional work required other than the proposed project activities, need to be assessed its potential environmental impacts. However, there might be minor contract variation which will have no adverse environment impact. Any contract variation proposals will be sent to ADB for concurrence before civil works commence. The flooding and riverbank erosion pattern of the river shall have to be closely monitored and analyzed during the proposed life span of the embankment and riverbank protection measures, and appropriate and timely measures need to be taken to adapt to any changes in the natural river environment. Over the medium to long terms, effective knowledge base needs to be established including the modeling of flooding and morphological behavior and sediment transport mechanisms of the Brahmaputra River and its

tributaries to quantitatively assess the implications of any past and new water sector investments.

372. For implementation of EMP, SIO office to be strengthened with training of environment safeguards to dedicated staff for WRD has limited capacity to address the environmental measures in house. There is a need to enhance institutional capacity of the WRD regarding environmental training, monitoring infrastructure and environmental guidelines. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned executing agency officials. It is recommended to develop environmental guidelines focused on effective implementation of mitigation measures. Performance indicators may also be developed as part of these guidelines to monitor and assess the effectiveness of the mitigation measures. Special emphasis to be given on the conservation of dolphin and their habitats by strictly following the mitigation measures prescribed.

373. Awareness program for public shall be launched for flood embankment strengthening and riverbank protection works, and conservation of natural environment and sanitation during construction and operation phase of the project.

APPENDIX 1-16

APPENDIX 1: USE OF GEOTEXTILE BAGS FOR RIVERBANK EROSION MITIGATION

The use of geotextile bags plays a major role in mitigation of erosion in a way that is both economical and flexible. Geotextile bags have the two most important properties for erosion control, the filter function to prevent the undermining of the riverbank and the ability to withstand the hydraulic load of the current. Geotextiles were first introduced in the market in 1950s and their use has increased rapidly due to the properties, flexible use and stability. Nowadays geotextile sand containers are used in the river and coastal engineering field as construction elements for erosion control, scour fill, artificial reefs, groynes, dams as well as in breakwater and dune revetments.

Geosynthetic containers are multi-purpose elements that can be manufactured according to almost any demand. The additional functions of geotextile bags, which make them so attractive, are as follows:

Filtration: Filtration restricts the migration of fine soil while remaining permeable to water movement at least greater than or at least to the permeability of the protected soil. Reinforcement: The geotextile bags must also withstand the hydraulic load of the current which can reach up to 3m/s. This function involves the stabilization of a soil mass by providing a closed compartment.

The gradual natural changes to environment may not have much impact as it occurs slowly, and fish may get opportunity to adapt. However, any man-made and quick changes might have a more important impact. The various field studies and observations show that the overall number of species were better in geotextile bag areas than in areas exposed to erosion or protected by CC-blocks. So, geotextile bags do not have any negative impact on fisheries rather the situation is slightly better. Small pockets in between bags, where flow velocity is decreased, may create shelter places for fishes (Munir Ahmed, 2007). After the geotextile gets the characteristics of the environment, fish species adapt to the new environment and hide in the shelter holes. During diving inspection, they feel the fishes and shrimp (Atiqur Afur, 2007).

There are no negative effects known on the flora if geotextile bags are used for river bank protection. The roots are small enough to pass through the geotextile. However, roots have negative effects on geotextile bags and on the whole protection design. In particular when roots dry out after having passed through the geotextile big pores remain where sand can be washed out. In this case the stability of the structure is reduced.

Under normal conditions polypropylene does not present any toxic hazard, either from skin contact or inhalation. The material is inert and shows no toxicity (Dow, 2007). Additionally, it can be said that polypropylene fibers are widely accepted. It is assumed that restrictions in these industries are much tighter. So, it can be postulated that PP fibers for geotextile are harmless from a toxicological point of view. (Naue Fasertechnik, 1995). Hence, the use of geotextile bags has no negative effect on the environment, neither to the water quality nor the flora and fauna.

APPENDIX 2: WATER QUALITY CRITERIA FOR DESIGNATED BEST USE

Designated-Best-Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • dissolved Oxygen 6mg/l or more • biochemical Oxygen Demand 5 days 20°Cmg/l or less
Outdoor bathing (organized)	B	• total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more • biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • dissolved Oxygen 4mg/l or more • free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • electrical Conductivity at 25°C micro mhos/cm Max 2250 • sodium absorption Ratio Max 26 • boron Max 2mg/l
	Below-E	• not Meeting A, B, C, D & E Criteria

APPENDIX 2 A. IS:10500 DRINKING WATER QUALITY STANDARD

	Parameters	Unit	Acceptable Limit IS:10500	Permissible Limit IS:10500
1	Color	Hazen units	5	15
2	Odor	-	Agreeable	Agreeable
3	Taste	-	Agreeable	Agreeable
4	Turbidity	NTU	1	5
5	Total Dissolved Solids	mg/l	500	2000
6	pH	-	6.5 to 8.5	No Relaxation
7	Total Hardness as $CaCO_3$	mg/l	200	600
8	Iron as Fe	mg/l	0.3	No Relaxation
9	Aluminum	mg/l	0.03	0.2
10	Copper as Cu	mg/l	0.05	1.5
11	Manganese as Mn	mg/l	0.1	0.3
12	Zinc as Zn	mg/l	5	15
13	Magnesium as Mg	mg/l	30	No Relaxation
14	Barium	mg/l	0.7	No Relaxation
15	Calcium as Ca	mg/l	75	200
16	Silver	mg/l	0.1	No Relaxation
17	Selenium as Se	mg/l	0.01	No Relaxation
18	Molybdenum	mg/l	0.07	No Relaxation
19	Boron	mg/l	0.5	1.0
20	Nitrates as NO_3	mg/l	45	No Relaxation
21	Sulphate	mg/l	200	400
22	Sulphide		0.01	No Relaxation
23	Fluoride as F	mg/l	1.0	1.5
24	Chlorides as Cl	mg/l	250	1000
25	Ammonia	mg/l	0.5	No Relaxation
26	Chloramines	mg/l	0.2	No Relaxation
27	Residual, Free chlorine	mg/l	0.2	1.0
28	Total Alkalinity as calcium carbonate	mg/l	200	600
29	Phenolic compounds (as C_6H_5OH)	mg/l	0.001	0.002
30	Mineral Oil	mg/l	0.03	No Relaxation
31	Anionic detergents (as MBAS)	mg/l	0.2	1.0
32	Chromium	mg/l	0.05	No Relaxation
33	Arsenic as As	mg/l	0.01	0.05
34	Mercury as Hg	mg/l	0.001	No Relaxation
35	Cadmium as Cd	mg/l	0.003	No Relaxation
36	Lead as Pb	mg/l	0.01	No Relaxation
37	Nickel as Ni	mg/l	0.02	No Relaxation
38	Cyanide as CN	mg/l	0.05	No Relaxation
39	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	0.0001	No Relaxation
40	Polychlorinated biphenyls	mg/l	0.0005	No Relaxation
41	Total Coliform	MPN/100ml	Nil	No Relaxation

APPENDIX 3: NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutants	Time-weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential, Rural and other Areas	Sensitive Areas	
SulphurDioxide (SO_2)	Annual Average*	80 µg/m^3	60 µg/m^3	15 µg/m^3	- Improved West and Geake Method - Ultraviolet Fluorescence
	24 hours**	120 µg/m^3	80 µg/m^3	30 µg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	80 µg/m^3	60 µg/m^3	15 µg/m^3	- Jacob and Hochheiser Modified (Na-Arsenite) Method
	24 hours**	120 µg/m^3	80 µg/m^3	30 µg/m^3	- Gas Phase Chemiluminescence
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m^3	140 µg/m^3	70 µg/m^3	- High Volume Sampling, (Average flow rate not less than 1.1 m3/minute).
	24 hours**	500 µg/m^3	200 µg/m^3	100 µg/m^3	
RespirableParticulate Matter (RPM) (size less than 10 microns)	Annual Average*	120 µg/m^3	60 µg/m^3	50 µg/m^3	- Respirable particulate matter sampler
	24 hours**	150 µg/m^3	100 µg/m^3	75 µg/m^3	
Lead (Pb)	Annual Average*	1.0 µg/m^3	0.75 µg/m^3	0.50 µg/m^3	- ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m^3	1.00 µg/m^3	0.75 µg/m^3	.
Ammonia1	Annual Average*	0.1 mg/ m^3	0.1 mg/ m^3	0.1 mg/m^3	.
	24 hours**	0.4 mg/ m^3	0.4 mg/m^3	0.4 mg/m^3	.
CarbonMonoxide (CO)	8 hours**	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/ m^3	- Non Dispersive Infra Red (NDIR)
	1 hour	10.0 mg/m^3	4.0 mg/m^3	2.0 mg/m^3	Spectroscopy

Pollutants	Time-weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential, Rural and other Areas	Sensitive Areas	
*	Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.				
**	24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.				

APPENDIX 4: NATIONAL AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE

Area code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note: -

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* **dB(A) Leq** denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A —decibel|| is a unit in which noise is measured.

—A||, in **dB(A) Leq,** denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

Note: The Principal Rules were published in the Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended by the Noise Pollution (Regulation and

APPENDIX 5: REPTILIAN FAUNA REPORTED IN MAJIRGOAN-NAGARBERA PROJECT SITES (DATA PRESENTED AS ABSENT DATA)

Reptilian Species/family	Present absent data of Reptilian fauna in different study sites													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Typhlopidae: Typhlops diardii Schlegel, 1839	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pythonidae: Python molurus bivittatus Kuhl, 1820	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Colubridae *Ptyas mucosa* (Linnaeus 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Oligodon albocinctus (Cantor, 1839)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dendreaphis pictus (Gmelin, 1789)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Lycodon aulicus (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Xenochrophis piscator (Schneider, 1799)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rhabdophis subminiatus (Schlegel, 1837)	1	1	1	0	0	1	0	0	0	0	0	1	1	1
Amphiesma stolatum (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Amphiesma platyceps (Blyth, 18540)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Enhydris enhydris (Schneider, 1799)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Elapidae: Naja kaouthia Lesson, 1831	1	1	1	1	0	0	1	1	1	1	1	1	1	1
Bungarus caeruleus (Schneider, 1801)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Agamidae Calotes jerdoni Gunther, 1870	1	1	0	0	1	0	0	0	0	0	1	0	0	1
Calotes versicolor (Daudin 1802)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gekkonidae: Hemedactylus frenatus Schlegal 1836	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Reptilian Species/family	Present absent data of Reptilian fauna in different study sites													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hemedactylus garnoti Dum. And Bibr. 1836	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gekko gecko (Linnaeus 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hemedactylus brooki Gray, 1845	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Scincidae Mabuya carinata (Schneider, 1801)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sphenomorphys maculatus (Blyth, 1853)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Riopa punctata (Linnaeus, 1766)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Anguidae Varanus bengalensis (Linnaeus, 1758)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
V. flavescens	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kachuga tecta (Gray)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kachuga smithi (Gray)	1	1	1	1	0	0	1	0	0	0	0	1	1	1
K. sylhetensis (Jerdon)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Geoclemys hamiltoni (Gray)	1	1	1	1	1	1	1	1	1	1	0	1	1	1
hardella thurgii (Gray)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Lacepede Lissemys punctata	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trionix hurum (Gray)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chitra Indica (Gray)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trionix gangeticus	1	1	1	1	1	1	1	1	1	1	1	0	1	1

Abbreviation: 1:(0point) Darapur; 2: Darapur; 3: jangrabari; 4: Alutalibari; 5: DBHcm; 6: dbh; 7: DBH; 8DBHin; 9: spur7th; 10: Majguri; 11: Goroimarialikash; 12: Borakhat;13: BejisutiKalidas; 14: Nagarberahillside (1: Present;0: Absent).

APPENDIX 6: COMPREHENSIVE LIST OF AVIAB FAUNA IN MAJIRGOAN-NAGARBERA PROJECT SITE

English Name	Family/Scintific Name
	Podicepedae
Little Grebe	Tachybaptus ruficollis
Great Crested Grebe	Podiceps cristatus
Red-Necked Grebe	P. grisegena
	Pelicanidae
Spot-billed Pelican	Pelecanus philippensis
	Phalacrocoracidae
Little Cormorent	Phalacrocorax niger
Indian Cormorent	Phalacrocorax fuscicollis
Great Cormorent	Phalacrocorax carbo
	Anhingidae
Darter	Anhinga melanogaster
	Ardeidae
Little Egret	Egretta garzetta
Intermediate Egret	Mesophoyx intermedia
Cattle Egret	Bubulcus ibis
Great Egret	Casmerodius albus
Indian Pond Heron	Ardeola grayii
Grey Heron	Ardea cinerea
Black-Crowned Night Heron	Nycticorax nycticorax
Grey Heron	Ardea cinerea
Purple Heron	Ardea purpurea
Chinese Pond Heron	Ardeola bacchus
Yellow Bitern	Ixobrychus sinensis
Black Bittern	Dupetor flavicollis
Cinnamon Bittern	Ixobrychus cinnamomeus
Little Bittern	Ixobrychus minutus
	Ciconidae
Asian Openbill	Anastomus oscitans
Lessar Adjutant Stork	Leptoptilos javanicus
	Dendrocygnidae
Fulvous Whistling-Duck	Dendrocygna bicolor
Lesser Whistling-Duck	Dendrocygna javanica
	Anatidae
Bar-Headed Goose	Anser indicus
Ruddy Shelduck	Tadorna ferruginea
Gadwall	Anas strepera
Mallard	Anas platyrhynchos
Spot-billed Duck	Anas poecilorhyncha
Common Teal	Anas crecca
Garganey	Anas querquedula

English Name	Family/Scintific Name
Northern Pintail	Anas acuta
Northern Shoveler	Anas clypeata
Red-crusted Pochard	Rhodonessa rufina
Common Pochard	Aythya ferina
Ferruginous Poachered	Aythya nyroca
Tufted Duck	Aythya fuligula
White-breasted Waterhen	Rallidae Amaurornis phoenicurus
Water Cock	Gallicrex cinerea.
Common Moorhen	Gallinula chloropus
Water Rail	Rallus aquaticus
Common Coot	Fulica atra
Pheasant-tailed Jacana	Jacanidae Hydrophasianus chirurgus
Bronze-winged Jacana	Metopedius indicus
Paintd Snipe	Rostratulidae Rostratula bengalensis
Common Snipe	Scolopacidae Gallinago gallinago
Solitary Snipe	Gallinago solitaria
Eurasian Woodcock	Scolopax rustica
Wood Sandpiper	Tringa glareola
Common Redshank	Tringa Totanus
Spotted Redshank	Tringa erythropus
Common Greenshank	T. nebularia
Nordman Greenshank	T. guttifer
Common Sandpiper	Actitis hypoleucos
Marsh Sandpiper	T. stagnatalis
Little Stint	Calidris minuta
Collared Partincole	GlareolidaeGlareola lecta
Small Indian Partincole	G. pratincola
Common Ringed Plover	Charadridae Charadrius hiaticula
Little Ringed Plover	Charadrius dubius
Pacific Golden Plover	Pluvialis fulva
Red-wattled Lapwing	Vanellus indicus
Grey-headed Lapwing	Vanellus cinereus
Northern Lapwing	Vanellus vanellus
River Tern	Laridae Sterna aurantia
Black-bellied Tern	Sterna acuticauda
Whiskered Tern	Chlidonias hybridus
White-winged Tern	C. leucopterus

