Initial Environmental Examination

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Nepal: Irrigation Modernization Enhancement Project

Rajapur Irrigation Project

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CURRENCY EQUIVALENTS
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Currency unit	–	Nepali Rupee (NR)
NR1.00	=	$0.0075
$1.00	=	NRs134.238

ABBREVIATIONS

AO	–	Association Organizer
ADB	–	Asian Development Bank
AKC	–	Agriculture Knowledge Center
BES	–	Brief Environment Study
BNP	–	Bardiya National Park
BOQ	–	Bill of Quantities
CAMO	–	Central Agriculture Development Office
CBD	–	Convention on Biodiversity
CGF	–	Credit Guarantee Fund
CO	–	Community Organizer
COVID-19	–	Coronavirus disease 2019
CPMO	–	Central project management office
CPR	–	Community Property resources
CSD	–	Central Safeguard Desk
DDR	–	Detail Design Report
DWRI	–	Department of Water Resources and Irrigation
EA	–	Executing Agency
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EPA	–	Environmental Protection Act
EPR	–	Environmental Protection Regulations
ESS	–	Environmental Safeguard Specialist
ESM	–	Environmental Safeguard Monitor
FMIS	–	Farmers-managed irrigation system
GoN	–	Government of Nepal
GRC	–	Grievance Readdress Committee
GRM	–	Grievance Readdress Mechanism
G-RM	–	Geruwa Rural Municipality
IBAT	–	Integrated Biodiversity Assessment Tool
IEE	–	Initial Environmental Examination
IFC	–	International Finance Corporation
IMEP	–	Irrigation Modernization Enhancement Project
IP	–	Indigenous People
KRMP	–	Karnali River Management Project

LAR	–	Land Acquisition and Resettlement
LGOA	–	Local Government Operational Act
MEWRI	–	Ministry of Energy, Water Resources and Irrigation
MOM	–	Management, operation, and maintenance
NAAQS	–	National Ambient Air Quality Standard
NLSS	–	Nepal Living Standard Survey
NOENQS	–	National Occupational Exposure Noise Quality Standard
NPHC	–	Nepal Population and Housing Census
O&M	–	Operation and maintenance
OHS	–	Occupational, Health and Safety
PIMS	–	Project Implementation Management and Support
PIU	–	Project implementation unit
PPE	–	Personal Protective Equipment
REA	–	Rapid Environmental Assessment
RIP	–	Rajapur Irrigation Project
RIRP	–	Rajapur Irrigation Rehabilitation Project
RIMO	–	Rajapur Irrigation Management Office
RM	–	Rural Municipality
SEMP	–	Site Specific Environmental Management Plan
SEMRs	–	Semi-Annual Environmental Monitoring Report
SLO	–	Safeguard Liaison Officer
SMU	–	Subproject Management Unit
SPS	–	Safeguard Policy statement
SPPR	–	Subproject Preparation Report
UN	–	United Nation
WUA	–	Water Users' Association
WHO	–	World Health Organization
WUC	–	Water User Cooperatives
WRIDD/ SD	–	Water Resources and Irrigation Development Division/ Subdivision

WEIGHTS AND MEASURES

%	–	Percentage
°C	–	degree Celsius
µg/m3	–	Microgram per cubic meter
dBA	–	decibels audible
ha	–	Hectare
km	–	Kilometer
m^3	–	cubic meter
mm	–	Millimeter

NOTES

In this report, "$" refers to US dollars unless otherwise stated.

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EXECUTIVE SUMMARY

1. This initial environmental examination (IEE) report, including an environmental management plan (EMP), has been prepared for the Rajapur Irrigation Project (RIP or Subproject) to be implemented under the Irrigation Modernization Enhancement Project (IMEP, hereafter referred to as the project) in Nepal. The project is proposed for financing from the Asian Development Bank (ADB). The subproject IEE is prepared following ADB's Safeguard Policy Statement (SPS 2009) requirements and with reference to national (Nepal) environmental, health and safety requirements and obligations under international agreements. The IEE is prepared based on the feasibility and design report for RIP and the results of site investigations and discussions with various stakeholders during environmental due diligence.

2. The project will (i) improve the productivity, profitability, and climate resilience of 113 farmer-managed irrigation systems (FMIS) across five provinces and (ii) institutionalize irrigation modernization and integrated crop and water management (ICWM). The project will help improve the incomes of approximately 56,000 families. The project will (i) modernize 32,000 hectares (ha) of surface water irrigation systems; (ii) pilot innovative hill lift irrigation systems to irrigate 1,400 ha of dry uplands (Tar); (iii) strengthen the capacity of local government institutions in integrating agriculture, water management, and irrigation; and (iv) introduce climate-smart agriculture and support in agriculture value chain services. The project will be aligned with the following impact: national food security increased. The project will have the following outcomes: increased productivity, sustainability, and profitability of farms. To meet the project objectives, the project will have three outputs, i.e., Output 1: Irrigation infrastructure modernized; Output 2: Irrigation and Agriculture Agencies and Farmer Organizations Strengthened; Output 3: Modern agriculture and value chain facilities introduced.

3. The government has requested a concessional loan of $85 million from ADB's ordinary capital resources to help finance the project. The government has also requested a loan not exceeding $30 million from the Saudi Fund for Development to help finance the project. The project will be implemented over a period of 7 years from the year 2024 to the year 2030. The executing agency will be the Federal Ministry of Energy, Water Resources, and Irrigation (MOEWRI). At the federal level, the implementing agencies will be the Department of Water Resources and Irrigation (DWRI) and the Ministry of Agriculture and Livestock Development, acting through the Department of Agriculture (DO). There will be implementing agencies at the provincial level as well. Project implementation units will be established at the federal level as well as at the provincial level.

4. **RIP Subproject Scope and Components.** The scope of work in the Rajapur Irrigation Project component mainly includes rehabilitating the existing canal system structures. The main interventions proposed under the subproject include (i) restoring and strengthening the approach channel to the Budhi Kulo intake; (ii) provision of gates and a scour sluice at the Budhi Kulo intake; (iii) providing additional river protection; (iv) provision of settling basins in a sample of branch canals; (v) restoring and strengthening the gabion weirs at the Maila/Manau and Khairi Chandanpur intakes; (vi) limited improvements to the internal irrigation system; (vii) institutional and capacity development to improve irrigation management of the system; and (viii) agricultural support to increase production and diversify cropping.

5. **Categorization.** The proposed Rajapur Irrigation Project under the IMEP is classified as environmental category "B" as per ADB's SPS 2009, and accordingly, this initial environmental examination (IEE) is carried out. In particular, the IEE's goal is to find out what impact the project activities might have on the environment and suggest measures to avoid or reduce risks during the planning, construction, and operation stages of the Project. The CPMO shall not award any works contract under the project components until (i) relevant provisions from the EMP are incorporated into the works contract; (ii) this IEE is updated to reflect project components detailed design and CPMO

has obtained ADB's clearance of such updated IEE; and (iii) the proposed RIP rehabilitation works are limited within the existing canal systems. There is no construction of new head works and changes in the main canal systems. Thus, per the Nepal Government regulatory framework requirements, the project component does not trigger the preparation of BES/IEE/EIA.

6. **Description of the Environment.** The RIP subproject components are located in the western part of the country in the Terai region. The subproject area is sectioned off from the rest of Bardia District by the Geruwa River on the east. Administratively, the northern part of the island lies in Geruwa Rural Municipality, and the southern part falls under Rajapur Municipality. The eastern part of the Geruwa River is the Bardiya National Park (BNP). The elevation of the command area is between 142 m to 180 m from the mean sea level. Karnali River is an aggressive and unpredictable gravel and boulder bed river that changes its course every year. The river carries large sediments from the highlands, and as the river emerges from Chisapani and flows towards the plain area, it loses its sediment-carrying capacity resulting in sediment deposition and eventually leading to the formation of meandering and braided channels. Moreover, changes in river morphology are also quite unpredictable. Shifting the dominant flow path to the left or right bank creates uncertainty in water diversion into the canal system.

7. The climate of the subproject area is a tropical monsoon climate with wet and dry seasons. The average annual rainfall is around 2500 mm, with most rain falling during the monsoon season from June to September. The temperature ranges from an average minimum of 10°C in winter to a maximum of 43°C in summer. The results of the baseline environmental monitoring carried out were representative of primary air quality monitoring at the RIP area. Results indicate that the concentration of PM_{10} was recorded at 54 to 110 µg/Nm^3 against the standard limit of 120 µg/Nm^3. In comparison, $PM_{2.5}$ concentration was recorded at only 11 to 32 µg/$Nm^{3,}$ which was also well below the standard limit of 40 µg/Nm^3. Similar to particulate matters, gaseous parameters such as lead, SO2, and NO_x concentration were also recorded, and all of these parameters were recorded within the National Ambient Air Quality Standards (NAAQ). Noise levels are also well within acceptable limits. The monitored soil quality of Jotpur and Jhapti is slightly alkaline in nature. The surface irrigation water quality of the Karnali River reveals that the physicochemical parameters chosen for analysis were found to be used for irrigation purposes and were found to be well within a suitable range in this season's monitoring.

8. The RIP is located within proximity to Bardiya National Park. Specifically, there is a buffer zone at several components and a Bardiya National Park close to the project area on the eastern side. Bardiya National Park, Dudhwa National Park and Katerniaghat Wildlife Sanctuary and Girijapur Barrage and a Ramsar Site (Wetland of International Importance) Ghodaghodi Tal and Krishnasar Conservation Area are within a 50 km buffer from the project area. The key biodiversity area is the Bardiya National Park, 10km from the proposed project area. The species number found in the proposed periphery in the IUCN Red List is 38 species. There is likely a critical habitat, with 14 species near the project area. Additionally, 24 are found to be endangered, and 38 are vulnerable species.

9. **Potential Environmental Impacts and Mitigation Measures.** The RIP scope of work is mainly limited to the rehabilitation of the existing canal structures. There will not be any canal extension work or construction activities in the forest patches and the agricultural command area, but the strengthening works of the intake and branch canal sections. The potential impacts were identified in relation to pre-construction, construction, and operation phases. Potential environmental impacts were assessed using secondary data, stakeholder consultations, and field visits. The project will not encroach upon core area of the national park , and ancient heritage sites. The project's key activities that attract environmental concerns are intake rehabilitation for surface water diversion, riverbank protection, strengthening irrigation infrastructure, labor camps, and quarry operations. The environmental impacts predicted during implementation are mainly restricted to the construction

stage. They will be site-specific, , temporary, and of less adverse, such as dust during construction, sediment flow from construction in the rivers, noise pollution, and camp operation. Various construction activities will result in various occupational health and safety risks, which need to be mitigated through compliance with the safety protocols. During the operation stage, increased fertilizer, pesticides, and other agricultural chemicals increase the risk of soil contamination and water pollution. Thus, awareness activities for the farmers and proper training on the sustainable use of water and the appropriate use of fertilizers and pesticides shall be provided by the agriculture unit.

10. **Environmental Management Plan.** All impacts identified during the environmental assessment are found to be moderate, and mitigation measures are readily available. Most of these impacts are linked to civil works and predicted to be of moderate significance, and localized, which can easily be avoided (through good design and construction planning) or mitigated through the proper implementation of the EMP proposed in this report.

11. The specific management measures laid down in the IEE will successfully address any adverse environmental impacts due to the subproject. Implementation of appropriate measures during the design, construction, and operation phases will minimize negative impacts to acceptable levels. To ensure that these mitigation measures are implemented, and negative impacts avoided, the measures will be included in the contractor's contract specification. Contractors' conformity with contract procedures and specifications and implementation of the approved Site-specific environmental management plan (SEMP) during civil works will be carefully monitored by the Central Project Management Office (CPMO). Further, the environmental monitoring plans also provide adequate opportunities for course correction to address any residual impacts during construction or operation stages.

12. In the event of unanticipated environmental impacts not considered as significant during implementation and not considered in the IEE and EMP, the CPMO shall prepare a corresponding time-bound and budgeted corrective action plan acceptable to ADB and ensure that these are implemented by the contractor/s and reported accordingly in environmental monitoring reports to ADB.

13. **Implementation Arrangement.** The Ministry of Energy, Water Resources and Irrigation (MEWRI) will be the Executing Agency (EA) and the Department of Water Resources and Irrigation (DWRI) will be the implementing agency of the project. The Central Project Management Office (CPMO) will be responsible for the project's overall implementation and ensuring compliance with ADB's environmental safeguards requirements. The CPMO will establish a "Central Safeguard Desk" (CSD) and comprise a Safeguard Liaison Officer (SLO) supported by an Environmental Safeguard Specialist (ESS) of PIMS. The SLO will ensure full compliance with the overall environmental and social safeguards requirements of the project. The SLO will work closely with the environmental and social development focal points of the Rajapur Irrigation Management Office (RIMO).

14. The ESS will support the CPMO and field offices in maintaining overall environmental safeguards and OHS requirements in the project. The ESS will prepare an e-MIS and support the safeguarding of field monitors at field offices in monitoring environmental and OHS activities. The CPMO will mobilize a full-time Environmental Safeguard Monitor (ESM) at the project site. ESM will work under the guidance of ESS of PIMS. The contractor supporting civil works under DWRI shall include the cost for preparing and implementing site-specific environmental management and OHS plan (SEMP) along with mobilizing a full-time senior safeguard officer and a senior safety officer and include the cost in their BOQ. The inclusion of sufficient cost for EMP and safeguard/OHS staff shall be verified and assured by the senior environment specialist at CPMO. The employer will approve the integrated SEMP before their field mobilization.

15. **Consultation, Information Disclosure, and Grievance Redress Mechanism.** Consultations were undertaken in the Rajapur Irrigation Project with the stakeholders in line with the

requirements for social and environmental considerations. Prior to consultation meetings with local stakeholders, advance notification was circulated, and coordination was established with stakeholders through the project office. Additionally, the consultations focused on seeking stakeholder's opinions, especially the local government's views on potential physical and economic impacts, key risks, mitigation measures, and many more. The RIP scope of rehabilitation works in the existing canal system was informed to officials of Bardiya National Park officers. The participants were in complete agreement about the benefits of the subproject and expressed full support for it. The ADB safeguard requirements on environmental assessment, involuntary resettlement, GRM procedures, etc., were shared with Municipal authorities, Water User Association (WUA), and National Park authorities.

16. As required under the ADB SPS 2009, a project-specific grievance redress mechanism (GRM) has been proposed. The GRM is a three-tier arrangement that facilitates time-bound grievance resolution at each level. Responsible persons and agencies/offices are identified to address grievances and seek appropriate advice at each stage, as required. Institutional arrangements, including the constitution of grievance redress committees (GRC) at various levels, will be ensured to function throughout the project duration. The CPMO shall ensure the constitution of these committees and oversee the implementation of grievance redress processes, including adherence to time limits, record keeping, and documentation at each level. The presence of GRM or seeking relief from GRM is not a bar to taking grievances and complaints to the judiciary system of the land. Further, there is an ADB Accountability Mechanism whereby people adversely affected by ADB-financed projects can express their grievances, seek solutions, and report alleged violations of ADB's operational policies and procedures, including safeguard policies.

17. **Monitoring and Reporting.** The CPMO will monitor the overall progress of EMP implementation of all IMEP components. The CPMO, PIMS, and contractor safeguard team will undertake their respective roles in site inspections and document reviews to verify compliance with the EMP and SEMP and progress toward the final outcome. The contractor will conduct the day-to-day implementation of the SEMP and will submit monthly reports to the CPMO.

18. The PIMS will submit quarterly environmental monitoring reports to CPMO, which will include a summary of the contractor's monthly monitoring activities and results of any independent monitoring or inspection activities of the project. CPMO, with support from the PIMS, shall accomplish semi-annual environmental monitoring reports (SEMRs) starting from the effectivity date up to the end of the construction phase, which shall be submitted to ADB for review and disclosure on the ADB website. The CPMO shall prepare and submit an annual environmental monitoring report during the operation phase until ADB issues a project completion report.

19. **Conclusion.** The IEE for the RIP within the buffer zone of Bardia National Park outlines a comprehensive framework aimed at minimizing environmental impacts and safeguarding terrestrial wildlife. Through detailed environmental impact assessments, baseline data collection, and active community consultation, the IEE ensures that construction activities are aligned with the conservation goals of Bardia National Park. The implementation of robust mitigation measures, such as erosion and sediment control, wildlife monitoring, and habitat restoration, underscores a commitment to preserving biodiversity and promoting sustainable development.

I. INTRODUCTION

A. Background and Rationale

1. ADB has supported Nepal since the 1980s through five FMIS sector projects consisting of 1,190 subprojects (456 small and 734 medium scale) irrigating a total area of 140,704 ha. Although the projects were evaluated as successful1, there are however key issues that need to be addressed to meeting the needs of productivity and climate resilience including; (i) the devolved irrigation and agriculture agencies lack capacities and resources to support the irrigation and agriculture management, issues include slow progress in passing needed legislation, deploying staff, as well as lack of clarity on mandates and responsibilities and coordination among the three tiers of government; (ii) the management performance of the WUA remains weak, with insufficient capacities and resources to meet present needs and future requirement under climate change; (iii) there is a need for a strong nucleus organization at the field level for integrated management of irrigation and agriculture to meet operational requirements including, improved irrigation efficiencies, agriculture productivity and climate resilience; (iv) there is a lack of communications to the dispersed schemes, effective communication to the to the different sub-project stakeholders is critical to meet long term long term needs of irrigation and agriculture including advisories on weather, climate change, water and agriculture management, crop technologies; (v) farmers face many challenges including climate change, acute labor shortages, low productivity and lack of access to inputs, marketing constraints, food and nutrition security and lack of dissemination of technologies. The government must support the sector in preparing a national strategy to address the increasing risks and understanding of climate change to make the systems resilient and self-sustainable.

2. The proposed Irrigation Modernization Enhancement Project (IMEP) will (i) improve productivity, profitability, and climate resilience of 113 farmer-managed irrigation systems (FMIS) across five provinces and (ii) institutionalize irrigation modernization and integrated crop and water management (ICWM).[1] The project will help improve the incomes of approximately 56,000 families. The project will (i) modernize 32,000 hectares (ha) of surface water irrigation systems; (ii) pilot innovative hill lift irrigation systems to irrigate 1,400 ha of dry uplands (Tar); (iii) strengthen the capacity of local government institutions in integrating agriculture, water management, and irrigation; and (iv) introduce climate-smart agriculture and support in agriculture value chain services.

B. The Proposed IMEP Project

3. The project will be aligned with the following impact: national food security increased. The project will have the following outcomes: climate-resilient irrigated agricultural productivity and enhanced sustainability. The project beneficiaries will be small and marginal farmers who will benefit through access to water, knowledge of managing modern and resilient infrastructure, increased yields, and incomes. The project will mainstream FMIS investments into the national financing system to reduce the country's reliance on external donor support.

4. The project will have the following outcome: increased farm productivity, sustainability, and profitability. To meet the project objectives, the project will have three outputs, as summarized below.

[1] ADB. 2020. Completion Report: Community Irrigation Project in Nepal. Manila. Covered small scale FMIS in Lumbini, Karnali and Sudurpaschim Provinces. Whereas the (i) ADB. Nepal: Irrigation Sector Project (1988), (ii) ADB. Nepal: Second Irrigation Sector Project (16 May 1996), (iii) ADB. Nepal: Community-Managed Irrigated Agriculture Sector Project (17 Nov. 2004), and (iv) Nepal: Community-Managed Irrigated Agriculture Sector Project–Additional Financing (10 April 2014) were the four medium scale FMIS supported by ADB, which covered Koshi, Madhesh, Bagmati, Gandaki, Lumbini, Karnali and Sudurpaschim Provinces.

(i) **Output 1: Irrigation Infrastructure Modernized**: This output will modernize FMIS infrastructure in Bagmati, Koshi, Lumbini, and Madhesh provinces to improve performance and increase resilience to climate change. Across those irrigation systems, the project will (i) provide gated intake structures and protect riverbanks and hill slopes to reduce flood and sediment ingress; (ii) improve irrigation efficiency, stability, and equitable management of irrigation water through targeted canal lining and improved control structures and provision of cross drainage; and (iii) support on-farm irrigation by upgrading minor canals and expanding use of modern pipe distributions. The project will introduce hill lifts and piped and micro irrigation schemes in the largely unirrigated mid-hill areas of Gandaki and Lumbini Provinces. Considering water scarcity in some areas, the project will pilot community-based conjunctive groundwater at selected schemes.

(ii) **Output 2**: **Irrigation and agriculture agencies and farmer organizations strengthened**. This output will update the national Integrated Crop and Water Management (ICWM) guidelines 2021, reflecting innovations introduced through the project, including the adoption of cropping patterns based on water availability and climatic conditions, enhancing equitable use and water use efficiency, and integrating ICWM in overall system planning. This output will also strengthen the capacity of WRIDDs, Agriculture Knowledge Centers (AKC), and the irrigation and agriculture units at the local level (AULLs) to integrate irrigation management and agriculture development in the overall FMIS sector. The project will support the Agriculture Information and Training Center under the DOA in developing training modules and training the agricultural extension agents on ICWM. At the farm level, the project will; (i) strengthen Water User Associations' (WUA) capacity to operate better and maintain irrigation systems; and (ii) establish in selected irrigation systems, Water User Cooperatives (WUCs) that will have agribusiness functions enabling them to access rural finance, receive government subsidies on agricultural inputs, support the market chain, facilitate agro-enterprises, and network with private agri-enterprises. For the hill lift irrigation schemes, the WUCs will operate as water utilities using metered charging systems and will collect fees to help meet full recovery costs for operating costs. The project will also update the irrigation design manual by integrating evolving issues like climate change impacts and prepare the management and operation and maintenance (MOM) manual for increased climate resilience and sustainable management of irrigation systems, respectively. WUAs will be supported in developing canal operation plans before commissioning the schemes.

(iii) **Output 3: Modern agriculture and value chain facilities introduced:** This output will implement agriculture development plans (ADPs) in the subproject areas. The activities will include demonstration and training in (i) adopting advanced agricultural technologies, including modern farm machinery and equipment to enhance efficiency and productivity and address labor shortages; (ii) adopting climate-smart agricultural practices to improve crop yield, quality, and production; storage, processing and marketing; and (iii) exploring upstream and downstream opportunities to promote value addition. The project will support the establishment of digital advisory services to provide information on weather, marketing, and agriculture advisory services. The digital apps will improve farmers' operational efficiency and decision-making. As the farmers and farmer organizations lack access to finance, the project will pilot the provision of partial financing to selected WUAs/WUCs who want to invest in modern agriculture machinery and facilities. The WUA/WUC will be required to contribute 50% of

financing for machinery and 15% for facilities. The aim is to demonstrate a viable and sustainable business model.

5. The government has requested a concessional loan of $85 million from ADB's ordinary capital resources to help finance the project. The government has also requested a loan not exceeding $30 million from the Saudi Fund for Development to help finance the project. implemented over a period of 7 years from the year 2024 to the year 2030. The executing agency will be the Federal Ministry of Energy, Water Resources, and Irrigation (MOEWRI). At the federal level, the implementing agencies will be the Department of Water Resources and Irrigation (DWRI) and the Ministry of Agriculture and Livestock Development, acting through the Department of Agriculture (DO). There will be implementing agencies at the provincial level as well. Project implementation units will be established at the federal level as well as at the provincial level.

6. This IEE report, including an environmental management plan, has been prepared for the Rajapur Irrigation Project (RIP or Subproject) to be implemented under Output 1 of the IMEP. All discussions hereafter in this report are focused on the RIP component of the IMEP.

7. **RIP Subproject Scope and Components.** The scope of work in the Rajapur Irrigation Project component mainly includes rehabilitating the existing canal system structures. The main interventions proposed under the subproject includes (i) restoring and strengthening the approach channel to the Budhi Kulo intake; (ii) provision of gates and a scour sluice at the Budhi Kulo intake; (iii) providing additional river protection; (iv) provision of settling basins in a sample of branch canals; (v) restoring and strengthening the gabion weirs at the Maila/Manau and Khairi Chandanpur intakes; (vi) limited improvements to the internal irrigation system; (vii) institutional and capacity development to improve irrigation management of the system; and (viii) agricultural support to increase production and diversify cropping.

C. Purpose and Objective of the IEE

8. This initial environmental examination (IEE) for the proposed Rajapur Irrigation Project component (under IMEP) has been carried out in compliance with ADB's Safeguard Policy Statement, 2009 requirements and with reference to national (Nepal) environmental, health, and safety requirements and obligations under international agreements.

9. Based on the likely types, sizes, and locations of the subproject facilities, the project has been classified by ADB as environment category B as determined by the project's most environmentally sensitive component, the irrigation system improvement, which will have adverse environmental impacts both during construction as well as operation stages. The specific objectives of the IEE are to:

(i) Provide an environmental and social baseline description of the project.

(ii) Identify and describe the potential environmental impacts of the project.

(iii) Design mitigation measures to minimize adverse impacts.

(iv) Describe the public consultation process and grievance redress mechanism.

(v) Provide an environmental management and monitoring plan for the project (including defining institutional responsibilities, capacity building and training, and the required budget).

10. The purpose of this IEE is to assess the potential environmental, health, safety, and social impacts of the proposed irrigation interventions and propose suitable mitigation measures where required. In case of any changes in the project design or locations of components during the detailed design stages, following ADB project approval, this IEE will be

updated for ADB's review and clearance in compliance with ADB's SPS 2009 prior to commencing any works.

11. The environmental studies have been confined to the site and its direct influence area. The IEE is based on proposed project components and its key civil works activities. The direct impact area is taken as a 100m radius of the proposed project site. However, the study area impact zone is considered up to a 500m radius to cover sensitive areas such as national protected areas networks. Assessment is carried out on various environmental components, including terrestrial and aquatic ecology, soil, water, air, noise, and socio-economic aspects.

D. Scope and Methodology of the IEE

12. The scope of this IEE covers the physical interventions proposed under the Rajapur Irrigation ProjectRIP component (under IMEP). The assessment of environmental, health, safety, and social impacts and risks has been undertaken based on the review of the project scope details on components and information on technical specifications for the irrigation system. Field visits, surveys, and consultations with key stakeholders and communities have also been undertaken as part of this assessment. Primary data was collected from the field visits, surveys, and consultations, and secondary information was collected from various sources. During site visits, the team had consultations with ward representatives, officials of respective municipalities, and community people have been carried out for their opinions on the project. The results of the consultations with ward representatives, officials of respective municipalities, and community people, as well as an evaluation of the institutional framework, have been incorporated into this assessment report.

13. This IEE was prepared during project feasibility and technical studies between the months of January to May 2024, covering the design details of the project components. Technical studies have been completed, and bid documents are being prepared, including a detailed bill of quantities (BOQ) to support the technical specifications. The contractors will carry out the final detailed design, which will be reviewed and approved by CPMO and technical consultants supporting them before the commencement of work. In case of any changes in the project design or locations of components during the detailed design stages, following ADB project approval, this IEE will be updated for ADB's review and clearance in compliance with ADB's SPS 2009 prior to commencing any works. Any update must ensure the Project continues to comply with the standards and measures specified in this IEE and the EMP and has the same or less environmental impact than is currently predicted, e.g., no significant impacts are anticipated.

E. Structure of the IEE

14. In compliance with ADB's SPS 2009 requirements, this IEE has been structured and consists of eight sections: (i) Introduction; (ii) Policy, Legal and Administrative Framework; (iii) Description of the Project; (iv) Description of the Environment; (v) Anticipated Environmental Impacts and Mitigation Measures; (vi) Consultation, Participation and Information Disclosure; (vii) Environmental Management Plan; and (viii) Conclusion and Recommendation. The executive summary is also provided at the beginning of the IEE report.

15. The IEE report is supported by appendices which include (i) a REA Checklist, (ii) photographs (consultations), (iii) a template of an environment monitoring report, and (iv) grievance forms, etc.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

16. An environmental assessment of the RIP subproject has been carried out in accordance with ADB's SPS 2009, considering the government of Nepal's environmental, health, and safety policy and legislation requirements. The subsequent sections summarize the policies, laws, regulations, and guidelines applicable to this project based on its location, design, construction, and operation. The administrative framework to implement these laws and regulations is also discussed.

A. ADB's Safeguard Policy Statement 2009 Requirements

17. ADB's Safeguard Policy Statement 2009 requires the consideration of environmental issues in all aspects of ADB's operations, and the requirements for environmental assessment are described in ADB SPS, 2009. ADB environmental safeguards are triggered if a project is likely to have potential environmental risks and impacts. A project is classified based on the most environmentally sensitive component and assigned one of the four environmental categories (A, B, C, or FI) defined in the SPS. These categories are as follows.

(i) **Category A**: Project that is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect areas larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA), including an environmental management plan (EMP), is required.

(ii) **Category B**: Project with potential adverse environmental impacts that are less adverse than those of category A projects. These impacts are site-specific, and few, if any, are irreversible. In most cases, mitigation measures can be designed more readily than for category A projects. An initial environmental examination (IEE), including an EMP, is required.

(iii) **Category C:** Project that is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications must be reviewed.

(iv) **Category FI**: The project is classified as category FI if it involves investing ADB funds in or through a financial intermediary.

18. The subproject underwent initial screening using ADB's rapid environmental assessment (REA) checklist (**Appendix 1**). The results of the rapid assessment show that the project is unlikely to cause any significant adverse impacts and is, therefore, classified under Category B per ADB SPS. Thus, this IEE report has been prepared following ADB SPS 2009 requirements for Category B projects.

19. **Environmental Assessment**. Environmental assessment shall include a description of environmental and social baseline to provide an understanding of current conditions, forming the benchmark against which project components' impacts are assessed. Environmental impacts and risks will be analyzed for all relevant stages of the project cycle, including the design and planning stage, construction, operations, decommissioning, and post-closure activities such as rehabilitation or restoration.

20. **Environmental Planning and Management**. The Central Project Management Office (CPMO) shall prepare an environmental management plan (EMP) to be included in the IEE report. The EMP shall describe and address the potential impacts and risks identified by the environmental assessment. The level of detail and complexity of the EMP and the priority of the identified measures and actions will be commensurate with the subproject's impact and risks.

The EMP shall include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.

21. **Public Disclosure**. The CPMO shall submit the following to ADB for review, clearance, and disclosure. ADB will disclose acceptable reports received and endorsed by the DWRI on the ADB website so affected people, other[2] stakeholders and the public can provide meaningful input into the subproject design and implementation.

(i) Draft / updated / final IEE upon receipt;

(ii) a new or updated IEE and corrective action plan prepared during subproject implementation, if any, upon receipt; and

(iii) environmental monitoring reports submitted during subproject implementation upon receipt.

22. **Consultation and Participation**. The CPMO shall carry out meaningful consultation[3] with affected people and other concerned stakeholders, including civil society, facilitating their informed participation. The environmental assessment report will document and reflect the consultation process and its results.

23. **Grievance Redress Mechanism**. The CPMO shall establish a mechanism to receive and facilitate the resolution of affected peoples' concerns, complaints, and grievances about the subproject's environmental performance. The grievance mechanism shall be scaled to the subproject's risks and adverse impacts.

24. **Monitoring and Reporting**. The CPMO shall monitor, measure, and document the progress of implementing the EMP. If necessary, the CPMO will identify and reflect the necessary corrective actions in a corrective action plan. The CPMO will prepare and submit to ADB semi-annual environmental monitoring reports that describe progress with implementing the EMP, compliance issues, and corrective actions, if any. Reporting will continue for subprojects likely to have significant adverse environmental impacts during operation until ADB issues a project completion report.

25. **Unanticipated Environmental Impacts**. Where unanticipated environmental impacts become apparent during subproject implementation, CPMO shall update the environmental assessment and EMP or prepare a new environmental assessment and EMP to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.

26. **Pollution Prevention and Control Technologies**. During the design, construction, and operation of the project component, the CPMO shall apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in

[2] Per ADB SPS, 2009, prior to disclosure on ADB website, ADB reviews the "borrower's/client's social and environmental assessment and plans to ensure that safeguard measures are in place to avoid, wherever possible, and minimize, mitigate, and compensate for adverse social and environmental impacts in compliance with ADB's safeguard policy principles and Safeguard Requirements 1-4." Upon its receipt of acceptable safeguard documents and endorsement by CPMO, ADB discloses the same on ADB website.

[3] Per ADB SPS, 2009, meaningful consultation means a process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle;1 (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

internationally recognized standards such as the International Finance Corporation (IFC) World Bank Group's Environmental, Health, and Safety Guidelines. These standards contain performance levels and normally acceptable measures applicable to subprojects. When the government regulations differ from these levels and measures, the subproject shall achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, DWRI, through CPMO, will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

27. **Occupational Health and Safety**. The CPMO shall ensure that workers are provided with a safe and healthy working environment, considering risks inherent to the sector and specific classes of hazards in the subproject work areas, including physical, chemical, biological, and radiological hazards. CPMO shall ensure to take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work by (i) identifying and minimizing, so far as reasonably practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances; (iii) providing appropriate equipment to minimize risks and requiring and enforcing its use; (iv) training workers and providing them with appropriate incentives to use and comply with health and safety procedures and protective equipment; (v) documenting and reporting occupational accidents, diseases, and incidents; and (vi) having emergency prevention, preparedness, and response arrangements in place.

28. **Community Health and Safety**. The CPMO shall identify and assess the risks to and potential impacts on the safety of affected communities during the project's design, construction, operation, and decommissioning and will establish preventive measures and plans to address them in a manner commensurate with the identified risks and impacts.

29. CPMO shall ensure the application of preventive and protective measures for occupational and community health and safety consistent with international good practice, as reflected in available national environmental, health, and safety standards. Where national standards are not available, internationally recognized standards such as the World Bank Group's Environmental, Health, and Safety Guidelines will be adhered to[4]CPMO shall also adhere to necessary protocols in response to emerging infectious diseases, such as coronavirus disease (COVID-19), consistent with the guidelines of relevant government healthcare agencies and the World Health Organization.