English Name	Family/Scintific Name
Brown-Headed Gull	Larus brunnicephalus
Black-headed Gull	Larus ridibundus.
Mew Gull	Larus canus
Black-winged Stilt	Himantopidae Himantopius himantopus
Osprey	Accipitridae Pandion haliatus
Black Kite	Milvus migrans
Brahmni Kite	Haliastur Indus
Pallas's Fish Eagle	Haliaeetus leucoryphus
Grey-headed Fish eagle	Ichthyophaga ichthyaetus
White-Ramped Vulture	Gyps bengalensis
Long-billed Vulture	Gyps indicus
Red-headed Vulture	Sarcogyps calvus
Crested Serpent Eagle	Spilornis cheela
Eurasian Marsh-Harrier	Circus aeruginosus
Pied Harrier	Crcus melanoleucos
Hen Harrier	C. cyaneus
Pallied Harrier	C. macrourus
Montagu's Harrier	C. pygargus
Shikra	Accipiter badius
Besra	Accipiter virgatus
Eurasian Sparrowhawk	A. nisus
Common Buzzard	Buteo buteo
Oriental Honey-Buzzard	Pernis ptilorhyncus
Long-legged Buzzard	Buteo rufinus
Lesser Spotted Eagle	Aquila pomarina
Greater Spotted Eagle	A. clanga
Red-necked Falcon	Falconidae Falco chicquera
Lesser Kestrel	Falco naumanni
Oriental Hobby	Falco severus
Peregrine Falcon	Falco peregrinus
Common Kingfisher	Alcidinidae Alcedo atthis
Blyth's Kingfisher	Alcedo hercules
Blue-eared Kingfisher	Alcedo meninting
White-throated Kingfisher	Halcyon smyrnensis
Stork-billed Kingfisher	Dacelonidae Halcyon capensis
Pied Kingfisher	Cerylidae Ceryle rudis
	Passeridae

English Name	Family/Scintific Name
House Sparrow	Passer domestica
Tree Sparrow	Passer montanus
Blackheaded Munia	Lonchura malacca
White-rumped Munia	Lonchura striata
White Wagtail	Motacilla alba
Yellow Wagtail	Motacilla flava
Grey Wagtail	Motacilla cinerea
Paddyfield Pipit	Anthus rufulus
Richard's Pipit	Anthus richardi
Citrine Wagtail	Motacilla citriola
Rosy Pipit	Anthus roseatus
Olive-backed Pipit	A. hodgsoni
Golden Fronted Leafbird	Irinidae Chloropsis aurifons
Orange Billed Lefbird	Chloropsis hardwiskii
Eurasian Golden Oriole	Corvidae Oriolus oriolus
Bick-hooded Oriole	Oriolus xanthornus
Rufous Treepie	D endrocitta vagabunda
House Crow	Corvus splendens
Large-billed Crow	Corvus macrorhynchos
Black Drango	Dicrurus macrocercus
Crow-billed Drongo	Dicrurus annectans
Bronzed Drongo	Dicrurus aeneus
Spangled Drongo	Dicrurus hottentottus
Ashy Drongo	Dicrurus leucophaeus
Common Iora	Aegithina tiphia
Black-naped Monarch	Hypothymis azurea
Large Cuckoo-shrike	Coracina macci
Ashy Wood Shallow	Artamus fuscus
Blue Throated Barbet	Megalaimidae Megalaima asiatica
Coppersmith Barbet	Megalaima haemocephala
Lineated Barbet	Megalaima lineata
Golden-throated Barbet	Megalaima franklinii
Blue-eared Barbet	Megalaima australis
Great Barbet	Megalaima viren
Asian Pied Starling	Sturnidae:Sturnus contra
Common Maina	Acridotheres tristis
Bank Maina	Acridotheres giginianus
Jungle Myna	Acridotheres fuscus
Whitevented Myna	A. grandis
Greyheaded Myna	Sturnus malabaricus

English Name	Family/Scintific Name
Hill Myna	Gracula religiosa
Creg Martin.	Hirundinidae Hirundo rupestris
Barn Swallow	Hirundo rustica
Northern House Martin	Delichon urbica
Sand Martin	Riparia riparia
Nepal House Martin	Delichon nipalensis
Red-Whiskered Bulbul	Pycnonotidae Pycononotus jocosus
Red-Vented Bulbul	Pycononotus cafer
Blue-tailed Bee-ater	Meropidae Merops philippinus
Green Bee-eater.	Merops orientalis
Chestnut-headed Bee-eater	Merops leschenaulti
Purple Sunbird	Necterinidae:Nectarinia asiatica
Purple-throated Sunbird	Necatrinia seperata
Mrs Gould's Sunbird	Aethopyga gouldiae
Crimson Sunbird	Aethopyga siparaja
Plain Flowerpacker	Dicaeum concolor
Common Tailor Bird	Sylvidae Orthotomus sutorius
Jungle Babbler	Turdoides striatus
Marsh Babbler	Pellorneum palustre
Black Redstart	Muscicapidae Phoenicurus ochruros
Oriental Magpie Robin	Copsichus saularis
Blue Whistling Thrush	Myophonus horsfieldii
Dark-sided Flycatcher	Muscicapa sibirica
Blackheaded Shrike-Babbler	Pteruthius rufiventer
Bluethroat	Luscinia svecica
Pied Buchchat	Saxicola caparata
Common Stonchat	Saxicola torquata
Verditer Flycatcher	Eumyias thalassina
Grey-breasted Prinia	Cisticolidae Prinia hodgsonii
Great Tit	Paridae Parus major
Graybacked Shrike	Lanidae Lanius tephronotus
Indian Roller	Coracidae Coracias benghalensis
Oriental Skylark	Alaudidae Alauda gulgula
Crested Lark	Galirida cristata

English Name	Family/Scintific Name
Rufous-winged Bushlark	Mirafra assamica
Common Swift	Apodidae Apus apus
House Swift	Apus affinis
Alpine Swift	Tachymarptis
Fork-tailed Swift	Apus pacificus
Asian Palmswift	Cypsturus balasiensis
Rose-ringed Parakeet	Psittacidae Pisttacula karmeri
Alexandrine Parakeet	Psittacula eupatria
Blossom-headed Parakeet	Psittacula roseata
Spotted Dove.	Culombidae Streptopelia chinensis
Red Collared Dove	Streptopelia tranquebarica
Eurasian Collared Dove	Streptopelia decaocto
Oriental Turtle Dove	Streptopelia orientalis
Emerald Dove	Chalcophaps indica
Yellow-footed Green Pigeon.	Treron phoenicoptera
Wedge-tailed Green Pigeon	Treron sphenura
Orange-breasted Green Pigeon	Treron bicincta
Black-rumped Flameback.	Picidae Dinopium bengalensis
Yellow-crowned Wood pecker	Dendrocoposmahrattensis
Grey-capped Pygmy Woodpecker	Dendrocopos canicapillus
Greater Coucal	Centropodidae Centropus sinensis
Lesser Caucal	Centropus bengelensis
Asian Koel	Cuculidae Eudynamys scolopacca
Common Hawk Cuckoo	Hierococcyx varius
Hodgson's hawk Cuckoo	Hierococcyx fugax
Large Hawk Cuckoo	Hierococcyx sparverioides
Indian Cuckoo	Cuculus micropterus
Oriental Cuckoo	Cuculus canorus
Lesser Cuckoo	Cuculus poliocephalus
Chestnut-winged Cuckoo	Clamator coromandus
Pied Cuckoo	Clamator jacobinus
Plantative Cuckoo	Cacomantis merulinus
Drongo Cuckoo	Surniculus lugubris
Green-billed Malkoha	Phaenicophaeus tristis
Common Hoopoe	Upopidae Upupa epops
Spotted Owlet	Strigidae Athene brama

English Name	Family/Scintific Name
Collared Scops Owl	Otus bakkamoena
Asian Barred Owlet	Glaucidium cuculoides
Jungle Owlet	Glaucidium radiatum
Great Eared Nightjar	Eurostopodus macrotis
Brown Fish Owl	Ketupa zeylonensis
Tawny Fish Owl	Ketupa flavipes

APPENDIX 7: COMPREHENSIVE LIST OF MAMMALIAN FAUNA IN STUDY AREA

S. No.	English Name	Order/ Family/ Scientific Name
1	Himalayan Hoary-bellied Squirrel	Order: Rodentia Fam: Sciuridae Callosciurus pygerythrus
2	House Shrew	Fam: Soricidae Suncus murinus
3	Pigmy shrew	Suncus etruscus
4	House Mouse	Fam: Muridae Mus musculus
5	Large Bandicota -rat	Bandicota indica
6	Lesser bandicota-rat	Bandicota bengalensis
7	Black Rat	Rattus rattus
8	Chinese Porcupine	Fam: Hystricidae Hystrix brachyura
9	India Hare	Order: Lagomorpha Fam: Leporidae Lepus nigricollis
10	Indian Elephant	Order: Proboscidea Fam: Elephantidae Elephas maximus
11	Domestic Pig	Order: Artiodactyla Fam: Suidae Sus sp.
12	Barking Deer	Fam: Cervidae Muntiacus muntjak
13	Domestic Buffalo	Fam: Bovidae Bubalus sp.
14	Domestic Cattle	Bos sp.
15	Domestic Goat	Capricornis sp.
16	Indian flying fox.	Order: Chiroptera Fam: Pteropodidae Pteropus gigenteus
17	Long-winged tom bat	Fam: Emballonuridae Taphozous longimanus
18	Rhesus Macaque	Order: Primate Fam: Cercopithecidae Macaca mulatta
19	Asiatic Jackel	Order: Carnivora Fam: Canidae Canis aureus
20	Common Otter	Fam: Mustelidae Lutra lutra
21	Large India Civet	Fam: Viverridae Viverra zibetha
22	Small India Civet	Viverricula indica
23	Indian Mongoose	Fam: Herpestidae Herpestes javanicus

APPENDIX 8: DIVERSITY INDEX AND SPECIES RICHNESS

Species Richness of Amphibian Species using Rarefaction on present absent data (Rarefaction, See Lambshead et al. 1983*).

Sample	Finite est.	Std. Error	Infinite est.	Std. Error
Using 1 samples	6.767	1.48	6.63	1.535
Using 2 samples	9.342	1.102	9.118	1.176
Using 3 samples	10.32	0.7539	10.11	0.8537
Using 4 samples	10.67	0.538	10.51	0.6522
Using 5 samples	10.85	0.3727	10.73	0.4977
Using 6 samples	10.93	0.2544	10.84	0.3884
Using 7 samples	10.97	0.1667	10.9	0.3072
Using 8 samples	10.99	0.1023	10.94	0.2446
Using 9 samples	11	0.05702	10.96	0.1954
Using 10 samples	11	0.02755	10.98	0.1564
Using 11 samples	11	0.01176	10.98	0.1281
Using 12 samples	11	0.003004	10.99	0.1026
Using 13 samples	11	0.0002211	10.99	0.08214
Using 14 samples	11	5.686E-7	11	0.06579

Abbreviation: 1:(0point)Darapur; 2: Darapur; 3: jangrabari; 4: Alutalibari; 5: DBHcm; 6:dbh; 7: DBH; 8DBHin; 9: spur7th; 10: Majguri; 11:Goroimarialikash; 12: Borakhat;13: BejisutiKalidas; 14: Nagarberahillside (1: Present; 0: Absent).

Species Diversity Index of Amphibian Fauna in Majirgaon- Nagarbera Project Sites

Sample	H	Variance H	Lower95%	Upper 95%
Darapur ("0" P) Ch. 0.0 km	2.398	0.04132	1.499	2.146
Darapur	2.398	0.04132	1.468	2.146
Jangrabari	2.303	0.045	1.359	2.025
Alutalibari Ch. 1.0km	2.197	0.04938	1.215	2.043
DBHcm	2.197	0.04938	1.273	2.043
Dbh	2.197	0.04938	1.244	2.043
DBH	2.197	0.04938	1.273	2.043
DBHin	2.197	0.04938	1.273	2.043
spur7th	2.197	0.04938	1.273	2.043
Majguri	2.197	0.04938	1.215	2.043
Goroimarialikash	2.303	0.045	1.418	2.095
Borakhat	2.398	0.04132	1.499	2.146
BejisutiKalidas	2.398	0.04132	1.468	2.146
Nagarbera hillside (Ch. 60)	2.398	0.04132	1.499	2.146

Diversity Index & Species Richness of Reptilian Species

Species Richness of Reptilian Species using Rarefaction on Present-Absent Data (Rarefaction, See Lambshead et al. 1983*).

Sample	Finite est.	Std. Error	Infinite est.	Std. Error
Using 1 samples	20.54	2.699	20.11	2.743
Using 2 samples	28.59	1.889	27.92	2.016
Using 3 samples	31.4	1.191	30.82	1.38
Using 4 samples	32.4	0.7424	32	0.952
Using 5 samples	32.76	0.4756	32.5	0.6787
Using 6 samples	32.9	0.3097	32.73	0.4982
Using 7 samples	32.96	0.2056	32.85	0.3821
Using 8 samples	32.98	0.133	32.91	0.3007
Using 9 samples	32.99	0.07984	32.94	0.2391
Using 10 samples	33	0.04424	32.96	0.1938
Using 11 samples	33	0.02095	32.97	0.1582
Using 12 samples	33	0.007389	32.98	0.1298
Using 13 samples	33	0.00114	32.99	0.1063
Using 14 samples	33	2.519E-7	32.99	0.08775

Abbreviation: 1: (0point) Darapur; 2: Darapur; 3: jangrabari; 4: Alutalibari; 5: DBHcm; dbh; 7: DBH; 8DBHin; 9: spur7th; 10: Majguri; 11: Goroimarialikash; 12: Borakhat;13: Bejisuti Kalidas; 14: Nagarbera hillside (1: Present; 0: Absent).

Species Diversity Index of Reptilian Fauna in Palasbari-Gumi Sites

Sample	H	Variance H	Lower 95%	Upper 95%
Darapur	3.497	0.01469	2.745	3.118
Jangrabari	3.497	0.01469	2.733	3.103
Alutalibari	3.466	0.01514	2.697	3.086
DBHcm	3.434	0.01561	2.668	3.059
Dbh	3.401	0.01611	2.619	3.032
DBH	3.401	0.01611	2.636	3.032
DBHin	2.636	3.032	2.657	3.068
spur7th	3.401	0.01611	2.638	3.032
Majguri	3.401	0.01611	2.627	3.032
Goroimarialikash	3.401	0.01611	2.624	3.032
Borakhat	3.401	0.01611	2.626	3.032
BejisutiKalidas	3.434	0.01561	2.667	3.059
Nagarbera hillside	3.466	0.01514	2.687	3.086

Shannon Diversity Indices of Avian Fauna in Inside and Outside the Embankment of Majirgaon-Nagarbera Project Site.