30. **Physical Cultural Resources**. The CPMO is responsible for siting and designing the project components to avoid significant damage to physical and cultural resources. Such resources likely to be affected by the subproject will be identified, and qualified and experienced experts will assess the subproject's potential impacts on these resources using field-based surveys as an integral part of the environmental assessment process. When the proposed location of a subproject component is in areas where physical, cultural resources are expected to be found as determined during the environmental assessment process, chance finds procedures shall be included in the EMP.

31. **Environmental Audit**. When the subproject involves existing activities or facilities, CPMO is responsible for ensuring that relevant external experts perform environmental audits to determine the existence of any areas where the subproject may cause or is causing environmental risks or impacts. If the subproject does not foresee any new major expansion, the audit constitutes the environmental assessment for the subproject.

32. **Bidding and Contract Documents**. IEE, which contains the EMP, shall be included in bidding and contract documents and verified by CPMO. The CPMO shall also ensure that bidding

[4] World Bank Group, 2007. Environmental, Health, and Safety General Guidelines. Washington, DC.

and contract documents include specific provisions requiring contractors to (i) comply with all other conditions required by ADB[5] and (ii) to submit to CPMO, for review and approval, a site-specific environmental management plan (SEMP), including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; (iii) monitoring program as per SEMP; and (iv) budget for SEMP implementation, among others as may be required. No work can commence prior to the approval of SEMP. A copy of the EMP and/or approved SEMP will always be kept on-site during construction. Non-compliance with, or any deviation from, the conditions set out in the EMP and/or SEMP constitutes a failure in compliance and shall require corrective actions.

33. **Conditions for Award of Contract and Commencement of Work**. CPMO shall not award any works contract under the project components until (i) relevant provisions from the EMP are incorporated into the works contract; (ii) this IEE is updated to reflect project components detailed design and CPMO has obtained ADB's clearance of such updated IEE; and (iii) The proposed Rajapur Irrigation Project rehabilitation works are limited within the existing canal systems. There has been no construction of new headworks or changes in the main canal systems. Thus, for the GoN requirements, the project component does not trigger BES/IEE/EIA.

B. National Environmental Legislations and Policy Framework

34. Most of GoN's national policies and laws are oriented towards achieving environmentally sound economic development and growth, as well as the conservation of the country's natural resources and cultural heritage. The following are summaries of the relevant policies, acts, regulations, and guidelines.

35. **The Constitution of Nepal, 2015**. This is the fundamental law of the country, and the sections pertaining to environmental protections are as follows:

36. **Article 30 (1)** of the constitution guarantees a "clean environment'' as a fundamental right and elaborates that "every citizen shall have the right to live in a clean and healthy environment."

37. **Article 30 (3)** encourages the state to formulate necessary legal frameworks to balance environment and development.

38. Nepal has enacted comprehensive environmental policies and laws covering various environmental and sector issues. The Environmental Protection Act (EPA) of 2019 and the Environmental Protection Regulations (EPR) of 2020 are two important legal frameworks for environmental protection. According to the EPA and EPR, all development projects should first be screened using criteria based on the project scale stipulated in Schedules 1, 2, and 3 of EPR to determine the level of environmental assessment required. Projects that could result in some environmental impacts are required to conduct a brief environmental study (BES) BES, projects having moderate environmental impacts are required with the initial environmental examination (IEE), and large projects that could result in major and adverse environmental impacts are required to undergo an environmental impact assessment (EIA) process. The EPA makes necessary arrangements to disclose EIA reports to the general public to render opinions and suggestions.

39. **Environment Protection Act 2019 (2076 BS).** The act emphasizes new aspects like

[5] Contractors to comply with (i) all applicable labor laws and core labor standards on (a) prohibition of child labor as defined in national legislation for construction and maintenance activities; (b) equal pay for equal work of equal value regardless of gender, ethnicity, or caste; and (c) elimination of forced labor; and with (ii) the requirement to disseminate information on sexually transmitted diseases, including HIV/AIDS, to employees and local communities surrounding the project sites..

BES, IEE, and EIA provisions under the jurisdiction of local authority, provincial government, and central government. This act is a pre-requirement for any development project in the country to comply with the environmental safeguards. Article 2 (3) 1 of this act provides environmental assessment. This clearly mentions that the environmental assessment is a prerequisite before implementing any project. The details of the criteria are indicated in Environment Protection Rules 2020.

40. **Environment Protection Rules 2020 (2077 BS).** This rule has defined thresholds and equivalent environmental assessments (i.e., BES, IEE, and EIA). The proposed RIP rehabilitation works are limited to the existing canal systems. There has been no construction of new headworks or changes in the main canal systems. Thus, as per EPR 2020, the project component scope does not trigger BES/IEE/EIA. The Rajapur Irrigation Project is located in the buffer zone of the Bardiya National Park (BNP). The Geruwa River separates the RIP from the Bardiya National Park. The Geruwa Rural Municipality is located within the buffer zone, and the local government and the National Park jointly initiate community development activities and manage natural resources in the buffer zones. Thus, the CPMO shall conduct meaningful consultations with the National Park and Local government authorities. The CPMO shall take no objection certificates from the National Park, i.e., taking permission for the construction activities in the buffer zone area.

41. Other relevant government laws and regulations. Government environmental acts, rules, policies, and regulations will govern the implementation of project components proposed under the project. The Rajapur Irrigation Project component contractor will need to comply with all the government laws and regulations stated in Table 1 below.

Table 1: Relevant Government Laws and Regulations

S.N.	Policies, Acts, Regulations, Guidelines	Relevant Provisions
1	**Fifteenth Five Years Plan, 2020−2024, Nepal**	• Requires all projects to be formulated and constructed basedon methods that optimally utilize local skills and resources andgenerate employment opportunities. • Attention is paid to minimizing the impacts of climate change and protecting the environment. It aims to minimize the adverse impacts of disasters on people, property, culture, environment, and economy. • The policy aims to integrate disaster risk management in all development activities to reduce the loss of people and property.
2	**Forest Act 2076 (2019)**	• Pertaining to Chapter 12, Section 42(1), if there is no other alternative to the use of forest area for the operation of a national priority project, a plan of which the Investment Board approves investment, project of national pride and it appears from the environment examination referred to in the prevailing law that the operation of such plan does not result in significant adverse effects on the environment, the Government of Nepal may approve, as prescribed, to use any part of the national forest to operate such plan, • Similarly, in providing the forest area for the operation of a plan pursuant to sub-section (1), to the extent possible, a land that is adjoining to the national forest area near the project site and situated in the same geographical and ecological belt and has such landscape where forest can be developed shall be provided to plant trees at least in the area equal to the forest area that has to be used.
3	**Forest Regulations, 2079 (2022)**	• According to Rule 87 (2), a development project related to forest land use must be coordinated with the concerned division forest office during the feasibility study and environmental study. • Rule 88, Application needs to be submitted in case of use of national forest land from the feasibility study, and application needs to be submitted to the Ministry of Forests and Environment through the subjective ministry • Rule 89: Following Rule 88, the Ministry of Forests and Environment

S.N.	Policies, Acts, Regulations, Guidelines	Relevant Provisions
		directs the Division Forest Office through its respective department for detailed field information, which should also be submitted to the provincial ministry. • Under Rule 90, following Rule 89, the Division Forest Office should submit the information with field monitoring (if necessary) to the Ministry of Forests and Environment. If the applicable information and letters are received, the ministry will ensure the use of forest land and give permission to the respective project by binding the rules stated in the Forest Regulations. • Rule 91, following Rule 90, after the decision made by the government of Nepal for the permission to use the forest land, the development project should make the availability of the applicable land for the forest development as per the Forest Act (2076), Section 42 (2). • Rule 92: Following Rule 91, if the applicable land is not available, it must go through the Land Acquisition Facilitation Committee at the district level. • Rule 93: Following Rule 92, if the land acquisition through the Committee fails, the respective department should permit the project to collect amounts in the government fund as per the land purchases for the development project specified in Shedule-51. • Rule 93 (5), the compensation for the loss of 1 tree loss should be made with the plantation of 10 trees with the amount based on the cost of the trees in the ratio of 1:10. In Rule 93 (5), the amount must include bi-annual production or purchase of trees, trees transportation, afforestation of 1600 trees per hectare, fencing and boundary for the protection of trees and require number of people for look after.
4	**Conservation Area Government Management Area Rules 2001**	• Contains a number of regulatory measures to minimize environmental impacts within the forests, national parks, wildlife reserves, and conservation areas. Before implementation, the EPA 2076 B.S. (2019 AD) requires a proponent to undertake BES, IEE, or EIA for a proposed project and have the report approved by the concerned ministries. Introducing the exotic species on the specific location may require an IEE before the implementation of the project as per the EPR, 2020 Appendixes 1, 2, and 3 Rule 3 a, b, and c.
5	**Water Resource Act, 1992**	• The Water Resource Act, 1992 of clauses 3, 7, 18, 20, 22, and 24 implies state ownership of any surface/stream bodies of Nepal and stresses the utilization of water resources by any individual or organization without causing harm to others. It embodies that the Government of Nepal can fix, monitor, and formulate regulations pertaining to water quality standards, pollution tolerance levels, and the development of water resources. It prohibits any action that may pollute water resources surpassing the threshold value. It has prioritized the use of water resources in successive order: drinking/domestic use, irrigation, fishery, electricity, water transport, and recreation. It urges that the utilization of resources should be carried out without causing considerable environmental damage such as soil erosion, floods, and other similar natural hazards. The Act fails to address the license mandatory for water extraction even from the landowner.
6	**Water Resource Regulation, 1993**	• The Water Resources Act was published in the Nepal Gazette on (2050/5/1). Persons who are interested in using water resources on an institutionalized basis may form a consumer association consisting of at least Seven persons as officials and members. Each District shall have a Water Resources Committee to issue licenses pursuant to Sub-section (1) of Section 8 of the Act to utilize Water Resources contained within Nepal. The government of Nepal may, giving due consideration to the types, structure, and capacity of the project relating to utilization of wat16 of the Act, prohibit from use of the house or land situated within the area of the project specifying the fixed distance for the site for specified worker resources for the purpose of Sub-section (3)
7	**Irrigation Rules, 2000 (Amendment in 2060)**	• Irrigation Rules, 2000 Chapter 2 provides the formation of the user's association in a format as prescribed in Schedule –1 and the procedure for transferring the project. Under Rule 12, the Users' association may plant

S.N.	Policies, Acts, Regulations, Guidelines	Relevant Provisions
		trees on the side or right of way of a Canal, Branch or Secondary Canal, Minor or Tertiary Canal, Water course, or Field Channel after the approval of the community forest work - plan according to the prevailing Forest Act and Rules from the concerned Forest Office. In the course of determining the place for the plantation, there shall be coordination with the concerned Irrigation Office. Until the work plan pursuant to Sub-rule (1) is approved, the Users' Association may sell the rotten or fallen trees lying on the side of the Canal, Branch or Secondary Canal, Minor or Tertiary Canal, Water course or Field Channel. The trees which need pruning may be pruned upon the approval of the committee. • Similarly, under Chapter 6, an irrigation project is provided, which shall be constituted to implement the large-scale irrigation project as designated by the GoN. It also deals with the function, duties, and power of the designated project committee, staff, and the establishment of the Project Unit Office.
8	**Irrigation Policy (2013)**	• The Irrigation Policy document sets out the rationale for subsector development and policy objectives and approaches for project development, water user associations, irrigation service charges, and irrigation system operation and maintenance
9	**Soil and Watershed Conservation Act, 2039 BS**	• To properly manage the watersheds of Nepal, the Soil and Watershed Conservation Act 1982 was enacted. Section 3 of the Act empowers GoN to declare any area as a protected watershed area. Section 4 of the Act provides that a watershed conservation officer has the authority to implement the following works in protected watershed areas: • Construct and maintain dam, embankment, terrace improvements, diversion channels and retaining walls, • Protect vegetation in landslide-prone areas, undertake afforestation programs, and • Regulate agricultural practices pertinent to soil and watershed conservation. • Under Section 10 of the Act, power is extended to the Watershed Conservation Officer to grant permission to construct dams, drainage ditches, and canals, cut privately owned trees, excavate sand, boulders, and soil, discharge solid waste, and establish industry or residential areas within any protected watershed. The Act outlines the essential parameters necessary for proper watershed management (including rivers and lakes). The Act applies to protected watersheds.
10	**Soil and Watershed Conservation Regulations, 2042 BS**	• In exercise of the powers conferred by Section 25 of the Soil and Watershed Conservation Act 1982, the Government of Nepal has framed Soil and Watershed Conservation Regulations, 2042 BS. Pursuant to sub-rule (1) of rule 10 natural calamity clause (a), (b), (c), (d), (e), (f), (g) of section 10 of the Act and (h) if anyone has to do the work mentioned in the reason to do so. An application has to be submitted to the Watershed Conservation Officer in the format of open schedule 4 (2). After receiving the application as per sub-rule (1), the watershed protection officer, in case of any action contrary to the purpose of the Act, in the format of Schedule 5 as per schedule. will allow.
11	**Water Induced Disaster Management Policy 2015 (2072)**	• The latest policy of the Government of Nepal recognizes climate change as one of the main causes of water-induced disasters in Nepal. • This policy is introduced to achieve the objectives of the National Water Resources Strategy and National Water Plan on water-induced disaster management through the participation and coordination of public, cooperative, and private sector institutions. It encourages people to contribute land to flood protection works voluntarily. • It has the main objective of making the infrastructures sustainable and has a policy on involving communities, cooperatives, and the private sector. It stresses the need for medium and long-term disaster prevention and control programs and makes them climate-resilient and environment-friendly.

S.N.	Policies, Acts, Regulations, Guidelines	Relevant Provisions
12	**Land Acquisition Act, 2034 BS (1978AD)**	• The government can acquire land at any place in any quantity by giving compensation pursuant to the act for any public purposes or the operation of any development project initiated by government institutions.
13	**Labor Act, 2074 (2017 AD)**	• This labor act was implemented under the management of parliament under sub-clause 1 of clause 296 of the Constitution of Nepal. Sub-section 3 of Section 2 states that the employees should not be compelled to do work other than what they are assigned. In addition, Sub-section 5 of Section 2 states about the prohibition of child labour in any organization, and Sub-section 6 of Section 2 states that there should not be any kind of discrimination among the employees regardless of religion, ethnicity, gender, origin, language or intelligence or another kind of characters.
14	**Child Labor (Prohibition and Regulation) Act, 2056 (2000 AD)**	• As per section 3 of this act, no child has not attained the age of 14 years shall be engaged in works as a labourer.
15	**Solid Waste Management Act, 2068 (2011 AD)**	• This act has been formulated with the goal of minimizing solid waste production from the target area by setting rules and regulations on solid waste management (SWM) in the country to develop a better environment for the systematic and effective management of solid waste and to involve all the concern stakeholders in SWM practice. The main feature of this act is a discussion of the 3R principle (Reduce, Reuse, and Recycle). The 3R principle seems very beneficial as it not only increases the life of landfill sites but also saves money, which could be used for other infrastructure development. Section 4 of the act assigns the local body to manage or use the solid waste discharged or dumped in a collection center, transfer station, or treatment plant or collected during cleaning.
16	**Solid Waste Management Rules, 2070 (2013 AD)**	• The solid waste management rule was formulated as per the provision made in Article 50 of the Solid Waste Management Act of 2068. This regulation has emphasized the segregation of waste at source and mentioned that the responsibility of proper disposal and management of source belongs to the producers themselves. Section 3 of the rule describes the segregation and management of solid waste. It has been mentioned that it is essential to segregate degradable and non-degradable solid waste at the source.
17	**The National Parks and Wildlife Conservation Act (1973AD)**	• This Act deals with the conservation and management of wildlife and habitat. The Act restricts entry into national parks without prior permission of the concerned authority. Hunting animals or birds, building or occupying houses, shelters, or structures, occupying, clearing, planting or growing in any part, cutting, felling, removing or overshadowing any tree, and removing any quarry or other activities in national parks are banned. • Under the Wildlife Reserve Regulations, 1977, entry, construction of houses or sheds, clearance of forest and forest products, quarrying, and overnight stays in a reserved area are prohibited unless authorized in writing by the relevant GoN authority. • Under the Buffer Zone Management Regulation, 1994, clearance of forests and forest products, acquisition of land, use of quarry sites, and hunting in buffer zones are restricted unless written approval of the relevant GoN authority is obtained.
18	**Local Self Governance Act (1999AD)**	• This Act gives Local Government the functions, duties, and power to, among others; (i) conserve and protect their local environment and natural resources; (ii) plan, implement, and/or operate and maintain local water supply projects; (iii) implement and/or arrange for implementation local sanitation/sewerage and drainage projects; (iv) protect cultural heritage and religious sites and/or (v) monitor project activities within their jurisdictions.

C. Applicable Environmental Standards

42. **National Ambient Air Quality Standards for Nepal, 2003.** As shown in Table 2 below, the air quality standards for Nepal have set standards for seven parameters: total suspended

particles (TSP), PM10, Sulphur Dioxide (SO2), Nitrogen Oxide (NO2), Carbon Monoxide (CO), Lead (Pb), and Benzene.

43. **The World Health Organization (WHO) Air Quality Guidelines.** The WHO guideline (Table 2) sets quality standards for four parameters: PM10, PM2.5, SO2, and NO_2. According to ADB SPS 2009, when host country regulations differ from international levels and measures, the project will achieve whichever is more stringent. Both policies provide guidelines and comply with the more stringent standards during construction.

Table 2: Standards for Ambient Air Quality for both GoN and WHO

Parameter	Averaging Period	Nepal's Ambient Air Quality Standard (µg.m^3) *	WHO Air Quality Guidelines (µg.m^3)	
			Global Update 2005**	Second Edition^ 2021
TSP	Annual	-	-	-
	24-hour	230	-	-
PM_{10}	Annual	-	20	15
	24-hour	120	50	45
$PM_{2.5}$	1-year	-	10	5
	24-hour	-	25	15
SO_2	Annual	50	-	-
	24-hour	70	20	40
	10-minutes	-	500	-
No_2	1-year	40	40	10
	24-hour	80	-	25
	1-hour	-	200	-
CO	8-hour	10,000	-	4 (24-hr)
	15-minutes	100,000	-	-
Pb	1-year	0.5	-	-
Benzene	1-year	20	-	-

Source: *National Ambient Air Quality Standard for Nepal, 2003. Obtained from Environment Statistics of Nepal, 2011, National Planning Commission Secretariat, Central Bureau of Statistics, Nepal.
** WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide, and sulfur dioxide. *Global update 2005*. WHO. 2006.
^ Global Air Quality Guidelines. WHO 2021.

44. **Emission standard for diesel generator EPR-14, 2020**. The emissions standards for new DG imports are equivalent to Bharat Stage III standards. In-use DGs are equivalent to Bharat S Inventories and Black Carbon Emissions in Kathmandu Valley, Nepal. Emission standards are set for four major pollutants: CO, HC, NOx, and PM.

45. **National Noise Standard Guidelines, 2012**. The guidelines set standards for noise levels measured in dBA, industrial, commercial, rural, urban, mixed, residential, and quiet areas. They also provide standard values for the noise level of water pumps and DG generated.

46. For international standards, WHO Noise Level Guidelines have set the noise levels measured in dBA for residential and commercial areas (Table 3). The project will achieve whichever is more stringent. Both policies provide guidelines to follow and comply with the more stringent standards during construction.

Table 3: Standards for noise levels for both GoN and WHO

Receptor/Source	National Noise Standard Guideline 2012 (dBA)		WHO Guidelines Values for Noise Levels Measured Out of Doors*(One Hour LA_q in dBA	
	Day	Night	07:00-22:00	22:00-07:00
Industrial Area	75	70	70	70
Commercial Area	65	55		
Rural Settlement Area	45	40	55	45

Receptor/Source	National Noise Standard Guideline 2012 (dBA)		WHO Guidelines Values for Noise Levels Measured Out of Doors*(One Hour LA_q in dBA	
	Day	Night	07:00-22:00	22:00-07:00
Urban Residential Area	55	50		
Mixed Residential Area	63	55		
Quiet Area	50	40	-	-
Water Pump	65		-	
Diesel Generator	90		-	

Guidelines for Community Noise, WHO, 1999

47. **Nepal Water Quality Guidelines for Irrigation Water, 2008**. The guidelines set the standards for irrigation water, with the targeted quality range for the different parameters (Table 4). The guideline also shows the acceptable concentration limits for the plant species.

Table 4: Nepal Water Quality Guidelines for Irrigation Water

S.N.	Parameter Name	Target Water Quality Range	Remarks
Microbiological constituents:			
1	Coliforms (fecal)	< 1 count /100 ml	1 – 1000 count / 100 ml could be used for plants for which edible parts are not wetted
Physical Constituents:			
1	pH	6.5 – 8.5	Adverse effects on plants outside this range
2	Suspended Solids	< 50 mg/L	Above the limit problem with sedimentation and irrigation system
3	Electrical Conductivity	< 40 mS/m	Up to 540 mS/m depending upon the sensitivity of crops
Chemical Constituents:			
1	Aluminum	< 5 mg/L	Up to 20 mg/L max. acceptable conc.
2	Arsenic	< 0.1 mg/L	> 2 mg/l creates a severe problem
3	Beryllium	< 0.1 mg/L	0.1 – 0.5 mg/L max. acceptable conc.
4	Boron	< 0.5 mg/L	Up to 15 mg/L depending upon species.
5	Cadmium	< 0.01 mg/L	0.01 – 0.05 mg/L max. acceptable conc.
6	Chloride	< 100 mg/L	Up to 700 mg/L depending upon species
7	Chromium	< 0.1 mg/L	Up to 1.0 mg/L max. acceptable conc.
8	Cobalt	< 0.05 mg/L	Up to 5.0 mg/L max. acceptable conc.
9	Copper	< 0.2 mg/L	Up to 5.0 mg/L max. acceptable conc.
10	Fluoride	< 2.0 mg/L	Up to 15 mg/L max. acceptable conc.
11	Iron	< 5.0 mg/L (non-toxic)	> 1.5 mg/L creates problem in drip irrigation system
12	Lead	< 0.2 mg/L	Up to 2.0 mg/L max. acceptable conc.
13	Lithium	< 2.5 mg/L	For citrus < 0.75 mg/l
14	Manganese	< 0.02 mg/L	Up to 10 mg/L max. acceptable conc.
15	Molybdenum	< 0.01 mg/L	Up to 10 mg/L max. acceptable conc.
16	Nickel	< 0.2 mg/L	Up to 2.0 mg/L max. acceptable conc.
17	Nitrogen (inorganic)	< 5 mg/L	Higher concentrations may affect sensitive plants and may contaminate groundwater
18	Selenium	< 0.02 mg/L	Up to 0.05 mg/L max. acceptable conc.
19	Sodium Adsorption Ratio (SAR)	< 2.0	Up to 10 depending upon the sensitivity of crops.
20	Sodium	< 70 mg/L	Up to 460, depending upon the sensitivity of crops
21	Total Dissolved Solids (as EC)	< 40 mS/m	Up to 540 mS/m depending upon the sensitivity of crops
22	Uranium	< 0.01 mg/L	Up to 0.1 mg/L max. acceptable conc.
23	Vanadium	< 0.1 mg/L	Up to 1.0 mg/L max. acceptable conc.
24	Zinc	< 1.0 mg/L	Up to 5 mg/L max. acceptable conc.

Source: Nepal Water Quality Guidelines for Irrigation, DWRI (Nepal Gazette (Number 10.16 June 2008)

D. IFC Environmental, Health and Safety (EHS) Guidelines

48. The Environmental, Health, and Safety (EHS) General Guidelines (April 30, 2007) will apply to this project. The project is required to comply with these guidelines regarding impacts and management, performance indicators, and monitoring. The project proponent/operator shall follow the IFC EHS Guidelines for this project and should also ensure that all appointed contractors/subcontractors follow the IFC EHS Guidelines.

E. International Environmental Agreements

49. Table 5 below lists the international environmental agreements that Nepal is a party to and their relevance with the WUC Project.

Table 5: International Environmental Agreements and standards ratified by GoN

International Convention	Year*	Relevant Provisions	Remarks
World HeritageConvention	1978	Parties to ensure the protection and conservation of the cultural and natural heritage situated onthe territory of, primarily belongingto the State. World Heritage sites are identified as per this convention.	The project components will not impact physical, cultural resources and natural heritageduring implementation and operation.
Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar Convention)	1987	Parties should conserve and wisely use wetlands (i.e., maintain their ecological character) to contribute to achieving sustainable development locally and worldwide. This convention will identify the Ramsar areas.	The project components are not located in wetlands as classified as Ramsar sites.
Convention on Biodiversity (CBD)	1992	Parties require the environmental assessment of projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects. The CBD also identified thebiodiversity identified the hot spot areas.	The project will not impact the country's biodiversity hot spot areas. The project component's scope is the rehabilitation of the existing canal structures.
UN Framework Convention on Climate Change	1992	Parties to take precautionary measures to anticipate, prevent, or minimize the causes of climate change and mitigate its adverse effects.	The project will help the Government of Nepal comply with this agreement. Theproject will ensure the implementation of farmers' resilience to climate change.
Basel Convention on the Control of Transboundary Movements ofHazardous Wastes and their Disposal	1996	Parties to, among others, minimizethe amount and toxicity of hazardous waste generated, manage the hazardous and other wastes they generate in an environmentally sound manner, and as close as possible to the source of generation.	The project will ensure the implementation of its EMP as a measure to avoid or minimize the generation and disposal ofany hazardous wastes.

*(Year) - Year last amended.

III. DESCRIPTION OF THE PROJECT COMPONENT

A. Rationale for RIP Component

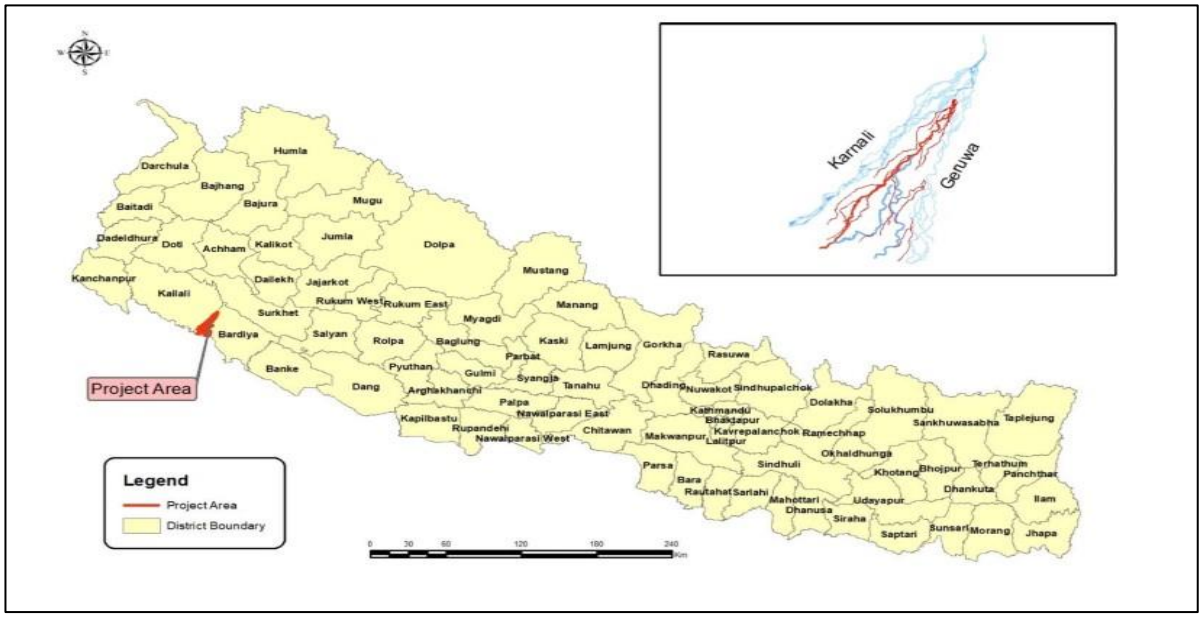
50. Rajapur Irrigation System (RIS) is a long-established traditional farmer-managed system taking water from the Karnali River and is situated between the two branches of the river - western (Karnali) and eastern (Geruwa). RIP originally comprised six individual irrigation systems rehabilitated between 1991 and 2001 with financial support from ADB under the Rajapur Irrigation Rehabilitation Project (RIRP). Problems of access to water for the Budhi kulo were largely resolved in RIRP. Still, there remains a serious problem of sediment control, which damages irrigation and leads to flooding downstream of the island. This problem has worsened as the increased water supply brings extra sediment into the system. This is the major issue to be addressed in the present project. The eastern intakes have been adversely affected by recent changes in river morphology, which cannot be easily resolved and require further assessments.

51. Agriculture remains important for local livelihoods and national food security. Thus, the Rajapur Irrigation Project requires continued maintenance for silt removal, gabion repair, and a small amount of locally managed upgrading and repair. For these reasons, a further Rajajpur Irrigation System Improvement Project is initiated.

B. Location of the Rajapur Irrigation Project

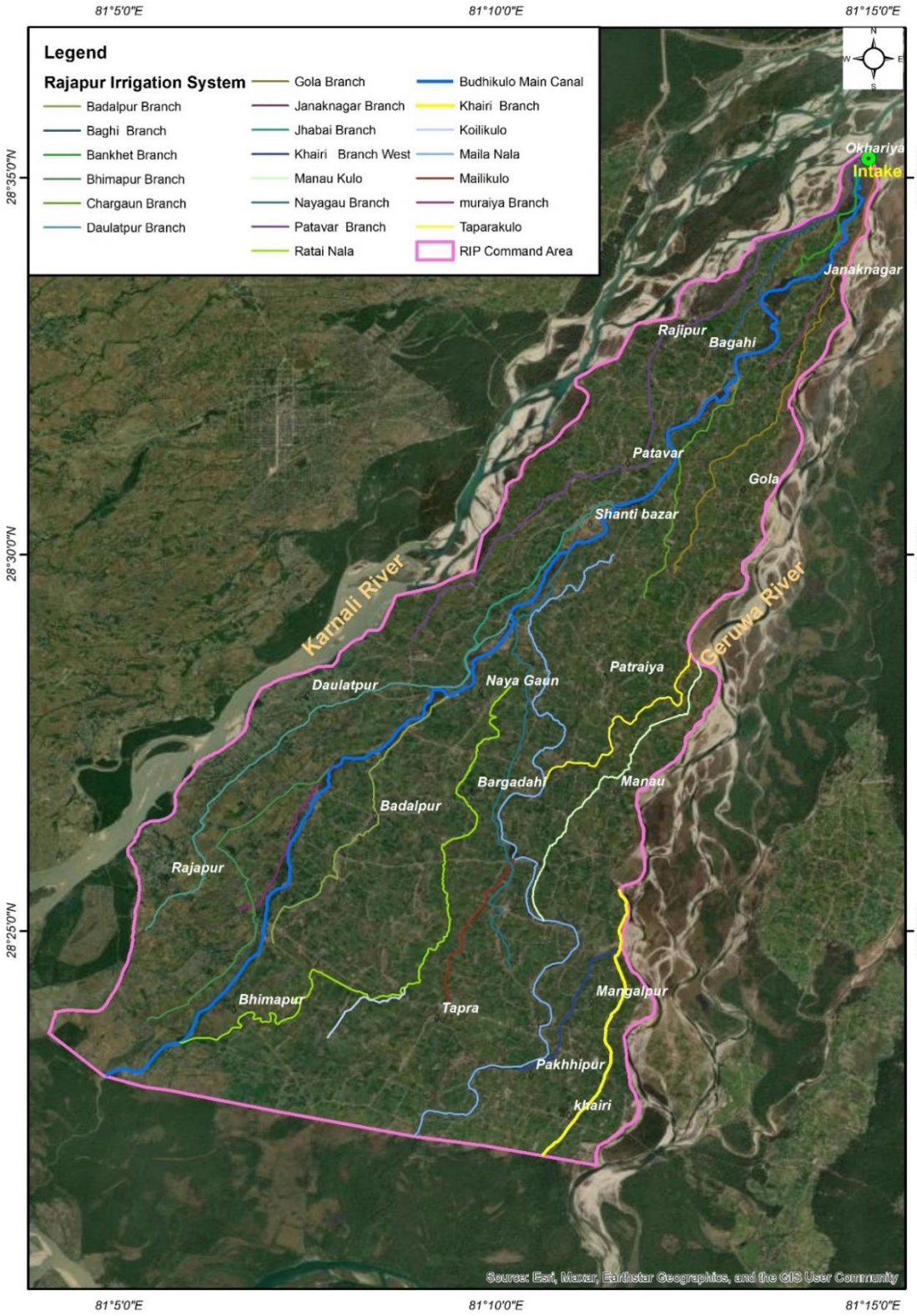
52. The Rajapur Irrigation Project (RIP) covers the entire area of Rajapur Municipality (R-M) and Geruwa Rural Municipality (G-RM) of Bardiya district under Lumbini Province. The system provides irrigation services to 14,500 ha of cultivated land spread over the command areas of Budhikulo, Tapara, Manu, and Khari-Chandanpur. These systems have a historical track record of operation through their indigenous institutions governed by traditionally evolved norms and regulations. The RIS location map and the irrigation command area with existing canal systems are shown in Figures 1, 2, and 3 below.

Figure 1: The location map of the Rajapur Irrigation Project



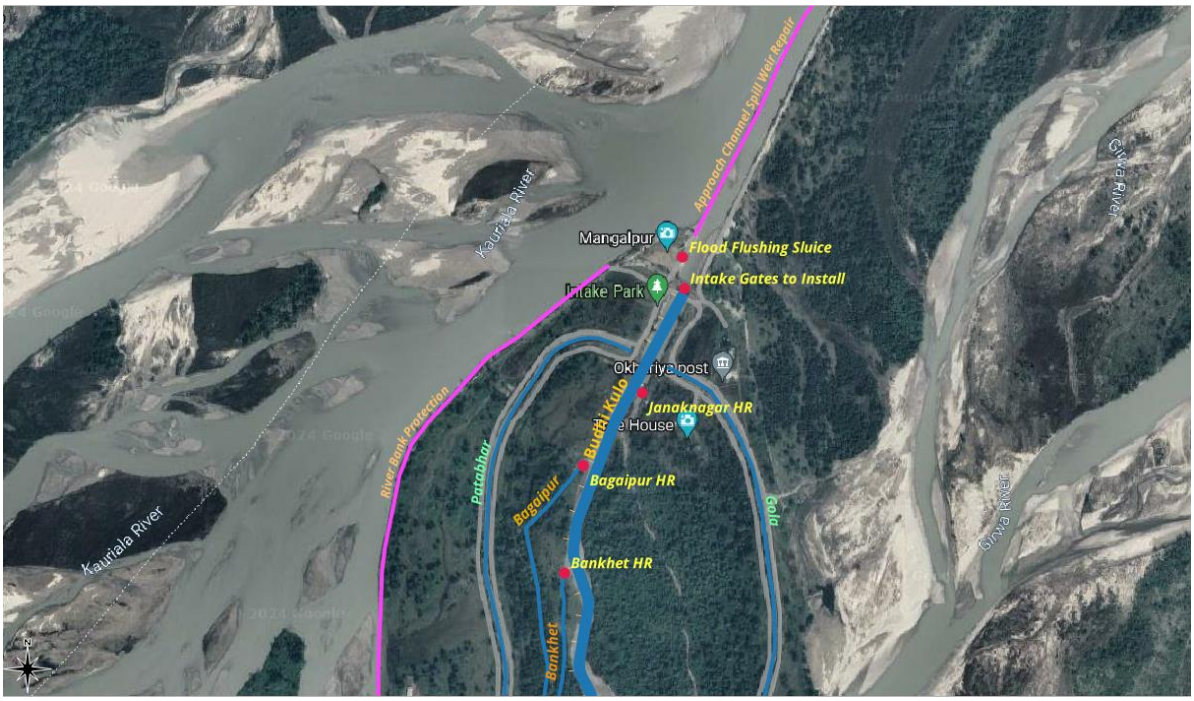
Source: Administrative boundary, Survey Department Nepal and DDR, 2024)

Figure 2: Existing Rajapur Irrigation Project with Command Area



Source: Detail Design Report 2024 and the Google Earth Image

Figure 3: Proposed Rehabilitation Works at the Budhi Kulo Intake Area



Source: Detail Design Report 2024 and the Google Earth Image

Figure 4: Physical condition of the intake area

Intake gate before water enter structure

Above structure condition

Upstream before intake

Downstream of intake

C. Scope of Project Components

53. The scope of work in the Rajapur Irrigation Project components mainly includes rehabilitating the existing canal system structures, as presented in Table 6. The detailed design study conducted during 2022-2024 has proposed improving the canal structures detailed in the following sections. The main interventions proposed are:

(i) Restore and strengthen the approach channel to the Budhi kulo intake.
(ii) Provision of gates and a scour sluice at the Budhi kulo intake reduces the sediment entry, which clogs irrigation canals and leads to flooding in the system's tail. Closing the gates during high rainfall and river flows will also greatly reduce flooding.
(iii) Providing additional river protection, mainly on the Karnali side where flow intensities are greater, and the canal system is directly threatened: damage to canals destroys agriculture over the entire command area downstream of the damaged area.
(iv) Provision of settling basins in a sample of branch canals to reduce sediment entry to branch canals tests the scope for further sediment control measures.
(v) Restoring and strengthening the gabion weirs at the Maila/Manau and Khairi Chandanpur intakes.
(vi) Limited improvements to the internal irrigation system, where significant problems in water control affect large areas.
(vii) Institutional and capacity development to improve irrigation management of the system.
(viii) Agricultural support to increase production and diversify cropping.

Table 6: Proposed Scope of Work in RIP Component

S. N.	Proposed Canal Structures	Priority Phase	Remarks
1	**Upgrading of Budhi Khola Approach Channel**		
1.1	Repairs to Approach channel	1a	Repairs of the approach channel and flood spillway walls at the right bank
1.2	Improvement Approach Channel	1b	Design and drawing during construction
1.3	Ramp Construction	1b	Design of new flood flush sluice and electrically operated gate
1.4	New Trash Deflector	1b	Electrically operated gates and renovation of an existing control room
2	**Upgrading of Budhi Kulo Intake**		
2.1	New Budhi Kulo Flushing Sluice	1a	Design of new flood flush sluice and electrically operated gate
2.2	Upgrading Budhi Kulo Intake gates	1a	Gates to operate at free weir flow range of neyrtec weir
3	**Karnali Riverbank Protection**		
3.1	Karnali RB protection (0+00-0+446)	1a	Conventional concrete revetment and stone/concrete block subjected to hydrodynamic drag and lift forces
3.2	Karnali RB protection (0+446-1+500)	1a	Design of launching apron as per IS: 14262 and length of apron 16.5m
3.3	Karnali RB protection (1+500-2+000)	1a	Machine-made gabion revetment and flexible structure and frequent repair and maintenance
4	**Main Canal Structures**		
4.1	Intake		
4.1.1	Bhagaipur New Intake from Budhikulo	1a	Designed as per IS 7114-1973, hydraulic jump for energy dissipation and stilling basin requirements
4.1.2	Bankhet New Intake from Budhikulo	1a	
4.1.3	Janaknagar New Intake from	1a	

S. N.	Proposed Canal Structures	Priority Phase	Remarks
	Budhikulo		
5	**Branch Canal Structures**		
5.1	**Settling Basins**		
5.1.1	Patabhar settling basin	1a	Hydraulic flushing into Karnali channel, design discharge 8.80m3/s, and storage capacity of basin Sv
5.1.2	Badalpur settling basin	1a	Hydraulic flushing into Budhi Kulo, design discharge 8.08m3/s, and storage capacity of basin Sv
5.1.3	Gola settling basin	1b	Hydraulic flushing from Gola into Geruwa, and design considerations based on sediment concentration
5.1.4	Bhimapur settling basin	1b	Hydraulic flushing from Bhimapur into Budhi Kulo and design considerations based on sediment concentration
5.1.5	Tapara settling basin	1c	Hydraulic flushing from Tapara into Karnali Channel and design considerations based on sediment concentration
5.2	**Regulators**		
5.2.1	Daulatpur -Murkatta Bandh	1a	Design as per IS 7114-1973, stilling basin requirements, and similar design principles for all regulators
5.2.2	Badalpur-Tethan	1a	
5.2.3	Patabhar-Tikuligarh	1a	
5.2.4	Patabhar-Dasnahari	1a	
5.2.5	Nayagaon-Indaiya	1a	
5.2.6	Nayagaon-Jagduwa Kulo	1a	
5.2.7	Bhimapur-Semarawa	1a	
5.2.8	Bhimapur-Satgaiya	1a	
5.2.9	Tapara-Pahadipur	1a	
5.2.10	Tapara-Ishworigunj	1a	
5.2.11	Bhimapur/Muraiya aqueduct/syphon	1a	Design of canal syphon barrel, trash Rack upstream of canal syphon barrel, and similar design principles
5.3	**Escapes**		
5.3.1	Nayagaun escape	1a	Broad crested weirs, Design as per IS 7114-1973, and the elevation difference between canal bed and escape outfall
5.3.2	Daulatpur escape	1a	Similar design principles as Nayagaun escape
5.3.3	Chargaun escape	1a	
5.3.4	Bagaipur escape	1b	
5.3.5	Janaknagar escape	1b	
5.3.6	Jhabai escape	1b	
5.3.7	Badalpur escape	1b	
5.3.8	Tapara escape	1b	
5.3.9	Manua escape	1b	
5.3.10	Bhimapur escape	1b	
5.4	**Secondary Canal Structures**		
5.4.1	Secondary Canal Proportional Flow Divider 3-Opening (10)	1b	Design as per IS 7114-1973, Similar design principles as main canal structures
5.4.2	Secondary Canal Proportional Flow Divider 2-Opening (15)	1b	Similar design principles as Secondary Canal Proportional Flow Divider 3-Opening
5.4.3	H-Canal for Khairi Chandanpur in Low land Area (430m)	1b	Design and construction as per detailed topographic survey and hydraulic requirements
5.4.4	Secondary Canal Escapes (30 Nos)	1b	Design based on secondary canal hydraulic data and field observations
6	**Rehabilitation of Geruwa Kulo Intakes**		
6.1	Rehab of Khairi's existing intake	1a	Design as per IS 6531-1972/1994 and rehabilitation of existing intake structures
6.2	Repair Khairi Gabion Weir	1a	Structural repairs based on hydrodynamic load calculations
6.3	Rehab of Manau's existing intake	1a	Similar design principles to Khairi's existing intake
6.4	Repair of Manau Gabion Weir	1a	Similar design principles to Khairi Gabion Weir
7	**Procurement of Equipment**		

S. N.	Proposed Canal Structures	Priority Phase	Remarks
7.1	Procurement of Excavators	1b	

Phase 1a = design and modification design is available during IEE preparation
Phase 1b = for further study
(Detail Design Report, 2024)

54. The IS (Indian Standards) mentioned in the table above are standards set by the Bureau of Indian Standards (BIS) to ensure the quality and safety of construction materials and practices. Here are the IS codes mentioned and their purposes:

(i) *IS: 11532-1985:* This standard provides guidelines for the design and construction of embankments. It includes specifications for top width, side slopes, and other structural aspects to ensure stability and safety.

(ii) *IS: 12094-2000:* This standard specifies the freeboard requirements for embankments: the vertical distance between the water level and the top of the embankment. This ensures that the embankment has sufficient height to prevent overtopping during high water levels.

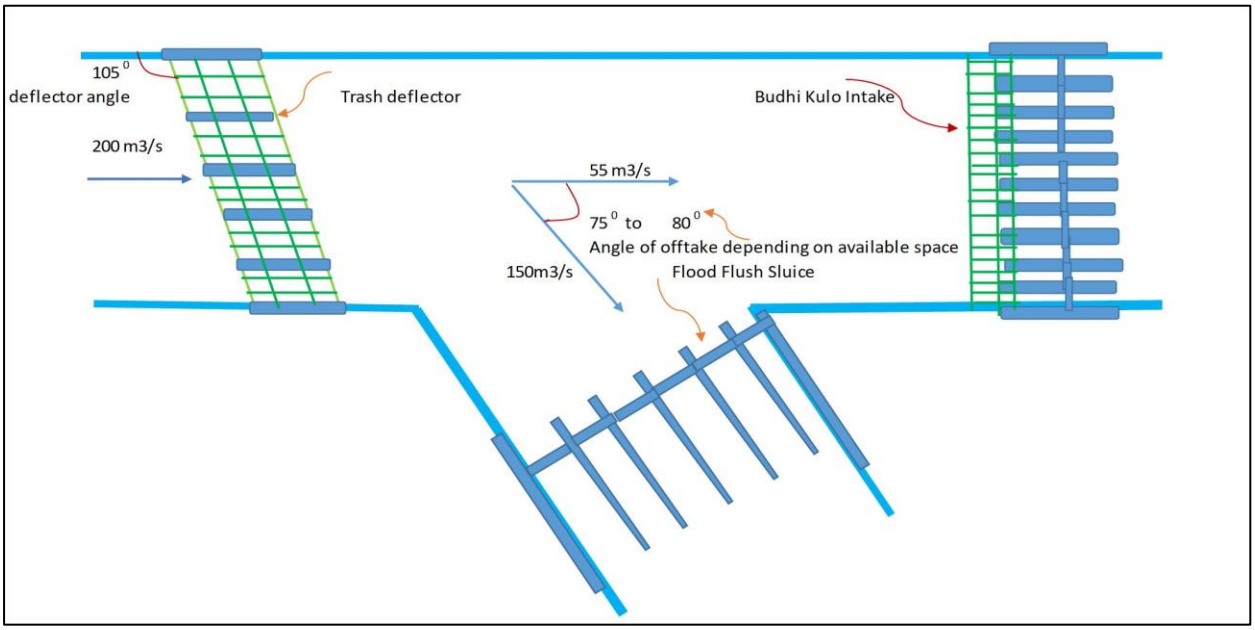
(iii) *IS: 14262:* This standard outlines the design and construction of launching aprons, which are structures designed to protect the toe of an embankment from scouring. The length and thickness of the apron are specified to provide effective protection against erosion.

(iv) *IS: 6531-1972/1994:* This standard pertains to designing and constructing intake structures for irrigation canals. It includes specifications for dimensions, materials, and construction practices to ensure efficient and safe water intake from rivers into irrigation canals.

55. **Upgrading of Budhi Khola Approach Channel (AC).** AC is a more permanent part of the approach and will comprise a semi-permanent gabion box embankment about 600m long, which will be tied into the apex protection works. This will be similar to but more robust than the RIRP approach channel. Immediate repairs will be undertaken in Phase 1a, with semi-permanent arrangements to be built in Phase 1b after a detailed dry-season survey and assessment have been completed.

56. **New Flood Flushing Sluice**. A flood flush sluice is designed (Figure 5) to flush the flood of AC at the right bank of AC aligned at an angle of 80º towards the Karnali River Channel; the center line is located 30 m upstream of Budhi Kulo intake, facilitating excess water entering into AC and flushing accumulated sediment in the approach channel bed upstream of the Intake. This will pass sediment-laden water back to the river upstream of the intake, particularly when the intake is closed during floods.

Figure 5: Distribution of Flood Flush Sluice



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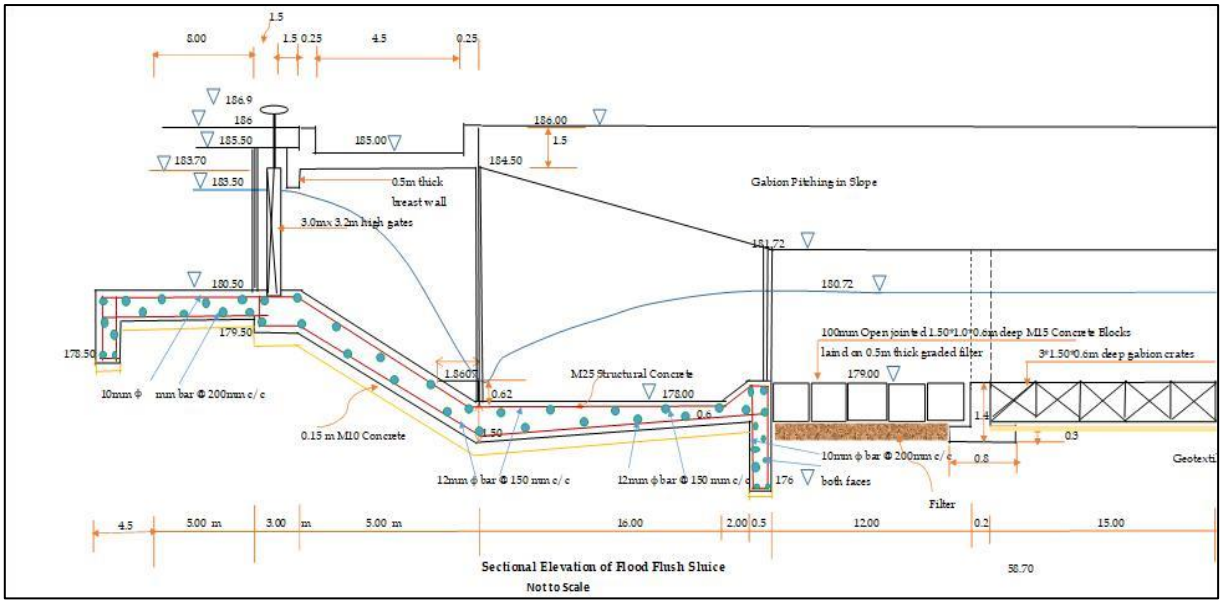
57. **Trash rack.** A separate trash deflector will supplement the existing trash rack on the intake further upstream to divert large trees and debris over the AC bank into the Karnali. The bar spacing on the trash rack will be modified to ensure that the combination of the deflector and trash rack effectively diverts large trees and debris and enables water to flow unimpeded. Sectional views of the Flood Flush Sluice are shown in the figure.

Figure 6: Sectional Elevation of Flood Flush Sluice



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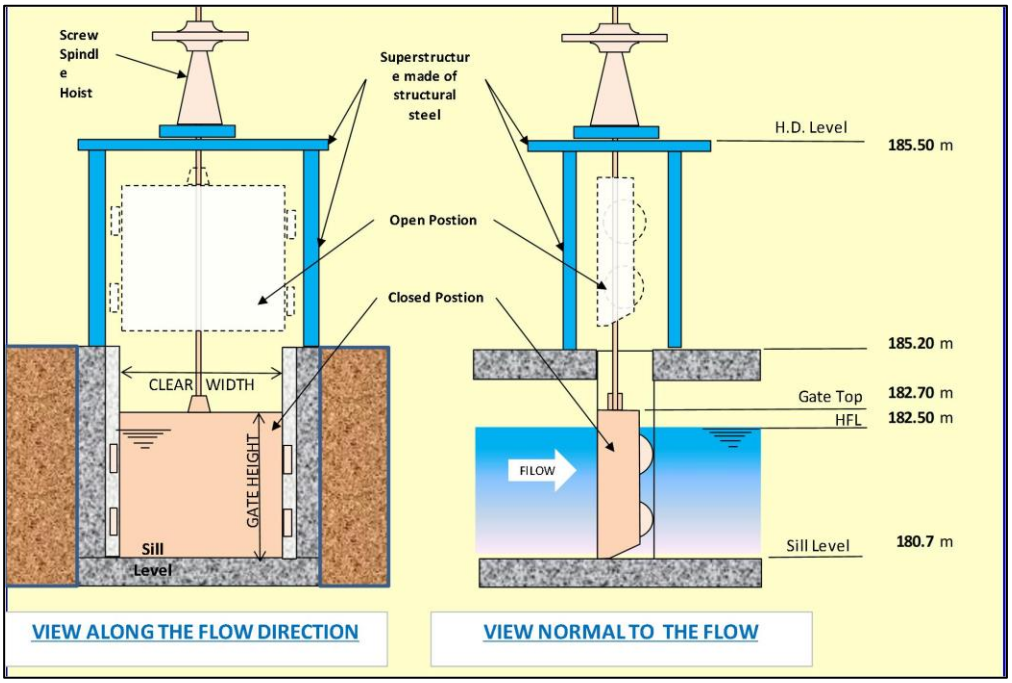
58. **Upgrading of Budhi Kulo Intake Structure.** Electrically operated gates 5 Nos. 3.0mx3.2m (B x H); and 10 Nos. 1.5mx2.0m (B x H) gates are proposed in the flushing sluice and Budhi Kulo intake, respectively (Figure 7). Gates are designed to enable manual operation in emergencies during power failure. This will close the intake completely when there is a flood, thus excluding a very large proportion of sediment. The existing building of Rajapur Irrigation at intake can be used for gate operation and control room, as well as Operator /Chaukidar quarter, after renovation. The existing Budhi Kulo intake has free flow and is a double-buffed Neyrtec weir. Elevations of the upstream channel bed, weir crest, and baffle wall are 180.5m, 181.20m, and 182.50m, respectively. Gate grooves are at 10.0m d/s of u/s cutoff at an elevation of 180.70m. An upstream water level of 183.50m must be maintained to enable design flow (55.0m/s) through weir barrels.

Figure 7: Typical Section of Gate at Budhi Kulo Intake



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59. **Karnali Riverbank Protection.** Under RIRP, gabion protection was provided at the apex of the Budhi kulo, and critical locations were selected, mainly on the Geruwa. These have performed well and remain intact, although repair has been necessary. RIRP focused on locations where canals were under direct threat from the river since if the river entered a canal, it was likely to be 'captured' and prevent irrigation in the downstream area with devastating impacts on many people. The Karnali River Management Project (KRMP) under DWRI is working to protect the Karnali River Banks. However, this is taking time, so critical works to protect irrigation are included in this project component. Riverbank protection has been proposed downstream of the intake location at a 2 km length. Stone/concrete blocks will be used for revetment for riverbank protection work.

60. Stone/concrete block used in revetment for riverbank protection is subjected to hydrodynamic drag and lift forces. These destabilizing forces are expressed in terms of velocity and tractive force. The stabilizing forces acting against these are competent in the submerged weight of the stone/concrete block and the downward component of the force caused by contact with the stones/concrete block. The total proposed protection work length is 2 km, and the top

width of the embankment is 5m with a side slope of 1V:2H and a free boar of 1.8 m. The Designed length of the launching apron is 16.5m; a 0.80m thick launching apron laid on an average riverbed level of 178.0m, filling 1.00m deep big boulders in ditches and swamps is proposed**.** Designed of launching refer to Table 7.

61. The design discharge for river training works is considered considering the 50-year return period (Q50) flood. However, considering the river's swinging nature and the division of flood discharge into the Karnali and Geruwa Rivers, the design discharge shall be taken as 2/3rd for either channel of Q50. Karnali River bank protection works are designed based on the survey and hydraulic data provided in the design report.

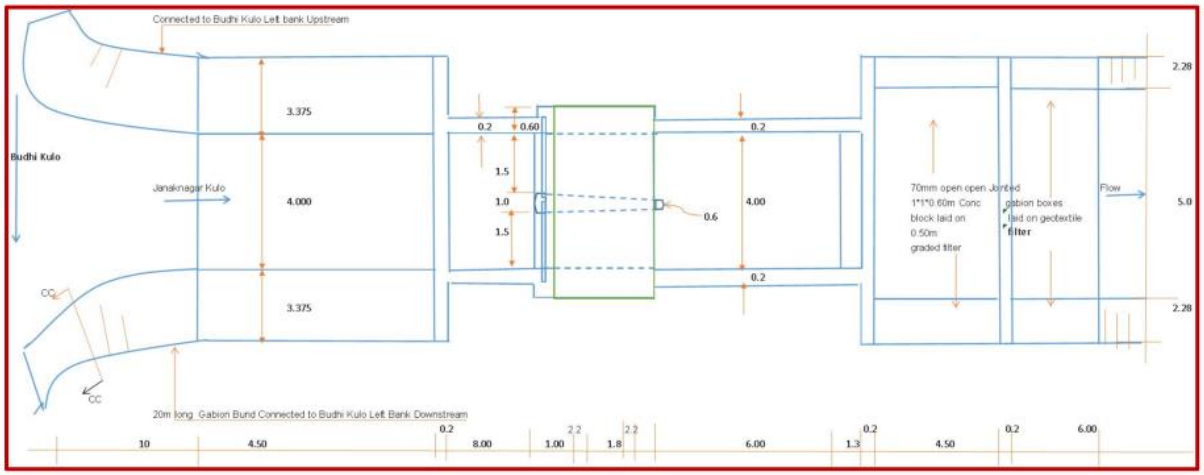
Table 7: Design Considerations of Karnali River Bank Protection

Aspect	Details
Design Discharge	Based on the 50-year return period flood (Q50) at 20,343 m³/s
- Design Discharge (2/3 Q50)	13,562 m³/s
Scour Depth Calculation	
- Formula	R=0.47(Q/f)1/3R=0.47(Q/f)1/3
- Silt Factor (f)	1.5
- Anticipated Scour Depth	1.5 times the calculated scour depth
Launching Apron	
- Length	16.5 meters
- Thickness	0.80 meters
Embankment Design	
- Top Width	5 meters (as per IS: 11532-1985, which provides guidelines for the design and construction of embankments)
- Side Slope	1 vertical to 2 horizontal (1V:2H)
- Freeboard	1.8 meters (as per IS: 12094-2000, which specifies the freeboard requirements for embankments)
Hydraulic and Geo-technical Data	
- Stream Average Velocity	3.5 m/s
- Width of River	2900 meters
- High Flood Level (HFL)	185.00 meters
- Low Water Level (LWL)	182.39 meters
- Average Bed Level	178.00 meters
- Mean Diameter of River Bed Material	1.27 mm
- Angle of Sloping Bank	26.56 degrees
- Slope of Hydraulic Grade Line (Sf)	0.25
- Flow Depth at Bank Full Stage	7.00 meters
Materials and Construction	
- Concrete Revetment	Conventional M15 PCC block revetment (Plain Cement Concrete)
- Gabion Revetment	Machine-made gabion revetment for flexibility and adaptability to changing river conditions

Figure 8: Current condition of the embankment

62. **Offtakes from Budhikulo.** Three branch canal offtakes do not have control structures at the junction of Budhi Kulo and off taking branch canal. These are located at the d/s of the first weir: Janaknagar branch at 0+750 at the left bank, Bagaipur and Bankhet at 0+820 and 1+050 from the right bank, respectively. The three off-takes will be the new structures, and head regulators are designed as control structures with the same principle as Flood Flush Sluice at Budhi Kulo Intake, as shown in the figure below.

Figure 9: Plan of Janaknagar Head Regulator



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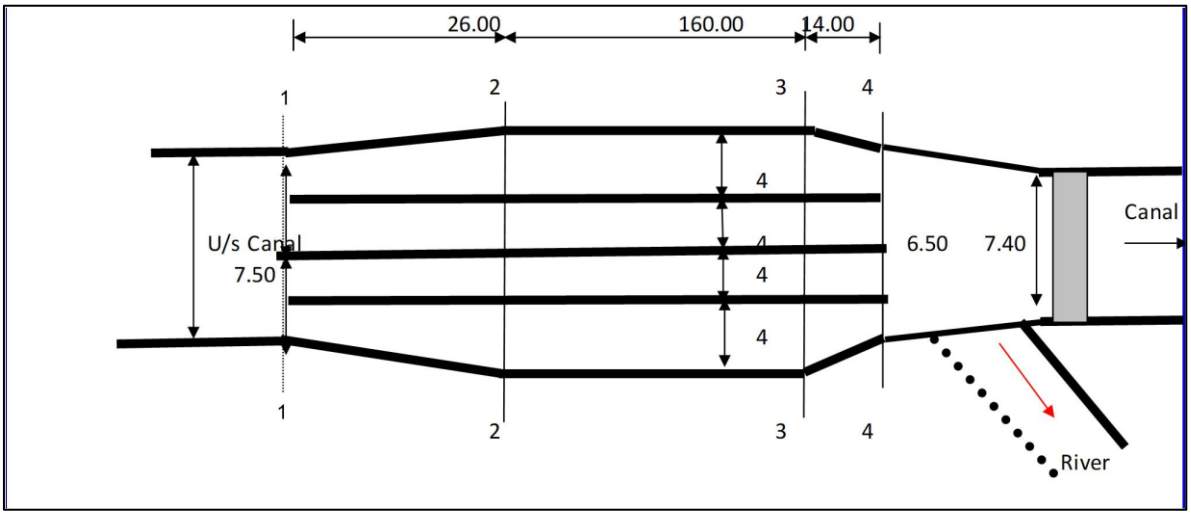
63. **Settling Basin.** The riverbed slope is flatter than the canal bed slope. Therefore, provision of hydraulic flushing settling basin from Budhi Kulo and hydraulic flushing other branches of Badalpur and Bhimapur-Muraiya is possible into Budhi Kulo. In contrast, hydraulic flushing from Gola into Geruwa and from Patabhar into Karnali Channel is feasible. On the basis severity of the silt load observed in the field, the following settling basins are proposed in advance work;

(i) Construction settling basin in Patabhar Kulo at 5+442 hydraulic flushing into Karnali.

(ii) Construction of settling basin in Badalpur Kulo; 0+400 flushing into Budhi Kulo.

64. Settling basins (Figure 10) are designed to settle particles >0.15mm. Deleterious materials finer than 0.15mm shall pass through the settling basin as suspended loads. Budhi Kulo intake gates are closed during high flood whenever sediment inflow exceeds 4000 ppm. Therefore, 1800ppm is taken as sediment concentration in the canal flow for design purposes.

Figure 10: Plan of Patabhar Settling Basin



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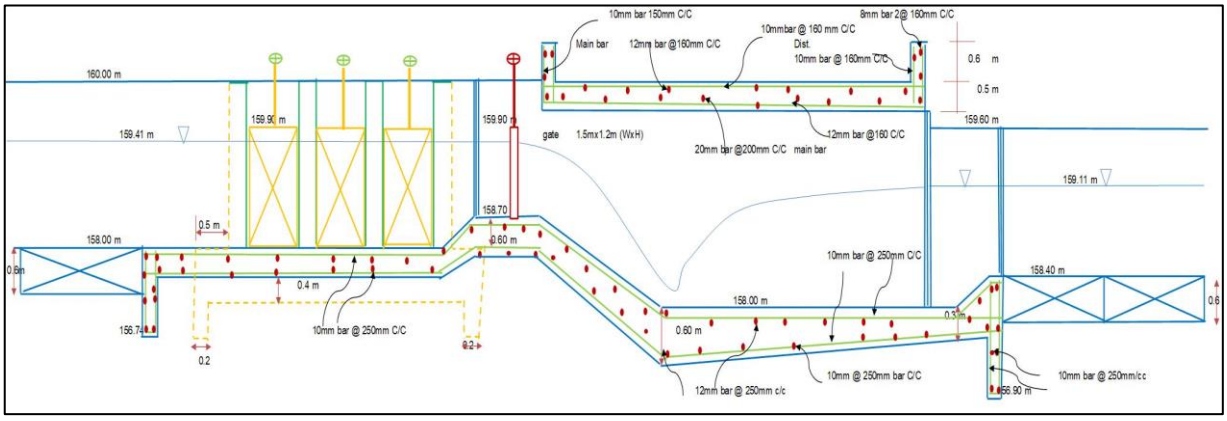
65. **Head and Cross Regulators.** All cross regulators are designed weirs with sloping glacis and formation hydraulic jump for energy dissipation. Downstream floor length is decided by stilling basin requirements. The final locations, ground elevations, and discharge of the branching canals should be decided by the construction management and Supervision Consultant (CMSC) during the construction survey and modified accordingly. Two new Cross and head regulators are proposed in Patabhar (Tikuligarh and Dasnahari), Bhimapur (Semarawa and Satgainya), and Tapara (Isworigunj and Pahadipur) Branch Canals each. In Daulatpur (Murkatta Bandh), Nayagaon (IndaiyaJagdawa) and Badalpur (Tethan) one each.

66. **Escapes.** Escape regulator structures (Figure 11) are designed as broad-crested weirs that flush into local drains or Budhi Kulo Itself. The elevation difference between the canal bed and escape outfall is sufficient to flush into the drain, and local existing channels are used as discharge carriers.

Figure 11: Sectional Elevation of Nayagaon Escape Canal Regulator



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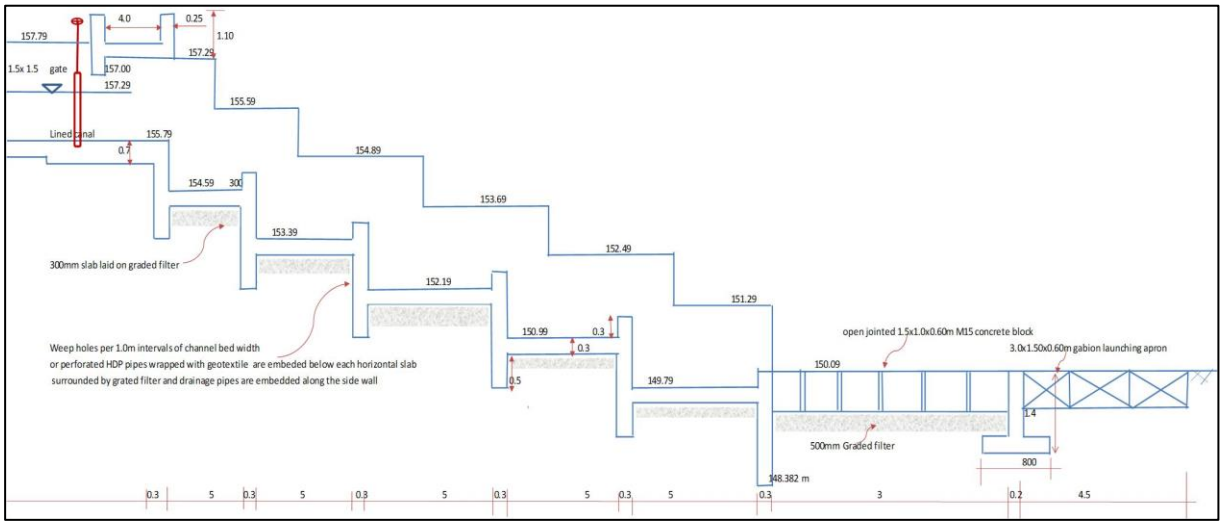
67. **Cascade Drop Escape.** Daulatpur Kulo runs parallel to Budhi Kulo. The bed difference between them is about 4.64m, and there is a very narrow space between them. Therefore, the cascade drop is designed as an escape, as shown in Figure 12 below.