Sample site	Shannon Wiener Diversity Indices H	Variance H	Lower 95%	Upper 95%
Inside the embankment	4.958	0.0008989	4.77	4.887
Outside the embankment	4.43	0.001312	4.201	4.337

Species Diversity and Richness of Mammalian Fauna in Majirgaon-Nagarbera Embankment Site

Sample	Finite est.	Std. Error	Infinite est.	Std. Error
Using 1 samples	18.66	0.8778	18.18	0.9651
Using 2 samples	19.99	0.08848	19.11	0.7772

Species Diversity and Richness of Mammalian Fauna in Majirgaon-Nagarbera Embankment Site

Sample	Finite est.	Std. Error	Infinite est.	Std. Error
Using 1 samples	18.66	0.8778	18.18	0.9651
Using 2 samples	19.99	0.08848	19.11	0.7772

APPENDIX 9: DETAILS PF FISH SPECIES, MACRO-INVERTIBRATES, CRABS, TURTLES AND TORTOISES, LIZARDS, SNAKES, MAMMALS, PLANKTON, CHLOROPHYCEAE, MYXOPHYCEAE, MYXOPHYCEAE, ZOOPLANKTON AND BENTHOS IN PALASBARI REACH

Fishes are listed based on all available published information as shown in table. Current status of nomenclature and systematics are done based on Catalog of Fishes (Eschmeyer, 2006, online version, updated April 16, 2006). Tentative IUCN criteria (EW=extinct in wild, CR=critically endangered, EN=endangered; VU=vulnerable, LR=lower risk (-nt -near threatened, lc=least concern and cd=least concern), DD=data deficient) of fishes are based on CAMP (1998). For fishes which are not assessed, it is marked NA. (Not available)

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
1.	Anguilla bengalensis	++	+	-	-	-	-	+	-	-	-	-	-	EN
2.	Gudusia chapra	-	-	-	-	-	+	-	-	-	-	-	+	LRlc
3.	Hilsa ilisha	-	-	-	-	-	-	-	-	-	-	+	+	Vu
4.	Chagunius chagunio	-	+	+	-	-	-	+	+	-	-	-	-	NE
5.	Cirrhinus reba	-	+	-	-	+	-	-	-	-	-	-	-	Vu
6.	Labeo calbasu	-	+	-	-	-	+	-	-	-	-	+	+	LRnt
7.	Labeo gonius	-	-	+	+	+	+	-	-	+	+	+	+	LRnt
8.	Osteobrama cotio	+	-	-	-	-	+	-	-	-	-	-	-	LRnt
9.	Puntius chola	-	-	-	-	-	-	-	-	-	+	+	-	Vu
10.	Puntius sarana	-	+	+	-	-	-	-	-	-	-	-	-	Vu
11.	Puntius ticto	-	-	-	+	+	+	-	-	-	-	+	-	LRnt
12.	Puntius sophore	-	-	+	+	+	-	-	-	-	-	-	-	LRnt
14.	Tor tor	+	+	-	-	-	-	+	-	-	-	-	-	EN
15.	Salmophasia bacaila	-	-	-	-	-	-	-	-	-	-	+	+	LRlc
16.	Barilius barna	-	+	+	+	-	-	+	+	+	-	-	-	LRnt
17.	Barilius	+	+	+	-	-	-	+	+	+	-	-	-	LRnt
18.	Barilius tileo	-	+	+	-	-	-	-	-	-	-	-	-	LRnt
19.	Danio Devario	+	+	+	+	+	+	+	+	+	+	+	+	LRnt
20.	Danio aequipinnatus	-	-	+	+	+	+	-	-	-	+	+	+	LRnt
21.	Devario devario	-	+	+	-	+	+	-	-	-	-	+	+	LRnt
22.	Raiamas bola	-	+	+	-	-	-	-	-	-	-	-	-	Vu
23.	Crossocheilus latius	-	+	-	-	-	-	+	+	-	-	-	-	DD
24.	Garra gotyla	+	+	-	-	-	-	+	-	-	-	-	-	Vu
25.	Garra gotyla stenorhynchus	-	+	-	-	-	-	-	-	-	-	-	-	EN
26.	Garra nasuta	+	+	-	-	-	-	-	-	-	-	-	-	NE
27.	Psilorhynchus balitora	-	+	+	+	-	-	+	+	-	-	-	-	NE
28.	Acanthocobitis botia	-	+	+	+	+	-	-	+	+	+	-	-	LRnt
29.	Schistura scaturigina	-	-	-	-	-	-	+	+	-	-	-	-	Vu
30.	Lepidocephalichthys	-	+	+	+	+	-	-	+	+	+	+	+	NE

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
	guntea (Hamilton-Buchanan)													
31.	Cantophrys gongota	+	-	-	-	-	-	-	+	-	-	-	-	LRnt
32.	Botia dario	-	-	-	-	+	+	-	-	-	-	+	+	NE
33.	Sperata aor	-	-	-	-	-	-	-	-	-	+	-	+	NE
34.	Batasio batasio	-	+	+	-	-	-	-	-	-	-	-	-	NE
35.	Ailia coila	-	-	-	-	-	-	-	-	-	-	-	+	Vu
36.	Clupisoma garua	-	-	-	-	-	-	-	-	-	-	+	+	Vu
37.	Eutropichthys vacha	-	-	-	-	-	-	-	-	-	-	+	+	NE
38.	Pseudeutropius atherinoides	-	-	-	-	-	-	-	-	-	-	+	+	NE
39.	Bagarius bagarius	-	-	-	-	-	-	-	-	-	+	-	+	Vu
40.	Erethistes pussilus	+	+	-	-	-	-	+	+	-	-	+	+	NE
41.	Erethistoides montana	-	-	+	+	-	-	-	-	-	-	-	-	CR
42.	Gagata cenia	-	-	-	-	-	+	-	-	-	+	+	+	NE
43.	Gagata gagata	-	-	-	-	-	-	-	-	-	-	+	+	NE
44.	Glyptothorax telchitta	-	-	-	-	-	+	-	-	-	-	-	+	LRnt
45.	Glyptothorax trilineatus	-	+	-	-	-	+	-	-	+	-	+	-	NE
46.	Hara hara	-	+	-	-	+	+	+	-	-	+	-	+	NE
47.	Pseudochenesis sulcatus	-	-	-	-	-	+	-	-	-	-	+	+	Vu
48.	Laguvia shawi	-	-	-	-	+	-	-	-	-	-	-	+	EN
49.	Clarias batrachus	-	-	-	-	-	-	-	-	+	+	-	-	Vu
50.	Heteropneustes fossilis	-	-	-	-	-	-	-	-	-	+	-	+	Vu
51.	Olyra longicaudata	-	+	+	-	-	-	+	-	-	-	-	-	NE
52.	Xenentodon cancila	-	-	-	-	+	-	-	-	-	+	-	+	LRnt
53.	Macrognathus pancalus	-	-	-	-	-	-	-	-	-	+	-	+	NE
54.	Mastacembelus armatus	-	-	+	-	+	-	-	-	-	+	-	+	NE
55.	Chaudhuria indica	-	+	+	-	-	-	-	-	-	-	-	-	Vu
56.	Chanda nama	-	+	+	+	+	+	-	+	+	+	+	+	NE
57.	Parambassis ranga	-	+	+	+	+	+	-	+	+	+	+	+	NE
58.	Johnius coitor	-	-	-	-	-	-	-	-	-	-	+	+	NE
59.	Badis badis	-	+	+	-	+	+	-	-	-	+	+	+	NE
60.	Glossogobius giuris	-	-	-	-	-	-	-	-	-	+	+	+	LRnt
61.	Channa gachua	-	+	-	-	+	-	-	-	+	+	+	-	Vu
62.	Channa punctatus	-	-	-	-	-	-	-	-	-	+	+	-	LRnt
63.	Channa striatus	-	-	+	+	+	-	-	-	-	-	-	-	LRnt

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
	guntea (Hamilton-Buchanan)													
31.	Cantophrys gongota	+	-	-	-	-	-	-	+	-	-	-	-	LRnt
32.	Botia dario	-	-	-	-	+	+	-	-	-	-	+	+	NE
33.	Sperata aor	-	-	-	-	-	-	-	-	-	+	-	+	NE
34.	Batasio batasio	-	+	+	-	-	-	-	-	-	-	-	-	NE
35.	Ailia coila	-	-	-	-	-	-	-	-	-	-	-	+	Vu
36.	Clupisoma garua	-	-	-	-	-	-	-	-	-	-	+	+	Vu
37.	Eutropichthys vacha	-	-	-	-	-	-	-	-	-	-	+	+	NE
38.	Pseudeutropius atherinoides	-	-	-	-	-	-	-	-	-	-	+	+	NE
39.	Bagarius bagarius	-	-	-	-	-	-	-	-	-	+	-	+	Vu
40.	Erethistes pussilus	+	+	-	-	-	-	+	+	-	-	+	+	NE
41.	Erethistoides montana	-	-	+	+	-	-	-	-	-	-	-	-	CR
42.	Gagata cenia	-	-	-	-	-	+	-	-	-	+	+	+	NE
43.	Gagata gagata	-	-	-	-	-	-	-	-	-	-	+	+	NE
44.	Glyptothorax telchitta	-	-	-	-	-	+	-	-	-	-	-	+	LRnt
45.	Glyptothorax trilineatus	-	+	-	-	-	+	-	-	+	-	+	-	NE
46.	Hara hara	-	+	-	-	+	+	+	-	-	+	-	+	NE
47.	Pseudochenesis sulcatus	-	-	-	-	-	+	-	-	-	-	+	+	Vu
48.	Laguvia shawi	-	-	-	-	+	-	-	-	-	-	-	+	EN
49.	Clarias batrachus	-	-	-	-	-	-	-	-	+	+	-	-	Vu
50.	Heteropneustes fossilis	-	-	-	-	-	-	-	-	-	+	-	+	Vu
51.	Olyra longicaudata	-	+	+	-	-	-	+	-	-	-	-	-	NE
52.	Xenentodon cancila	-	-	-	-	+	-	-	-	-	+	-	+	LRnt
53.	Macrognathus pancalus	-	-	-	-	-	-	-	-	-	+	-	+	NE
54.	Mastacembelus armatus	-	-	+	-	+	-	-	-	-	+	-	+	NE
55.	Chaudhuria indica	-	+	+	-	-	-	-	-	-	-	-	-	Vu
56.	Chanda nama	-	+	+	+	+	+	-	+	+	+	+	+	NE
57.	Parambassis ranga	-	+	+	+	+	+	-	+	+	+	+	+	NE
58.	Johnius coitor	-	-	-	-	-	-	-	-	-	-	+	+	NE
59.	Badis badis	-	+	+	-	+	+	-	-	-	+	+	+	NE
60.	Glossogobius giuris	-	-	-	-	-	-	-	-	-	+	+	+	LRnt
61.	Channa gachua	-	+	-	-	+	-	-	-	+	+	+	-	Vu
62.	Channa punctatus	-	-	-	-	-	-	-	-	-	+	+	-	LRnt
63.	Channa striatus	-	-	+	+	+	-	-	-	-	-	-	-	LRnt

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
Macro-Invertebrates														
1.	Gastropods													
2.	Pila globosa	+	+	+	+	+	+	+	+	+	+	+	+	
3.	Pila scutata	+	-	+	+	+	-	-	+	+	+	+	-	
4.	Brotia costula	+	+		+	+		+	+	+	+	+		
5.	Paludomus pustulosa	+	+	+			+	+	+			+	+	
6.	Bivalves													
7.	Lamellidens corrianus	+	+		+	+		+		+		+	+	
8.	Prawn													
9.	Macrobrachium malcomsoni	+	+	+	+	+		+	+	+		+	+	
10.	M. lanchesteri	+	+	+		+	+	+		+	+	+	+	
	Crabs													
1.	Sterteriane spinigera	+	+	+		+	+		+	+	+	+	+	
2.	Peratelphusa eduntula	+		+	+	+	+	+	+			+	+	
3.	P. spingera	+	+		+	+		+	+			+		
4.	Potaman woodmansoni	+	+	+			+	+	+	+	+			
5.	Amphibians													
6.	Chirixalus simus	+	+	+	+	+			+	+	+	+		
7.	Bufo melanostictus	+	+		+		+	+						
8.	Hoplobatrachus tigerinus	+	+	+			+	+	+	+	+		+	
9.	Limnonectes laticeps			+	+	+	+			+	+	+	+	
	Turtles and Tortoises													
1.	*Kachuga sylhetensis*	+	+		+		+	+	+		+	+	+	
2.	*Aspideretes gangeticus*	+		+		+	+	+		+	+	+	+	
3.	*Kachuga tecta*	+	+				+	+	+				+	
	Lizards													
1.	*Gecko gecko*	+		+	+	+	-	+		+	+	+	+	
2.	*Varanus bengalensis*	+	+		+		+	+	+				+	
3.	*Varanus salvator*	+		+	+	+	+	+		+	+	+	+	
4.	*Calotes emma*	+	+				+	+	+				+	
5.	*Calotes maria*	+		+		+	+	+		+	+	+	+	
	Snakes													
1.	*Ophiophagus hannah*	+		+		+	+	+		+	+	+	+	

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
2.	Naja naja	+	+				+	+	+				+	
	Mammals													
1.	River Dolphin	+	+		+	+	+		+		+	+	+	
2.	Otter	-	-	-	+	-	-	-	+	+	+	+	+	
	(Conservation status of the above species will be mentioned later on as per IUCN report)													
	Plankton													
1.	Bacillariophyceae													
2.	Diatoma	+		+	+	+	-	+		+	+	+	+	
3.	Fragilaria	+	+		+		+	+	+				+	
4.	Synedra	+		+	+	+	+	+		+	+	+	+	
5.	Cocconeis		+				+	+	+				+	
6.	Achnanthes	+		+		+	+	+		+	+	+	+	
7.	Eucocconeis			+	+	+	-	+		+	+	+	+	
8.	Navicula	+	+		+		+	+	+				+	
9.	Pinnularia			+	+	+	+	+		+	+	+	+	
10.	Gyrosigma	+	+				+	+	+				+	
11.	Frustulia	+		+		+	+	+		+	+	+	+	
12.	Gomphonema			+	+	+				+				
13.	Cymbella		+	+	+		+	+	+		+	+	+	
14.	Nitzschia	+	+	-	+		+	+	+			+		
15.	Surirella	+		+	+	+				+	+		+	
16.	Melosira	+	+	+	+		+	+	+			+	+	
	Chlorophyceae													
1.	Ulothrix		+	+	+		+	+	+	+	+	+	+	
2.	Microspora	+		+		+	+	+	+		+		+	
3.	Cladophora		+	+	+		+		+	+	+	+		
4.	Closterium	+	+	+	+			+			+		+	
5.	Cosmarium	+				+	+	+	+	+			+	
6.	Spirogyra		+	+	+				+		+	+	+	
	Myxophyceae													
1.	Oscillatoria	+	+		+	+		+		+	+	+	+	
2.	Rivularia	+		+			+	+	+		+	+		
3.	Anabaena		+	+	+					+	+	+	+	
	Zooplankton													
1.	Vorticella	+	+	+			+	+	+		+	+	+	
2.	Cyclops	+			+	+			+	+	+	+	+	
3.	Daphnia	+			+	+	+	+	+		+	+	+	
4.	Zoea larva		+	+	+			+	+	+	+	+		
5.	Keratella	+	+	+	+	+	+							
6.	Moina	+	+	+			+	+	+		+	+	+	

Sl. No		Stations												Cons. Stat.
		1	2	3	4	5	6	7	8	9	10	11	12	
	Fish Sp.													
7.	Chironomous	+			+	+			+	+	+	+	+	
8.	Gomphus	+			+	+	+	+	+		+	+	+	
9.	Bosmina		+	+	+			+	+	+	+	+		
10.	Ceriodaphnia	+	+	+	+	+	+							
11.	Chydorus	+	+	+			+	+	+		+	+	+	
12.	Nauplis	+			+	+			+	+	+	+	+	
13.	Diaptomus	+			+	+	+	+	+		+	+	+	
14.	Canthocamptus		+	+	+			+	+	+	+	+		
15.	Asplanchna	+	+	+	+	+	+							
16.	Kellicotia		+				+	+	+				+	
17.	Arcella	+		+		+	+	+		+	+	+	+	
18.	Paramecium			+	+	+	-	+		+	+	+	+	
19.	Brachionus	+	+		+		+	+	+				+	
20.	Asplanchna			+	+	+	+	+		+	+	+	+	
21.	Filinia	+	+				+	+	+				+	
22.	Semiocephalus	+		+		+	+	+		+	+	+	+	
23.	Moinodaphnia			+	+	+				+				
24.	Sida		+	+	+		+	+	+		+	+	+	
25.	Macrothrix	+	+	-	+		+	+	+			+		
26.	Epistilis	+		+	+	+				+	+		+	
27.	Rotifer eggs	+	+	+	+		+	+	+			+	+	
28.	Gomphus		+				+	+	+				+	
	Benthos													
1.	Nais			+	+	+	-	+		+	+	+	+	
2.	Tubifex	+	+		+		+	+	+				+	
3.	Chironomus			+	+	+	+	+		+	+	+	+	
4.	Viviparus	+	+				+	+	+				+	
5.	Gyraulus	+		+		+	+	+		+	+	+	+	
6.	Pisidium			+	+	+				+				