Figure 12: Cascade Drop at Daulatpur Escape



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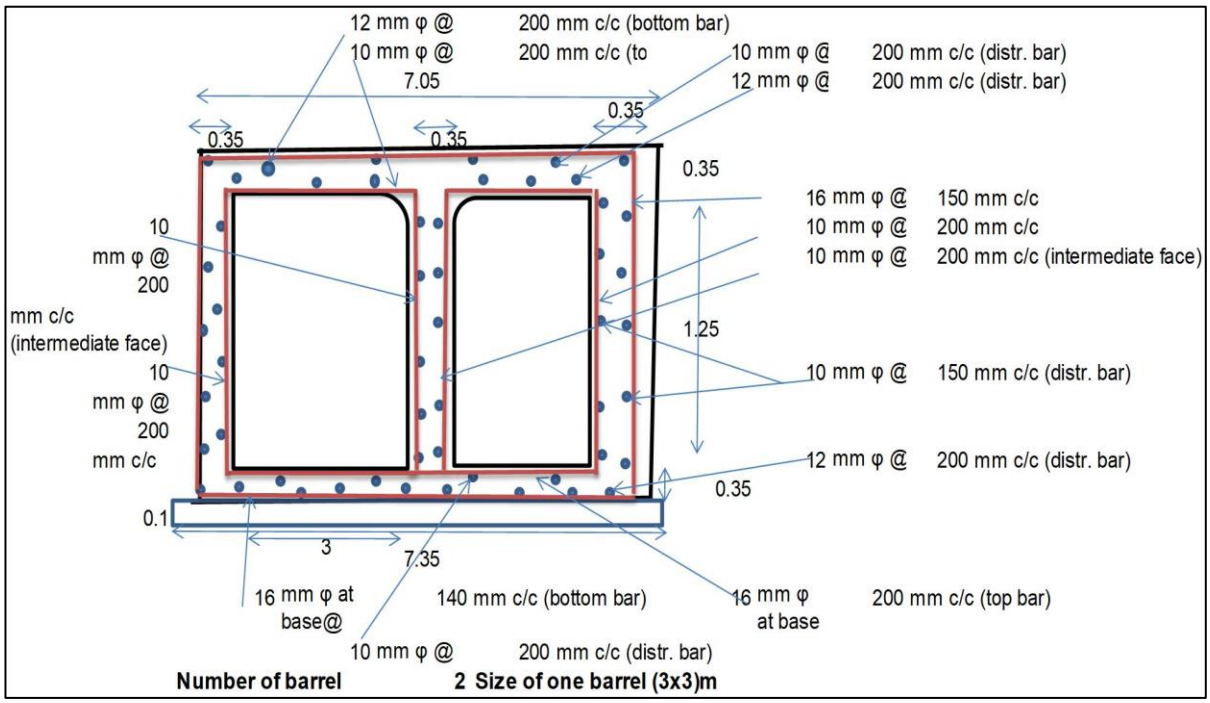
68. **Canal Syphon.** Bhimapur Kulo is choked; it is very difficult to pass the design discharge. It decided to dismantle the existing aqueduct and provide a canal siphon during the joint site with the Bhimapur Kulo offtake, and Muraiya Kulo offtake is at 21+900 of Budhi Kulo at the right bank. The command area of Bhimapur Kulo is on the western side, whereas the command area is on the western side, and the offtake locations are on the reverse side. Muraiya Kulo Command area is at a higher level than Bhimapur. Therefore, an aqueduct was provided on Bhimapur Kulo to cross over by Muraiya Kulo at 0+300, and a canal siphon barrel is proposed in the Bhimapur canal section, as shown in the figure below.

Figure 13: Section of Syphon Barrel



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69. **Drain Syphon.** Due to the flow from upstream the command area of Jhabai and Daulatpur Kulo, a drain is formed, passing parallel to Muraiya and Bhimapur Kulo. This causes the breaching of both canals and the flooding of Daulatpur's lower Command area. A drain siphon is provided at 0+150 of Bhimapur Kulo.

70. **Eastern Branch Canal Intake Improvement**. The three eastern intakes (Manau, Tapra and Khairi Chandanpur) take water from various branches of the Geruwa River. This river used to take most of the water emerging from the hills at Chisapani, but recent morphological changes have stopped this direct flow completely, and there is just seepage and drainage water entering the Geruwa or reaching these three systems via drains. The project has aimed to strengthen the existing weir system and proposed a silt flush sluice at the intake systems, as shown in the figure below.

Figure 14: Plan of Eastern Canal Intake Improvement

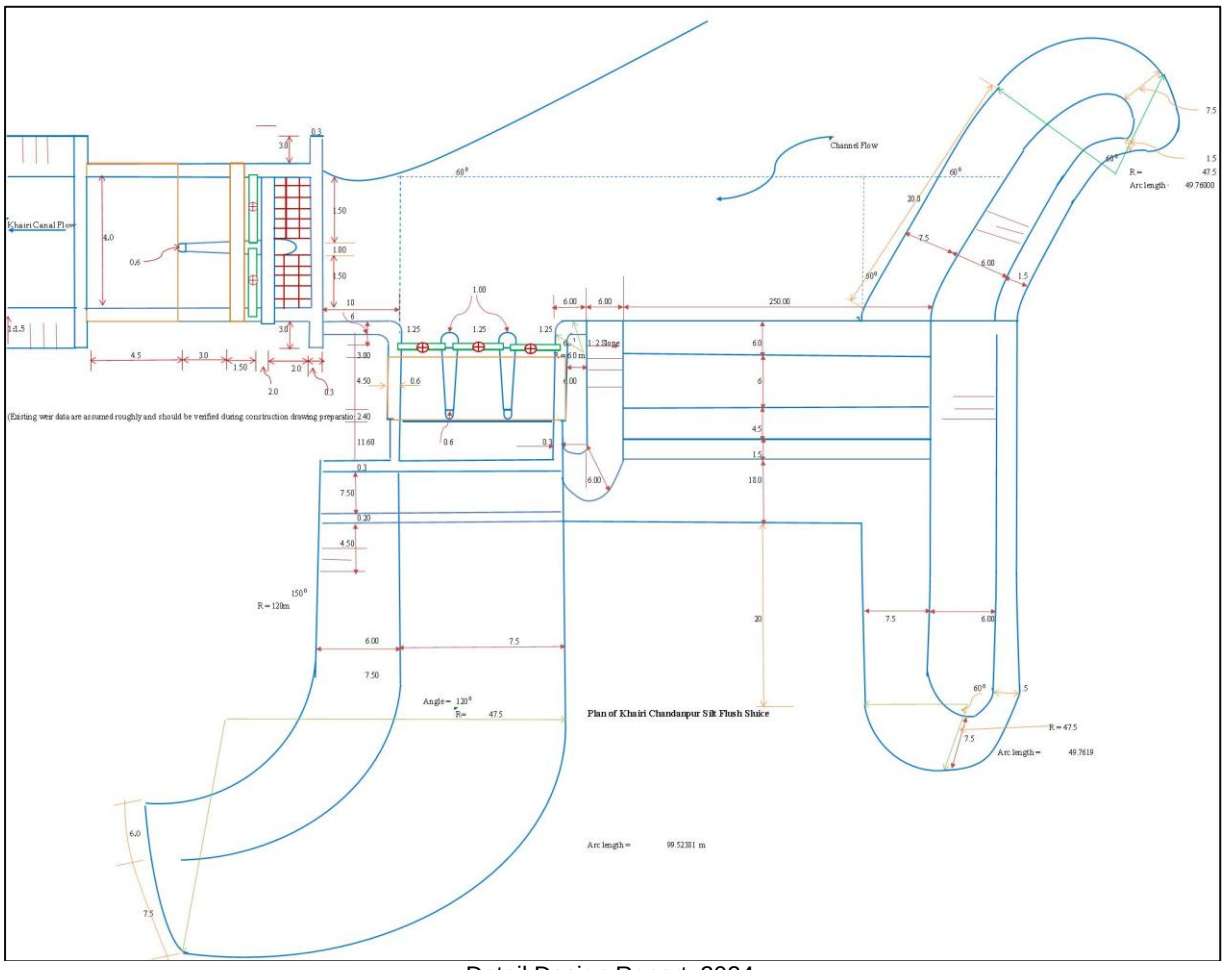

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Figure 15: Existing RIP Canal Structures Proposed for Rehabilitation

Existing Budhi Kulo Intake site –Regulating Gates

Existing Approach Canal: Proposed for Improvement

Proposed Head Regulator structure at Bagaipur Intake

Karnali River Bank Near Intake: Proposed Protection Work

Existing Intake of Khairichandan Canal system - Proposed Repair and Maintenance Works

D. Contract Packaging, Project Cost, Implementation Schedule

71. Under the RIP, All the physical project components will be packaged into five works contract packages and goods contracts. The total cost of the project is estimated at $28.91 million. The feasibility study is completed, and the subproject is currently at the detailed design stage. The RIP subproject will be for implementation over a time period of 5 years (from Q4 2024 – Q2 2029) from the date of approval.

72. The executing agency will be the Federal Ministry of Energy, Water Resources, and Irrigation (MOEWRI). At the federal level, the implementing agencies will be the Department of Water Resources and Irrigation (DWRI) and the Ministry of Agriculture and Livestock Development acting through the Department of Agriculture (DO). Implementing agencies will also be established at the provincial level. Project implementation units will be established at the federal and provincial levels.

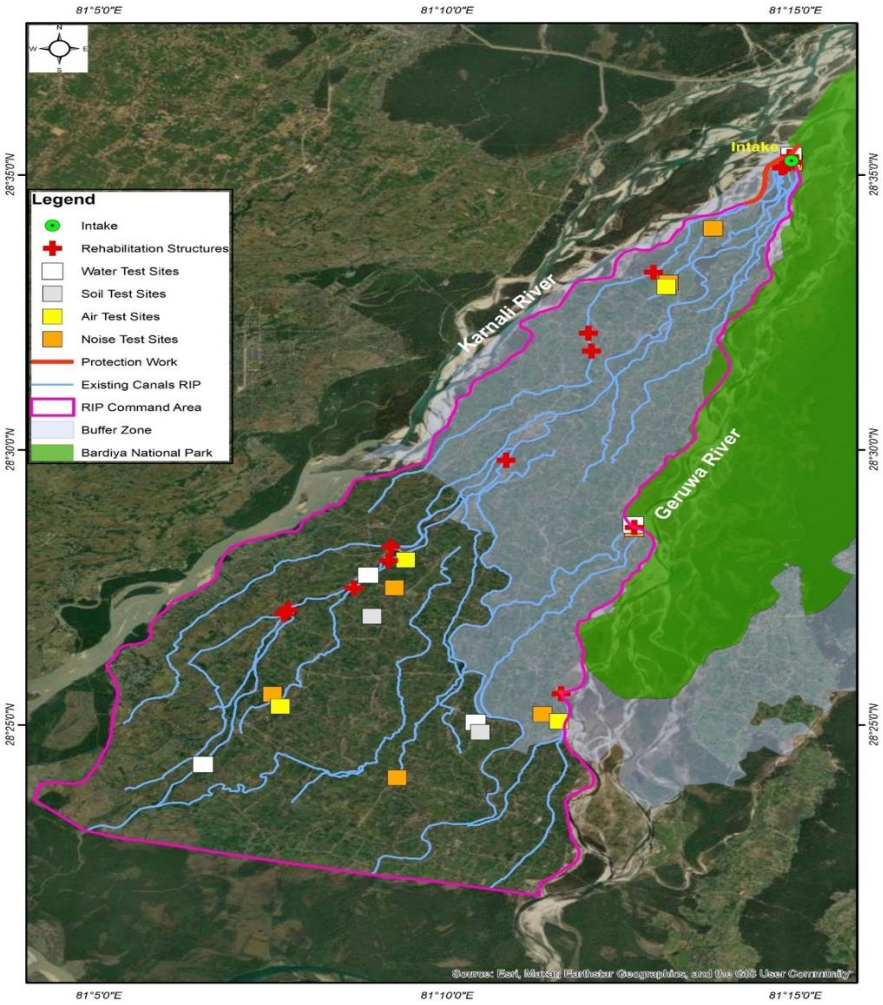
73. The Central Project Management Office (CPMO) will be under DOWRI. For RIP, there will be the Rajapur Irrigation Management Office (RIMO). The CPMO will be responsible for overall intra-agency and intra-department coordination, project design and environmental assessment, bid management, project management, project implementation, safeguards supervision, monitoring and reporting, and monitoring and evaluating project outputs and results. It will provide project implementation support to the contractors. It will also be responsible for organizing training programs to build the institutional capacity of PPUC for the operation and maintenance of the upgraded grids for the operational phase. A team will be established as the Project Implementation Support Consultant (PISC) to support PPUC. The PISC will support the project implementation and PMU and conduct training and capacity building. The RIMO will be responsible for procurement of all civil works under RIP. Project implementation and management support (PIMS) consultant will support both the CPMO and CAMO/project management units (PMUs) and project implementation units (PIUs).

IV. DESCRIPTION OF THE ENVIRONMENT

74. This section describes the environmental baseline of the RIP subproject areas. Considering the nature of the proposed works and geographical locations, the environmental conditions of the project area are presented first, followed by the site-specific description of the environmental baseline and the proposed locations of the subproject components. The baseline data was established based on collecting and reviewing secondary sources, including government publications, published reports, technical and research reports, and data from government websites.

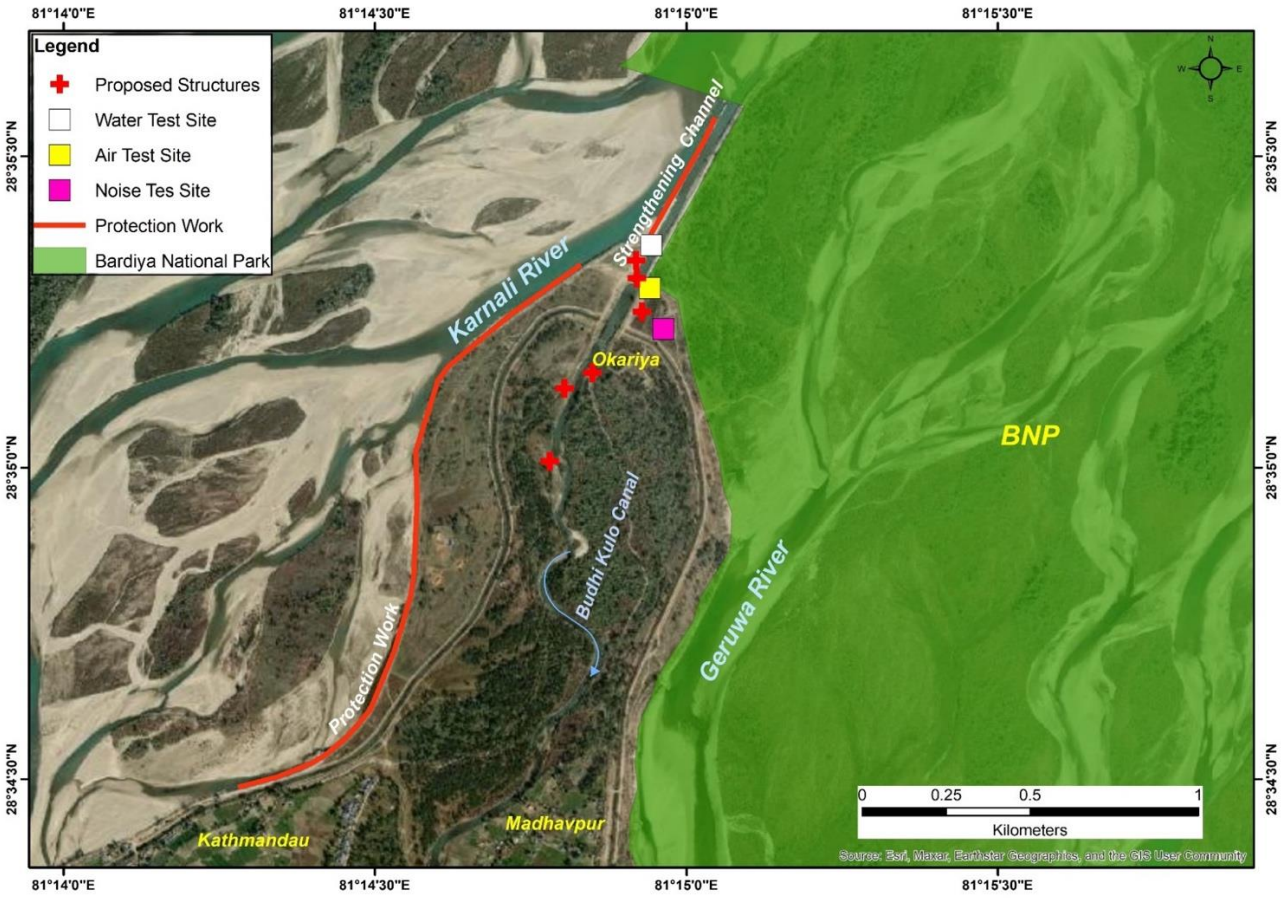
75. Baseline data includes an inventory of physical, ecological, and socio-economic parameters. Baseline environmental data presented in this chapter are based on available secondary information and field monitoring. Within the RIS command area, considering the proposed rehabilitation activities of the canal structures, the air, water, soil, and noise quality sampling were conducted by the consultant team during the field visits. Baseline air, water, noise, and soil quality monitoring were conducted in the project area at selected locations. Figure 16 and Figure 17 show the locations of the monitoring stations in the project area.

Figure 16: Proposed Structures and Environmental Baseline Monitoring Locations



Source: Detail Design Report 2024, Environment Field Assessment and the Google Earth Image

Figure 17: Proposed Structures in the Canal System and Baseline Monitoring Sites at Intake Area



Source: Detail Design Report 2024, Environment Field Assessment and the Google Earth Image

A. Physical Environment

76. **Location and Topography.** The Rajapur Irrigation Project component is located in the western part of the country in the Terai region. The RIP area is sectioned off from the rest of Bardia District by the Geruwa River on the east. Administratively, the island's northern part lies in Geruwa Rural Municipality, and the southern part falls under Rajapur Municipality. The eastern part of the Geruwa River is the Bardiya National Park (BNP). All the administrative boundaries of the G-RM are located within the buffer zone of the Bardiya National Park. The elevation of the command area is between 142 m to 180 m from the mean sea level. The irrigation system provides irrigation services to 14,500 ha of cultivated land spread over the command areas within two municipalities.

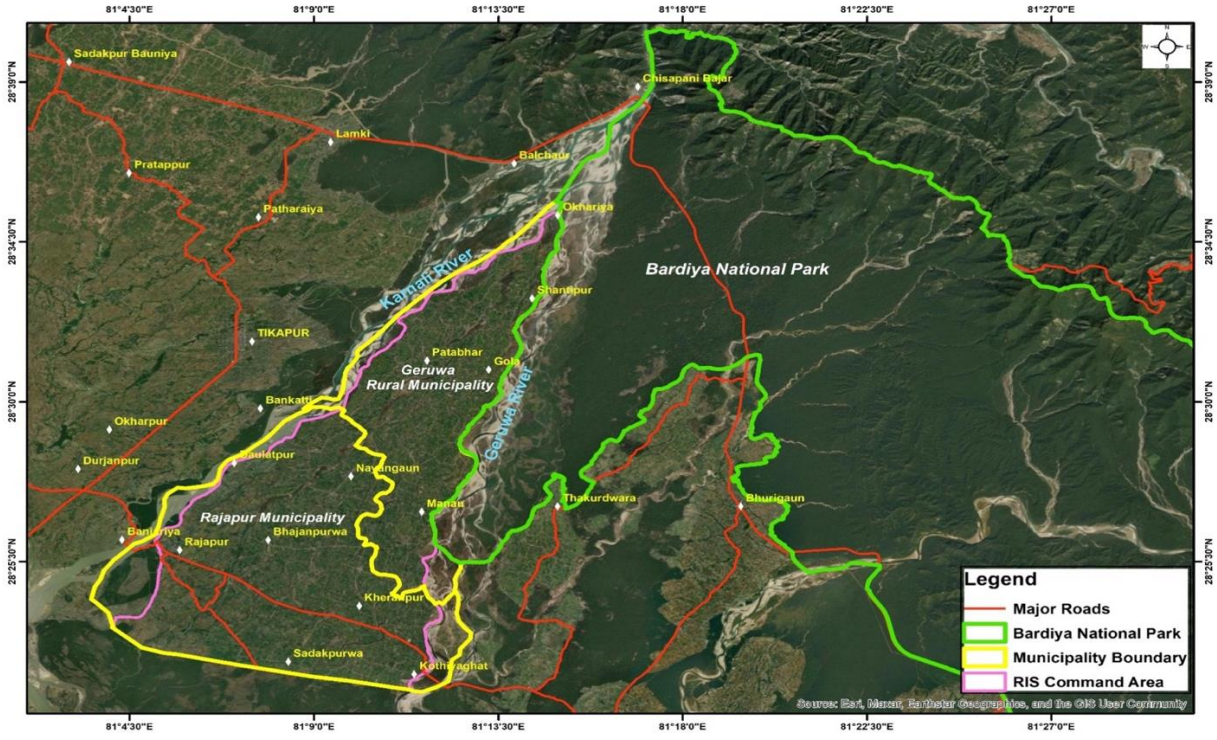
77. **Water Resources.** The project area possesses ample networks of streams, rivers, and lakes that get water from monsoon rainfall and groundwater recharge. The main rivers and streams in the area are Karnali River and Geruwa River. All these rivers have plenty of flow during the monsoon season, while the flow is very low during winter. The Karnali River, the longest river flowing inside Nepal, originates south of Mansarovar and Rokas lakes. Similarly, the tributary streams joining Karnali River in the north and south have steep longitudinal profiles. These Rivers have a gully-like morphology at the headwaters and have the potential to expand laterally and headward.

78. **Drainage Network.** The internal drainage network consists of four categories of drains based on their outfall. The first category of drain's outfall is Geruwa River, the next category of drain's outfall is Karnali River, the next category of drain's outfall is Budhi Kulo, and the rest category of drains crosses the Nepal border, and their outfall is Ghagara in India. The main transboundary drains are Maila Nala and Budhi Kulo, Khairi, and Bhimapur. Budhi Kulo, including other branch canals, functions as irrigation and drainage canals.

79. **River Morphology.** Karnali River is an aggressive and unpredictable gravel and boulder bed river that changes its course every year. The river carries huge amounts of sediments from the highlands, and as the river emerges from Chisapani and flows towards the plain area, it loses its sediment-carrying capacity resulting in sediment deposition and eventually leading to the formation of meandering and braided channels. In the process, it erodes river banks and poses a threat to the important infrastructures and settlement areas. As the command area of the Rajapur Irrigation System is bounded by two branches of the Karnali River, the canal system, specifically the Gola and Pathabar branches, including Budikulo intake, is highly vulnerable to the attack of a river flood. Moreover, changes in river morphology are also quite unpredictable. Shifting the dominant flow path completely to the left or right bank creates uncertainty in the diversion of water into the canal system.

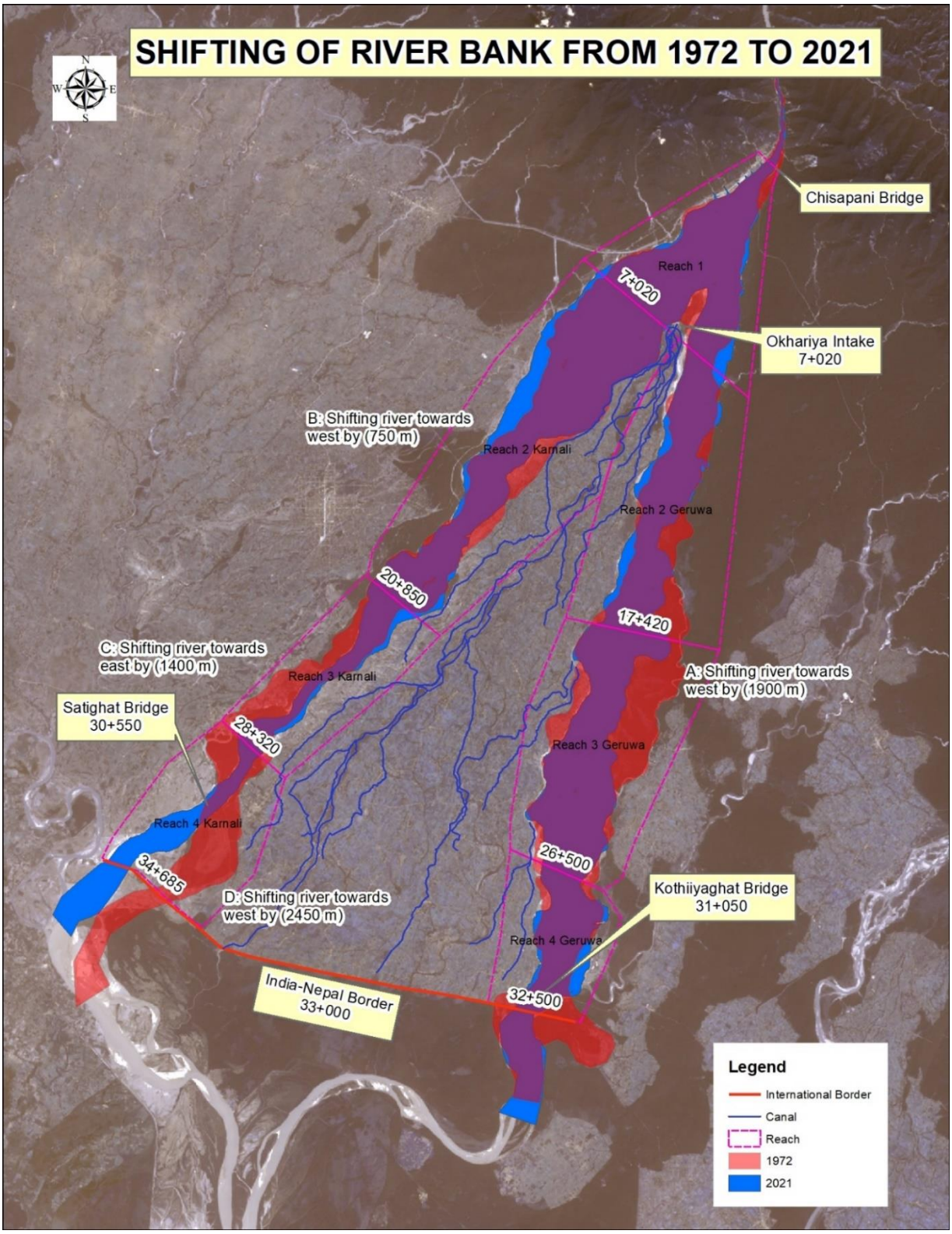
80. Figure 18 shows the RIP's location map, and Figure 19 shows the Karnali River Shifting between 1972 and 2021.

Figure 18: Location Map of Rajapur Irrigation Project



Source: Administrative boundary, Survey Department Nepal and the Google Earth Image

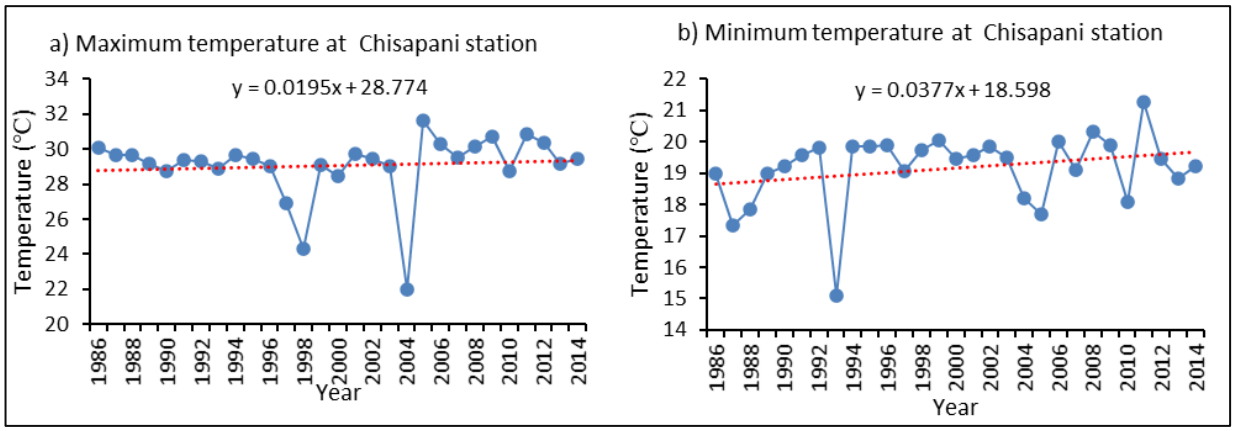
Figure 19: Karnali River Shifting between 1972 to 2021



Morphological Study of Karnali River, November 2022

81. **Climate.** The climate of Bardiya district is a tropical monsoon climate, with wet and dry seasons. The average annual rainfall is around 2500 mm, with most rain falling during the monsoon season from June to September. The temperature ranges from an average minimum of 10°C in winter to a maximum of 43°C in summer. The maximum and minimum temperature analysis for 1986 to 2014 shows that the maximum temperature increased by 0.0195℃ per year, whereas the minimum temperature increased by 0.0377℃ per year see Figure 20. This elaborate minimum temperature rise is faster than the maximum temperature.

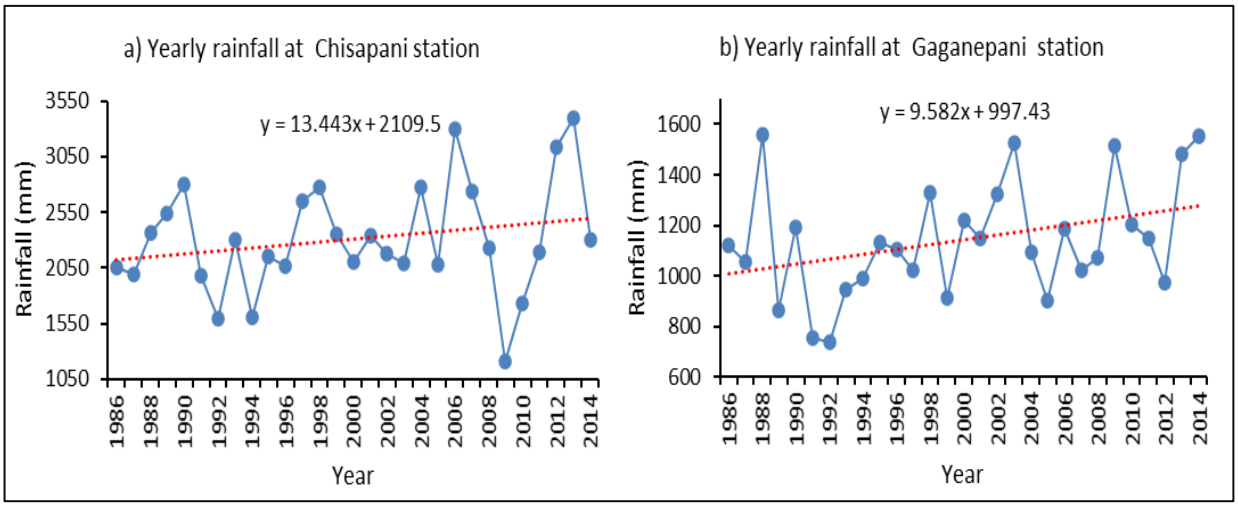
Figure 20: Maximum and Minimum Yearly Temperature at Chisapani Station



Source: DHM, 2020

82. The rainfall pattern in both stations shows erratic behaviour. Comparing maximum and minimum rainfall from 1986 to 2014, the fluctuation rate is nearly threefold in Chispani station and twofold in Gaganepani station. The trend lines of both Chisapani and Gaganepani stations show the precipitation rate increasing by 13.44 mm and 9.58 mm per year, respectively, as depicted in Figure 21. This result gives clear insight into the impact of climate change on local weather patterns.

Figure 21: Ground-based Yearly Rainfall at Chisapani and Gaganepani Station



Source: DHM, 2020

83. **Geology and Geomorphology.** The project area lies in the Bardiya district and is divided into

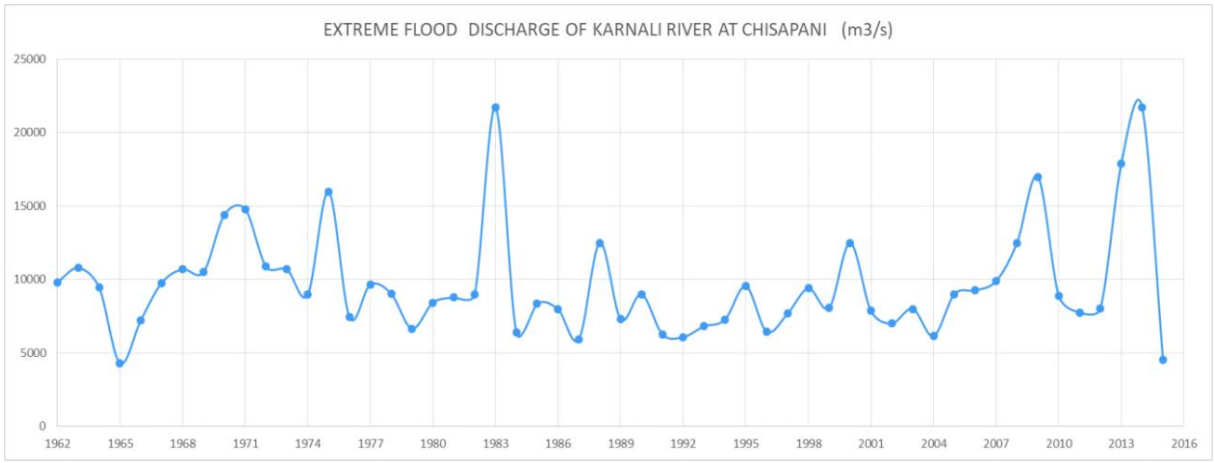
three main parts: the Northern Siwalik zone, the Central Bhabhar zone, and the Southern plainland. The Siwalik Hill covers the northern part of the district, and it is geologically made of consolidated sedimentary rocks, like sandstone, siltstone, mudstone, shale, and conglomerates ranging in age from the Plio-Pleistocene age. The steeply sloped Siwalik Hill has many geologic structures, such as folds, faults, fractures, and joints. The northern part of the Terai Plain is called the Bhabhar Zone, made of unconsolidated sedimentary rocks that are very coarse (gravel, cobble, pebble, boulder) materials. It is hard and highly porous too.

84. The RIP area can be subdivided into different landforms represented by unique geomorphic conditions and sediment variation. There are three main landforms in the project area: Active Alluvial Plain, Recent Alluvial Plain, and Alluvial Fan. The Alluvial fan is marginally distributed in the northern part of the study area, which is almost equivalent to the Bhabar zone that lies southwards from the Siwalik foothill. The alluvial fan forms a piedmont zone that has a bit higher elevation and constitutes coarser sediments. The Recent Alluvial Plain predominantly occupies the project area and is represented by sand, gravel, and, to some extent, silt and clay. Likewise, the Active Alluvial Plain refers to the area lying within the floodplain of the river.

85. **Road Network.** During RIRP, 39.5 km of service road was improved with the construction of bridges, culverts, and gravel metal surfaces. The network stretched in the east-west and north-south directions. The east-west road is now part of Postal Highway, a black-top all-weather road. Part of the north-south highway has also been blacktopped. In addition, a 38-km long ring road is in operation and touches all wards of both Geruwa and Rajapur Municipality. Now the project has been linked with the rest of the country by an all-weather road.

86. **Hydrology.** The hydrological data required for various studies has been gathered from the Department of Hydrology and Meteorology (DHM) office of Nepal. The hydrological data comprises peak discharges, daily discharges, and monthly discharge data of the Karnali River measured at Chisapani Station (Hydrological Station No. 280). Chisapani Station is just downstream of the Karnali Chisapani Multipurpose Project dam site. Daily discharge data of the Karnali River from 1962 are available at the Chisapani station. The yearly peak flood discharge is presented in Figure 22.

Figure 22: Yearly Peak Discharge of Karnali River at Chisapani Station (Station no. 280)

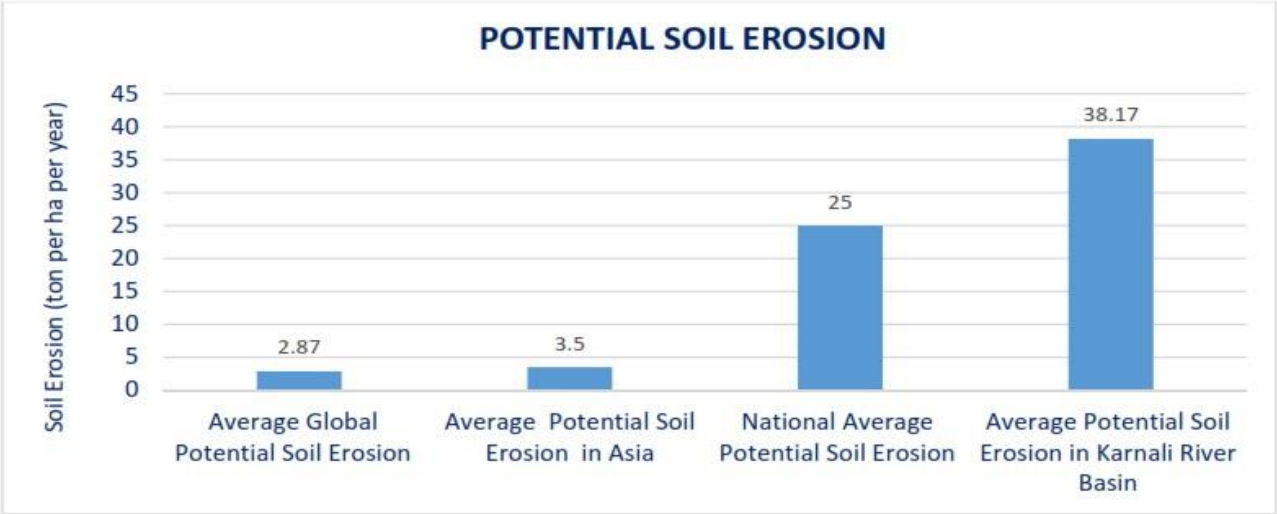


Source: DHM, 2020

87. **Soil Erosion.** Ashish Pandey and others conducted a soil erosion study in the Karnali River Basin and published it in the Journal of Water Resources and Hydraulic Engineering in 2015. The average annual soil loss of the Karnali River Basin was found to be 38.17 t $ha^{-1}yr^{-}1$. The average annual soil losses were grouped into different classes. According to the study, approximately 30.86% of the river basin area was found to be in the slight erosion class. Areas covered by moderate, high, very

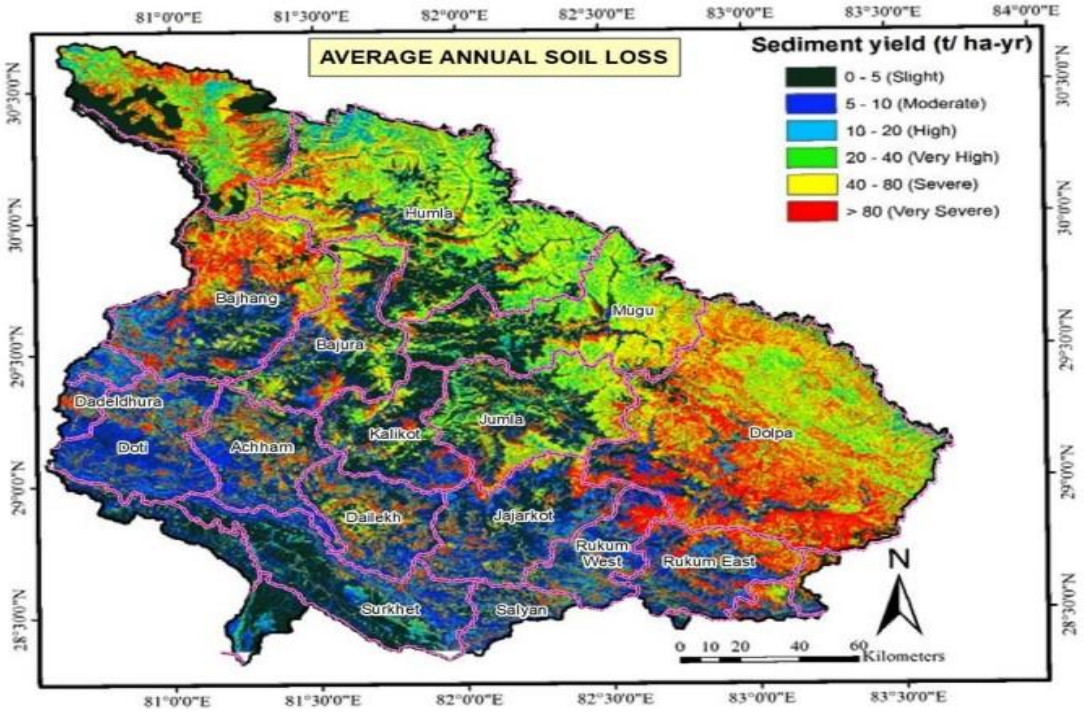
high, severe, and very severe erosion potential zones accounted for 13.09%, 6.36%, 11.09%, 22.02%, and 16.64%, respectively. The potential soil erosion figure depicts that the erosion in the Karnali basin is 1.5 times the national figure, as depicted in Figure 23. The global and continental value of soil erosion is quite small compared to the erosion in the Karnali River Basin. Approximately 69% of the Karnali River Basin requires immediate attention from soil conservation analysts. The spatial distribution of the soil loss is presented in Figure 24.

Figure 23: Comparison of potential soil erosion



Morphological Study of Karnali River, November 2022

Figure 24: Average Annual Soil Loss in Karnali River Basin



Morphological Study of Karnali River, November 2022

88. **Sedimentation.** While flowing from Chisapani to the Budikulo intake site, the Karnali River experiences large variations in gradient, plan forms, bed form, and cross sections. It is apparent that the sediment data measured at the Chisapani hydrological station does not represent the sediment concentration of flood water at the intake site of the Rajapur Irrigation Project. So, the consultant team has arranged to measure suspended sediment concentration during the monsoon season at the Budi Kulo intake site. The sediment concentration data was collected from Budi Kulo between 7 July 2022 and 10 October 2022 and is presented in the table below.

Table 8: Suspended Sediment Concentration Recorded at Budi Kulo Intake

S.N.	S.Date	Con. (PPM)	S.N.	S.Date	Con. (PPM)	S.N.	S.Date	Con. (PPM)
1	7/7/2022	1,254	37	8/8/2022	2,021	73	9/9/2022	1,095
2	8/7/2022	1,084	38	9/8/2022	1,383	74	10/9/2022	944
3	9/7/2022	3,934	39	10/8/2022	2,644	75	10/9/2022	1,390
4	9/7/2022	2,003	40	10/8/2022	1,836	76	11/9/2022	1,087
5	10/7/2022	3,100	41	11/8/2022	1,959	77	12/9/2022	652
6	11/7/2022	1,420	42	12/8/2022	1,510	78	13/09/2022	532
7	12/7/2022	1,237	43	13/08/2022	1,220	79	14/09/2022	399
8	13/07/2022	1,652	44	14/08/2022	1,387	80	15/09/2022	10,859
9	14/07/2022	1,710	45	15/08/2022	1,542	81	16/09/2022	23,592
10	15/07/2022	2,146	46	16/08/2022	912	82	17/09/2022	15,501
11	16/07/2022	1,188	47	17/08/2022	1,176	83	17/09/2022	12,947
12	16/07/2022	1,207	48	17/08/2022	1,198	84	18/09/2022	3,748
13	17/07/2022	1,109	49	18/08/2022	776	85	19/09/2022	3,862
14	18/07/2022	1,149	50	19/08/2022	1,103	86	20/09/2022	1,546
15	19/07/2022	4,845	51	20/08/2022	899	87	21/09/2022	1,145
16	20/07/2022	7,136	52	21/08/2022	876	88	22/09/2022	585
17	21/07/2022	7,000	53	22/08/2022	555	89	23/09/2022	509
18	22/07/2022	5,265	54	23/08/2022	554	90	24/09/2022	545
19	23/07/2022	2,055	55	24/08/2022	578	91	24/09/2022	644
20	24/07/2022	2,105	56	25/08/2022	656	92	25/09/2022	1,697
21	24/07/2022	2,246	57	26/08/2022	636	93	26/09/2022	1,676
22	25/07/2022	2,462	58	26/08/2022	539	94	27/09/2022	658
23	26/07/2022	2,408	59	27/08/2022	679	95	28/09/2022	524
24	27/07/2022	1,463	60	28/08/2022	750	96	29/09/2022	607
25	28/07/2022	1,609	61	29/08/2022	3,811	97	30/09/2022	290
26	29/07/2022	1,403	62	30/08/2022	1,210	98	1/10/2022	257
27	30/07/2022	2,191	63	31/08/2022	807	99	2/10/2022	234
28	31/07/2022	2,936	64	1/9/2022	1,864	100	2/10/2022	215
29	31/07/2022	3,302	65	2/9/2022	3,366	101	3/10/2022	228
30	1/8/2022	1,872	66	3/9/2022	1,930	102	4/10/2022	4,355
31	2/8/2022	3,877	67	3/9/2022	1,183	103	5/10/2022	4,882
32	3/8/2022	3,798	68	4/9/2022	2,038	104	6/10/2022	7,319
33	4/8/2022	2,521	69	5/9/2022	1,269	105	7/10/2022	6,846
34	5/8/2022	2,541	70	6/9/2022	873	106	8/10/2022	12,958
35	6/8/2022	2,044	71	7/9/2022	545	107	9/10/2022	11,675
36	7/8/2022	2,275	72	8/9/2022	465	108	9/10/2022	11,669
Average Suspended sediment Concentration - 2688 PPM						109	10/10/2022	6,993

89. *Analysis of Suspended Sediment Concentrations*: The table presented provides a comprehensive record of suspended sediment concentration measurements taken over a period of time, with the concentrations recorded in parts per million (PPM). The data spans multiple dates and includes 109 samples divided into three sections. The average suspended sediment concentration across all samples is 2688 PPM.

90. The first section of the table starts with a sample taken on 7 July 2022, which recorded a sediment concentration of 1,254 PPM. The highest concentration in this section was recorded on 20 July 2022, with a notable 7,136 PPM. Conversely, the lowest concentration in this section was noted on 16 July 2022, at 1,109 PPM. This section indicates significant variability in sediment concentrations within a relatively short span.

91. The second section begins with a sample dated 8 August 2022, showing a concentration of 2,021 PPM. The highest concentration in this section, 3,811 PPM, was observed on 29 August 2022. The lowest concentration recorded in this section was 555 PPM on 21 August 2022. Similar to the first section, this period exhibits considerable sediment level fluctuations.

92. The third section, starting from 9 September 2022 with a concentration of 1,095 PPM, shows even greater variability. The highest recorded concentration in this section was 10,859 PPM on 27 September 2022, while the lowest was 228 PPM on 1 October 2022. This section includes the entire dataset's highest and lowest concentrations, indicating extreme sediment load variations during this period.

93. *Key Observations and Trends*: One of the most striking observations from the dataset is the significant variation in suspended sediment concentrations over the sampled dates, with values ranging from as low as 228 PPM to as high as 23,589 PPM. Such high variability suggests dynamic environmental conditions influencing sediment transport and deposition. Weather patterns, river flow rates, erosion, and runoff events likely contribute to these fluctuations.

94. The highest concentration recorded was 23,589 PPM on 16 September 2022. This exceptionally high value may correspond to a specific event, such as heavy rainfall leading to increased runoff and sediment load. On the other hand, the lowest concentration, 228 PPM, recorded on 1 October 2022 represents a period of minimal sediment transport, possibly due to stabilized river conditions or reduced flow.

95. Overall, the dataset illustrates the dynamic nature of sediment transport within the river system, with suspended sediment concentrations showing significant temporal variations. The average suspended sediment concentration of 2688 PPM indicates a generally high sediment load in the river, which could affect river management and infrastructure planning. Understanding these patterns is crucial for developing strategies to mitigate erosion, manage sediment deposition, and maintain river health.

96. **Ambient Air Quality.** To establish the baseline air quality scenario in the project area, ambient air quality monitoring was conducted at five locations around the proposed components and surrounding areas with the project corridor of impact. The ambient air quality samples were collected from the field for a 24-hour duration and analyzed in the laboratory. The results are compared with the National Ambient Air Quality Standard (NAAQS) as well as WHO Ambient Air Quality Guidelines values for interim target 4 (2021). The monitored results and comparison with standards are presented in Table 9 and also shown graphically in Figure 25.

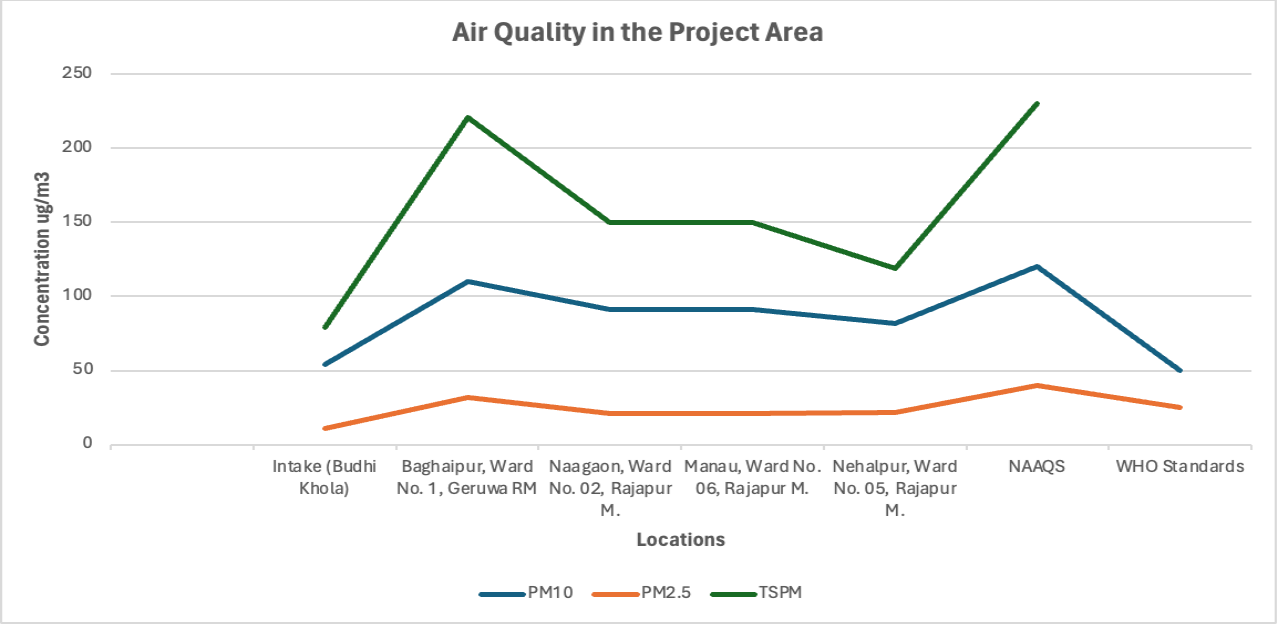
Table 9: Ambient Air Monitoring Results of Rajapur Irrigation Project Area

S. N.	Location	PM_{10}	$PM_{2.5}$	TSPM	Lead	SO_2	NO_X	Benzene	Ozone	CO %
		($\mu g/Nm^3$)								
1.	Intake (Budhi Khola)	54.0	11.0	79.0	<0.002	<0.02	0.4	<2.0	19.0	ND*
2.	Baghaipur, Ward No. 1, Geruwa RM	110.0	32.0	221.0	<0.002	<0.02	0.19	<2.0	21.0	ND*
3.	Naagaon, Ward No. 02, Rajapur M.	91.0	21.0	150.0	<0.002	<0.02	0.15	<2.0	17.0.0	ND*
4.	Manau, Ward No. 06, Rajapur M.	91.0	21.0	150.0	<0.002	<0.02	0.15	<2.0	17.0.0	ND*
5.	Nehalpur, Ward No. 05, Rajapur M.	82.0	22.0	119.0	<0.002	<0.02	0.19	<2.0	19.0	ND*
	NAAQS	**120**	**40**	**230**	**0.5 (A)**	**70**	**40**	**5 (A)**	**157**	**<1.0**
	WHO Guideline	**50**	**25**	**-**		**50**	**50**	**-**	**120**	**4**

* ND - Not Detected NAAQS - National Ambient Air Quality Standard A – Annual

Source: Baseline Environmental Monitoring Study of RIP, February 2024

Figure 25: Existing Ambient Air Quality in the Project Area (Day Time)



97. It can be seen from the table above that the observed ambient air quality in the project area for all the parameters is well within the NAAQS Nepal National Ambient Air Quality Standard (NAAQS) as

well as WHO guideline values except participant matter. The PM_{10} concertation was observed to be higher than the WHO guideline value of 50 µg/m3 with a maximum value of 110 µg/Nm^3 recorded at Baghaipur (Ward No. 1 of Geruwa RM). $PM_{2.5}$ concentration was also higher at this location, with a recorded value of 32 µg/Nm^3 against the WHO guideline value of 25 µg/Nm^3. It was observed that the aggravated level of the particulate matter in the ambient air quality at these locations was mainly due to the moving of existing vehicles and construction activities ongoing in the project area locations.

98. WHO does not specify guidelines for TSPM, but all locations are within the NAAQS limit of 230 µg/Nm^3. This suggests that, while particulate pollution is present, it does not exceed national regulatory limits for TSPM.

99. Lead levels are well below detectable limits (<0.002 µg/Nm^3) at all locations, indicating no significant lead pollution. This is well within the NAAQS annual average limit of 0.5 µg/Nm^3. The absence of detectable lead levels suggests effective control of lead emissions in the monitored areas.

100. SO_2 levels are significantly below the WHO guideline of 50 µg/Nm^3 and the NAAQS limit of 70 µg/Nm^3, with all measurements below detectable levels (<0.02 µg/Nm^3). This indicates that sulfur dioxide emissions are well controlled and do not pose a significant air quality issue.

101. The WHO guideline for NOx is 50 µg/Nm^3, and all locations show levels well within this limit. The measurements are 0.4 µg/Nm^3 at Intake (Budhi Khola), 0.19 µg/Nm^3 at Baghaipur, and 0.15 µg/Nm^3 at both Naagaon and Manau, with Nehalpur at 0.19 µg/Nm^3. This indicates that nitrogen oxide pollution is not a major concern in the monitored areas.

102. Benzene levels are below detectable limits (<2.0 µg/Nm^3) at all locations, within the NAAQS annual average limit of 5 µg/Nm^3. The absence of detectable benzene levels suggests that this pollutant does not pose a significant air quality issue in the monitored areas.

103. The WHO guideline for ozone is 120 µg/Nm^3. All locations have ozone levels well within this guideline, with measurements of 19.0 µg/Nm^3 at Intake (Budhi Khola), 21.0 µg/Nm^3 at Baghaipur, 17.0 µg/Nm^3 at Naagaon and Manau, and 19.0 µg/Nm^3 at Nehalpur. This indicates that ozone pollution is not a significant issue.

104. The WHO guideline for CO is 4%. All locations have non-detectable CO (ND*) levels, indicating that carbon monoxide is not a significant pollutant in the monitored areas.

105. **Water Quality.** Water samples were collected from both surface and groundwater sources. A total of 5 samples (4 surface and 1 groundwater) were collected from these sources in the project areas. The samples were analyzed for both physical and chemical parameters. The results were compared with national and WHO water quality standards. The results of the water quality monitoring are presented in the table below.

106. The table below shows that the observed quality characteristics of all water sampling points indicate better source quality from the physical and chemical point of view for irrigation purposes, which was found well within a suitable range in this monitoring season. Turbidity and silt content in the Bore Well Water of 100 m depth collected from Jhapti, Rajapur Municipality, Ward No. 05 are significantly higher.

107. The physical parameters measured include color, turbidity, conductivity, total dissolved solids, total suspended solids, sand and silt, pH, and lab temperature. All locations have color measurements below 5.0 Hazen, indicating no significant color pollution. Turbidity levels are generally low, at or below 1.0 NTU, except for Jhapti, which shows a high turbidity of 65.0 NTU, indicating significant particulate matter or sediment in the water. Conductivity values are well within the NDWQS limit of 1500 µS/cm, with the highest recorded at 397.0 µS/cm in Jhapti, suggesting acceptable ionic content in the water.

108. Total dissolved solids (TDS) levels are also within safe limits, well below the 1000 mg/l threshold, with the highest at 221.0 mg/l in Jhapti. This indicates that the dissolved solids in the water

are within safe levels. Total suspended solids (TSS) are minimal across most locations, below detectable levels (<1.0 mg/l), except for Jhapti, which shows 38.0 mg/l. Sand and silt content is significantly high at Jhapti (7,662.0 mg/l), while other locations have levels below detectable limits. pH levels are within the acceptable range of 6.5 - 8.5 across all locations, and water temperatures are consistent, ranging from 15.8°C to 17.4°C.

109. Chemical parameters include total hardness, calcium hardness, magnesium hardness, total alkalinity, chloride, ammonia, sulfate, nitrate, nitrite, iron, manganese, arsenic, copper, zinc, sodium, sodium absorption ratio, potassium, dissolved phosphate, organic matter, and total nitrogen. Total hardness is within the acceptable limit of 500 mg/l as CaCO3, with the highest recorded at Jhapti (210.0 mg/l). Calcium and magnesium hardness are also within safe limits, with the highest values at Jhapti (190.0 mg/l and 4.85 mg/l, respectively).

110. Total alkalinity and bicarbonate alkalinity are within the safe limit of 500 mg/l as CaCO3, with the highest at Jhapti (264.0 mg/l). Chloride levels are below detectable limits (<1.0 mg/l) at all locations. Ammonia levels are low, with the highest at Jhapti (0.06 mg/l), well within the WHO and NDWQS guideline of 1.5 mg/l. Sulfate levels are low across all locations, with the highest at Badalpur (15.6 mg/l), well within the NDWQS limit of 250 mg/l. Nitrate levels are also low, with the highest at Jhapti (0.97 mg/l), within the WHO and NDWQS guidelines of 50 mg/l. Nitrite levels are below detectable limits (<0.02 mg/l), except at Geruwa Khola (0.02 mg/l).

111. Iron levels are within safe limits at most locations but are significantly high at Jhapti (9.92 mg/l), exceeding the WHO and NDWQS guideline of 0.3 mg/l. Manganese levels are within safe limits except at Jhapti (0.26 mg/l), exceeding the NDWQS guideline of 0.2 mg/l but within the WHO guideline of 0.4 mg/l. Arsenic levels are below detectable limits (<0.005 mg/l) at all locations, within the WHO guideline of 0.01 mg/l and the NDWQS guideline of 0.05 mg/l. Copper levels are below detectable limits (<0.01 mg/l) at all locations, well within the WHO guideline of 2 mg/l and the NDWQS guideline of 1 mg/l. Zinc levels are within safe limits, with the highest at Jhapti (0.34 mg/l), well below the NDWQS limit of 3 mg/l.

112. Sodium levels are within safe limits, with the highest at Jhapti (5.77 mg/l). The sodium absorption ratio is highest at Jhapti (0.907) but generally low across all locations. Potassium levels are within safe limits, with the highest at Geruwa Khola (4.14 mg/l). Dissolved phosphate levels are within safe limits, with the highest at the Intake of Budhi Kulo-Approach Channel (0.04 mg/l). Organic matter levels are consistent across locations, with the highest at Badalpur (1.2 mg/l). Total nitrogen levels are highest at Jhapti (5.6 mg/l), suggesting higher nutrient levels in the water at this location.

113. Biological parameters include total coliform and E. coli. Total coliform levels are high at Badalpur (>300 CFU/100ml) and Jhapti (>300 CFU/100ml), indicating potential fecal contamination. E. coli levels are also high at Badalpur (82 CFU/100ml) and Jhapti (>300 CFU/100ml), confirming significant fecal contamination. These findings suggest that biological contamination is a significant concern at these locations, necessitating targeted interventions to ensure safe drinking water quality.

Table 10: Water Quality Monitoring Results of Rajapur Irrigation Project Area

Parameters	Units	WHO GV	NDWQS	Surface Water				Deep Tubewell
				Intake of Budhi kulo-Approach Channel	Budhi Kulo - Lower Reach	Badalpur, Branch Canal Water	Geruwa Khola	Jhapti
PHYSICAL								
Color	Hazen	15	5 (15)	<5.0	<5.0	<5.0	<5.0	<5.0
Turbidity	NTU	5	5 (10)	1.0	1.0	<1.0	1.0	65.0

Parameters	Units	WHO GV	NDWQS	Surface Water				Deep Tubewell
				Intake of Budhi kulo-Approach Channel	Budhi Kulo - Lower Reach	Badalpur, Branch Canal Water	Geruwa Khola	Jhapti
Conductivity	µS/cm	-	1500	208.0	278.0	241.0	278.0	397.0
Total Dissolved Solids	mg/l	1000	1000	112.0	147.0	135.0	147.0	221.0
Total	mg/l	-	-	<1.0	<1.0	<1.0	<1.0	38.0
Sand and Silt	mg/l	-	-	<1.0	<1.0	<1.0	<1.0	7,662.0
pH	-	6.5 -	6.5-8.5*	7.3	8.1	7.7	8.1	7.5
Lab	^{0}C	-	-	15.8	17.4	17.2	17.4	17.4
CHEMICAL								
Total Hardness	mg/l as $CaCO_3$	500	500	130.0	208.0	154.0	174.0	210.0
Calcium Hardness	mg/l as $CaCO_3$	-	-	88.0	108.0	102.0	118.0	190.0
Magnesium Hardness	mg/l as $CaCO_3$	-	-	43.0	100.0	52.0	56.0	20.0
Calcium	mg/l	-	-	35.23	43.24	40.84	47.24	76.07
Magnesium	mg/l	-	-	10.2	24.29	12.63	13.60	4.85
Total Alkalinity	mg/l as $CaCO_3$	500	-	108.0	206.0	134.0	166.0	264.0
Bicarbonate Alkalinity	mg/l as $CaCO_3$	-	-	108.0	206.0	134.0	166.0	264.0
Carbonate Alkalinity	mg/l as $CaCO_3$	-	-	Nil	Nil	Nil	Nil	Nil
Chloride	mg/l	250	250	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia	mg/l	1.5	1.5	<0.02	0.05	0.03	0.04	0.06
Sulphate	mg/l	-	250	13.2	14.0	15.6	9.1	12.4
Nitrate	mg/l	50	50	0.41	0.10	0.16	0.36	0.97
Nitrite	mg/l	3	-	<0.02	<0.02	<0.02	0.02	<0.02
Iron	mg/l	0.3	0.3 (3)	0.16	0.18	0.14	0.30	9.92
Manganese	mg/l	0.4	0.2	0.03	0.04	0.02	0.02	0.26
Arsenic	mg/l	0.01	0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	mg/l	2	1	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	-	3	0.02	0.08	0.01	0.02	0.34
Sodium	mg/l	-	-	4.06	4.05	3.95	4.14	5.77
Sodium	-	-	-	0.852	0.697	0.764	0.751	0.907
Potassium	mg/l	-	-	2.50	3.36	2.80	4.14	4.02
Dissolved	mg/l	-	-	0.04	0.04	0.02	0.04	<0.02
Organic	mg/l	-	-	0.8	0.8	1.2	0.8	0.8
Total	mg/l	-	-	2.8	1.4	1.4	4.2	5.6

Parameters	Units	WHO GV	NDWQS	Surface Water				Deep Tubewell
				Intake of Budhi kulo-Approach Channel	Budhi Kulo - Lower Reach	Badalpur, Branch Canal Water	Geruwa Khola	Jhapti
BIOLOGICAL								
Total Coliform	CFU/100ml	Nil	Nil	8	110	205	> 300	> 300
E. Coli	CFU/100ml	Nil	Nil	Nil	41	82	23	> 300

Source: Baseline Environmental Monitoring Study of RIP, February 2024

114. **Noise Level.** No ambient air quality monitoring stations are available in the project area. Monitoring was conducted at key locations in the project area to establish existing baseline noise levels using noise meters for daytime and nighttime. Eight locations within the project component areas were selected for noise level monitoring. The selected monitoring locations represent the semi-urban project area. The background noise levels at the monitoring locations are generated from normal activities and traffic on the road.

115. The noise monitoring results are compared with the National Ambient Noise Quality Standard (NANQS) and IFC/WBG Ambient Air Quality Standards for daytime and nighttime. The monitored results and comparison with standards are presented in Table 11 and also shown graphically in Figure 26 (daytime) and Figure 27 (nighttime), respectively.

Table 11: Noise Quality Monitoring Results of Rajapur Irrigation Project Area

Location / Spots	Equivalent Noise Level (L_{eq})							
	Intake, Okhariya	Baghaipur	**B**adalpur	Sarkhol	Manau	Geruwa Khola	Nehalpur	Tapara Bazar
Time Zone: 07:00	54.9	44.0	52.1	46.9	54.1	40.1	50.8	61.2
Time Zone: 10:00	72.4	44.3	52.3	47.0	53.3	39.5	51.3	60.8
Time Zone: 13:00	71.8	44.0	47.8	46.7	53.7	38.9	50.8	61.4
Time Zone: 16:00	70.3	42.6	45.3	46.8	54.7	40.2	41.9	60.7
Time Zone: 19:00	63.7	42.4	44.3	46.8	53.3	39.7	41.4	56.9
Time Zone: 22:00	58.3	40.9	43.8	45.3	50.2	36.7	41.5	55.3
Time Zone: 01:00	56.3	40.4	43.5	45.1	49.2	36.4	41.2	53.8
Time Zone: 04:00	57.7	39.8	43.9	45.3	49.4	36.5	49.6	55.1
Average Day Time Noise Level (Leq day)	76.6	50.5	56.6	53.8	60.8	46.7	56.1	67.5
Average Night Time Noise Level (Leq night)	62.3	45.2	48.5	50	54.4	41.3	50.7	59.6
National Ambient Noise Standard for Mixed Residential Area - Day Time Exposure	63	63	63	63	63	63	63	63
National Ambient Noise Standard for Mixed Residential Area - Night Time Exposure	55	55	55	55	55	55	55	55

Location / Spots	Equivalent Noise Level (L_{eq})							
	Intake, Okhariya	Baghaipur	Badalpur	Sarkhol	Manau	Geruwa Khola	Nehalpur	Tapara Bazar
National Ambient Noise Quality Standard (NANQS 2012, Nepal)	90	90	90	90	90	90	90	90
OSHA TLV Guideline	85	85	85	85	85	85	85	85
IFC/WHO Guideline (daytime)	55	55	55	55	55	55	55	55
IFC/WHO Guideline (night time)	45	45	45	45	45	45	45	45

Source: Baseline Environmental Monitoring Study of RIP, February 2024

Figure 26: Existing Noise Levels in the Project Area (Day Time)

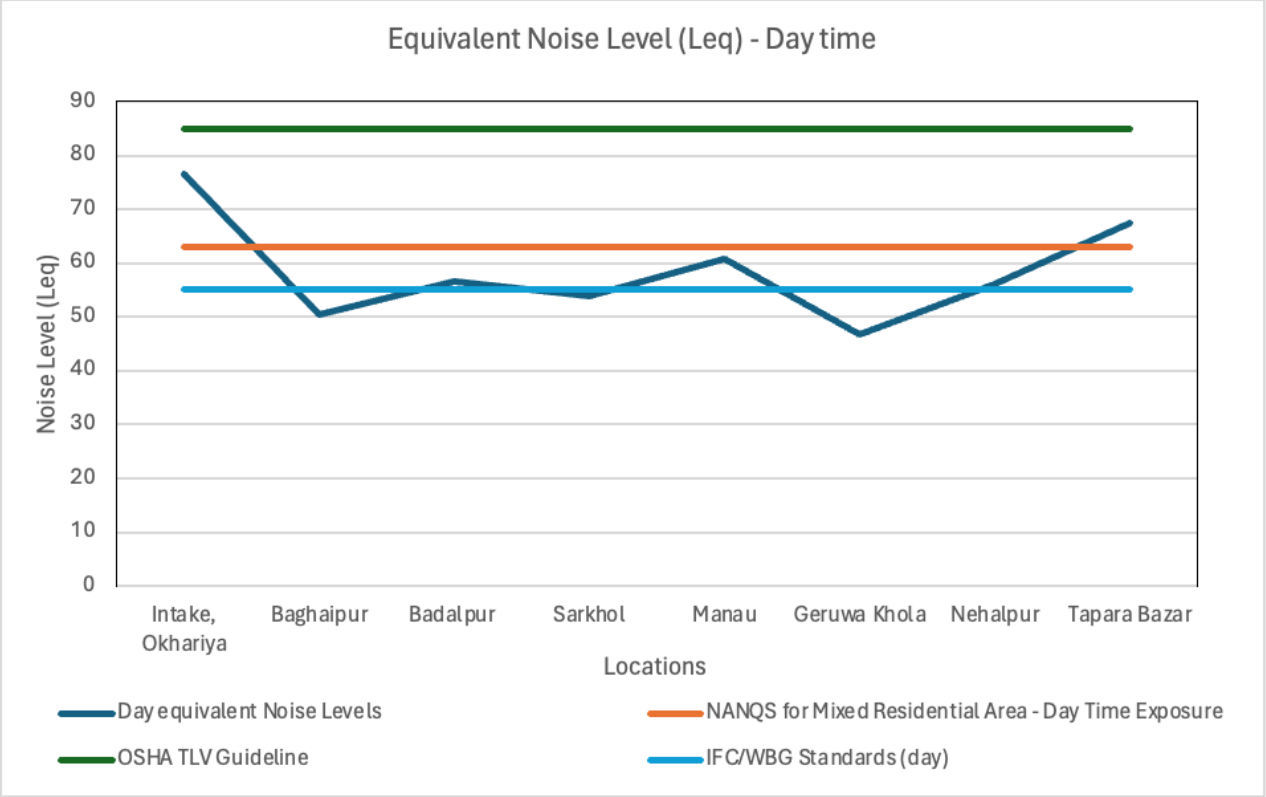
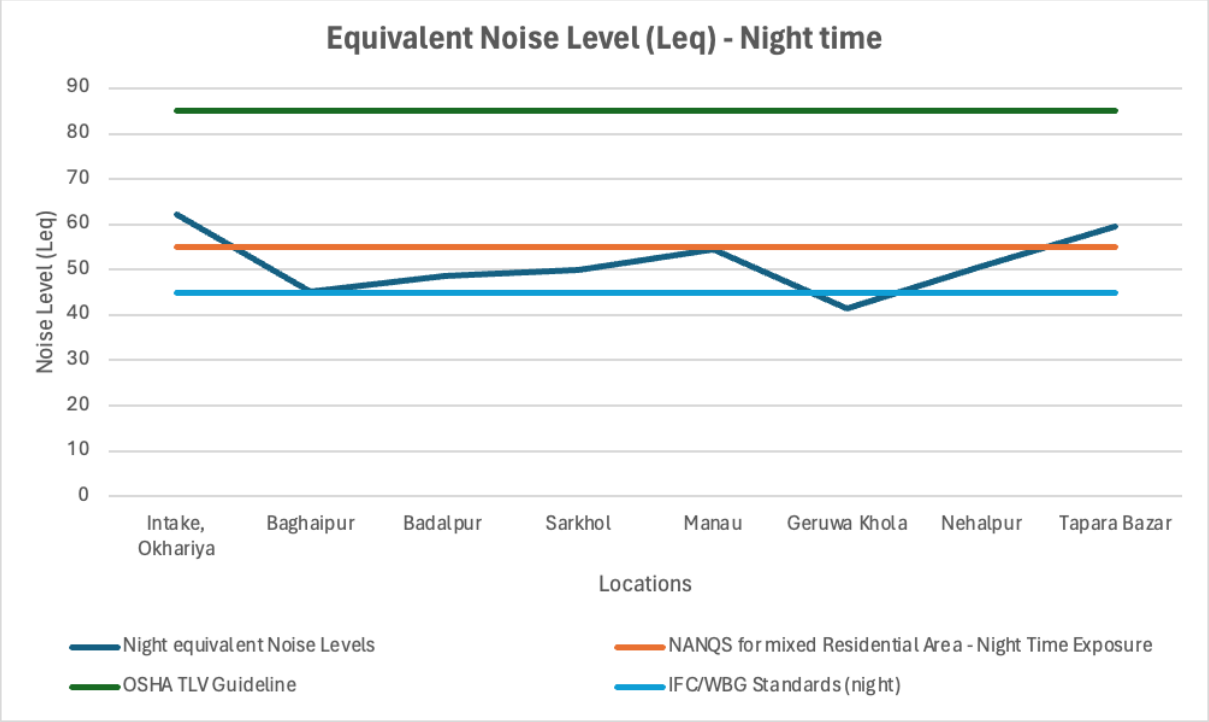


Figure 27: Existing Noise Levels in the Project Area (Night Time)



116. It can be seen from Table 11 and Figures 26 and 27 above that the equivalent sound pressure levels in the project area were found within the National Occupational Health Noise Quality Standard and OSHA TLV Guideline. Except for the Night Time Zone of 10:00, 13:00, 16:00 and 10:00 at Budhi Kulo Intake (Near Bardiya National Park), Okhariya; 22:00 and 04:00 Hour at Tapara Bazar area, the observed equivalent noise pressure levels are well within the allowable limit as per National Ambient Noise Quality Standard (NAAQS) and National Occupational Exposure Noise Quality Standard (NOENQS) in other locations.