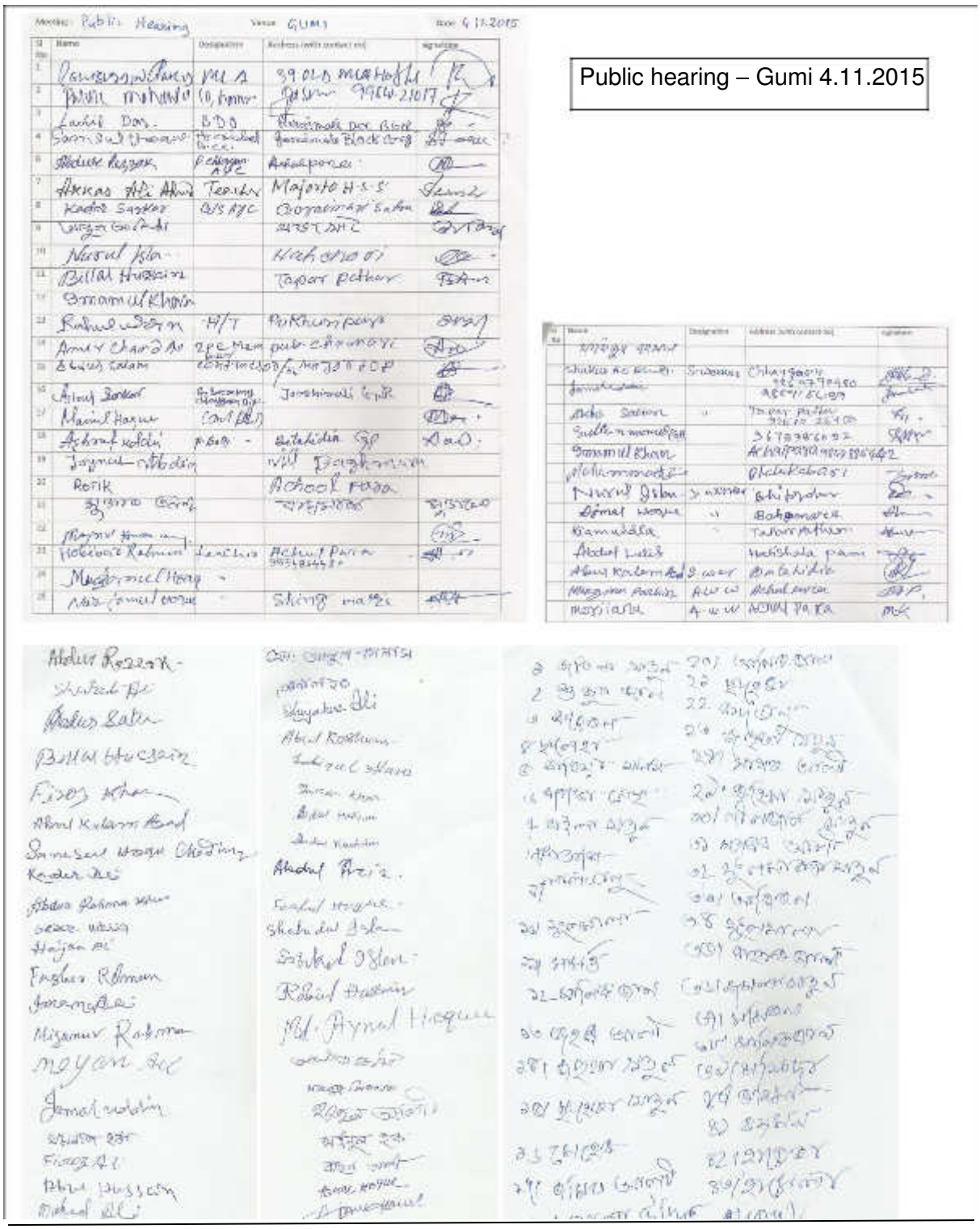
N.B. Fishes were identified after the methods of Talwar and Jhingran (1991), Nath and Dey (2000) and Vishwanath (2002).
The plankton were identified after Edmonson (1959), Needham and Needham (1966) and APHA (1998).

APPENDIX 10: EMISSION FACTORS OF VARIOUS DUST GENERATION PROCESS

Source	Unit	Emission Factor
Receipt of new aggregate at Hot Mix Plant	g/ton	1.86
Transfer of aggregate from storage to conveyor belt or between conveyor belts in Hot Mix Plant	g/ton	0.021
Screening of aggregate in Hot Mix Plant	g/ton	0.38
RAP crushing	g/ton	0.27
Paved road dust emissions	g/VMT	7.26
Unpaved road dust emissions	g/VMT	925.3

(Note: VMT: Vehicle Mile Traveled)

APPENDIX 11: ATTENDANCE SHEET OF PUBLIC CONSULTATION DURING UPDATE PROCESS



Public hearing – Gumi 4.11.2015

Public hearing- Simina, Palasbari
5.11.2016

00 Lakhs

MEETING: Public Hearing
VENUE: Simina, Palasbari DATE: 05/11/2015

SL NO	NAME	ADDRESS & (CONTACT)	SIGNATURE
1			
2	Prabhat Konwar	DEO (NT) FREMAA	[signature] 5/11/15
3	Nilkanta ch. Medhi	S.E. P.T.P. WRD	[signature] 05/11/15
4	Saiken Thakuria	Advisor, Dakhin Kamrup Ban Prokalpa Sangram Samittee	
5	Jayanti Goswami	President – Dakhin Kamrup Gramin Samiti	[signature]
6	Md Samlal Ali	President Simina G.C. Comittee	
7	Bhrigu Rajbongshi	Nahira, Secretary (Dakhin Kamrup Gramin S.S)	[signature] 05-11-15
8	Abdul Sheikh Alam	Simina	
9	Ganiullah Sheikh	Simina	[signature] 5.11.15
10	Mainul Hoque	Simina	[signature]
11	Azahar Ali	Simina	[signature]
12	Anwar Hussain	Gumara	[signature]
13	Sri Bisuna Sarma	Satrapara	[signature]

MEETING: Public Hearing
VENUE: Simina, Palasbari DATE: 05/11/2015

SL NO	NAME	ADDRESS & (CONTACT)	SIGNATURE
1			
2	Prabhat Konwar	DEO (NT) FREMAA	[signature] 5/11/15
3	Nilkanta ch. Medhi	S.E. P.T.P. WRD	[signature] 05/11/15
4	Saiken Thakuria	Advisor, Dakhin Kamrup Ban Prokalpa Sangram Samittee	
5	Jayanti Goswami	President – Dakhin Kamrup Gramin Samiti	[signature]
6	Md Samlal Ali	President Simina G.C. Comittee	
7	Bhrigu Rajbongshi	Nahira, Secretary (Dakhin Kamrup Gramin S.S)	[signature] 05-11-15
8	Abdul Sheikh Alam	Simina	
9	Ganiullah Sheikh	Simina	[signature] 5.11.15
10	Mainul Hoque	Simina	[signature]
11	Azahar Ali	Simina	[signature]
12	Anwar Hussain	Gumara	[signature]
13	Sri Bisuna Sarma	Satrapara	[signature]

28/ Arjun Chandra Das
29/ Sri Lilakanta Das
30/ Hari Kakati Satrapara
31/ Saratchandra ch. Das
32 Dipjyoti Kalita
33. Joymoni Das
34. Rupam Ali Satrapara
35/ Pradip ch. Kalita
36. Mantu Das
37. Sikim Abdulla Ali
38 [illegible]
39 Samsul Hoque
40/ Sri. Chabin Mosum der
41/ Md. Jakir Hussain (Simina)
42/ Md Abdul Hussain (Simina)
43/ Abdul Jalil (Simina)
44/ Md. Jabed Ali (Simina)
45. Utpal Kalita (Satrapara)
46/ Zainul Hoque (Patuna)
47/ [illegible]

1	Regarding any specific problem(s) related to environment as a result of flood & erosion of the Brahmaputra	[illegible]
2	Whether the proposed project will help in providing safety to the people their property and environment of the area	[illegible]
3	3. Any significant negative impact of the project on the overall environment of the area	[illegible]
4	Possible impacts of the project on Agriculture, Wetlands, Drinking Water & Local Economy	[illegible]
5	Suggestion or comment on issues other than those discussed so far	—
6	Related to tree cutting, afforestation programme (optional)	[illegible]

Name: Bhrigu Rajbongshi ([illegible])
Designation: [illegible]
Address: [illegible]
Ph- 9954[illegible]
Contact: [illegible]
Signature: [illegible]

(1) Dipamani Goswami (2) Nizamuddin Ahmed, Simina VP. & P.S.S
Vill. Nahira
(3) Sri Phanil Mazumdar (4) Bhrigu Kalita
Chhapahuru

APPENDIX 12: ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
Climate Change	increase in temperature and also due to construction activities and trees to be cut	Minimization of tree cutting while designing the embankment Compensatory tree plantation preferably on the basis of 3 trees plantation against each tree cut	Government of India action plan after Paris agreement.	Through out the stretch of reach	Throughout the construction period	--	Contractor with guidance of Social Forestry Department	WRD and FREMAA
Change in Land use	Loss of agriculture land	Use of uncultivated areas near embankments only for storage and/or handling of construction materials	-	Construction sites and service areas throughout the reach	During design and construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Construction camps on uncultivated areas only with requisite facilities of drinking water supply, sanitation, waste collection and fuel supply		Identified locations of construction camps (4 to 5)		Included under soil contamination prevention costs	Contractor	WRD and FREMAA
		No dumping of construction waste on agricultural land					Contractor	WRD and FREMAA
		Adequate compensation for loss of land and/ or loss of crops	As per Social Assessment and R&R	Identified as per the social assessment		Included in R&R Cost	Contractor	WRD and FREMAA
		Land used for construction camps shall made reusable/ cultivable after closer of construction camp		Sites used as construction camp	After completion of construction	Included in construction cost	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		All efforts during the design stage shall be made to minimize the tree felling requirement.		Entire project area	During complete construction phase	Included in design engineering cost	Engineering Team/WRD Field Officer	WRD and FREMAA
	Loss of homestead plantation	Compensatory plantation shall be started during construction phase parallel to the construction activities (1:3)		Entire project area	During construction	2,340,000	WRD-SIO	WRD and FREMAA
		Monitoring of tree felling (census of trees, their numbering etc. based on engineering design)		Entire project area	During complete construction phase	Included in the Monitoring Costs (refer Monitoring Plan)	Independent agency	WRD and FREMAA
Borrow area location and rehabilitation	Loss of agricultural land and homestead plantation due to borrowing earth from country side of embankment	Borrow pits shall be preferred on river side to embankment as these can get silted in the course of time or earth from retired Embankment	WRD guidelines	Identified locations for borrowing of earth	During complete construction phase	Included in construction cost	Contractor/WRD Field Officers	WRD and FREMAA
	Permanent disfiguration of land	Use of waste land or excavation or enlargement of existing lank or any hump above ground level for borrowing of earth		Identified locations for borrowing of earth	During complete construction phase	Included in construction cost	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
	Seepage to the foundations of embankment	Use of dredge material from River Kulsi/ Jaljali		Banks of River Kulsi/ Jaljali	During construction	Included in construction cost	Contractor	WRD and FREMAA
		Strictly following WRD guidelines with respect to borrow area location and rehabilitation		Entire project area	During construction phase as well as after construction	Included in construction cost	Contractor	WRD and FREMAA
Change in Land use and Borrow Area Rehabilitation	Encroachment on embankment for habitation and cultivation Cutting of embankment to create approach to river side Non-rehabilitation of borrow areas	Provision shall be made in the embankment design for providing access to river bank close to the habitats. Constructions contractors shall ensure rehabilitation of borrow areas before handling over the project.		Entire project area and Borrow Areas	Operation Phase	Included in construction cost	Contractor, WRD (Field Staff)	WRD and FREMAA
Construction material sourcing (Quarrying)	Illegal quarrying may lead to land use change, unstable rock formation, air and noise pollution	Aggregates required for construction of embankment and roads shall be procured from quarries approved by SPCB.	Environmental Protection Act and Rules, 1986; Water Act, Air Act	River and Hill Quarries approved by Assam Govt.	During complete construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Air and noise emissions from quarries shall be well within the prescribed limits for the protection of workers health		Quarrying sites	During complete construction phase	-	WRD	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		Stone crushers, if required, shall be set up only after consent from SPCB and taking adequate measures for air pollution control.		Location of stone crushers	During complete construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Land earmarked for dumping of construction waste shall be free from any social and R&R issue and away from settlements			During complete construction phase	Included in R&R Cost	Contractor	WRD and FREMAA
Soil erosion	Soil erosion from construction sites during monsoon season	Opening of borrow areas near the embankments shall not be done during monsoon season		Identified areas for borrowing earth	Except monsoon season during construction phase	Included in construction cost	Contractor	WRD and FREMAA
	Loss of topsoil	Identification of potential erosion zones during construction phase			Especially during monsoon season	Included in construction cost	Contractor	WRD and FREMAA
		Stabilization of soil around the approach roads/ slopes by turfing and tree plantation in ROW		Along the embankment and approach roads	Especially before monsoon starts	Included in construction cost	Contractor	WRD and FREMAA
		Slope stabilization measures on the embankment like selection of less eroding materials		As suggested by the engineering team	During the construction period	Included in construction cost	Contractor	WRD and FREMAA
	Net benefits due to construction of embankment and anti-erosion measures in river banks	Periodic checking of the stabilization measures		Project Benefit Area.	Post Operation Phase	included in Monitoring Costs. Water Shed Management to be initiated by WRD Separately	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
Soil compaction	Soil compaction around construction sites, haulage roads, construction camps, and workshops due to transportation of man, machine, and materials	Movement of construction vehicles, machinery and equipment in embankment site and pre-defined haulage road		Construction material dumping sites and construction sites	During the entire construction period	Included in construction cost	Contractor	WRD and FREMAA
	Construction waste handling	Adequate provision for approach roads capable of handling movement and haulage of heavy vehicles and machines		Approach roads used for material handling	During the entire construction period	Included in construction cost	Contractor	WRD and FREMAA
Soil contamination	Soil contamination around construction sites, machine maintenance areas, fueling stations, construction camps, hot mix plant and haulage roads	Fueling and maintenance of construction machinery and vehicles shall be carried out at designated place with proper arrangement of waste collection and disposal.		Fuel storage and workshop areas	During the entire construction period	3,20,000	Contractor	WRD and FREMAA
		Fuel storage and refueling sites to be kept away from drainage channels.		Fuel storage and workshop areas	During the entire construction period	Included in construction cost	Contractor	WRD and FREMAA
		Unusable debris to be dumped in designated places.		Identified inert material dumping sites	During construction phase	Included in construction cost	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		Provision of oil interceptors		At fuel handling and workshop areas	During construction phase	Included above	Contractor	WRD and FREMAA
		Waste oil shall be sold off to recyclers authorized by SPCB/ MoEF.		At fuel handling and workshop areas	During construction phase	Earnings from selling	Contractor	WRD and FREMAA
Site clearing etc.	Contamination of soil from construction wastes and quarry materials	All spoils to be disposed of as desired and the site to be restored back to its original conditions before handing over.		Construction material handling areas and construction sites	After completion of construction phase	Part of Construction Costs	Contractor	WRD and FREMAA
		Non-bituminous wastes from construction activities to be dumped in borrow pits and covered with a layer of the conserved topsoil.		Inert material dumping sites	After completion of construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Bituminous wastes to be disposed of in identified dumping sites.		Identified dumping sites	After completion of construction phase	Included in construction cost	Contractor	WRD and FREMAA
Flood	Inundation during heavy flood	Adequate provisions of sluice gates shall be made.		In proposed embankment	During the construction phase	Included in construction cost	Engineering team and contractor/WRD Field Officer	WRD and FREMAA
		Natural drainage systems shall not be disturbed.		Country side of embankment in the buffer zone	During the construction phase as well as operation phase	Included in construction cost	Engineering team and contractor/WRD Field Officer	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		Adequate provisions shall be made in engineering design to withstand extreme meteorological and geo-physical events		Proposed embankment	During the detailed engineering design stage	Included in engineering design cost	Design Team and WRD	WRD and FREMAA
Drainage system	Embankment acts like a barrier for the drainage of accumulating country side water into the Brahmaputra during monsoon season.	Provision shall be made to the extent possible not to obstruct the natural drainage.		Entire project area	During the detailed engineering design stage	Included in engineering design cost	Engineering Team	WRD and FREMAA
Effect on flow velocity/ discharge intensities	No significant change due to project intervention	Monitoring of flow shall be carried out at regular intervals using field data as well as satellite remote sensing data.		At upstream and in between the reach	During the lifespan of the project	Part of Engineering Cost	Engineering Team	WRD and FREMAA
Silt deposition and bed level change	Prevention in silt deposition on agricultural land due to breach of embankments	Monitoring of anti-erosion and river training works at regular intervals		At upstream and in between the reach	During the lifespan of the project	WRD shall take initiative	WRD	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
Impacts from external factors such as climate change, upstream dam construction, and watershed development	Design Parameters has considered the CC impacts. However, it may need to be monitored over the years	Systematic monitoring of hydrology, morphology, and sediment transport with acquisition of data Establishment of information network of discharges from upstream reservoirs Developing capacities in WRD to cope with changes in environment		Subproject reach in but also include basin wide information and tributaries	During the lifetime of the project	Included in data and knowledge development component of IFRERM ASSAM	WRD	WRD and FREMAA
Impacts of morphological changes to subproject areas	Upstream and downstream erosion process may affect the sustainability of subproject structures	Systematic monitoring of morphology and sediment transport, with establishment of short term prediction models Preparation and implementation of protection measures to prevent outflanking of structures		Subproject reach in but also include basin wide information and tributaries	During the lifetime of the project	Included in data and knowledge development component of IFRERM ASSAM	WRD	WRD and FREMAA
Water quality	Impact on surface and ground water quality	Adequate supply of drinking water to workers.	The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereof	At construction camps and construction sites	During construction phase	3,60,000	Contractor	WRD and FREMAA
	Contamination of water due to construction waste	Septic tanks shall be provided to treat the domestic sewage from construction camps.		At construction camps	During construction phase		Contractor	WRD and FREMAA
		Provision of mobile toilets for use at flood platforms		At high altitude areas	During Operation Phase	Included in construction cost	WRD Field Officer	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
	Contamination of water from fuel and lubricants	Construction work close to the channels or other water bodies to be avoided.			During construction phase	-	Contractor	WRD and FREMAA
		All necessary precautions to be taken to construct temporary devices to prevent water pollution due to increased siltation and turbidity.			During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Oil and grease traps to be provided at fueling locations, to prevent contamination of water.		Fuel handling and workshop areas	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Slopes of embankment leading to water bodies to be modified and screened so that contaminants do not enter the water channel/ water body.		Along the reach	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Water quality to be monitored as envisaged in the environmental monitoring plan.		As per monitoring plan	During construction phase	Included in the monitoring costs	Contractor And WRD	WRD and FREMAA
	Discharge of domestic effluents from nearby villages to the river	Sanitation facilities shall be provided		Entire Project Benefit Area	Operation Phase	WRD to Initiate with concerned civic authorities	contractor	WRD and FREMAA
Air Environment	Change in air quality due to construction activities	Approach roads shall be paved and widened	Environmental Protection Act, 1986; The Air (Prevention and	Approach roads to construction sites	At the start of construction activity	Included in construction cost	Contractor/ WRD	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		All slopes and embankments to be turfed as per best engineering practices to minimize the dust generation	Control of Pollution) Act, 1981 and amendments thereof	Construction area	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		All the machinery and plants to be placed at the downwind direction with respect to human settlements.			Construction period	Included in construction cost	Contractor	WRD and FREMAA
		All vehicles, equipment and machinery used for construction to be regularly maintained.		Workshop areas	Construction period	Included in construction cost	Contractor	WRD and FREMAA
		The hot mix plants, crushers and batching plants to be sited at least 500 m in the downwind direction from the nearest human settlement.			At the start of construction activity	Included in construction cost	Contractor	WRD and FREMAA
		Hot mix plants shall comply with applicable National/State Pollution Control Board Standards for emissions from hot mix plants.			Construction period	Included in construction cost	Contractor	WRD and FREMAA
		Fugitive emissions from handling of construction material, storage as well as from transportation shall be taken care.		Construction and storage sites	During the construction period	Included in construction cost	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		Dust Suppression by water sprinkling		Construction and storage sites	During the construction period	Included in construction cost	Contractor	WRD and FREMAA
		Monitoring of Ambient Air Quality		near sensitive locations/ human settlements near to construction sites, crushers and hot mix plants	During the construction period as per environmental monitoring plan	Included in the monitoring costs	WRD (Environmental Officer)	WRD and FREMAA
		Speed restriction, surface improvement and surface treatment shall be taken as options for control of emissions from unpaved roads.		Approach roads	During the construction period	Included in project cost	WRD	WRD and FREMAA
	Change in air quality due to traffic	Plantation along the embankment Turfing of the embankment slopes Regular maintenance of the road on the top of embankment as well as approach roads		Entire Project Area	Operation Phase	Included as part of regular Maintenance costs	WRD	WRD and FREMAA
Noise	Increase in sound pressure levels due to construction machineries, vehicles etc.	Options of noise control by site controls, scheduling of project activities	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof	At all construction sites	During the construction period	Included in engineering cost	Contractor	WRD and FREMAA
		Protection devices (ear plugs or ear muffs) to be provided to the workers operating in the vicinity of high noise generating machines.		At all construction sites of high noise intensities	During the construction period	Part of Contractor Obligation	Contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
		Construction equipment and machinery shall be fitted with silencers and maintained accordingly.		Construction sites	At the start of construction activity and during the construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Construction of temporary noise barriers near the sensitive areas, e.g. schools		At identified sensitive locations near the construction sites	Before start of construction activities near sensitive locations	Included in construction cost	Contractor	WRD and FREMAA
		Noise and vibration level monitoring as per monitoring plan.		As per monitoring plan	Once in every year	Included under Monitoring Costs	WRD	WRD and FREMAA
	Increase in sound pressure levels due to traffic	Adequate signage to restrict use of pressure horns particularly in noise sensitive locations Tree barriers between the road and village/ semi urban/ and urban areas. All the machineries used by contractor should obtain a clearance from State Pollution Board					**Contractor**	WRD and FREMAA
Disturbance to overall livings condition of the people living in the project areas	Increase traffic to serve construction works, limitation access due to location of construction work, creation of danger areas for children	The contractor should provide clear signage for danger areas and provide a safe passage for local communities to reach all basic services e.g. schools, clinics, religious worship places as well as market. The contractor should rehabilitate to at least at the level where communities can continue their convenient living conditions prior to project works. The rehabilitation should not be limited in areas used for their working camps, storage	During the construction period	Entire project site where construction works taking place		Part of construction cost	**contractors**	WRD and FREMAA

		areas, and parking areas						
Disturbance to vegetation	Cutting of trees in core zone during project intervention	Minimization of tree cutting while designing the embankment		Entire project site	During complete construction phase	-	Contractor in close coordination with Forest Department	WRD and FREMAA
		Compensatory tree plantation preferably on the basis of 3 trees plantation against each tree cut		Entire project site and nearby areas	Starting from construction phase	Already indicated above	Contractor	WRD and FREMAA
Animal distribution/ migratory route Endangered Species	Impact on Dolphin breeding sites No Adverse Impact of Endangered Species	Construction activities shall be restricted during Dolphin breeding period (May to August) at breeding sites. Due to sensitivity of Dolphins with polluted water, construction waste should not be dumped near the river bank		Identified breeding sites	During construction phase		WRD guide the contractor	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
Fishing activities/ productivity, Migratory Route	Impact on boat Ghats (un-official fish landing places).	Adequate provision shall be made in the design to ensure access to the fish landing sites/ boat ghats Contractor must put adequate signage to guide fishing boat not to land in the construction areas		Temporary boat ghats identified along the reach (because locations have always changed depend on the convenience of the fisherfolks)	During construction phase itself	Included in engineering design cost	Engineering team and Contractor	WRD and FREMAA
Spawning and Breeding Grounds/Pond Fisheries	Disturbance on breeding and spawning grounds. No Adverse Impact on Pond Fisheries	Restriction of construction activities near the identified breeding and spawning grounds during the breeding period of April to august Fish productivity can be improved substantial with use of better fish culture and increasing the capacity of fish pond		At identified spawning and breeding grounds	During April to august in construction phase	-	Contractor	WRD and FREMAA
Habitat fragmentation	Inappropriate opening of the sluice gate	Appropriate management to be made for the operation of the sluice gates		Project Benefit Area	Operation Phase	-	WRD	WRD and FREMAA

Activity	Environmental Issue/ Component	Remedial Measures	Legislative Requirement/ Framework	Approximate Location	Time Frame	Mitigation Cost (₹)	Institutional Responsibility	
							Implementation	Supervision
Socio-economic impact	Impact on fish landing sites	Training programmes for agriculture and fish production improvement		Project buffer zone	During construction phase	Already included above	WRD	WRD and FREMAA
		Guidance will be given to the fisherfolk to land their boat so the construction works will not affect their livelihood so that economic activities of the fishermen can not disturb during project intervention		Identified fish landing sites	During construction phase	Included in construction cost	Contractor/ WRD	WRD and FREMAA
Safety	Risk of accidents and safety due to narrow roads and encroachment of people near construction areas	Adequate lighting and fluorescent signage shall be provided at construction sites.		Construction sites and approach roads	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Signage in local language		Construction sites and approach roads	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Setting up of speed limits and speed breakers	50,000	Construction sites and approach roads	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Personal protective equipment for workers	Included in construction cost	At construction sites	During construction phase	Included in construction cost	Contractor	WRD and FREMAA
		Health checkup camps for workers	4,50,000	At construction camps	During construction phase	4,50,000	Contractor	WRD and FREMAA

APPENDIX 13: GOOD PRACTICES: HEALTH AND SAFETY, AND MANAGEMENT OF BORROW AREAS, QUARRY, LABOUR CAMP, AND TOP SOIL

GUIDELINE: LABOUR AND WORKER'S HEALTH AND SAFETY

1. INTRODUCTION

The safety and health concerns of the workers and the community are impacted due to the hazards created during the construction of road. **Box: 1** gives the safety concerns during construction. This Guideline describes the hazards and measures that need to be taken to mitigate the impacts.

2. PROJECT PLANNING AND DESIGN STAGE

To address health and safety concerns, the DPR shall contain selection criteria for setting up:

- Construction Camps (as per guideline);
- Borrow Areas (as per guideline); and
- In case of opening new quarry areas (as per guideline).

To address the safety concerns to road user during operational phase, the DPR shall contain the following:

- Selection and location of regulatory as well as informatory signs as per IRC: 67-2001, depending upon the geometry of the road.

Box 1: Safety Concerns during Construction

Community due to:

- Improper scheduling of construction activities especially near the settlements and sensitive areas;
- Parking of equipments and vehicles at the end of the day likely to cause accidents to the general public especially during night hours;
- Transportation of uncovered loose material or spillage of material increases the chances of accidents to road users and surrounding settlements.

Workers due to:

- Improper handling of materials like bitumen, oil and other flammable material at construction sites, likely to cause safety concerns to the workers;
- Lack of safety measures such as alarm, awareness and safety equipment result in accidents, especially working with or around heavy machinery / equipments.

PRE-CONSTRUCTION STAGE

In order to incorporate public health and safety concerns, the PIU and the Contractor shall disseminate the following information to the community:

- Location of construction camps, borrow areas and new quarry areas;
- Extent of work;
- Time of construction;
- Diversions, if any;
- Precaution measures in sensitive areas;
- Involvement of local labors in the road construction;
- Health issues - water stagnation, exposure to dust, communicable disease; and
- Mechanism for grievances.

Health Concerns are adversely impacted.....

Public due to:

- Unhygienic conditions due to water logging (improper drainage of waste water), either by improper decommissioning of Construction Camps and parking lots, or improper disposal of construction wastes, leading to the breeding of vectors that are likely to impact the health of the general public
- Interaction between workers and host community is likely to increase the risk of spread of communicable diseases.

Workers due to:

- Low quality drinking water as well as inappropriate storage of drinking water likely to cause water borne diseases among workers.
- Absence of proper sanitary facility likely to act as a breeding ground for vectors raising health concerns among workers.

The information dissemination could be through the local newspaper, billboards, panchayats meetings, etc. The Contractor must educate the workers to undertake the health and safety precautions. The contractor shall educate the workers regarding:

- Awareness on HIV/AIDS awareness and usage of safety measures such as condoms;
- Awareness on hygienic sanitary practices;
- Personal safety measures and location of safety devices;
- Interaction with the host community;
- Protection of environment with respect to:
  - Trampling of vegetation and cutting of trees for cooking;
  - Restriction of activities in forest areas and also on hunting;
  - Water bodies protection;
  - Storage and handling of materials;
  - Disposal of construction waste.

3. CONSTRUCTION STAGE

During the progress of work, following are the safety requirements that need to be undertaken by the contractor at the construction site:

- Personal Protective Equipment (PPE) for the workers. **Table 1** gives the safety gear to be used by the workers during each of the construction activities.
- All measures as per bidding document shall be strictly followed.
- Additional provisions need to be undertaken for safety at site:

FIRST AID FACILITIES

- First Aid Kit, distinctly marked with Red Cross on white back ground and shall contain minimum of following:
  - 6 small-sterilized dressings
  - 3 medium and large sterilized dressings
  - 1 (30 ml.) bottles containing 2 % alcoholic solution of iodine
  - 1(30 ml) bottle containing salvolatile
  - 1 snakebite lancet
  - 1 pair sterilized scissors
  - 1 copy of first-aid leaflet issued by the Director General, Factory Service & Labour Institute, Government of India
  - 100 tablets of aspirin
  - Ointment for burns
  - A suitable surgical antiseptic solution
- Adequate arrangement shall be made for immediate recoupment of the equipments, whenever necessary.
- A trained personnel incharge of first aid treatment to be readily available during working hours at construction site
- Suitable transport to the nearest approachable hospital should be made available.
- Tetanus injection must be made compulsory for all workers every 6 months.