117. Compared with IFC ambient noise standards, the monitored levels are higher, both daytime and nighttime. Out of eight monitoring locations, higher noise levels were recorded at 5 locations, with maximum daytime equivalent noise levels of 76.6 dB(A) recorded at the Intake location of Okhariya. Night-time noise levels are higher at all the monitored locations except Geruwa Khola, where the recorded noise levels were 41.3 dB(A) against the IFC permissible limit of 45 dB(A). External factors, such as local traffic, construction activities, etc., are the main sources of elevated noise in these locations.

118. **Soil Quality.** Soil quality samples were collected from two locations in the project area and analyzed for physical and chemical properties. The results are presented in the table below.

119. The pH values of the soil samples from Jotpur and Jhapti indicate slightly alkaline conditions, with pH levels of 7.9 and 8.2, respectively. These pH levels fall within the typical range for agricultural soils but suggest different soil chemistries that could affect nutrient availability. Both soil samples were analyzed at a consistent lab temperature of 18.2°C, ensuring reliable comparisons between the two locations.

120. Calcium levels in the soil are notably higher in Jotpur (5484.95 mg/kg) compared to Jhapti (3961.91 mg/kg). High calcium levels are beneficial for soil structure and plant cell wall development. Magnesium content is relatively similar between the two locations, with Jotpur having 238.24 mg/kg and Jhapti 220.0 mg/kg. Magnesium is crucial for chlorophyll production in plants. Bicarbonate levels

are higher in Jhapti (667.29 mg/kg) than in Jotpur (596.44 mg/kg), affecting soil pH and nutrient availability.

121. Chloride concentrations are higher in Jhapti (144.64 mg/kg) compared to Jotpur (77.28 mg/kg). While chloride is essential in small amounts, high concentrations can harm plant health. Ammonia levels are slightly higher in Jotpur (21.1 mg/kg) than in Jhapti (18.29 mg/kg), providing a nitrogen source for plants. Nitrate levels are significantly higher in Jotpur (192.61 mg/kg) than in Jhapti (25.98 mg/kg), offering readily available nitrogen for plant growth. Both locations have low nitrite levels, with Jotpur at 0.33 mg/kg and Jhapti at 0.49 mg/kg, preventing potential plant toxicity.

122. Sulfate concentrations are higher in Jotpur (483.45 mg/kg) than in Jhapti (339.86 mg/kg), supporting plant protein synthesis. Iron content is extremely high in both soils, with Jotpur at 15872.46 mg/kg and Jhapti at 13890.22 mg/kg. Iron is essential for plant respiration and chlorophyll synthesis, but excessive iron can lead to toxicity. Manganese levels are slightly higher in Jhapti (240.89 mg/kg) compared to Jotpur (226.24 mg/kg), which is crucial for photosynthesis and nitrogen metabolism.

123. Arsenic levels are higher in Jhapti (6.35 mg/kg) than in Jotpur (4.87 mg/kg), which can be toxic to plants and animals at high concentrations. Copper content is low in both soils, with Jotpur at 0.31 mg/kg and Jhapti at 0.19 mg/kg, essential for plant enzyme systems. Zinc levels are similar, with Jotpur at 46.0 mg/kg and Jhapti at 47.94 mg/kg, vital for plant growth and development. Sodium levels are higher in Jotpur (389.53 mg/kg) compared to Jhapti (189.54 mg/kg), with high sodium potentially leading to soil salinity issues affecting plant growth.

124. Potassium content is significantly higher in Jhapti (2918.76 mg/kg) than in Jotpur (1800.51 mg/kg), which is essential for various plant physiological processes. Phosphate levels are also higher in Jhapti (1573.74 mg/kg) than in Jotpur (810.51 mg/kg), which is crucial for plant energy transfer and photosynthesis. Total nitrogen content is slightly higher in Jotpur (502.0 mg/kg) than in Jhapti (439.0 mg/kg), a vital nutrient for plant growth. Organic matter levels are higher in Jhapti (1.43 mg/kg) compared to Jotpur (1.15 mg/kg), improving soil structure and fertility.

125. The sodium absorption ratio is higher in Jotpur (7.28) than in Jhapti (4.14), with a higher ratio indicating potential soil sodicity issues affecting soil structure and permeability. Molybdenum levels are low in both soils, with Jotpur at 0.021 mg/kg and Jhapti at 0.019 mg/kg, essential for plant enzyme function. Boron levels are higher in Jhapti (0.118 mg/kg) than in Jotpur (0.094 mg/kg), which is important for plant cell wall formation and reproductive development.

126. In summary, the soil quality data indicate that both Jotpur and Jhapti soils have adequate levels of most essential nutrients but exhibit some differences. Jotpur soil has higher calcium, nitrate, sulfate, and total nitrogen levels, which benefit plant growth. However, it also has higher sodium levels, which could pose a risk of soil salinity. Jhapti soil has higher levels of potassium, phosphate, and organic matter, which are crucial for plant health. Both soils show high levels of iron and manganese, which are beneficial in small amounts but can be toxic at high concentrations. The higher levels of arsenic in Jhapti are concerning and could impact plant and animal health. Regular soil testing and appropriate soil management practices are recommended to maintain soil health and fertility.

Table 12: Soil Quality Test made at two locations of RIP Command Area

Parameters	Units	Soil 1, Jotpur	Soil 2, Jhapti	Methods used
PHYSICAL				
pH	-	7.9	8.2	IS: 2720 (P-26)
Lab Temperature	^{0}C	18.2	18.2	
CHEMICAL				
Calcium	mg/kg	5484.95	3961.91	*Methods Manual Soil testing in India, Department of Agriculture, Ministry of agriculture, Govt. of India
Magnesium	mg/kg	238.24	220.0	
Bicarbonate	mg/kg as $CaCO_3$	596.44	667.29	
Carbonate	mg/kg as $CaCO_3$	Nil	Nil	
Chloride	mg/kg	77.28	144.64	
Ammonia	mg/kg	21.1	18.29	
Nitrate	mg/kg	192.61	25.98	
Nitrite	mg/kg	0.33	0.49	
Sulphate	mg/kg	483.45	339.86	
Iron	mg/kg	15872.46	13890.22	
Manganese	mg/kg	226.24	240.89	
Arsenic	mg/kg	4.87	6.35	
Copper	mg/kg	0.31	0.19	
Zinc	mg/kg	46.0	47.94	
Sodium	mg/kg	389.53	189.54	
Potassium	mg/kg	1800.51	2918.76	
Phosphate	mg/kg	810.51	1573.74	
Total Nitrogen	mg/kg	502.0	439.0	
Organic Matter	mg/kg	1.15	1.43	
Sodium Absorption	mg/kg	7.28	4.14	
Molybdenum	mg/kg	0.021	0.019	
Boron	mg/kg	0.094	0.118	

Source: Baseline Environmental Monitoring Study of RIP, February 2024

Figure 28: Photographs of the Physical Environment Measurements at RIP

Air Quality Measurement at Budhi Kulo Intake, Okhariya

Water Sample taken from the RIP Approach Canal

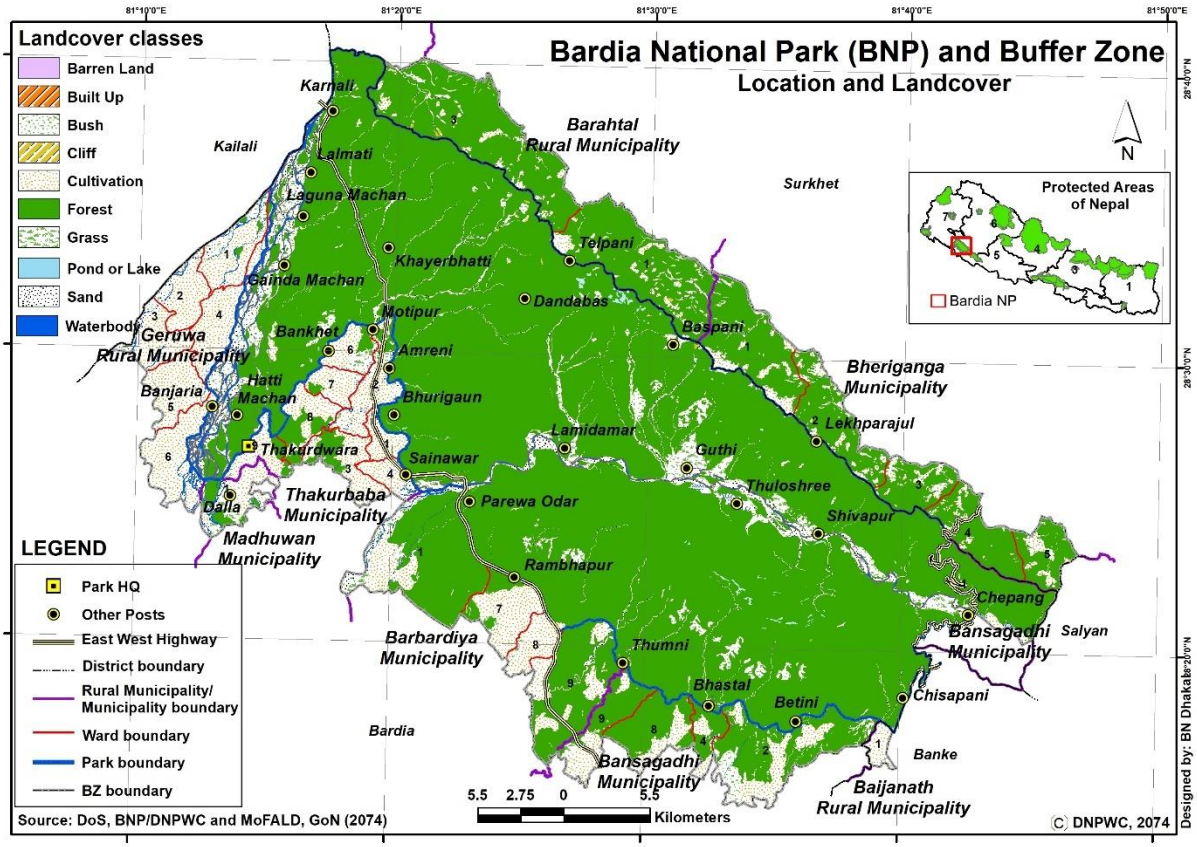
Deep Tube Well (New) - 100 m Depth, Jhapti

Noise observation at Manau

B. Biological Environment

127. **National Park.** Bardiya National Park is the largest national park in the lowland Nepal Terai, covering 968 km^2 on the southern slopes of the Siwalik Hills. The park in Nepal's Western Terai was established to protect representative ecosystems and conserve the tigers and their prey species. Initially, a small area was gazetted as the Karnali Wildlife Reserve in 1976. In 1997, an area of 327 km^2 surrounding the park was declared a buffer zone consisting of forests and private lands. The park and local communities jointly manage the buffer zone. Together they initiate community development activities and manage natural resources in the buffer zones. About 70% of the park forest consists of Sal trees with a mixture of grassland and riverine forests. The park is home to endangered animals such as the Royal Bengal Tiger, Asian Elephant, Greater one-horned Rhinoceros, Swamp Deer, and Black Buck. The other endangered species include the Gharial-Crocodile, Marsh Mugger, and Gangetic Dolphin. Endangered birds found in the park are Bengal florican, lesser florican, and sarus crane; more than 30 different mammals, over 230 species of birds, and several species of snakes, lizards, and fish have been recorded in the park's forest, grassland, and river. Karnali River is a suitable home for Gangetic dolphins. Babai Valley is a majestic place to visit where flagship Rhinos, Tigers, and Elephants can be cited in the wilderness site. Figure 29 shows the Bardiya National Park Adjacent to the Geruwa Rural Municipality.

Figure 29: Bardiya National Park Adjacent to the Geruwa Rural Municipality



128. A comprehensive management plan for Bardia National Park and its buffer zone addresses the emerging issues and challenges, and for translating the legislative provisions into action.[6] The

[6] Government of Nepal, Ministry of Forests and Environment, Department of National Parks and Wildlife Conservation Bardia National Park Office. 2022. Management Plan of Bardia National Park and its Buffer Zone.

management plan (2079/80) 2083/84 BS (2022/23-2026/27) is the continuation of the previous management plan. This plan has opened up an avenue and paved the way ahead for conserving core values of biodiversity, promoting sustainable and wise use principles of natural resources, including wetlands, regulating eco-tourism, and fulfilling the development aspirations of local communities of the buffer zone.

129. The proposed works of RIP will be inside the buffer zone of the national park. In order to meet the requirement of ADB SPS 2009 for legally protected areas, RIP must demonstrate to: (i) act in a manner consistent with defined protected area management plans, (ii) consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project, and (iii) implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area. RIP will implement components that will enhance conservation in the buffer zone. These are the following:

130. **Embankments.** The Management Plan of Bardia National Park and its Buffer Zone emphasizes the strategic importance of embankments for flood control and habitat protection. Embankments help manage the flow of water during the monsoon season, preventing the inundation of critical wildlife habitats and human settlements. This control is crucial for maintaining the natural balance of the park's ecosystems and protecting agricultural lands in the buffer zone from flood damage. Additionally, by stabilizing riverbanks and preventing erosion, embankments safeguard the integrity of both terrestrial and aquatic habitats. This is particularly important for species such as the Gangetic dolphin and gharial, which rely on stable riverine environments for breeding and feeding. By mitigating flood impacts and preserving habitat stability, embankments play a vital role in the overall conservation strategy for Bardia National Park.

131. The 2 km river embankment to be rehabilitated under the RIP will significantly help reduce the impacts of flooding in the buffer zone of Bardia National Park, where this structure will be implemented. By stabilizing riverbanks and controlling the flow of water during the monsoon season, the embankment will reduce overflow into recreation parks, irrigation structures, and local wildlife habitats. This proactive measure will protect both the natural and human-modified environments, enhancing the resilience of the buffer zone to seasonal flooding.

132. **Intakes and Channels.** The canal intake of Budhi Khola is designed to regulate the flow of water from the river into irrigation canals, ensuring that agricultural water needs are met without compromising the Karnali River's flow. The management plan stresses the importance of preventing over-extraction of water, as excessive water withdrawal can lead to reduced water levels in rivers and wetlands, adversely affecting the flora and fauna dependent on these habitats. By carefully managing the volume of water diverted for irrigation, canal intakes help preserve the natural flow and health of aquatic ecosystems. Additionally, the dual role of canal intakes in supporting local agriculture while protecting the park's natural resources aligns with the management plan. By balancing the water needs of agriculture with the ecological requirements, the canal intakes play a pivotal role in promoting sustainable development and conservation in the region.

133. **Sediment Control.** The RIP places significant emphasis on sediment control as a crucial aspect of its implementation, aligning well with the conservation and management objectives of Bardia National Park. The management plan highlights the importance of maintaining water quality and habitat integrity, which are directly impacted by sediment levels. The RIP includes the design and implementation of sediment control structures such as settling basins, silt traps, and sedimentation ponds. These structures are intended to capture and manage sediments before entering irrigation channels, ensuring that only clean water is used for irrigation purposes. By preventing excessive sediment from being transported through the irrigation system, these measures help maintain the integrity of the canals and reduce the need for frequent maintenance.

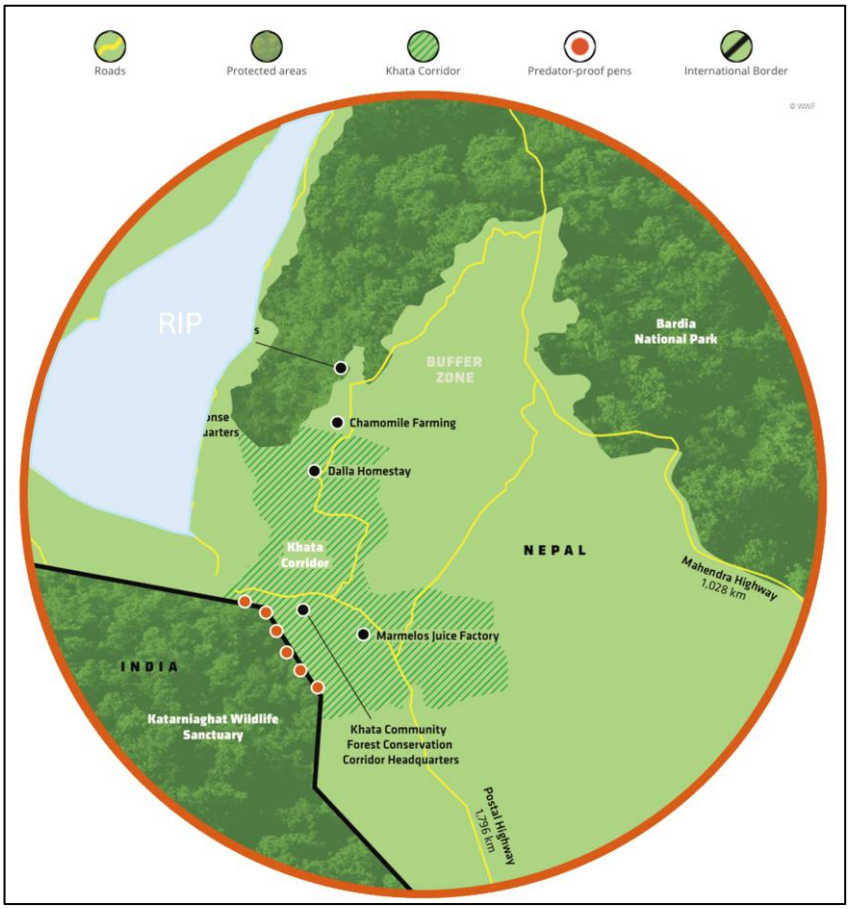
134. **Wildlife Corridor.** Khata Corridor is a vital wildlife pathway spanning approximately 24

kilometers and covering an area of around 202 square kilometers. It connects Nepal's Bardia National Park (map above) with India's Katarniaghat Wildlife Sanctuary, providing a crucial link for various wildlife species' movement and genetic diversity. The corridor has been significantly restored from its previously degraded state to a lush habitat rich with trees, shrubs, and grasslands. This transformation has been achieved through the collaborative efforts of local communities, the Nepal government, and international organizations.

135. The wildlife in the Khata Corridor includes some of the region's most iconic and endangered species. Tigers are one of the primary inhabitants, with 87 tigers recorded in Bardia National Park and its buffer zones in a 2018 census and an additional 28 tigers in Katarniaghat. The corridor also supports a population of wild elephants, with 120 individuals recorded in a 2021 census. Other notable species include the greater one-horned rhino, which has seen significant conservation success, and leopards, which use the corridor for movement and hunting. Additionally, the corridor is home to various species, such as spotted deer, grey langurs, and giant hornbills, contributing to its rich biodiversity.

136. The corridor is in the southeastern part of the command area of Rajapr. There are no components of RIP within this corridor. See map below:

Figure 30: Location of Khata Corridor and RIP



137. **Forests and vegetation.** A number of forest patches in the western part of the Geruwa River (near the right bank of the river) are under the jurisdiction of BNP, and community forest patches within the Geruwa Rural Municipality are under state management. The major forest types in and around the project area with smaller portions of moist evergreen forest of Saal (*Shorea robusta*), dry deciduous forest with Khair–Sisau (*Acacia catechu-Dalbergia sisoo*) Simal-Bhellar (*Bombax ceiba-Trewia nudiflora*), Satisal (*Dalbergia latifolia*), Bot Dhaiyanro (*Anogeissus latifolia*), elephant apple (*Dillenia*

indica) and Dabdabe (*Garuga pinnata*). Khair-Sisau (*Acacia catechu-Dalbergia sissoo*) associations predominate on recent alluvium deposited during floods and in lowland areas that escape the most serious flooding, with undershrubs Guenlo (*Callicarpa macrophylla*), Rajbeli (*Clerodendrum viscosum*) and Amala (*Phyllanthus emblica*), represent a later stage in succession. As per local consultations, the common vegetation within the project area is described in the following paragraphs.

138. **Mammals and Herpetofauna:** The wild fauna that is partially seen in the Rajapur Irrigation Command area are Spotted Deer (*Axis axis*) Hog Deer (*Axis porcinusporcinus*), Nilgai (*Boselaphustragocamelus*) Black Buck (*Antilope cervicapra*), Barking Deer (*Muntiacusmuntjak*), Golden Jackal (*Canis aureus*), Common Otter (*Lutralutra*), Wild Boar (*Sus scrofa*), Bengal Tiger (*Panthera tigris*)

139. , Indian Grey Mongoose (*Herpestesedwardsii*), Jungle Cat (*Felis chaus*), Common Leopard (*Panthera pardus*), Asiatic Elephant (*Elephas maximus*) and Rhesus Monkey (*Macaca mulatta*). Commonly found Reptiles in the project area are Yellow Monitor (*Varanus flavescens*), Frog (*Rana tigrina*), Asian Common Toad (*Bufo melanosticus*), Land tortoise (*Testudinidae species)*, Indian Cobra (*Naja naja*), King Cobra (*Ophiophagus hannah*), Chequered Keelback (*Fowlea piscator*) and Common Rat Snake (*Ptyas mucusa*).

140. **Aves.** The commonly found birds in the project area are House Sparrow (Passer domesticus), Indian Peafowl (*Pavo Cristatus*), Sugaa (*Alexandrinus krameri*), House Crow (*Corvus splendens*), Red Jungle Fowl (*Gallus gallus*), Black Stork (*Ciconia nigra*), Common Hill Myna (*Gracula religiosa*), White Stork (*Ciconia ciconia*), Laughing Dove (*Spilopelia senegalensis*), Bakulla (*Bubulcusibis*), Common Quail (*Coturnix coturnix*), Black Francolin (*Francolinusfrancolinus*), Common Teal (*Anas crecca*), Comb Duck (*Sarkidiornis melanotos*), Common Hoopoe (*Upupa epops*), House Swift (*Apus affinis*), Asian Koel (*Eudynamysscolopacea*) and Hill Pigeon (*Columba rupestris*).

141. **Aquatic Life.** The Karnali River and Geruwa River are the excellent habitat for migratory river Ganges River Dolphin (*Platanista gangetica*), Mugger Crocodile (*Crocodilus palustris*) and Gharial Crocodile (*Gavialis gangeticus*) and game fishes Mahseer (*Tor putitora*) and Gonch (*Bagarius bagarius*) and many others. According to the fishermen and cow herders of Rajapur island, the flood brings school of catfishes such as Suhjana *(Sperata seenghala),* Sidra (*Puntius sps*.), Thedd *(Labeo angra*), Catla (*Labeo catla*), Rohu *(Labeo rohita),* Large Razorbelly Minnow *(Salmostoma bacaila),* and Jalkapoor *(Pseudotropius murius).* Both rivers support the habitat of fish-eating predators, including dolphins and water birds, Indian River Tern (Sterna aurantia), Great Cormorant (*Phalacrocorax carbo*), Eurasian Otter (Lutra lutra), and Indian Softshell Turtle (*Nilssonia gangetica).*

Threatened Species

142. **Nilgai (*Boselaphus tragocamelus*)**. The Nilgai, also known as the blue bull, is classified as Vulnerable on the IUCN Red List, with an estimated global population of approximately 100,000 individuals. These large Asian antelopes inhabit open grasslands and scrub forests across India, Nepal, and Pakistan. While specific population data for the Nilgai in Lumbini Province or nearby areas is unavailable, they are known to be present in these regions.

143. **Common Leopard (*Panthera pardus*)**. The Common Leopard, listed as Vulnerable, has a global population of around 250,000. These adaptable big cats are found in various habitats, including sub-Saharan Africa, Northeast Africa, Central Asia, India, and the People's Republic of China. Despite their widespread distribution, they face threats from habitat loss and human-wildlife conflict. Specific population data for the Common Leopard in Lumbini Province is unavailable, but they are present in several protected areas across Nepal, requiring ongoing conservation measures to mitigate threats.

144. **Black Buck (*Antilope cervicapra*)**. The Black Buck, an Endangered species, has a global population of about 50,000. These antelopes are primarily found in India and Nepal, with significant populations in the Bardiya region. However, exact numbers for Lumbini Province are not specified.

Black Bucks inhabit grasslands and lightly forested areas and face threats from habitat fragmentation and poaching.

145. **Hog Deer (*Axis porcinusporcinus*)**. Hog Deer are also listed as Endangered, with an estimated global population of 20,000. They are found in India, Nepal, Pakistan, and Bangladesh, preferring marshy and swampy areas. Data specific to Lumbini Province is unavailable, but the species is known to be under threat due to habitat destruction and hunting.

146. **Asiatic Elephant (*Elephas maximus*)**. The Asiatic Elephant, classified as Endangered, has a global population of 40,000 and 50,000. These elephants are distributed across South and Southeast Asia, including India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and Sri Lanka. In Nepal, approximately 120 elephants are found in Bardiya and surrounding areas.

147. **Bengal Tiger (*Panthera tigris*)**. The Bengal Tiger has an endangered status and a global population of about 3,900. These apex predators are found in India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Indonesia, and the People's Republic of China. In Nepal, Bardiya National Park has approximately 87 Bengal Tigers, highlighting successful conservation efforts. Continued protection of habitats and prey species, along with stringent anti-poaching measures, are essential to sustain their populations.

148. **Ganges River Dolphin**. In Nepal, Dolphins have been reported from the Karnali River in the study conducted by Shrestha (1989) and Smith (1994). Shrestha (1989) recorded 30 dolphins in the Karnali River, but within 5 years, the population had plummeted to 7 (Smith, 1994). The study conducted by Timilsina et al. (2003) in the Geruwa River from Chisapni Bridge to Kothia Ghat recorded 3 dolphins in Gola, Banjariya, and Kothia Ghats in pre-monsoon season (April/May). Their study further stated that the existing water velocity at these slow-flowing habitats was 0.24 m/sec, and the water depth ranged from 5 to 15 m in Gola, Manau, and Kothia Ghats, were the primary habitats, where most of the dolphin movement was confined. The construction of barrages, especially the Kailashpuri dam on the Indian side, has isolated the wildlife population from any possible interchange with species inhabiting downstream waters, which could be the major cause of the decline in population. The boated survey applying occupancy and N-mixture models was carried out by Paudel et al. (2015) in the 3 major river systems (Karnali, Sapta Koshi, and Narayani) and found higher occurrence probabilities and abundance for Ganges River Dolphin in Karnali River.

149. **Nilgai (*Boselaphus tragocamelus*)**. The Nilgai, also known as the blue bull, is classified as Vulnerable on the IUCN Red List, with an estimated global population of approximately 100,000 individuals. These large Asian antelopes inhabit open grasslands and scrub forests across India, Nepal, and Pakistan. While specific population data for the Nilgai in Lumbini Province or nearby areas is unavailable, they are known to be present in these regions.

150. **Common Leopard (*Panthera pardus*)**. The Common Leopard, listed as Vulnerable, has a global population of around 250,000. These adaptable big cats are found in various habitats, including sub-Saharan Africa, Northeast Africa, Central Asia, India, and the People's Republic of China. Despite their widespread distribution, they face threats from habitat loss and human-wildlife conflict. Specific population data for the Common Leopard in Lumbini Province is unavailable, but they are present in several protected areas across Nepal, requiring ongoing conservation measures to mitigate threats.

151. **Black Buck (*Antilope cervicapra*)**. The Black Buck, an Endangered species, has a global population of about 50,000. These antelopes are primarily found in India and Nepal, with significant populations in the Bardiya region. However, exact numbers for Lumbini Province are not specified. Black Bucks inhabit grasslands and lightly forested areas and face threats from habitat fragmentation and poaching.

152. **Hog Deer (*Axis porcinusporcinus*)**. Hog Deer are also listed as Endangered, with an

estimated global population of 20,000. They are found in India, Nepal, Pakistan, and Bangladesh, preferring marshy and swampy areas. Data specific to Lumbini Province is unavailable, but the species is known to be under threat due to habitat destruction and hunting.

153. **Asiatic Elephant (*Elephas maximus*)**. The Asiatic Elephant, classified as Endangered, has a global population of 40,000 and 50,000. These elephants are distributed across South and Southeast Asia, including India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and Sri Lanka. In Nepal, approximately 120 elephants are found in Bardiya and surrounding areas.

154. **Bengal Tiger (*Panthera tigris*)**. The Bengal Tiger has an endangered status and a global population of about 3,900. These apex predators are found in India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Indonesia, and the People's Republic of China. In Nepal, Bardiya National Park has approximately 87 Bengal Tigers, highlighting successful conservation efforts. Continued protection of habitats and prey species, along with stringent anti-poaching measures, are essential to sustain their populations.

155. **Ganges River Dolphin**. In Nepal, Dolphins have been reported from the Karnali River in the study conducted by Shrestha (1989) and Smith (1994). Shrestha (1989) recorded 30 dolphins in the Karnali River, but within 5 years the population had Plummeted to 7 (Smith, 1994). The study conducted by Timilsina et al. (2003) in the Geruwa River from Chisapni Bridge to Kothia Ghat recorded 3 dolphins in Gola, Banjariya and Kothia ghats in pre-monsoon season (April/May). Their study further stated that the existing water velocity at these slow-flowing habitats was 0.24 m/sec and the water depth ranged from 5 to 15 m in Gola, Manau and Kothia Ghats, were the primary habitats, where most of the dolphin movement were confined. The construction of barrages, especially the Kailashpuri dam on the Indian side, has isolated the wildlife population from any possible interchange with species inhabiting downstream waters, which could be the major cause of the decline in population. The boated survey applying occupancy and N-mixture models was carried out by Paudel et al. (2015) in the 3 major river systems (Karnali, Sapta Koshi, and Narayani) and found higher occurrence probabilities and abundance for Ganges River Dolphin in Karnali River.

156. **King Cobra (*Ophiophagus hannah*)**. The King Cobra, listed as Vulnerable, is widely distributed across South and Southeast Asia, including India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and the Philippines.