- Adequate lighting arrangement;
- Adequate drainage system to avoid any stagnation of water;
- Lined surface with slope 1:40 (V:H) and provision of lined pit at the bottom, at the storage and handling area of bitumen and oil, as well as at the location of generator (grease trap); and
- Facilities for administering first aid.

Table 1: Worker Safety Measures

Sl. no.	Activity	Safety Requirement
1.	Setting out and levelling	• Luminous jackets; • Helmets; • Boots for protection against insect bite; and Dust Mask
2.	Tree cutting	• Helmet Boots • Luminous safety jackets
3	Reinforced yard/ carpentry/ reinforcement cutting/ bending work.	• Hand gloves
4.	Shuttering work	• Goggles Hand gloves
5.	Plant and Machinery	• Hand gloves • Boots • Helmets • Dust Mask
6.	Material handling	• Hand gloves • Dust mask
7.	Batching plant	• Goggles • Hand gloves • Dust mask
8.	Weeding	• Goggles
9.	Binding reinforcement	• Safety belt • Boots
10.	Manual concrete laying	• Gum boots • Hand gloves • Helmet
11.	Piling	• Helmet • Hand gloves, gumboots.

The following measures need to be adopted by the contractor to address public safety concerns:

- The Contractor shall schedule the construction activities taking into consideration factors such as:
  - Sowing of crops;
  - Harvesting;
  - Local hindrances such as festivals etc.; and
  - Availability of labor during particular periods.
- All the cautionary signs as per IRC: 67-2001 and traffic control devices (such as barricades, etc.) shall be placed as soon as construction activity get started and shall remain in place till the activities get completed.
- Following case specific measures need to be followed during the progress of the activity:
  - In case of blasting, the Contractor must follow The Explosives Rules, 1983.
  - In case of construction activity adjoining the water bodies, measures shall be taken as per measures suggested in Guideline on “Water Body”.
  - If construction of road is within the settlement, the contractor must ensure that there

shall not be any unauthorized parking as well as storage of material, adjacent to road.
- Approved chemicals should be sprayed to prevent breeding of mosquitoes and other disease-causing organisms, at all the water logging areas

The PIU shall carry out periodic inspections to ensure that all the measures are being undertaken as per the guideline.

4. POST-CONSTRUCTION STAGE

During this stage a major concern is on road user safety. Following are the measures that need to be undertaken by the PIU to ensure safer roads:

- Inspection and maintenance of installed regulatory and informatory signs.
- Ensure that the location of signage does not obstruct the visibility
- In case of hill roads, maintenance of parapet wall as well as of overtaking zones.

The PIU must ensure that during the maintenance operation of road, road materials are stored at a location such that they shall not create any risk to road users.

The construction site shall be cleaned of all debris, scrap materials and machinery on completion of construction for the safety of public and road users, as per the measures given in Guideline on “Construction and labor Camp” and “Waste Management and Debris Disposal.”

GUIDELINE: QUARRY MANAGEMENT

1. INTRODUCTION

This guideline pertains to the measures to be taken to address environmental concerns in quarry areas. The general practice adopted is to procure materials from existing quarries operating with the requisite permits. The measures to be taken for operation and management for quarries during all stages of construction have been discussed in this Guideline.

2. PROJECT PLANNING AND DESIGN STAGE

The PIU shall provide in the DPR / bid document, a list of licensed quarries operating within the district and adjoining districts. In addition, the DPR shall contain the following: (i) Quantity of materials available in quarries (ii) Lead from the various existing quarries and (iii) Adequacy of materials for the project in these quarries. **Table 1** and **2** give the format for preparing a list of quarries.

Table 1 Details of Sand Quarry

Sample No.	Source of Sand	Name of quarry area	Site Identification/ Location			Approximate Quantity (cum)	Approximate basic cost of the material (Rs.)	Remarks
			Nearest Chainage (Km.)	Left/Right	Offset from nearest chainage (km)			

Table 2 Details of Quarry Area for Aggregates

Sample No.	Chainages(Km.)	Left/Right	Name of Quarry Area	Name of Crusher	Lead from nearest chainage (Km.)	Basic cost of the material (Rs.)	Available land/terrain	Surrounding land Terrain	Remarks

Only in the event of non-availability of existing quarries, the Contractor shall open a new quarry in accordance with Mines and Minerals (Development & Regulation) Act, 1957. The bid document shall include the exhaust quarry reclaim plan per needs of the landowner / community.

3. PRE-CONSTRUCTION STAGE

The Contractor shall select an existing licensed quarry identified in DPR for procuring materials. The Contractor shall establish a new quarry with the prior consent of the PIU only in cases when: (i) Lead from existing quarries is uneconomical and (ii) Alternative material sources are not available. The Contractor shall prepare a Redevelopment Plan for the quarry site and get it approved by the PIU.

The construction schedule and operations plan to be submitted to the PIU prior to commencement of work shall contain a detailed work plan for procuring materials that includes procurement, transportation and storage of quarry materials.

4. CONSTRUCTION STAGE

4.1 Development of Quarry Area

To minimize the adverse impact during excavation of material following measures are needed to be undertaken:

- Adequate drainage system shall be provided to prevent the flooding of the excavated area
- At the stockpiling locations, the Contractor shall construct sediment barriers to prevent the erosion of excavated material due to runoff.
- Construction of offices, laboratory, workshop and rest places shall be done in the up-wind of the plant to minimize the adverse impact due to dust and noise.
- The access road to the plant shall be constructed taking into consideration location of units and slope of the ground to regulate the vehicle movement within the plant.
- In case of storage of blasting material, all precautions shall be taken as per The Explosive Rules, 1983.

4.2 Setting up of Crushers and other equipment

The following measures shall be undertaken for setting up of crushers are other equipment.

- The contractor shall obtain “No Objection Certificate (NoC)” from the Assam State Pollution Control Board.
- All vehicles must possess Pollution Under Control (PUC) Certificate and shall be renewed accordingly
- All machinery, equipment, and vehicles shall comply with existing CPCB noise and emission norms.
- The PIU must ensure that contractor shall submit the copy of NoC and PUC Certificate before the start of work.

4.3 Quarry operations

The followings precautions shall be undertaken during quarry operations. vii) Overburden shall be removed and disposed as per **Guideline 8** “Waste Management and Debris Disposal”.

- During excavation slopes shall be flatter than 20 degrees Guideline 8 on to prevent their sliding
- In case of blasting, the procedure and safety measures shall be taken as per The Explosive Rules, 1983
- The Contractor shall ensure that all workers related safety measures shall be done as per measures for, “Labor& Workers Health & Safety” (**Guideline 12**).
- The Contractor shall ensure maintenance of crushers regularly as per manufacturer’s recommendation.
- Stockpiling of the excavated material shall be done as per stockpiling of topsoil explained in **Guideline 4**, “Topsoil Salvage, Storage& Replacement.”
- During transportation of the material, measures shall be taken as per **Guideline 11** “Construction Plants and Equipment Management” to minimize the generation of dust and to prevent accidents

- The PIU and the concerned authority shall review the quarry site for the management measures during quarry operation, including the compliance to pollution norms.

5. POST CONSTRUCTION STAGE

A quarry redevelopment plan shall be prepared by the Contractor. All haul roads constructed for transporting the material from the quarries to construction site shall be restored to their original state.

The PIU and the concerned authority shall be entrusted the responsibility of reviewing the quarry site for the progress of implementation of Redevelopment Plan.

The plan shall include:

- Photograph of the quarry site prior to commencement
- The quarry boundaries as well as location of the materials deposits, working equipment, stockpiling, access roads and final shape of the pit.
- Drainage and erosion control measures at site
- Safety measures during quarry operation
- Design for redevelopment of exhaust site.

Two options for redevelopment of quarry areas are given below:

Option A: Revegetating the quarry to merge with surrounding landscape. This is done by conserving and reapplying the topsoil for the vegetative growth.

Option B: Developing exhausted quarries as water bodies. The pit shall be reshaped and developed into pond, for harvesting rainwater. This option shall only be considered where the location of quarry is at the lowest point, i.e. surrounding areas/ natural drainage slopes towards it.

GUIDELINE: BORROW AREAS

1. INTRODUCTION

Embankment fill material is to be procured from borrow areas designated for the purpose. Borrow areas cause significant adverse environmental impacts if appropriate mitigation measures are not taken. The scope of this guideline includes measures that are required during project planning and design stage, pre-construction, construction stage and post construction stage. Borrow areas are related only to road construction activities.

2. PROJECT PLANNING AND DESIGN STAGE

Design measures for reduction in the quantity of the earthwork will have to be undertaken to reduce the quantity of material extracted and consequently decrease the borrow area requirement. Borrow area siting should be in compliance with IRC: 10-1961. The DPR shall contain (i) Guidelines for locating site of borrow areas (ii) The arrangements to be worked out with the land owner/community for the site and (iii) Sample designs for redevelopment of borrow areas.

3. PRE-CONSTRUCTION STAGE

The contractor shall identify the borrow area locations in consultation with the individual owners in case of private lands and the concerned department in case of government lands, after assessing suitability of material. The suitable sites shall be selected and finalized in consultation with the PIU. Borrowing to be avoided on the following areas:

- Lands close to toe line.
- Irrigated agricultural lands (In case of necessity for borrowing from such lands, the topsoil shall be preserved in stockpiles. The subsequent Guidelines discuss in detail the conservation of topsoil.
- Grazing land.
- Lands within 0.8km of settlements.
- Environmentally sensitive areas such as Reserve Forests, Protected Forests, Sanctuary, wetlands (including beel). Also, a distance of 500 m should be maintained from such areas.
- Designated protected areas / forests.
- Unstable side-hills.
- Water-bodies.
- Streams and seepage areas.
- Areas supporting rare plant/ animal species;
- Ensure unsuitable soft rock is not prominent within the proposed depth of excavation which will render rehabilitation difficult.

3.1. Arrangements for Borrow Area

The Contractor will work out arrangements for borrowing with the land owner/concerned department. The arrangements will include the redevelopment after completion of borrowing. The arrangements will be verified by the PIU to enable redressal of grievances at a later stage of the project. The Engineer of PIU shall approve the borrow area after inspection of the site to verify the reclamation plan and its suitability with the contractor and landowner. The contractor shall commence borrowing soil only after the approval by the PIU. The contractor shall submit to the PIU the following before beginning work on the borrow areas.

- Written No-objection certificate of the owner/cultivator;

- Estimate extent of earth requires;
- Extent of land required and duration of the agreement;
- Photograph of the site in original condition; and
- Site redevelopment plan after completion.

The depth of excavation should be decided based on natural ground level of the land and the surroundings, and rehabilitation plan. In case higher depth of excavation is agreed with backfilling by unsuitable excavated soil (from roadway), then filling should be adequately compacted except topsoil, which is to be spread on the top most layer (for at least 20m thick). The guidelines for location, depth, size and shape of the borrow areas are available in the following:

- Clause 305.2.2.2 of MoRTH specification for roads and bridge works of IRC;
- Guidelines for environmental impact assessment of highway projects, Indian Roads Congress, 1989: (IRC: 104-1988);
- IRC: 10-1961-Recommended practice for borrow pits for road embankments constructed by manual operations, as revised in 1989;
- IRC SP: 58-2001 guideline for use of fly ash in road construction;
- EIA manual of MoEF, 2001;
- MoEF notification on utilization of fly ash dated 27 August 2005.

3.2. Documentation of Borrow Pit

The contractor must ensure that following data base must be documented for each identified borrow areas that provide the basis of the redevelopment plan.

- Chainage along with offset distance;
- Area (m^2);
- Photograph of the pit from all sides;
- Type of access/width/kutcha/pucca, etc. from the carriageway;
- Soil type;
- Slope/drainage characteristics;
- Water table of the area or identify from the nearest well, etc.;
- Existing land use, for example barren/agricultural/grazing land;
- Location/name/population of the nearest settlement from borrow area;
- Present usage of borrow area; and
- Community facility in the vicinity of borrow pit.

3.3. Redevelopment Plans for Borrow Pits

The following checklist provides guidelines to ensure that redevelopment of borrow areas must comply with MoRTH, clause 305.2.2.2 and EMP requirement. Borrow areas can be developed as:

- Ponds (various types) (e.g.: Drinking Water only; Washing and for other Domestic Chores; Only for Cattle; Mixed Uses etc.) (a large pond can be divided into two parts - each having a defined use)
- Farmland
- Water Recharging Zones
- Pastureland
- Fish Ponds (pisciculture)
- Waste disposal Sites (depending upon the location, distance from settlements, pollution

- risks, safety, associated environmental risks and hazards, regulations/ permissions of

appropriate authority and other such factors)
- Plantation Zones
- Recreational Zones (depending upon location, size, potential of the site, willingness of the local bodies to develop it)
- Wildlife Refuge and Drinking Area (applicable only in case of sensitive environs with appropriate planning and understanding including regulation of depth for safety of animals etc.)

The rehabilitation measures for the borrow areas shall be dependent on the following factors:

- Land use objectives and agreed post-borrowing activities;
- Physical aspects (landform stability, erosion, re-establishment of drainage);
- Biological aspects (species richness, plant density,) for areas of native re vegetation;
- Water quality and soil standards; and
- Public safety issues.

Rehabilitation should be simple and maintenance free. Depending on the choice of the individual land owner/community, the contractor shall prepare redevelopment plans for the borrow areas. The options can be: (i) Restoring the productive use of the land (ii) Development of detention ponds in barren areas.

Option I: Suitable in locations with high rainfall and productive areas

Topsoil must be placed, seeded, and mulched within 30 days of final grading if it is within a current growing season or within 30 days of the start of the next growing season. Vegetative material used in reclamation must consist of grasses, legumes, herbaceous, or woody plants or a combination thereof, useful to the community for the fuel and fodder needs.

Plants must be planted during the first growing season following the reclamation phase.

Selection and use of vegetative cover must consider soil and site characteristics such as drainage, pH, nutrient availability, and climate to ensure permanent growth. The vegetative cover is acceptable if within one growing season of seeding, the planting of trees and shrubs results in a permanent stand, or regeneration and succession rate, sufficient to assure a 75% survival rate.

Option II: In barren land, the borrow areas can be redeveloped into detention ponds.

These will be doubled up as water bodies and for removal of sediment from runoff flowing through the ponds. Design of the detention basin depends upon the particle size, settling characteristics, residence time and land area. A minimum of 0.02 mm size particle with a settling velocity of 0.02 cm/sec (assuming specific gravity of solids 2.65) can be settled in the detention basin.

Following parameters are to be observed while setting up a detention pond:

- Pond should be located at the lowest point in the catchment area. Care should be taken that the horizontal velocity should be less then settling velocity to prevent suspension or erosion of deposited materials.
- Minimum Effective Flow Path: 5 times the effective width
- Minimum Free Board: 0.15 m
- Minimum Free Settling Depth: 0.5 m

- Minimum Sediments Storage Depth: 0.5 m

- Maximum interior slope: 2H : 1V
- Maximum exterior slope: 3H : 1V
- The inlet structure should be such that incoming flow should distribute across the width of the pond. A pre-treatment sump with a screen should provide to remove coarse sediments. Settled sediment should be removed after each storm event or when the sediment capacity has exceeded 33% of design sediment storage volume. Accumulated sediment must be disposed of in a manner, which will prevent its re-entry into the site drainage system, or into any watercourse.

1. CONSTRUCTION STAGE

No borrow area shall be operated without permission of the Engineer. The procurement of borrow material should be in conformity to the guidelines laid down in IRC: 10-1961. In addition, the contractor should adopt precautionary measures to minimize any adverse impacts on the environment. Checklists for monitoring borrow areas operation and management has been prepared (**Table 1**).