157. **Mugger Crocodile (*Crocodilus palustris*)**. With a Vulnerable status, the Mugger Crocodile's global population is estimated to be between 5,000 and 10,000. They are found in India, Nepal, Pakistan, Sri Lanka, and Iran, preferring freshwater habitats. Specific data for Lumbini Province is not available, but the species is threatened by habitat destruction and illegal hunting. Conservation actions include habitat protection and enforcement of anti-poaching laws.

158. **Gharial Crocodile (*Gavialis gangeticus*)**. The Critically Endangered Gharial Crocodile has fewer than 1,000 individuals globally, mainly in India and Nepal. It inhabits river systems and faces severe threats from habitat loss and fishing net entanglements. Specific data for Lumbini Province is not available, but efforts to restore river habitats and reduce human impacts are crucial for its survival.

159. **Indian Softshell Turtle (*Nilssonia gangetica*)**. Listed as Vulnerable, the Indian Softshell Turtle's population is not precisely known but is decreasing. They are found in India, Nepal, Bangladesh, and Pakistan, mainly in rivers and lakes. Specific population data for Lumbini Province is not available. Conservation efforts should focus on protecting freshwater habitats and mitigating exploitation for trade.

160. **Black Stork (*Ciconia nigra*)**. The Black Stork, classified as Vulnerable, has a global population of approximately 10,000 to 15,000. They inhabit wetlands and riverine forests across Europe, Asia, and Africa. Data for Lumbini Province is not available.

161. **Appendix 3** shows a summary list of species classified as vulnerable, endangered, and critically endangered.

Occurrence of Threatened Species in the RIP area

162. **Nilgai and Black Buck**: These species inhabit open grasslands and lightly forested areas. The RIP project sites are primarily located in agricultural and irrigation command areas, which do not provide the preferred habitats for these antelopes. Consequently, the likelihood of significant Nilgai and Black Buck populations within the project sites is low.

163. **Common Leopard and Bengal Tiger**: These big cats reside in dense forests and protected areas such as national parks and wildlife reserves. Bardiya National Park, for instance, is a significant habitat for Bengal Tigers, with approximately 87 individuals recorded. The project sites of RIP, being mainly agricultural and irrigation zones, are not conducive to supporting large populations of these apex predators. Thus, their presence within the project areas is minimal.

164. **Asiatic Elephant:** While elephants are known to traverse large areas, they primarily inhabit forested regions and protected areas. The estimated 120 elephants in Bardiya and surrounding areas are more likely to be found within these protected habitats rather than the proposed locations of the RIP project.

165. **Ganges River Dolphin and Aquatic Species**: The Ganges River Dolphin, along with species like the Mugger and Gharial Crocodiles, predominantly inhabit large river systems. The Karnali and Geruwa Rivers are key habitats for these species, distinct from the irrigation channels and smaller water bodies associated with the RIP project. Hence, the operations of RIP are unlikely to intersect significantly with these aquatic habitats.

166. **King Cobra and Indian Softshell Turtle:** These reptiles are found in diverse habitats, including forests, rivers, and wetlands. The primary project areas of RIP, focused on irrigation infrastructure, are not ideal habitats for these species. Therefore, their presence within the project sites is expected to be limited.

167. **Black Stork**: This bird species inhabits wetlands and riverine forests, typically protected areas. The agricultural and irrigation landscapes of the RIP project sites do not align with the black stork's preferred habitats, suggesting minimal impact from the project's operations.

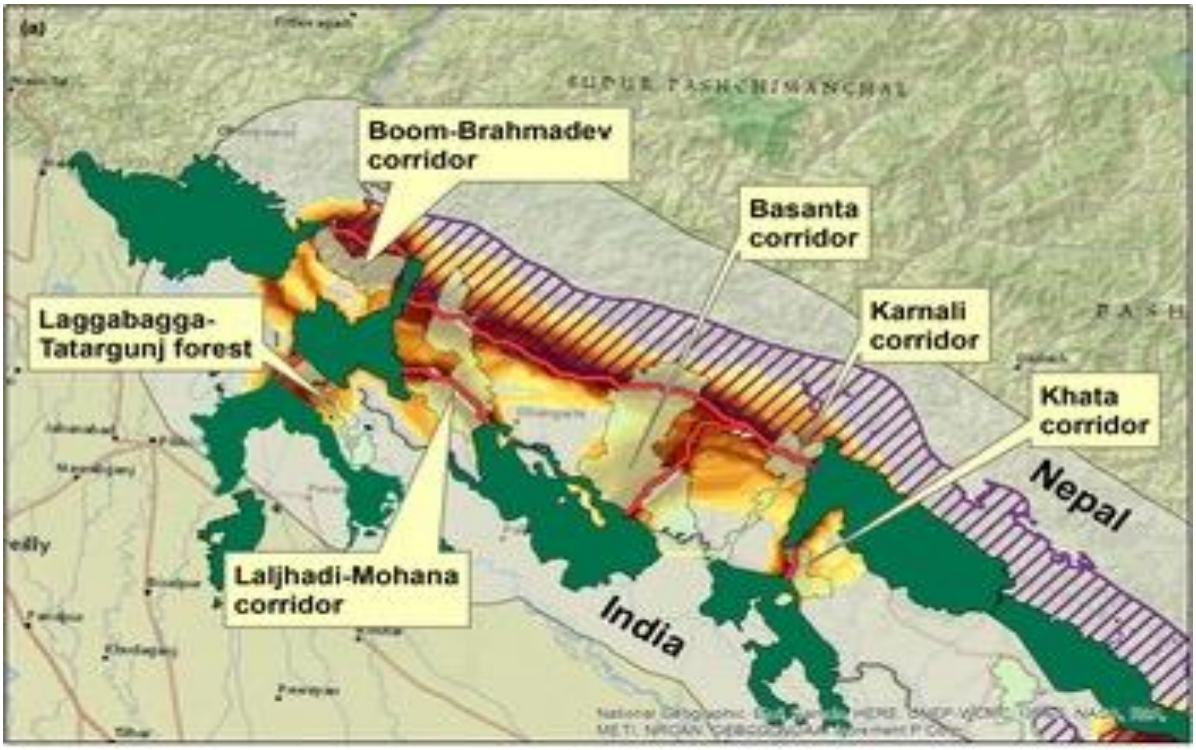
168. **Integrated Biodiversity Assessment Tool (IBAT).** The project area is located within Terai Arc Landscape and close proximity to certain protected areas. Specifically, there is a buffer zone within a 1 km radius and a Bardiya National Park within a 10 km radius of the project area. Bardiya National Park, Dudhwa National Park, Katerniaghat Wildlife Sanctuary and Girijapur Barrage and a Ramsar Site (Wetland of International Importance) Ghodaghodi Tal and Krishnasar Conservation Area are within a 50 km buffer from the project area (Figure 30). The key biodiversity area is the Bardiya National Park, within 10km of the proposed project area. The species number found in the proposed periphery in the IUCN Red List is 38 species. It is likely the existence of a critical habitat, 14 species near the project area. Additionally, 24 are found to be endangered, and 38 vulnerable types of species.

169. Dudhwa National Park and Katerniaghat Wildlife Sanctuary are protected areas of India and are located across the Indo-Nepal border. Both the protected areas are part of Dudhwa Tiger Reserve and are connected with Bardiya National Park; Asian elephants and tigers migrate from these protected areas to Bardiya National Park in Nepal. The protected species reported from these areas for mammals include the Royal Bengal Tiger, Pangolin, Hyaena, Four-horned Antelope, Asian Elephant, Hispid Hare, One-Horned Rhino, Dolphin, Gray Wolf, Swamp Deer, and Leopard Cat, for birds species are Black Stork, Giant Hornbill, White Stork, Sarus Carne, Bengal Florican, Lesser Florican, reptiles species are Asiatic Rock Python, Golden Monitor Lizard and Gharial Crocodile.

170. The continued forest area and Karnali- Geruwa river system near Bardiya National Park to

Katarniyaghat Wildlife Reserve, India[7] are used as migratory routes and seasonal alternative habitat megafauna of elephants, Tigers rhinos, and other species. The forest area along the river system is used for movement between two protected areas[8] is identified as the Khata wildlife corridor, as shown in Figure 31. The project components are located away from the identified wildlife corridor, and work will be limited within the existing canal system.

Figure 31: Identified wildlife movement corridor between BNP and KWR



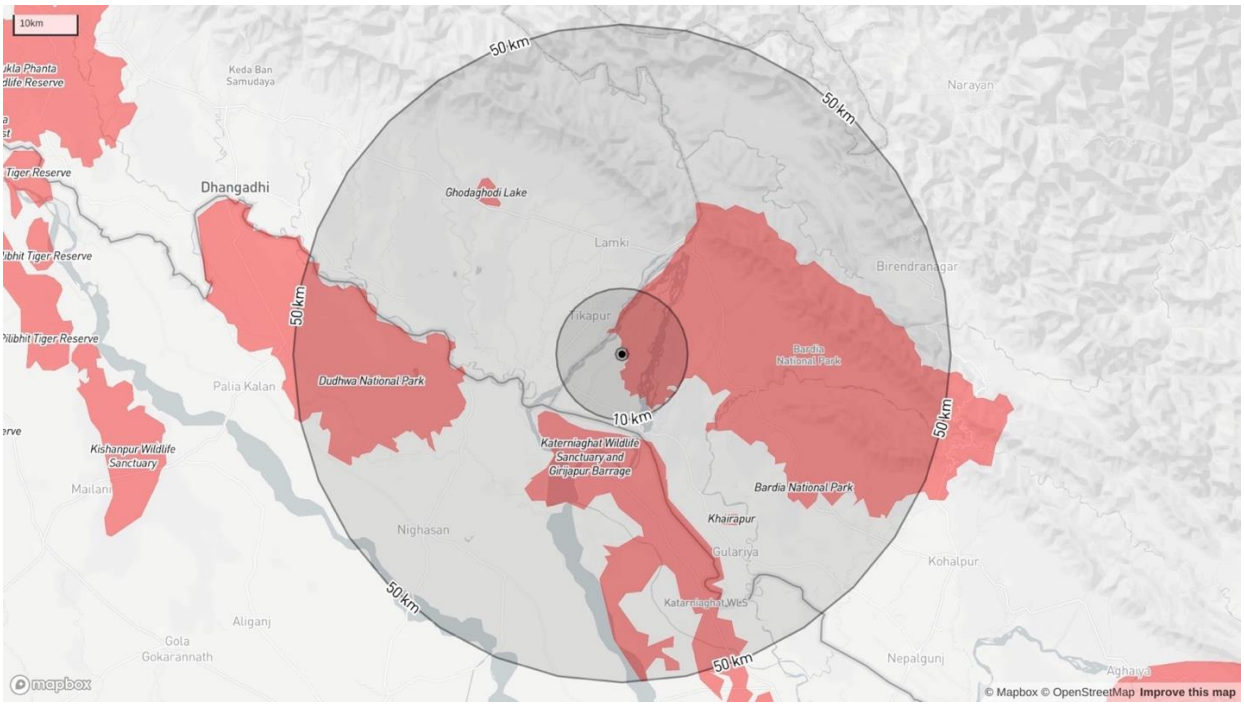
171. **Project Footprint Area.** Several components of the RIP area are within the buffer zone of Bardia National Park. Despite the proximity of the RIP to this critical habitat, the scale of construction and operations of the project will only have minor impacts on wildlife. The RIP scope of work is mainly limited to the rehabilitation of the existing canal structures. There will be no canal extension work or construction activities in the forest patches and the agricultural command area, but the strengthening works of the intake and branch canal sections. There are no impacts of loss of vegetation and no impact to any flora, fauna, or any aspect of the biological environment arising from the implementation of the rehabilitation works of the Rajapur Irrigation Project. The primary impact area will be confined to the location of the existing Rajapur Irrigation System canal structure. Delivery of construction materials to the site would extend the project influence area. This means that during the transport of construction materials, the impact area is extended along the roadside settlements traversed by the transporting equipment. During the construction period, the contractors need to perform the activities in close coordination with the local government and the project office.

172. Biodiversity action plan (BAP) is prepared for the RIP. The purpose of a BAP is to ensure the protection and enhancement of biodiversity within project areas, especially in contexts where development activities might impact wildlife and habitats. **Appendix 4** provides the BAP that can be utilized for construction.

[7] Wildlife corridor mapping between Royal Bardiya National Park, Nepal and Katarniyaghat Wildlife Reserve, India by using GIS

[8] Connecting tiger (Panthera tigris) populations in Nepal: Identification of corridors among tiger-bearing protected areas

Figure 32: Key Biodiversity Areas within the 50-km radius of the RIP Site



Source: IBAT PS6 & ESS6 Report, 2024

Critical Habitat Assessment

173. Critical habitat refers to areas of high biodiversity value in which development would be particularly sensitive and require special attention. The purpose of a critical habitat assessment is to identify the level of high biodiversity value within the subproject areas. Critical habitat is defined in ADB SPS 2009 as areas or sites:

(i) with high biodiversity value, including habitat required for the survival of critically endangered or endangered species;
(ii) having special significance for endemic or restricted-range species;
(iii) that are critical for the survival of migratory species;
(iv) supporting globally significant concentrations or numbers of individuals of congregatory species;
(v) with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services;
(vi) having biodiversity of significant social, economic, or cultural importance to local communities

174. Moreover, based on ADB SPS 2009, critical habitats can be either natural or modified or a combination of both. These include legally protected areas or those officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

175. The area of analysis (AoA) for assessing critical habitat is assigned for the buffer zone of Bardia National Park since this is the area of RIP. Existing ecological data are used to identify critical habitats within the AoA. This step ensures that all significant ecological areas are considered in this assessment.

176. To support the critical habitat assessment in subproject sites, International Finance Corporation's (IFC) Guidance Note 6[9] on Biodiversity Conservation and Sustainable Management of Living Natural Resources is used to determine any trigger as per SPS 2009. The guidance note defines critical habitat as areas of high biodiversity value that include or meet at least one of the following:

(i) Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
(ii) Criterion 2: Endemic or restricted-range species
(iii) Criterion 3: Migratory or congregatory species
(iv) Criterion 4: Key evolutionary processes
(v) Criterion 5: Areas having biodiversity of significant social, economic, or cultural importance to local communities
(vi) Criterion 6: Protected or designated areas.

177. ***Criterion 1*: *Critically Endangered (CR) and/or Endangered (EN) species***. Species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species shall be considered as part of Criterion 1. Critically Endangered species face an extremely high risk of extinction in the wild. Endangered species face a very high risk of extinction in the wild. Thresholds and analysis for Criterion 1 are the following:

(i) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species).
(ii) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a).
(iii) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

178. The following species listed below are categorized as critically endangered (CR), and vulnerable (VU), and there have been no firsthand sightings of these animals in the subproject areas. Nevertheless, these species may be likely present in the RIP areas according to secondary information.

(i) Black Buck (*Antilope cervicapra*). The Black Buck, an Endangered species, has a global population of about 50,000. These antelopes are primarily found in India and Nepal, with significant populations in the Bardiya region.

(ii) Common Leopard (*Panthera pardus*). The Common Leopard, listed as Vulnerable, has a global population of around 250,000. Specific population data for the Common Leopard in Lumbini Province is unavailable, but they are present in several protected areas across Nepal.

(iii) Hog Deer (*Axis porcinusporcinus*). Hog Deer are also listed as Endangered, with an estimated global population of 20,000. They are found in India, Nepal, Pakistan, and Bangladesh, preferring marshy and swampy areas.

(iv) Asiatic Elephant (*Elephas maximus*). The Asiatic Elephant, classified as Endangered, has a global population of 40,000 and 50,000. Approximately 120 elephants are found in Bardiya National Park.

[9] International Finance Corporation's Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (ifc.org)

(v) Bengal Tiger (*Panthera tigris*). The Bengal Tiger has an endangered status and a global population of about 3,900. Bardiya National Park has approximately 87 Bengal Tigers, highlighting successful conservation efforts.

(vi) Ganges River Dolphin. In Nepal, Dolphins have been reported from the Karnali River. The existing water velocity at these slow-flowing habitats was 0.24 m/sec, and the water depth ranged from 5 to 15 m in Gola, Manau, and Kothia Ghats, were the primary habitats, where most of the dolphin movement was confined.

(vii) Gharial Crocodile (*Gavialis gangeticus*). The Critically Endangered Gharial Crocodile has fewer than 1,000 individuals globally, mainly in India and Nepal.

(viii) Nilgai (*Boselaphus tragocamelus*). The Nilgai, also known as the blue bull, is classified as Vulnerable on the IUCN Red List, with an estimated global population of approximately 100,000 individuals.

(ix) Common Leopard (*Panthera pardus*). The Common Leopard, listed as Vulnerable, has a global population of around 250,000. These adaptable big cats are found in various habitats, including sub-Saharan Africa, Northeast Africa, Central Asia, India, and China.

(x) King Cobra (*Ophiophagus hannah*). The King Cobra, listed as Vulnerable, is widely distributed across South and Southeast Asia, including India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and the Philippines.

(xi) Mugger Crocodile (*Crocodilus palustris*). With a Vulnerable status, the Mugger Crocodile's global population is estimated to be between 5,000 and 10,000. They are found in India, Nepal, Pakistan, Sri Lanka, and Iran, preferring freshwater habitats.

(xii) Indian Softshell Turtle (*Nilssonia gangetica*). Listed as Vulnerable, the Indian Softshell Turtle's population is not precisely known but is decreasing. They are found in India, Nepal, Bangladesh, and Pakistan, mainly in rivers and lakes.

(xiii) Black Stork (*Ciconia nigra*). The Black Stork, classified as Vulnerable, has a global population of approximately 10,000 to 15,000. They inhabit wetlands and riverine forests across Europe, Asia, and Africa. Data for Lumbini Province is not available.

179. For item (c) of criterion 1, wildlife in the Khata Corridor includes some of the region's endangered species. Tigers are one of the primary inhabitants, with 87 tigers recorded in Bardia National Park and an additional 28 tigers in Katarniaghat. The corridor also supports a population of wild elephants, with 120 individuals recorded in a 2021 census. Other notable species include the greater one-horned rhino, which has seen significant conservation success, and leopards, which use the corridor for movement and hunting. Additionally, the corridor is home to various species, such as spotted deer, grey langurs, and giant hornbills, contributing to its rich biodiversity. There no components under RIP that are within the corridor, so the RIP does not trigger item (c) of criterion 1.

180. ***Criterion 2: Endemic and Restricted-range Species*.** For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an extent of occurrence less than 50,000 square kilometers (km^2). The threshold for Criterion 2 is area holds ≥10% of the global population size and ≥10 reproductive units of a species.

181. The species in the subproject areas can be found across multiple countries in South Asia, and while they may be significant to local ecosystems, these are not considered endemic or restricted range species limited to the specific subproject sites.

182. ***Criterion 3: Migratory and Congregatory Species.*** Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem). While congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable. The thresholds for Criterion 3 are:

(i) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle. Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.

183. There are no identified Migratory and Congregatory Species in the subproject area. Hence, this criterion is not triggered.

184. ***Criterion 4: Key evolutionary processes.*** Topography, geology, soil, temperature, vegetation, and their combinations can affect evolutionary processes that create regional species and ecological features. Unique landscape features have been linked to genetically distinct plant and animal populations. Physical or geographical elements are commonly linked to species diversification as surrogates or spatial accelerators for evolutionary and ecological processes. In recent decades, biodiversity conservation has focused on maintaining these crucial evolutionary processes in a landscape and the resulting species (or subpopulations). Genetic diversity conservation is especially important. In a rapidly changing climate, species variety and genetic variation within species enable evolutionary flexibility.

185. There is no such site within the subproject area that is characterized as above. Thus, this criterion is not triggered.

186. ***Criterion 5: Areas having biodiversity of significant social, economic, or cultural importance to local communities.***

187. Areas having biodiversity of significant social, economic, or cultural importance to local communities. This criterion focuses on regions where biodiversity is intrinsically linked to the well-being of local communities through various means such as traditional practices, economic benefits, cultural values, or social significance. Such areas often support livelihoods, maintain cultural heritage, and provide ecosystem services that are crucial for local communities. Identifying and conserving these areas is essential to ensure that biodiversity conservation efforts also support the social and economic fabric of the communities that depend on them.

188. ***Criterion 6: Legally protected or officially proposed for protection.*** This critical habitat requirement, as stipulated by the SPS 2009, focuses on areas that are either legally protected or officially proposed for protection.

189. **Conclusion:** Based on the guidelines provided by IFC GN6 and ADB SPS 2009 for CHA, the criteria 6 is triggered by the project due to the components of RIP in the buffer zone of Bardiya National Park. To meet the SPS 2009, RIP needs to meet the critical habitat requirement, which are discussed in the following:

190. (i) There are no measurable adverse impacts, or likelihood of such, on the critical habitat (i.e. buffer zones of Chitwan and Langtang national parks) which could impair its high biodiversity value or the ability to function, and (ii) the project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised. Several

components of the RIP area are within the buffer zone of Bardia National Park. Despite the proximity of the RIP to this critical habitat, the scale of construction and operations of the project will only have minor impacts on wildlife. The RIP scope of work is mainly limited to the rehabilitation of the existing canal structures. There will be no canal extension work or construction activities in the forest patches and the agricultural command area, but the strengthening works of the intake and branch canal sections. There are no impacts of loss of vegetation and no impact to any flora, fauna, or any aspect of the biological environment arising from the implementation of the rehabilitation works of the RIP. The primary impact area will be confined to the location of the existing Rajapur Irrigation system canal structure.

(i) **Limited Scope of Work**: The RIP components are restricted to the rehabilitation and enhancement of existing structures. The RIP works ensure a minimal environmental footprint by improving current infrastructure rather than engaging in extensive new construction. Consequently, this approach significantly reduces the risk of disrupting habitats vital for local biodiversity. There are no RIP component that will fall inside the core area of the national park.

(ii) **Localized Impacts**: The rehabilitation activities are localized and temporary, involving tasks like repairs, replacement of structures and maintenance within confined areas over brief periods. This localized, short-term work minimizes potential habitat disruptions, making them minimal.

(iii) **Command area Use**: The selected areas for the RIP are predominantly command area used for farming and irrigation for many years. These areas are already modified environments, having undergone significant changes from their natural state.

(iv) Any lesser impacts are mitigated. Mitigation measures will be designed to achieve at least no net loss of biodiversity. Additionally, a biodiversity action plan (BAP) is prepared for the RIP (See Appendix 4). The purpose of a BAP is to ensure the protection and enhancement of biodiversity within project areas, especially in contexts where development activities might impact wildlife and habitats. The IEE for the RIP within the buffer zone of Bardia National Park outlines a comprehensive framework aimed at minimizing environmental impacts and safeguarding terrestrial wildlife. Through detailed environmental impact assessments, baseline data collection, and active community consultation, the IEE ensures that construction activities are aligned with the conservation goals of Bardia National Park. The implementation of robust mitigation measures, such as erosion and sediment control, wildlife monitoring, and habitat restoration, underscores a commitment to preserving biodiversity and promoting sustainable development.

Summary of Critical Habitat Assessment

Critical Habitat defined by ADB (2009)	Quantitative Thresholds of Critical Habitat based in IFC PS-6	Species/sites	Likelihood to trigger criterion	Remark
Criterion 1: The area includes habitat required for the survival of critically endangered (CR) or endangered (EN) species	(a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species).	*Antilope cervicapra,* EN, (Black Buck)	Unlikely	Has a global population of about 50,000. These antelopes are primarily found in India and Nepal, with significant populations in the Bardiya region. However, exact numbers for Lumbini Province are not specified.
		Axis porcinusporcinus, EN, (Hog Deer)	Unlikely	It is estimated with global population of 20,000. They are found in India, Nepal, Pakistan, and Bangladesh, preferring marshy and swampy areas. Data specific to Lumbini Province is unavailable, but the species is known to be under threat due to habitat destruction and hunting.
		Elephas maximus, EN, (Asiatic Elephant)	Unlikely	Has a global population of 40,000 and 50,000. In Nepal, approximately 120 elephants are found in Bardiya National Park.
		Panthera tigris, EN, (Bengal Tiger)	Unlikely	The Bengal Tiger has an endangered status and a global population of about 3,900. In Nepal, Bardiya National Park has approximately 87 Bengal Tigers, highlighting successful conservation efforts.

Critical Habitat defined by ADB (2009)	Quantitative Thresholds of Critical Habitat based in IFC PS-6	Species/sites	Likelihood to trigger criterion	Remark
		Gavialis gangeticus, CN, (Gharial Crocodile)	Unlikely	The Critically Endangered Gharial Crocodile has fewer than 1,000 individuals globally, mainly in India and Nepal. Specific data for Lumbini Province is not available, but efforts to restore river habitats and reduce human impacts are crucial for its survival.
		Ganges River Dolphin (*Platanista gangetica*).	Unlikely	In Nepal, Dolphins have been reported from the Karnali River. The existing water velocity at these slow-flowing habitats was 0.24 m/sec, and the water depth ranged from 5 to 15 m in Gola, Manau, and Kothia Ghats, were the primary habitats, where most of the dolphin movement was confined.
	(b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN	*Boselaphus tragocamelus,* VU, (Nilgai)	Unlikely	With an estimated global population of approximately 100,000 individuals. While specific population data for the Nilgai in Lumbini Province or nearby areas is unavailable, they are known to be present in these regions.

Critical Habitat defined by ADB (2009)	Quantitative Thresholds of Critical Habitat based in IFC PS-6	Species/sites	Likelihood to trigger criterion	Remark
	or CR and meet the thresholds of (a).	*Ophiophagus hannah,* VU, (King Cobra)	Unlikely	It is widely distributed across South and Southeast Asia, including India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and the Philippines.
		Crocodilus palustris, VU, (Mugger Crocodile)	Unlikely	Global population is estimated to be between 5,000 and 10,000. They are found in India, Nepal, Pakistan, Sri Lanka, and Iran, preferring freshwater habitats. Specific data for Lumbini Province is not available
		Common Leopard (*Panthera pardus*)	Unlikely	Has a global population of around 250,000. These adaptable big cats are found in various habitats, including sub-Saharan Africa, Northeast Africa, Central Asia, India, and China.
		Nilssonia gangetica, VU, (Indian Softshell Turtle)	Unlikely	Population is not precisely known but is decreasing. They are found in India, Nepal, Bangladesh, and Pakistan, mainly in rivers and lakes. Specific population data for Lumbini Province is not available.
	(c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species	Khatta Corridor	Unlikely	No component of RIP is within the corridor.

Critical Habitat defined by ADB (2009)	Quantitative Thresholds of Critical Habitat based in IFC PS-6	Species/sites	Likelihood to trigger criterion	Remark
Criterion 2: The area has special significance for endemic or restricted-range species;	a) Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species	NA	Unlikely	The species in the subproject areas can be found across multiple countries in South Asia
Criterion 3: The area represents a site that is critical for the survival of migratory species; or supports globally significant concentrations or numbers of individuals of congregatory species;	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.	NA	Unlikely	There is no such site/species within the sites of the RIP components.
	(b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.	NA	Unlikely	There is no such site/species within the sites of the RIP components.
Criterion 4: The area includes unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services;		NA	Unlikely	There is no such site/species within the sites of the RIP components.
Criterion 5: The area holds biodiversity of significant social, economic, or cultural importance to local communities;		NA	Unlikely	The areas of RIP components do not have biodiversity that are intrinsically linked to the well-being of local communities through traditional practices, economic

Critical Habitat defined by ADB (2009)	Quantitative Thresholds of Critical Habitat based in IFC PS-6	Species/sites	Likelihood to trigger criterion	Remark
				benefits, cultural values, or social significance.
Criterion 6: The area is either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's World natural Heritage sites.		Buffer zone of Bardiya National Park	Yes	Majority of the components of RIP are within the buffer zone of Bardiya National Park

EN = Endangered, IUCN = International Union for Conservation of Nature, PAI =project area of influence, VU = vulnerable

C. Socio-economic and Cultural Environment

191. **Population and Demography.** The total population of the Rajapur project component area is 81,206 (Males: 37,707, Females: 43,499) residing in 14,501 households with a household size of 5.6. The age group of the project beneficiaries has been derived by applying the respective age group ratio of the municipality /ward population in which the project area exists. The population proportion has been taken from the statistics available in Nepal Population and Housing Census (NPHC) 2021[10]. Among the project beneficiaries, the majority of the population (66.46%) belonged to the age group ranging between 15-59 years. These groups of the population are considered economically active and can benefit from the temporary employment opportunity generated by project intervention. The rest of the groups of population are dependent, i.e., age group between 0-14 (24.08%) and population above years (9.45%)

192. **Cast ethnicity of HH head.** Bardiya is known as the indigenous Tharu majority district. The survey area (Rajapur and Geruwa) also covers the majority of Tharu in all canal systems. The household survey data shows that 87.06% of beneficiary households belonged to Tharu. Households of hill-originated Brahmin/Chhetri castes were in second rank, consisting of 7.61 % in overall survey areas. Since the district is located in Terai, 4.2 % of Musalim is found compared to other Terai districts. Hill-based Dalit households covered 1.04 % of the total. Likewise, the percentage of households in Hill Janajati and Newars fell to less than 1 %.

193. **Migration.** The survey data shows that an overarching majority (96.5%) of households have been permanently living in the Rajapur area for 20 years or more. This indicates that not only the indigenous Tharu but also other castes, like hill-based ethnic groups (higher castes, Janajati, and Dalit), have been residing for a long time. Out of the total, only 3.5 per cent of families migrated from different locations in the countries.

194. **Educational Status.** The educational status has been collected from surveyed households with ages exceeding five years. Among the surveyed population, the highest percentage of educational level lies in basic level or up to grade 8 of formal education (43.5%), followed by secondary level (30.1%), bachelor level, and master's level (3.7%). The percentage of 22.7 population declared them illiterate.

195. **Occupational Status of the Households.** At the national level, 50.1 percent of the population is engaged in agriculture, forestry, and fishery-skilled economic activities. In the project province, agriculture and related activities remain the primary and major occupation of most people (54.0%), followed by wage labor (23%). About 14 % of the people relied on services both in the government and non-government sectors for their livelihood. Out of the total economically active population engaged in agriculture, forestry, and fishery-related skills, 56 percent are women from Lumbini province. In Baridya district, 37% of the population works in agriculture and related occupations, and 60% of this workforce are women of active age.

196. **Source of Income**. The total annual income of all beneficiaries' households of both canal systems in the last year has been recorded as NRs. 353,919,588.00. The annual average household income of the project area, calculated by dividing by the number of HHs, was NRs. 660254.34, which is higher than the National average of NRs. 202,374 (NLSS, 2011). The average per capita income of 1077 households in the survey area was NRs. 1,17 945.0 is also higher than the average National per capita NRs. 41,659 (NLSS, 2011): however, this amount of per capita income seemed to be less than the recurrent (FY 2022/23) Budgetary Assumption

[10] Government of Nepal, National Statistics Office. National Population and Housing Census 2021. Ward Report.

of Federal Government (NRs. 1,64,521).

197. **Landholding**. Land is one of the most important livelihood assets for rural communities in Nepal. Around 33.9% of the project beneficiaries hold less than 0.5 ha of cultivated land, followed by 31.9% above 1.0 ha. Likewise, 18% of farmers hold between 0.5- 1.0 ha. whereas around 15.5% of people don't have arable land in the command area of the system. It is expected that improved irrigation facilities will lead to an increase in cropping intensity, which will demand additional farm labor by creating on-farm employment opportunities for landless or farmers having small holdings, who are in the majority among project beneficiaries. The people living in the RIP highly depend on irrigation facilities.

198. **Poverty:** Individual in Nepal is classified as poor if their annual per capita total consumption expenditure is less than NRs. 72,908, as the 2022-23 official poverty line. 20.27 percent of the population in Nepal lives below the poverty line based on the new poverty line in the project province. The poverty incidence in rural areas of the country is 24.66 per cent, which is higher than in urban areas, with 18.34 per cent of the population. In the rural areas of project province Lumbini, 24.73 percent of the population lives in poverty.

199. **Women headed Households.** Agriculture Census 2021-22 shows that 32.4 percent, or 1.33 million, households in the country are headed by women. Female-headed households' information on project implementation provinces illustrates that about 34.84% of households are headed by women, which is slightly higher than the national scenario (34.4%) of all those having ownership or secure rights over agricultural land. In Bardiya district[11] 24.9 percent of households are headed by women, significantly lower than the national figures for women-headed households. There is 3.89 percent of the total population (81206) of 14501 no. households in the RIP area are disabled.

Figure 33: Settlement area and the existing road near the Patabhar Branch Canal

200. **Industry.** The project zone is an agricultural zone and barren land. A few industries include rice processing (part-boiling and drying) plants and brickfields (making, drying, burning, stacking, and grinding yards). Rice Mill, Furniture, Grill Mill, Masala, etc., are the major small and medium-scale industries inside the municipality with inter-domestic markets like Lakhna, Uttarbhakhari, Bansghadi, Tharugaun, Motipur, Hasnapur, and intra-domestic markets like Banke, Gulariya, Nepalgunj and Kathmandu. Therefore, they are generating some employment

[11] Factsheet on Women - Nepal, Province 5 - Lumbini

opportunities for local people.

201. **Drinking Water Supply.** The availability of water resources makes the project-impacted municipalities good locations with sufficient water supply resources. The community approach also promotes the water supply facility. Tube wells and Hand pumps are the major sources of water supply for drinking purposes. 95.89% of households use tube wells as the major source due to the municipality's flat land.

202. **Surface Drainage, Sanitation, and Sewerage.** The municipality's wastewater includes grey water and black water generated by every household. Most of the households in the municipality have access to toilets but with inappropriate septic tanks and soak pit systems, which leads to soil and groundwater contamination. There are no public toilets. Most of the urban roads do have facilities for surface drainage but are inadequately designed for handling monsoon rains. Similarly, due to the rapid population growth in the service area, the upgradation of the facilities of surface drainage, sewerage, and solid waste management is a significant requisite for a healthy and hygienic environment.