Table 1: Checklist for Monitoring Borrow Area Operation and Management

Attributes	Requirements
Access Road	Access road shall be used for hauling only after approved
Top soil preservation	To soil, if any, shall be stripped and stored at corners of the area before the start of excavation for material collection; Top soil should be reused / re-laid as per agreed plan; In case of riverside, borrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood. In no case shall be borrow pit be within 1.5m from the Toe line of the proposed embankment.
Depth of excavation	For agricultural land, the total depth of excavation should be limited to 150cm including top 30 cm for top soil preservation; For river side borrow area, the depth of excavation shall be regulated so that the inner edge of any borrow pit, should not be less than 15m from the toe of the bank and bottom of the pit should not cut the imaginary line of 1:4 projected from the edge of the final section of the embankment. To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Engineer.
Damage to surrounding land	Movement of man and machinery should be regulated to avoid damage to surrounding land. To prevent damages to adjacent properties, the Contractor shall ensure that an undisturbed buffer zone exists between the distributed borrow areas and adjacent land. Buffer zone shall be 3 m wide or equal to the depth of excavation whichever is greater.
Drainage control	The Contractor shall maintain erosion and drainage control in the vicinity of all borrow pits and make sure that surface drains do not affect the adjacent land or future reclamation. This needs to be rechecked by the engineer of the PIU.
Dust Suppression	Water should be sprayed on kutcha haul road twice a day or as may be required to avoid dust generation during transportation of material; Depending on moisture content, 0.5 to 1.5% water may be added to excavated soil before loading during dry weather to avoid fugitive dust emission.
Covering material for transport material	Material transport shall be provided with tarpaulin cover
Personal Protective Equipment	Workers should be provided with helmet, gumboots and air mask and their use should be strictly enforced.

Attributes	Requirements
Redevelopment	The area should be redeveloped within agreed timeframe on completion of material collection as per agreed rehabilitation plan.

2. POST CONSTRUCTION STAGE

All reclamation shall begin within one month of abandonment of borrow area, in accordance with the redevelopment plan. The site shall be inspected by the PMU after implementation of the reclamation plan. Certificate of Completion of Reclamation is to be obtained by the Contractor from the landowner that "the land is restored to his satisfaction". The final payment shall be made after the verification by PIU.

3. CHECKLIST FOR INSPECTION OF REHABILITATION AREA

Inspection needs to be carried out by the PMU for overseeing the redevelopment of borrow areas as per the plan. The checklist for the inspection by the PIU is given below.

- Compliance of post-borrowing activities and land use with the restoration plan;
- Drainage measures taken for inflow and outflow in case borrow pit is developed as a detention pond;
- Levelling off the bottom of the borrow areas;
- In case the borrow area is on private property, the contractor shall procure written letter from landowner for satisfaction on rehabilitation. In case of no rehabilitation is desired by the landowner, the letter should include statement "no responsibility of R&BD on contractor in the event of accident.
- Condition of the reclaimed area in comparison with the pre-borrowing conditions.

GUIDELINE: CONSTRUCTION AND LABOUR CAMPS

1. INTRODUCTION

The scope of this guideline pertains to the siting, development, management and restoration of construction and labor camps to avoid or mitigate impacts on the environment. The area requirement for the construction camp shall depend upon the size of contract, number of laborer employed, and the extent of machinery deployed. The following sections describe the siting, construction, maintenance, provision of facilities in the camps and finally rehabilitation of the construction and labor camps. These are described in three stages, pre-construction, construction and post-construction stage. The issues related to construction camps are similar in the case of road construction and hence have been taken together.

2. PRE-CONSTRUCTION STAGE

Identification of site for construction and labor camps is the first task. The Contractor shall identify the site for construction camp in consultation with the individual owners in case of private lands and the concerned department in case of Government lands. The suitable sites shall be selected and finalized in consultation with the PIU. **Table 1** gives the lands that could be avoided for construction camps and conversely those that could be preferred.

Table 1: Selection Criterion for Construction Camps.

Avoid the following …	Prefer the following …
• Lands close to habitations. • Irrigated agricultural lands. • Lands belonging to small farmers. • Lands under village forests. Lands within 100m of community water bodies and water sources as rivers. • Lands within 100m of watercourses. • Low lying lands. • Lands supporting dense vegetation. • Grazing lands and lands with tenure rights. • Lands where there is no willingness of the landowner to permit its use.	• Waste lands. • Waste Lands belonging to owners who look upon the temporary use as a source of income. • Community lands or government land not used for beneficial purposes. • Private non-irrigated lands where the owner is willing. • Lands with an existing access road.

The contractor will work out arrangements for setting up his facilities during the duration of construction with the land owner/concerned department. These arrangements shall be in the form of written agreement between the contractor and the land owner (private/government) that would specify:

a) photograph of the proposed camp site in original condition;

b) activities to be carried out in the site;

c) environmental mitigation measures to be undertaken to prevent land, air, water and noise pollution;

d) detailed layout plan for development of the construction and labor camp that shall indicate the various structures to be constructed in the camp including temporary, drainage and other facilities (**Figure 1** gives a layout plan for a construction camp); and

e) Restoration plan of camp site to previous camp conditions.

The arrangements will be verified by the PIU to enable redressal of grievances at a later stage of the project.

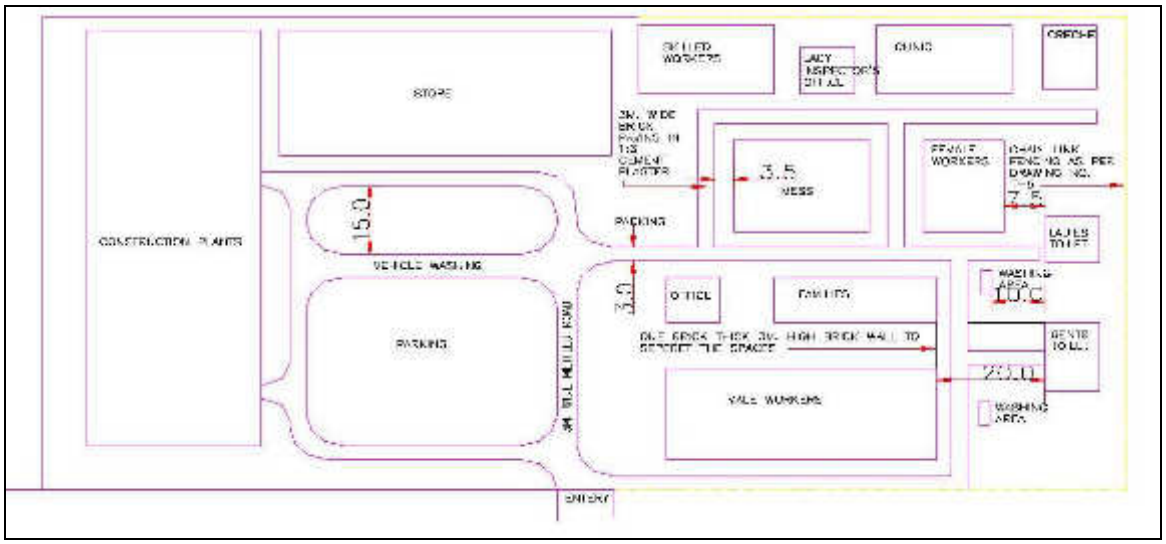


Figure 1: Layout Plan for Construction Camp

2.2 Setting up of labor camp

The contractor shall provide, free of cost in the camp site, temporary living accommodation to all the migrant workers employed by him for complete construction/maintenance work is in progress. A minimum area of 6 m^2 per person shall be provided. The rooms of labor shall be well lighted and ventilated. The facilities to be provided for the labor are discussed below:

a) Drinking Water

Towards the provision and storage of drinking water at the construction camp, the contractor shall ensure the following provisions

- The contractor shall provide for a continuous and sufficient supply of potable water in the camps, in earthen pots or any other suitable containers.
- The contractor shall identify suitable community water sources for drinking. Only in the event of non-availability of other sources of potable water, the Contractor shall obtain water from an unprotected source only after the testing for its potability. Where water must be drawn from an existing open well, the well shall be properly chlorinated before water is drawn from it for drinking. All such wells shall be entirely closed in and be provided with dust proof trap door.
- Every water supply or storage shall be at not less than 15m from any wastewater / sewage drain or other source of pollution. Water sources within 15m proximity of toilet, drain or any source of pollution will not be used as a source of drinking water in the project.
- A pump shall be fitted to covered well used as drinking water source, the trap door shall be kept locked and opened only for cleaning or inspection, which shall be done at least once a month.

b) Washing and Bathing Facilities

In every site, adequate and suitable facilities for washing clothes and utensils shall be provided and maintained for the use of contract labor employed therein. Separate and adequate bathing shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic conditions.

c) Toilets Facilities

Sanitary arrangements, latrines and urinals shall be provided in every work place separately for male and female workers. The arrangements shall include:

- A latrine for every 15 females or part thereof (where female workers are employed).

- A latrine for every 10 males.
- Every latrine shall be under cover and so partitioned as to secure privacy and shall have a proper door and fastenings.
- Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by most of the workers "For Men Only" or "For Women Only" as the case may be.
- The latrines and urinals shall be adequately lighted and shall be maintained in a clean sanitary condition at all times and should have a proper drainage system;
- Water shall be provided in or near the latrines and urinals by storage in suitable containers.

d) Waste Disposal

- Disposal of sanitary wastes and excreta shall be into septic tanks.
- Kitchen waste water shall be disposed into soak pits/kitchen sump located preferably at least 15 meters from any water body. Sump capacity should be at least 1.3 times the maximum volume of wastewater discharged per day. The bottom of the pit should be filled with coarse gravel and the sides shored up with board, etc. to prevent erosion and collapse of the pit. New soak pits shall be made ready as soon as the earlier one is filled.
- Solid wastes generated in the kitchen shall be reused if recyclable or disposed of in land fill sites.

e) Medical and First Aid Facilities

Medical facilities shall be provided to the labor at the construction camp. Visits of doctor shall be arranged twice a month wherein routine checkup would be conducted for women and children. A separate room for medical checkups and keeping of first aid facilities should be built. The site medical room should display awareness posters on safety facilitation hygiene and HIV/AIDS awareness.

- First Aid Box will be provided at every construction campsite and under the charge of a responsible person who shall always be readily available during working hours. He shall be adequately trained in administering first aid-treatment. Formal arrangement shall be prescribed to carry injured person or person suddenly taken ill to the nearest hospital. The first aid box shall contain the following.
  - 6 small sterilized dressings
  - 3 medium size sterilized dressings
  - 3 large size sterilized dressings
  - 3 large sterilized burns dressings
  - 1 (30 ml) bottle containing 2 % alcoholic solution of iodine
  - 1 (30 ml) bottle containing Sal volatile
  - 1 snakebite lancet
  - 1 (30 g) bottle of potassium permanganate crystals
  - 1 pair scissors
  - Ointment for burns
  - A bottle of suitable surgical antiseptic solution

In case, the number of labor exceeds 50, the items in the first aid box shall be doubled.

f) Provision of Shelter during Rest

The work place shall provide four suitable sheds, two for meals and two for rest (separately for men and women). The height of the shelter shall not be less than 3.0m from the floor level to the lowest part of the roof. These shall be kept clean.

g) Crèches

In case 20 or more women workers are employed, there shall be a room of reasonable size

for use of children under the age of six years. The room should have adequate light and realization. A caretaker is to be appointed to look after the children. The use of the room shall be restricted to children, their mothers and the caretaker.

2.2 Storage of Construction Material in Construction Camps

For storage of Petrol/Oil/Lubricants, brick on edge flooring or sand flooring will be provided at the storage places of Petrol/Oil/Lubricants to avoid soil and water contamination due to spillage. These should be kept away from labor residential areas. The storage of cement shall be at Damp-proof flooring, as per IS codes. All materials shall be stored in a barricaded area. In case of electrical equipment, danger signs shall be posted. The batch mix plant is to be located away from the residential area and not in the wind direction. Separate parking areas for vehicles and workshop areas need to be provided.

2.2 Firefighting arrangement

- The following precautions need to be taken:
- Demarcation of area susceptible to fires with cautionary signage;
- Portable fire extinguishers and/or sand baskets shall be provided at easily accessible locations in the event of fire;
- Contractor shall educate the workers on usage of these equipment.

2.2 Interactions with host communities

To ensure that there is no conflict of the migrant labor with the host communities, the contractor shall issue identity cards to laborer and residents of construction camps.

3. CONSTRUCTION STAGE

Construction camps shall be maintained free from litter and in hygienic condition. It should be kept free from spillage of oil, grease or bitumen. Any spillage should be cleaned immediately to avoid pollution of soil, water stored or adjacent water bodies. The following precautions need to be taken in construction camps.

- Measures to ensure that no leaching of oil and grease into water bodies or underground water takes place.
- Wastewater should not be disposed into water bodies.
- Regular collection of solid wastes should be undertaken and should be disposed of safely.
- All consumables as the first aid equipment, cleaning equipment for maintaining hygiene and sanitation should be recouped immediately.
- The debris/scrap generated during construction should be kept in a designated and barricaded area.

The PIU will monitor the cleanliness of construction campsites and ensure that the sites are properly maintained throughout the period of the contract.

4. POST CONSTRUCTION STAGE

At the completion of construction, all construction camp facilities shall be dismantled and removed from the site. The site shall be restored to a condition in no way inferior to the condition prior to commencement of the works. Various activities to be carried out for site rehabilitation include:

- Oil and fuel contaminated soil shall be removed and transported and buried in waste disposal areas.
- Soak pits, septic tanks shall be covered and effectively sealed off.
- Debris (rejected material) should be disposed of suitably (Refer **Guideline - 10** on “Waste Management and Debris Disposal”).
- Ramps created should be levelled.

- Underground water tank in a barren/non-agricultural land can be covered. However, in an agricultural land, the tank shall be removed.
- If the construction camp site is on an agricultural land, top soil can be spread to aid faster rejuvenation.
- Proper documentation of rehabilitation site is necessary. This shall include the following: −Photograph of rehabilitated site;

    - Land owner consent letter for satisfaction in measures taken for rehabilitation of site;
    - Undertaking from contractor; and
    - Certification from Engineer in-charge of the PIU.

In cases, where the construction camps site is located on a private land holding, the contractor would still have to restore the campsite as per this guideline. Also, he would have to obtain a certificate for satisfaction from the landowner.

APPENDIX 14: ENVIRONMENTAL MONITORING PLAN (EMoP)

Environmental Component	Project stage	Parameter	Standards	Location	Duration / Frequency	Cost (₹)	Implementation on	Supervision
Fisheries	Construction Stage	water quality monitoring	water quality for fish production	Flood plains, beels, rivers and ponds	Once in a year throughout the construction phase	1,50,000	Contractor and WRD	WRD and FREMAA
Air Quality	Construction Phase	SPM, RSPM, SO_2, NOx, CO, Pb	National Ambient Air Quality Standards	Within 100 m of Hot mix plant, construction camp, crusher and near sensitive locations/ settlement	Continuous 24-hourly, twice a week, for two weeks once every year (summer)	250,000 (@RS. 83,333/y ear for three year)	Independent Environmental Laboratories approved by SPCB/ MoEF&CC	WRD and FREMAA
Hydrology	All phases	Water level, discharge, river cross sections	Central W. Commission	As per CWC guidelines	As per CWC guidelines	Data and knowledge components	WRD	WRD and FREMAA
Morphology	All phases	Bank line profiles, sediment transport, velocity, float tracking	Same as above	Same as above	Same as above	Same as above	WRD	WRD and FREMAA
Surface Water Quality	Construction Stage	pH, BOD, COD, TDS, TSS, DO, Oil & Grease	As per CPCB Water Quality Criteria	Brahmaputra river and wetlands/ ponds	Once during the dry season.	100,000 (@ Rs. 33,000/year for three year)	Independent Environmental Laboratories approved by SPCB/ MoEF&CC	WRD and FREMAA

Environmental Component	Project stage	Parameter	Standards	Location	Duration / Frequency	Cost (Rs.)	Implementation	Supervision
Ground water and Drinking Water Quality	Construction Stage	pH, BOD, DO, total coliform, As, Cd, Mn and Ground Water levels	As per IS 10500:1991	Construction site, Rehabilitation site, service areas,	Once at the start of construction	15,000	Independent Environmental Laboratories approved by SPCB/ MoEF&CC	WRD and FREMAA
Noise and Vibration	Construction Phase	Noise Level in dB (A)	As per National Standards for Noise	Near the construction sites and sensitive locations close to embankment	One day hourly measurement, once in six months	15,000	Independent Monitoring Agency	WRD and FREMAA
Soil Erosion (inland erosion) and siltation	Construction Phase	Visual check for Soil erosion and siltation	-	River bank and River training Structure	After first precipitation	Part of routine action of engineering g team	Independent monitoring agency	WRD and FREMAA
	Operation Phase	Study of Soil erosion and siltation	-	River Training Structure, Up stream and Down Stream of the reach	Once during operation of 1st year	Part of routine action of engineering g team	Engineering Team	WRD and FREMAA
Drainage Congestion	Construction Phase	Visual check	-	Project benefit area	After one year of construction.	Part of routine action of Engineering Team	Engineering Team	WRD and FREMAA

Environmental Component	Project stage	Parameter	Standards	Location	Duration / Frequency	Cost (₹)	Implementation	Supervision
	Operation Phase	Visual check	-	Project benefit area	Once during operation of 1st year	Part of routine action of Engineering Team	Engineering Team	WRD and FREMAA
River Hydrology, Morphology and Sediment Transport	Construction Phase	Scientific techniques applicable to the monitoring of these components	-	Entire sub-project area	Regular	Part of routine action of Engineering Team	Engineering Team, WRD	WRD and FREMAA
	Operation Phase	Scientific techniques applicable to the monitoring of these components	-	Entire sub-project area	Regular	Part of routine action of Engineering Team	Engineering Team, WRD	WRD and FREMAA
Tree Plantation	Operation Phase	Scientific techniques applicable to the monitoring of these components	-	Entire Subproject area	Regular	3,00,0000	Forest Department in coordination with WRD	WRD and FREMAA

Environmental Component	Project stage	Parameter	Standards	Location	Duration / Frequency	Cost (₹)	Implementation	Supervision
	Operation Phase	Survival rate of trees success of re-plantation	The survival rate should be at least 70% below which replantation shall be done.	Entire stretch of the project reach	Every year for 3 years	1,50,000	WRD Field Officers with the help of Social Forestry Programme	WRD and FREMAA
Total Costs of monitoring construction stage						**₹8,30,000**		
Total Costs of monitoring operation Stage						**₹3,00,000**		
Transportation for sample collection, contingencies and other logistic support (₹2,00,000 per year)						**₹6,00,000**		
Total cost of monitoring						**₹17,30,000**		

(As there are two reaches Palasbari and Gumi under 2 SIOs so the monitoring cost will be double i.e., ₹17.30,000 X 2 reach – ₹34,64,000)
FREMAA- Flood and River Erosion Management Agency of Assam,
CWC- Central Water Commission, dbA- Decibel, IS- Indian Standard,
SIO- Subproject Implementation Office, SPCB- State Pollution Control Board,
WRD- Water Resource Department, Govt. of Assam.

APPENDIX 15: TRAINING

No.	Target group	Subject(s)	Method	Time Frame
Planning, and Construction Phase[2]				
1	All WRD program staff	**Environmental Overview:** Environmental regulations and national standards, process of impact assessment and identification of mitigation measures, importance of EMP and monitoring, and monitoring methodology (Refresher training)	Lectures (by consultants and local training institutes)	Before implementation of the Tranche-2
2	Environmental engineers, field officers, contractors, supervision consultants	**Implementation of EMPs:** Basic features of an EMP, planning, designing and executing of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions during construction and operation	Workshops and seminars (by in tranche 2 consultants and trained PMU staff)	Before the construction begins
3	Environmental engineers, field officers, contractors, supervision consultants	**Environmentally Sound Construction Practices:** Soil conservation; vegetation protection; waste management and minimization in construction; pollution control at construction camps, construction sites, hot mix plants, and material transportation; devices and methods for construction sites and equipment; environmental clauses in contract documents and their implications; environmental monitoring during construction	Seminars, lectures and site visits (by consultants and trained PMU staff)	Before the construction begins in tranche 2
4	Environmental engineers, field officers, contractors, supervision consultants	**Monitoring Environmental Performance during Construction:** Monitoring air, water, soil erosion, noise, and their effect on vegetation and fisheries; evaluation and review of results; performance indicators and their applicability; possible corrective actions; reporting requirements and mechanisms	Lectures, workshop, and site visitsin tranche 2 (by consultants and trained PMU and SIO staff)	During initial phases of construction
5	Construction laborers	**Waste Handling and Sanitation at Construction Sites and Construction Camps:**	Workshops and signage (by in tranche 2 consultants and trained SIO staff)	During initial phases of construction

The training programs are to be conducted through in-house trainers and hired consultants/professionals. The train the trainer mode delivery may also be considered for in house training capacity development.
During construction phase training/awareness programs will be organized twice a year. During operational phase one workshop/awareness program should be organized every year for the first 2 years. This workshop should highlight the details of environmental condition monitored and tips for environmental protection.

No.	Target group	Subject(s)	Method	Time Frame
During Operation Phase				
6	Environmental engineers, field officers, contractors	**Long-Term Environmental Issues in Program Management:** Designing and implementing environmental surveys for ambient air, noise, biological, and water quality; data storage, retrieval, and analysis; contract documents and environmental clauses; risk assessment and management; contingency planning and management; and value addition	Workshops and seminars (b y consultants and local trainint institutes	During implementation of the program
7	Farmers of the area program benefit area, fishers associated with beel and pond fisheries	Cropping Pattern and high yielding crop production techniques	Workshops and seminars (b yin tranche 2 consultants, and resource persons from research institutes and line departments)	Construction and operations phase
8	Public	Environmental protection awareness program	Workshops and seminars (b yin tranche 2 consultants and trained PMU and SIO staffs)	Construction and operations phase

EMP = environmental management plan, PMU = program management unit, SIO = subproject implementation office, WRD = Water Resources Department.

Source: Water Resources Department, State Government of Assam

Besides above Emphasis must be given on:

(i) Training of the SIOs or their representatives who will monitor the environmental safeguards are the key to the achievement of the proper execution of EMPs in the site, particularly the frequency of the tests of the ambient environment. So, Training on ADB's environmental Safeguards before the start of the actual execution of the physical works under each package are to be carried out by PMC and FREMAA. It was learnt from the Tranche 1

(ii) Employment of the environmental Inspector by each of the contractors before the initiation of the contract package and their training on ADB's SPS, 2009 to be strictly followed.

APPENDIX 16: ENVIRONMENTAL BUDGET PALASBARI AND GUMI REACH

Component	Item	Unit	Quantity	Rate	Amount (million Rs.)
Construction Phase					
Technical Support	Preparation of environmental guidelines and performance indicators		Lump sum	Rs.0.25 million	0.25
Flora	Clearing of plantation	km	Covered in engineering costs		
	Compensatory afforestation (minimum 1:3) (plantation and maintenance for 1 year)	No of tree	Total 1439 trees will be affected. (Plantation 1439 X 3 times) = 4317	Rs20 per sampling and Rs1000 for maintenance for 5 years	4.4
Tree survival monitoring			Rs 100000 per year for 3 years		0.3
Drainage Congestion	Provision of adequate opening		Covered in engineering cost		
Navigation	Adequate lighting and signals		Covered in engineering cost		
Erosion and Sedimentation	Riverbank protection measures		Covered in engineering cost		
Land	Compensation against land acquisition and development of rehabilitation sites		Covered in R&R Budget		
Soil	Maintenance cost in soil conservation		Covered in engineering cost		
Noise	Provision for noise barriers		Covered in engineering cost		
Water	Installation of oil and grease traps at construction sites and wastewater collection and disposal system		Covered in engineering cost		
	Construction of soak pits at construction sites		Covered in engineering cost		
Dust Management during Construction	Water sprayer and watering		Covered in engineering cost		
Construction Safety	Accident risks in construction activity		Covered in engineering cost and insurance		

	General safety (provision of PPE, e.g., ear muffs, gloves etc.)		To be part of contractor's costs		
Health	Health checkup camps for construction workers. AIDS awareness camp	camps	1 camp per 6 months	Rs0.05 million per camp for 3 years	0.45
Environmental Monitoring in the Construction Phase	Terrestrial and aquatic fauna including fisheries		Cost as mentioned in monitoring plan. For Palasbari reach		0.53
	Ambient air quality				
	Surface water quality				
	Ground water and drinking water quality				
	Noise quality				
	Soil erosion and siltation				
	Drainage congestion				
	Monitoring tree felling and plantation				
	Additional monitoring by FREMAA, SIO (if required)				0.2
		SUB TOTAL (CONSTRUCTION STAGE)			6.13
Operations Phase					
Erosion Control and Landscaping	Reserve Fund for Erosion Control and Embankment Protection	Lump Sum	To be part of regular maintenance and operation costs		
Tree survival	Survival monitoring and Provision of additional tree plantation	Lump sum	Costs towards survival monitoring are included in the monitoring budget.		2.0
Monitoring of performance indicators	Terrestrial and aquatic fauna		Cost as mentioned in the monitoring plan. Monitoring costs considered on an average same for each reach (@ Rs0.5 million per reach for entire construction period)		0.5
	Ambient air quality				
	Surface water quality				
	Groundwater Quality and levels				
	Levels of noise				
	Soil erosion and siltation				
	Drainage congestion				
	Monitoring of				

	Plantation				
		SUB TOTAL (OPERATION PHASE)			2.5
EASTABLISHMENT AND TRAINING					
Establishment	Construction stage - Environment Inspector, Safety Inspector, Nurse	36 man-months each	36 man - months each	@ 0.05 million per reach per month (0.05 X 36 months)	1.8
	Fuel storage and workshop areas				0.62
	Operation Stage	12 man-months	12	Rs75,000 per person/ month	0.9
Training	Environmental training and awareness	Lump sum		As per training details	1.0
Management Information system, Documentation		Lump sum			1.0
Transportation for sample collection				Rs 200000 per year for 3 years	0.6
		SUB TOTAL (Establishment and Training)			5.92
Subtotal (Establishment & Training)					5.92
Subtotal (Construction, and Operation and Mobilization)					8.63
Contingencies @ 10 % on total environmental costs					1.4
GRAND TOTAL					**15.95**

PPE = personal protective equipment, R&R = resettlement and rehabilitation.
Source: Water Resources Department, State Government of Assam

(As there are two reaches Palasbari and Gumi under 2 SIOs so the monitoring cost will be double i.e., Rs. 15.95 million X 2 reach – Rs. 31,9 million)

PHOTO DOCUMENTATION PLATES 1

Palasbari – Gumi Subproject

Plate 1&2- Proposed work sites (Gumi)

Plate 3 &4- Proposed work sites (Gumi)

Plate 5 Proposed work sites (Palasbari)

Plate 6 Proposed work sites (Gumi)

Plate 7: Existing Embankment

Plate 8: Existing Bolder Flow Deflector (near Gumi)

Plate 9: Proposed works site at Palasbari

Plate 10: Bamboo Vegetation along the Embankment

Public hearing on 4thNovember, 2015 at Gumi

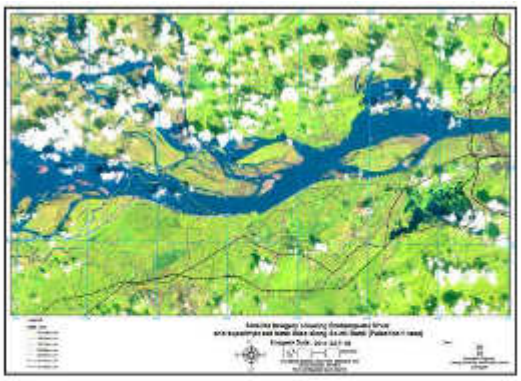
Public hearing- Simina under Palasbari reach on 5thNovember, 2015

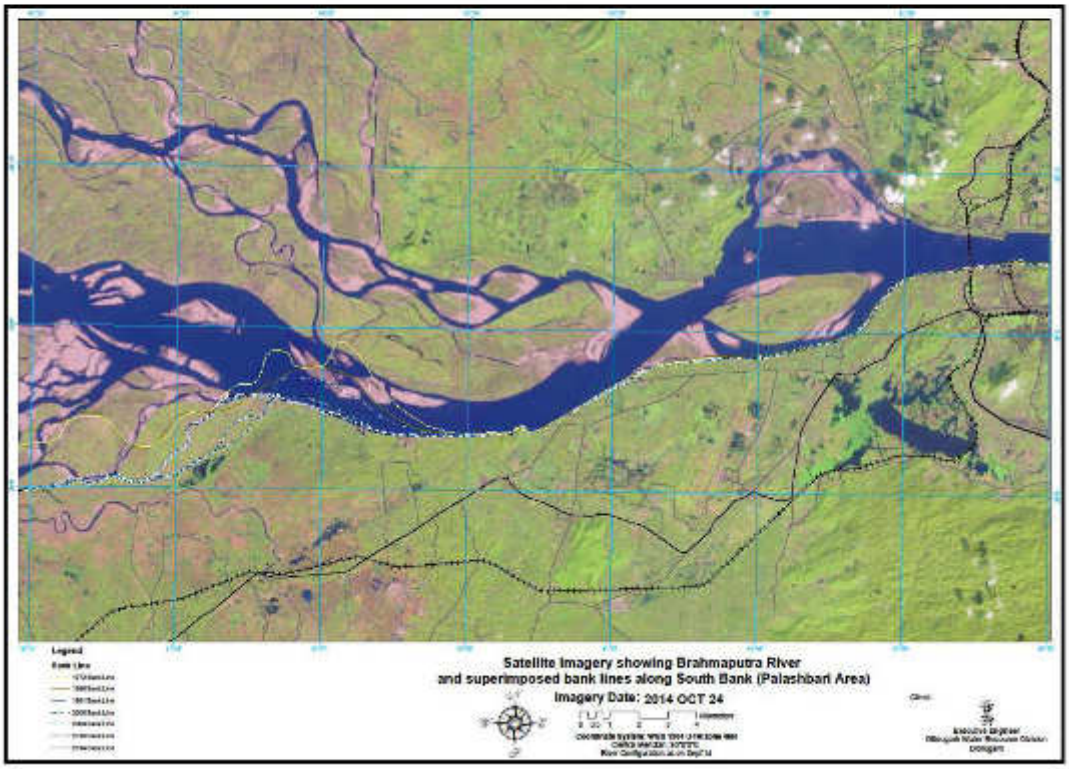
Plate-11: Public hearing for tranche -2

Plate 12: Public consultation on 10th November, 2016 at Palasbari

Plate 13: River Erosion near Gumi site

Plate 14: Kanjan River near Brahmaputra Confluence (river dolphin breeding site)




Legend
Satellite Imagery showing Brahmaputra River
and superimposed bank lines along South Bank (Palashbari Area)
Imagery Date: 2014 OCT 24