203. **Transportation.** The proposed project affected municipalities in the Terai area and has connections with highways, feeder roads, district roads, and Nepal's overall road network. The Postal Highway connects Rajapur Municipality. East–West Highway is connected through the municipality via the Bhuregaun - Gulariya – Murtihawa Road Section. Similarly, the Junga - Rajapur - Bhimapur Road Section connects the project area with the market centers, i.e., Nepalgunj. The growth in the roads and other infrastructures in the area has had social and economic impacts on the living and livelihoods of the people. The emergence of several townships and market centers along the road corridors has increased the demand for food commodities- grain, vegetables, fruits, and other consumer goods- and increased the opportunity for trade and commerce in the area.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

204. The environmental impact is assessed for different project phases, including the irrigation systems rehabilitation project's pre-construction, construction, and operation phases. The study team visited the proposed project component sites and nearby areas to identify the potential impacts, met stakeholders, and conducted meetings, field examinations, and data gathering. The identified significant adverse impacts will form the basis for developing an environmental management plan to be implemented for mitigation. The potential environmental impacts of various activities pertaining to project components during the pre-construction, construction, and operation phases of the project are elaborated in the following sections.

A. Pre-Construction Impacts and Mitigation Measures

205. **Consents and Permits Requirements.** The Rajapur Irrigation Project is located in Geruwa Rural Municipality, i.e., within the buffer zone of the Bardiya National Park (BNP). The local government and the National Park jointly initiate community development activities and manage natural resources in the buffer zones. Failure to obtain necessary consent and permits can result in design revisions and work stoppage. The Central Project Management Office (CPMO) shall obtain all the necessary consents and permits shall be obtained from the national park authority and the local government stakeholders before the start of civil works.

206. **Integration of EMP in bidding documents and contracts.** Lack of awareness by contractors on ADB SPS 2009 requirements may result in insufficient budget and non-implementation of the Environmental Management Plan (EMP). To ensure that EMP will be provided with a sufficient budget and implemented:

207. The CPMO will incorporate the costs of implementing OHS and the EMP as well as specific provisions requiring contractors to comply with all other conditions required by ADB into the bidding and contract document.

208. Once the Contractor is selected, the CPMO, with support from a Project Implementation Management and Support (PIMS) consultant, will inform contractors of their responsibilities in EMP implementation in compliance with ADB and government requirements, self-monitoring, and reporting procedures.

209. **EMP Implementation Training.** If the contractors and construction supervision engineers are not aware of the requirements of this EMP, the project may not proceed and comply with ADB and GoN environmental policies. The CPMO, PIMSC, and contractors must undergo training on EMP implementation. The capacity building program will be participatory to the extent possible to make it more effective, with learning by doing, role-playing, group exercises, on-the-job training, etc. Pre- and post-training assessments will be conducted to measure the effectiveness of the program.

99. **Updating of IEE.** The CPMO shall update the IEE in case of a change in design/based on the final detailed design and submit the same for review and clearance of ADB.

100. **Community awareness of project activities and impacts.** Lack of community awareness of project activities may result in potential community health and safety concerns and complaints. Before the start of project construction, a meaningful consultation with the affected communities will be conducted. This meaningful consultation will aim to engage community stakeholders, listen to their views, and arrive at a common understanding of the ways to implement the project. To aid in the consultation process, it is important that the community should be made aware of the details of project activities. Important information to be disseminated to the people are, among others, the following:

(i) Overview and objectives of the proposed project;

(ii) Preliminary and/or final detailed design of proposed project components;
(iii) Potential environmental and social impacts (positive and negative) of the project and the proposed mitigation measures for the perceived negative impacts; and
(iv) Grievance redress mechanism and contact details of the project.

B. Construction Phase Impacts and Mitigation Measures

210. The rehabilitation of the existing Rajapur Irrigation Project will not have an impact on the loss of vegetation and land acquisitions since all the strengthening works are proposed within the canal sections and 2 km river protection bunds. The detailed design study conducted during 2022-2024 has proposed improving the canal structures. The main interventions proposed in the canal systems are shown in the table below:

Table 13: Rehabilitation Canal Structures in RIP

S. N.	Proposed Canal Structures
1	Upgrading of Budhi Khola Approach Channel
2	Upgrading of Budhi Kulo Intake with Flushing Sluice
3	Karnali Riverbank Protection 2 Km at the intake site
4	Main Canal Structures-3 new Intakes
5	Branch Canal Structures
5.1	Settling Basins-5
5.2	Regulators-11
5.3	Escapes-10
5.4	Secondary Canal Structures-Flow dividers (25) Escapes (30)
6	Rehabilitation of Geruwa Kulo Intakes-2 (Manau, Khairi)

211. **Construction Planning.** It has been observed that inadequate planning could lead to the non-implementation of EMP during the construction phase and result in significant environmental impacts that lead to non-compliance with ADB's environmental safeguard requirements. To ensure that EMP will be implemented during the construction phase, the contractor should, prior to the start of construction activities, undertake the following:

(i) Appoint a Senior Safeguard Officer and a Senior Safety officer (EHS) Supervisor;

(ii) Develop a Site-Specific Environmental Management Plan (SEMP) and Occupational Health and Safety (OHS) Management Plan and get it approved by the Client;

(iii) Conduct training on the rationale for and implementation of the SEMP and EMP to enhance general understanding and clarify responsibilities regarding implementation, including monitoring and reporting, which must also be provided to all relevant staff of contractors;

103. The major works are within the existing canal systems and distributed at intake locations, Karnali River bank 2 km stretch below intake, desilting basins at canal sections locations to control the silt, rehabilitation of weirs in Geruwa intakes, head regulators, and canal structures. The locations for labor campsites, batching plant sites, etc., that would be required by the Contractor temporarily during the construction period have not been finalized. The Contractor should select the locations for the campsites, batching plant sites, etc., in consultation with Geruwa Rural Municipality and Rajapur Municipality and get it approved by the CPMO. The Contractor should provide all infrastructure and services necessary to ensure that the laborers' needs are addressed throughout their stay at the campsites. No campsites will be set up in the forest area or area near the protected area of BNP. Also, the Contractor should deploy construction equipment, plant, and machinery in good condition, provided with necessary pollution control apparatus, and operate as per standards and meet all

environmental standards specified by the GoN for such operations; the Contractor shall ensure necessary fitness, pollution under control certificates, and are operated by qualified/licensed drivers/operators.

104. The Contractor will be required to submit to CPMO, for review and approval, a SEMP including (a) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes, (b) specific mitigation measures following the approved EMP; (c) monitoring program as per EMP; and (d) budget for SEMP implementation. No works can commence prior to the approval of SEMP. The SEMP will include the following, among others:

(i) Construction Compound Management Plan;
(ii) Construction Health and Safety Plan (including COVID-19 H&S guidance- **Appendix 5**);
(iii) Emergency Incident Response Plan.

B.1. Positive Impacts and Benefits

212. The project will improve water management and sustainable agriculture through environmental, social, and economic benefits. This includes:

(i) More equitable management of water resources by rehabilitation of the canal structures
(ii) More water is available for irrigation without increasing the water taken from the Karnali River
(iii) Provision of robust as well as automated gated at intake structures will reduce flood and sediment ingress
(iv) Upgrading irrigation infrastructure will improve the performance and provide resilience to climate change
(v) Generates employment opportunities for the local people and enhances their skills and knowledge
(vi) Increasing awareness and capacity of sustainable water use amongst users will also likely reduce fertilizer and pesticide run-off.
(vii) Improvements in agricultural outputs, productivity, and income
(viii) Improve water usage and reduce water loss

B.2. Negative Impact and Mitigation Measures

213. The project components do not fall in forest sections, protected areas with wildlife habitat, and heritage sites. The size of the works is small, with environmental impacts predicted mainly during the construction stage. Still, it could be readily mitigated and will be site-specific, short, local in extent, temporarily reversible in nature, and of low significance. The accruing impacts from the enhancement of the irrigation systems will be avoided, minimized, or mitigated. The rehabilitation activities of the irrigation structures are limited within the canal systems, construction activities have a noticeable impact, and the mitigation measures are discussed below.

214. **Impact on Air Quality.** Air quality is impacted at the construction sites because of vehicle movements, construction equipment operations, generator sets, etc., and dust generation. The construction activities will cause an increase in the level of some of the air pollutants in the air. Emissions from concrete mixers, excavation activity along the canal, and loading and unloading operations during construction activities pose potential impacts on air quality as an increase in PM level in the ambience on a temporary basis. Vehicular movements during construction phases along the existing earthen road will be another major factor that will increase dust and gaseous emissions. Construction machinery, diesel generators, and project

vehicles will release exhaust emissions containing carbon monoxide (CO), sulfur dioxide (SO_2), oxides of nitrogen (NOx), and particulate matter (PM). The released gaseous emissions and particulate matter can cause health impacts, i.e., respiratory problems, eye irritation, and visibility reduction. During the construction period, the contractor shall implement the following mitigation measures.

(i) Take every precaution to reduce the levels of dust at construction sites and not exceed the pre-project ambient air quality standards;
(ii) Fit all heavy equipment and machinery with air pollution control devices that are operating correctly;
(iii) Construction vehicles must travel at speeds that minimize dust generation;
(iv) Reduce dust by spraying water on stockpiled soil, excavated materials, and spoils
(v) Cover with tarpaulin vehicles transporting soil and sand;
(vi) Cover stockpiled construction materials with tarpaulin or plastic sheets;
(vii) Water spraying to access roads, campsites, and work sites to reduce dust emissions;
(viii) Machines and vehicles must be regularly examined and maintained to comply with requirements of technical specifications;
(ix) All vehicles, equipment, and machinery used for construction will be regularly maintained to ensure that pollution emission levels comply with the relevant standards;
(x) prohibit burning firewood in work and labor camps (promote liquified petroleum gas for cooking purposes and electric heaters for heating purposes;
(xi) prohibit open burning of solid waste;
(xii) Monitor air quality according to the environmental monitoring plan.

215. **Noise Emissions.** The static sources include construction equipment such as concrete mixture, diesel generator sets, and all heavy machinery. The noise levels were measured near the sources. Construction activities are expected to involve noise generation above 90 dB (A). The sound pressure level generated by a noise source decreases with increasing distance from the source due to wave divergence. The rehabilitation works of the project component are located in the Buffer Zone of the Bardiya National Park adjacent to the intake area, with a significant presence of wildlife and sensitive receptors. Additionally, the onsite workers are also exposed to noise levels that may be higher than the permitted levels due to their proximity to the noise sources. The significance of noise impact will be higher in the immediate vicinity of the construction sites where sensitive receptors are situated. Mitigation measures to reduce the noise impacts off-site at the nearest sensitive receptors include the following:

(i) Arrive at the construction schedule upon discussions with the nearby stakeholders, especially when works are carried out near sensitive receptors such as hospitals, schools, places of worship, etc.;
(ii) Comply the terms and conditions of clearance/approval from BNP authority;
(iii) Install noise barriers between the source and receptor, where necessary;
(iv) Enclose and locate generators away from sensitive receptors;
(v) Operate construction machines/conduct noise operations sequentially rather than all together;
(vi) spread out the schedule of material, spoil, and waste transport;
(vii) minimize drop heights when loading and unloading coarse aggregates;
(viii) avoid the use of horns unless necessary;
(ix) Use modern vehicles and machinery with standard adaptations to reduce noise and exhaust emissions and ensure they are maintained to manufacturer's

specifications;
(x) Noise-generating equipment must be fitted with silencers;
(xi) Optimize the use of noisy construction equipment and turn off any equipment if not in use;
(xii) Regular maintenance of all equipment and vehicles;
(xiii) Stop all construction activities at night;
(xiv) Implement a complaint handling system;
(xv) Workers should be provided with Ear muffs / protective hearing equipment in noise-critical areas;
(xvi) Place visually clear instructions in areas where noise levels are significant;
(xvii) Measure noise levels periodically as per the Environmental Monitoring Plan.

216. **Impact on Surface Water Quality:** During project implementation, the Contractor shall set campsites, material storage areas, and vehicle washing areas. Silt-laden run-off from stockpiled materials, solid wastes, and domestic wastewater from the construction camp, and leaks from chemical storage areas and machinery may contaminate or result in water pollution if disposed of or discharged to nearby receiving bodies of water. Solvents, vehicle maintenance fluid (oil, coolant), and diesel fuel may contaminate surface and groundwater if spilled on the ground, disposed of directly, or washed into the Budhi kulo channel. Rajapur Irrigation System intake guard quarter compound could be the possible contractor's camp, which the Project Office will decide. Human wastes from construction workers may also contaminate surface water and groundwater without adequate sanitary facilities. The mitigation measures to prevent the impact on surface water shall be maintained at the intake area since the distribution of the main and branch canals starts from the Budhi Kulo intake area. To mitigate these impacts, the contractor will be required to:

(i) Provision of temporary sedimentation canal and/or silt traps along construction areas, particularly alignments that are adjacent to receiving bodies of water or canals;
(ii) The measures to address soil erosion at the proposed facilities will consist of measures per design or as directed by the PIMSC to control sedimentation and water pollution in Rajapur Components. All temporary sedimentation, pollution control works, and maintenance thereof will be deemed incidental to the earthwork or other items of work;
(iii) All temporary discharge points shall be located, designed, and constructed in a manner that will minimize erosion in the receiving channels;
(iv) Avoid scheduling of excavation work during the monsoon season;
(v) Confine the construction area, including the material storage (sand and aggregate), so that runoff will not enter the site;
(vi) Ensure that drains are not blocked with excavated soil or other materials;
(vii) Stockyards at least 50 meters (m) away from watercourses;
(viii) Fuel and other petroleum products stored at storage areas away from water drainage and protected by impermeable lining and bunded;
(ix) Prohibit cleaning of construction vehicles/equipment within 300 m of waterways/drains;
(x) Prohibit siting of construction camps and disposal of construction waste within 500 m of waterways;
(xi) Effective maintenance of machinery and vehicles to avoid leakages;
(xii) For effluents from workplaces, camps, and offices, provide treatment arrangements such as retention ponds and septic tanks, which should be incorporated in the facility designs; provide proper systems for collection, treatment, and safe disposal of wastewater from construction camps and

facilities; no pit latrines shall be allowed; toilets. Septic tanks should be sealed from the bottom and sides to prevent seepage;

(xiii) Solid waste management, as detailed in the approved SEMP, should be implemented throughout the construction period;

(xiv) Monitor water quality according to the environmental monitoring plan

217. **Impact on Groundwater** During the construction period, there is an increased demand for groundwater arising from water required for various civil works and for personal consumption by the workers. The Contractor will be required to source the groundwater from approved sources so as to avoid impacting the availability of the water to the local community, particularly when the local community is dependent on the same aquifer. Thus, the camp area and the stockyard, along with the material storage areas, equipment and vehicle maintenance areas, solid waste disposal, and the like, if not managed effectively, can contaminate the groundwater. Mitigation measures will include:

(i) Use the groundwater resources judiciously with prior approval from the competent authority;

(ii) All tube wells, test holes, and monitoring wells that are no longer in use or needed shall be properly decommissioned;

(iii) Storage of lubricants and fuel at least 50 m from water bodies and in double-hulled tanks;

(iv) Storage of fuel and lubricants in double-hulled tanks. Fuel and other petroleum products are stored in storage areas away from water drainage and protected by impermeable lining and bonded 110%;

(v) Effective maintenance of machinery and vehicles to avoid leakages;

(vi) Effective management of solid waste and construction debris as per an approved SEMP;

(vii) Provide uncontaminated water for dust suppression.

218. **Drainage Management.** Construction material getting into surface runoff or uncontrolled disposal may cause drainage congestion. These impact on hydrology is expected to be more pronounced during the monsoon period with rapid movement of rainwater through existing drainage structures, which, if blocked by construction waste and debris, may cause flooding or waterlogging in neighboring areas. Since the proposed upgrades are along the canal sections, timely completion of the construction works plays a significant role in the drainage management and timely irrigation of the farmlands. Hence, the following mitigation measures should be adopted by the Contractor:

(i) The contractor shall dispose of debris/waste soil only in designated and pre-approved locations by the Rajapur Irrigation Management Office (RIMO);

(ii) Wastes and construction debris will not be disposed of in a manner that ends up in drainage canals.

(iii) Excessive quantities of unwanted spoil and aggregate materials should be avoided by avoiding on-site storage. Where storage is necessary, the Contractor shall ensure heaps and stockpiles are located at sites that do not permit direct runoff into watercourses.

(iv) All heaps shall be of a size and stability that will minimise the risk of mass movement during periods of heavy rainfall.

219. **Construction Waste Management.** Solid wastes will include construction wastes (solid wastes: pieces of rods, wood, bricks, stones, containers, electric wire, pipes, etc., liquid waste: paint, oil, etc.) and general wastes (solid wastes: papers, plastic containers, residues of food, fruits, etc. and liquid waste: from kitchen and bathroom, etc.). These wastes will be generated

due to construction camps, activities, and materials used for construction. Inadequate management of construction wastes will negatively impact the soil, surface water, groundwater, aesthetic beauty of the area, and workers' health and safety. To mitigate the impacts, the contractor will implement the following to manage waste:

(i) Prepare Construction Waste Management Plan as per the SEMP;
(ii) Identify and seek approval for the areas where construction waste could be disposed;
(iii) The contractors should take every opportunity to reduce the amount of waste generated and collect recyclable material for processing by local operators.
(iv) Contractor shall implement waste segregation on site.
(v) Receptacles for solid waste should be provided for the use of workers, and their contents should be disposed of properly;
(vi) Clean construction waste such as excess soil or rubble should be used in on-site landscaping or given to landowners and developers seeking fill material.
(vii) Waste auditing. The contractor will record the quantity and types of waste and materials leaving the site during the construction phase;
(viii) Waste fuels/oils may be generated from on-site equipment during construction and classified as hazardous waste. Such wastes will be stored in a secure, bunded area on-site prior to collection by relevant parties;
(ix) Domestic solid wastes should be properly segregated into biodegradable and non-biodegradable for collection and disposal at designated solid waste disposal sites; create a compost pit at workers' campsites for disposal of biodegradable waste; non-biodegradable / recyclable material shall be collected separately and sold in the local recycling material market;
(x) Conduct site clearance and restoration to original condition after the completion of construction work;
(xi) All construction waste should be managed as per the approved SEMP.

220. **Impact on Flora and Fauna:** The RIP is the existing irrigation system, and the proposed rehabilitation/construction of irrigation infrastructures will be limited to the canal structures. The project will not encroach upon the core zone protected areas of Bardiya National Park. Since the RIP intake site and embankment rehabilitation are located within the buffer zone, the likelihood of the presence of large mammals there is likely. The following mitigation measures must be paid particular attention to in the construction and operation phases and aligned with the objectives and activities of the Bardiya Management Plan:

(i) Noise and vibration and emissions of dust and other harmful substances into the ambient air shall be limited during the construction phase.
(ii) Construction work at the intake area shall be done during the daytime only and shall limit noise and vibration.
(iii) The long-term operation of machines and vehicle movements at the intake sites during the construction works can disturb and frighten animals near BNP and the forest area downstream of Budhi Kulo.
(iv) Training on good environmental practices and prohibited activities for the workforce engaged at the project site.
(v) Wildlife information boards should be installed near the forest and BNP area at the project site.
(vi) If any wild animal (except birds) comes within 100 m of the construction site, construction must immediately stop and resume only after the wild animals have moved away.
(vii) Project staff and work crews should not have firearms and animal traps in the

work zone near BNP and forest areas.

(viii) Employment agreements should specify heavy penalties for illegal hunting, fishing, trapping, and wildlife trading. All other ancillary workers should also agree not to participate in such activities.

(ix) Strict anti-poaching surveillance measures will be implemented, especially during the project construction.

(x) The construction machinery and vehicles should be cleaned properly before entry to the site to avoid invasive species.

(xi) It is prohibited to dump or spill waste in an uncontrollable manner during construction works to avoid environmental pollution.

(xii) Trenches with earth excavation works during the canal upgrade work shall be completed in a timely manner to minimize the risk to small mammals, as they may fall into the trenches, injure themselves, or die.

221. **Impacts on Aquatic Ecology.** The construction works near the Karnali River at the Budhi Kulo intake are the upgradation of the gated structures with the provision of flushing sluice and strengthening works of the approach channel and river bank protection work of 2 km. There is a certain risk of getting the sediment load, construction wastes, or harmful substances into the water, harming species living in the water. The mitigation measures for impact include:

(i) Construction activities should be carried out during non-breeding periods of aquatic species, and consultation with the community;

(ii) Strict Monitoring of the daily activities of workers;

(iii) Provision of temporary but well-equipped toilets;

(iv) Restriction to workers from fishing in the water bodies;

(v) Adopt measures for the solid waste management;

(vi) Implement strict controls on the disposal of construction waste and hazardous materials to prevent contamination of water bodies;

(vii) Use silt fences, sediment traps, and settling ponds to capture and manage sediments from construction runoff;

(viii) Restore and stabilize riverbanks with native vegetation to prevent erosion and provide habitat for aquatic species;

(ix) Conduct regular monitoring of water quality parameters, including turbidity, pH, and pollutant levels;

(x) Perform periodic surveys of aquatic wildlife populations to monitor health and population trends.

(xi) The civil construction works on water bodies in dry periods or limited to the lean phase of water flow.

222. **Occupational Health and Safety.** Construction may cause noise, vibration, water, and air emissions, as well as handling heavy materials, vehicle and machinery hazards, falls, water hazards, and similar hazards. There will be OHS-related risks throughout the project and typically during construction. There is also a risk to the public from vehicles travelling to and from the site and from entry to the site (whether authorized or unauthorized).

223. An increase in the number of workers within an area will always bring the potential for negative social interactions with the community and the risk of transmitting diseases (communicable and sexually transmitted diseases). This level of risk will be linked to if and where any construction camps are located.

224. For this, good international practice will be enforced, and the following mitigation measures will include:

(i) Access and use of PPE and first aid equipment with an adequate supply of sterilized dressing materials and appliances;
(ii) Health and Safety Plan, including first aid, emergency procedures, training, PPE, labelling, and more, will be developed and implemented throughout the project;
(iii) Provide adequate space and lighting, temporary fences, reflectorized barriers, and signages at the work site;
(iv) Secure all work sites from unauthorized intrusion and accident risks;
(v) Ensure the contractor has a Health and Safety Officer trained in emergency procedures;
(vi) Accident recording and reporting system maintained until handover;
(vii) Sanitary facilities provided to the workers;
(viii) Provide supplies of potable drinking water;
(ix) Provide clean eating areas where workers are not exposed to hazardous or noxious substances;
(x) Provide H&S orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuries to fellow workers;
(xi) Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;
(xii) Safe areas for breaks provided to the workers;
(xiii) Person(s) on site that are fully trained in first aid;
(xiv) Clear demarcation and preventing access to unauthorized personnel;
(xv) Good international practices for water, air, noise, vibration, and dust management.
(xvi) Conduct regular health check-ups for workers;
(xvii) Suitable transport will be provided to facilitate the transfer of injured or ill persons to the nearest hospital.

225. **Community Health and Safety Risks.** Communities will be moderately exposed to threats due to impacts on air and ambient noise levels, mobility of people, goods, and services, access to properties, economic activities, social services, etc. To mitigate these impacts, the contractor will be required to implement the following measures:

(i) Code of conduct for workers includes restricting workers in designated areas, no open defecation, no littering, no firewood collection, no fire except designated places, no trespassing, no residence at construction sites, and no obligation to potentially dangerous work;
(ii) Follow International best practices on community health and safety, such as those in Section 4.3 of World Bank Environmental Health and Safety (EHS) Guidelines on Construction and Decommissioning Activities.
(iii) Provide prior information to the local people about the nature and duration of work.
(iv) Follow established community health and safety protocols on emerging infectious diseases such as COVID-19;
(v) Implement measures to prevent the proliferation of vectors of diseases at the work site;
(vi) Maintain a complaint logbook in the worker's camp and promptly resolve complaints. Follow the established GRM of the overall project (IMEP);
(vii) Schedule transportation activities by avoiding peak traffic periods;
(viii) Clean wheels and undercarriage of haul trucks prior to leaving the construction site;

(ix) Educate drivers: limit speed not more than 30 km/h in settlements and avoid the use of horns;
(x) No parking shall be allowed on the roads that may disturb traffic movement.

226. **Post-construction Clean-up and Reinstatement**. If left unattended after construction, construction debris, spoils, and excess construction materials may pose hazards to properties, communities, and the environment. The contractor will reinstate all the working areas of the RIP in usual condition. All plants, equipment, materials, temporary infrastructure, and vehicles will be removed at the earliest opportunity, and the ground's surface will be restored as near as practicable to its original condition. The following generic measures should be taken:

(i) Remove all spoils wreckage, rubbish, or temporary structures (such as camp shelters and latrines) which are no longer required;
(ii) All excavated materials shall be reinstated to their original condition;
(iii) All disrupted utilities restored;
(iv) All affected structures rehabilitated/compensated;
(v) The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc., and these shall be cleaned up;
(vi) All hardened surfaces within the construction camp area shall be ripped;
(vii) All imported materials removed, and the area shall be top soiled and regressed using guidelines set out in the re-vegetation specification that forms part of this document;
(viii) The contractor must arrange the cancellation of all temporary services;
(ix) Request CPMO to report in writing that worksites and camps have been vacated and restored to pre-project conditions before acceptance of work.

C. Operational Phase Impacts

227. No permanent noise, vibration, or harmful substance emission will exist in the operation phase.

228. **Temporary Impacts during Maintenance and Repairs.** In the project operation phase, an impact on the water resources, dust emissions, noise, and vibration is possible only during the rehabilitation and repair works, and the impacts will be local and short.

229. The Karnali River carries huge amounts of sediment during the monsoon period. The construction of the flushing sluice and electro-mechanical gates at Budhi Kulo intake, settling basins, and head regulator at branch intakes will reduce the sediment along the distribution canals and crop fields. During the operation phase, the canal will need to be occasionally cleaned and flushed as part of general maintenance.

230. General good construction practices are required, as are good health and safety practices and appropriate management of material and waste, including considerate transportation, covering of loose material, separate storage for waste, etc.

231. **Induced Impacts**. Soil and water pollution from increased fertilizer and other agricultural chemicals use increases the risk of soil contamination and water pollution from fertilizers and pesticides. This is caused by a lack of awareness among farmers regarding the use of pesticides and fertilizers that should be provided to all the farmers during the project operation period. To mitigate this, the agriculture unit formed in RIP shall provide part of any training for farmers. The following generic measures should be taken:

(i) Sustainable use of water and appropriate use of fertilizer and pesticides.
(ii) Use Integrated Pest Management techniques to control pests.
(iii) Use the recommended dose of inorganic fertilizers

(iv) Provide training to farmers

D. Cumulative Impacts and Mitigation Measures

232. No similar construction or project activities in the area would result in cumulative environmental impacts. Direct impacts during the construction phase, including, among others, increase in noise levels, fugitive dust, and common air emissions near the construction areas, are temporary in nature and will not result in cumulative adverse impacts to people and the environment with the implementation of mitigation measures discussed in this IEE report.

E. Unanticipated Impacts during Construction and Operation

233. In the event of unanticipated environmental impacts not considered as significant during implementation and not considered in the IEE and EMP, the CPMO shall prepare a corresponding time-bound and budgeted corrective action plan acceptable to ADB and ensure that these are implemented by the contractor/s and reported accordingly in environmental monitoring reports to ADB. If unanticipated environmental impacts deemed as significant become apparent during project implementation, the CPMO will: (i) inform and seek ADB's advice, wherever necessary; (ii) assess the significance of such unanticipated impacts; (iii) evaluate the options available to address them; and (iv) update the IEE including EMP.

VI. CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

A. Consultation and Participation

234. In accordance with ADB's SPS 2009 and GoN requirements, public consultations were held as part of the environmental impact assessment study. Meaningful consultation is an essential part of the environmental assessment process, which enables the incorporation of all relevant views of affected people and other stakeholders into decision-making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The process also helps avoid potential conflicts with stakeholders for smooth project implementation. The findings from the public consultations are documented and considered in the development of the EMP, especially in identifying the significant impacts of the proposed project components and developing the corresponding mitigation measures. The key stakeholders consulted were:

(i) Project beneficiaries' farmers and Water Users Association members;

(ii) Elected representatives, community leaders, and representatives of community-based organizations;

(iii) Local government and relevant government agency representatives, National Park Authorities, and other relevant government departments;

B. Public Consultation Conducted

235. Consultations were undertaken in the Rajapur Irrigation Project with the stakeholders in line with the requirements pertaining to social and environmental considerations. Prior to consultation meetings with local stakeholders, advance notification was circulated, and coordination was established with stakeholders through the project office. Additionally, the consultations were focused on seeking stakeholder's opinions, especially the local government's views on potential physical and economic impacts, key risks, including the mitigation measures, and many more. The summary of consultations is provided in the table below, and Figure 33 shows the photographs of the consultations. The attendance sheet of the meeting held in RIP is placed in **Appendix 6**.

Table 14: Rajapur Irrigation Project - Summary of Public consultation

S. No.	Date and Place	Persons Consulted	Number of Participants		
			Male	Female	Janjati (IP)
1	Rajanpur Municipality office Bardiya, 12 February 2024	- Mayor /deputy mayor and other elected government representatives of Rajapur and Geruwa municipalities - WUA members and beneficiaries of RIP - Staff member of Rajapur Irrigation Management office - Bardiya National Park Officers - TA social and environment consultant.	10	2	5
2	Geruwa Rural Municipality office Geruwa. 12 February 2024		5	1	3
3	13 February 2024, WUA Main Canal Committee office, Rajapur		51	12	53
		Total	**66**	**15**	**61**

Source: Focus group discussion, February 2024

C. Key Points Discussed and Findings of Consultations

236. The key discussions and the assessment information shared with the different

stakeholders during the consultations are as follows:

(i) ADB safeguard requirements on environmental assessment, involuntary resettlement, GRM procedures, etc., were shared with Municipal authorities, the Water User Association (WUA) and National Park authorities.
(ii) The key intervention sites were visited and confirmed that canal rehabilitation and improvement works will be limited within the existing irrigation canal systems, the intervention will not result in any IR and IP impacts. Likewise, the sections proposed for improvements are free of encumbrances, having no formal or informal use or occupation.
(iii) The possible environmental impacts due to the project implementation were discussed with stakeholders, and the environmental assessment and findings were shared; impacts will be site-specific, short in duration, local in extent, temporary and reversible, and of low significance, such as dust during construction, sediment flow from construction in the river, noise pollution, and camp operation.
(iv) The project scope of rehabilitation works of the project component was informed to officials of Bardiya National Park officers and were positive and in support of the project implementation.
(v) For further confirmation on the legal status of the land, the team requested the Rajapur Irrigation Management office to obtain the legal status of the land of the particular sections where interventions are proposed. (even if it exists in the canal section).
(vi) Local government and community support were noticed in favour of the proposed intervention.

D. Information Disclosure

237. The project executing agency will be responsible for the disclosure of this IEE in compliance with ADB's Communication Policy 2011 and ADB SPS 2009. The draft IEE will be disclosed in the English language in the office of EA and IA. The report will also be made available to interested parties on request from the office of the RIMO. Since this is a Category B subproject, this draft IEE report will be disclosed to the public through the ADB website prior to Board approval. This IEE report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009.

Figure 34: Public Consultation in Rajapur Irrigation Project Component

Consultation with the Mayor of Rajapur Municipality

Consultation with the Mayor of Geruwa R. Municipality

Consultation with Bardiya National Park authorities.

Consultation with Rajapur WUA central Committee

Separate Meeting with women WUA member and beneficiaries

Consultation with WUA at headwork site

VII. GRIEVANCE REDRESS MECHANISM

A. Introduction

238. To receive and facilitate the resolution of affected peoples' concerns, complaints, and grievances about the project's environmental and social safeguards performance, a Grievance Redress Mechanism (GRM) has been proposed. When and where the need arises, this mechanism will address any complaints that may arise during the project's pre-construction, construction, and operation. The grievance mechanism is scaled to the risks and adverse impacts of the project. It will address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender-responsive, culturally appropriate, and readily accessible to all segments of the affected people at no cost and without retribution. It will be accessible to community members and workers upon ADB approval of the project. The mechanism does not impede access to Nepal's judicial or administrative remedies. EA, with the support of CPMO and RIMO, will appropriately inform the affected people about the approval mechanism for the project.

B. Proposed Grievance Redress Mechanism

239. A common Grievance Redress Mechanism (GRM) has been proposed and will be in place to redress environmental and social safeguard concerns about the project. Grievance is defined as any issues/concerns resulting in the non-performance of obligations of any parties involved in project processes, particularly in safeguards implementation. The GRM described below has been developed in consultation with the stakeholders and will apply to all subprojects implemented by DWRI and CAMO under the IMEP. The GRM is anchored on the five principles, underpinning the grievance redress processes and the arrangements envisaged to implement these:

(i) **Transparency.** The GRM encourages comments and feedback (negative and positive) to improve the Project. The community must be aware of all complaints, grievances, and problems reported, involved in their redress, and kept informed on progress made in resolving grievances. A public awareness campaign will be conducted to ensure that awareness of the project and its grievance redress procedures is generated. The campaign will ensure that the poor, women, IPs, the vulnerable, and the disadvantaged groups are made aware of grievance redress procedures, and CPMO (the central office of the DWRI) and the CAMO (the central agriculture management office of DOA) will ensure that their grievances are addressed according to the time schedule. Feedback will be provided to the affected person or the complainant.

(ii) **Socially Inclusive**. The whole community, and even those outside, are given the opportunity to raise concerns and the right to receive a response. The GRM provides an accessible, inclusive, gender-sensitive, and culturally appropriate platform for receiving and facilitating the resolution of affected persons' grievances related to the project.

(iii) **Simple and Accessible.** Procedures to file complaints and seek redress are kept simple and easy to understand by the affected people, especially the non-literate and their communities. Affected persons will have the flexibility of conveying grievances/suggestions through verbal narration from walk-in affected person, by dropping grievance redress/suggestion forms in complaints/suggestion boxes put up at accessible locations, through telephone hotlines, by e-mail, by post, or by writing in a complaint register at project site, SMC (Subproject Management Committee), and CPMO offices.

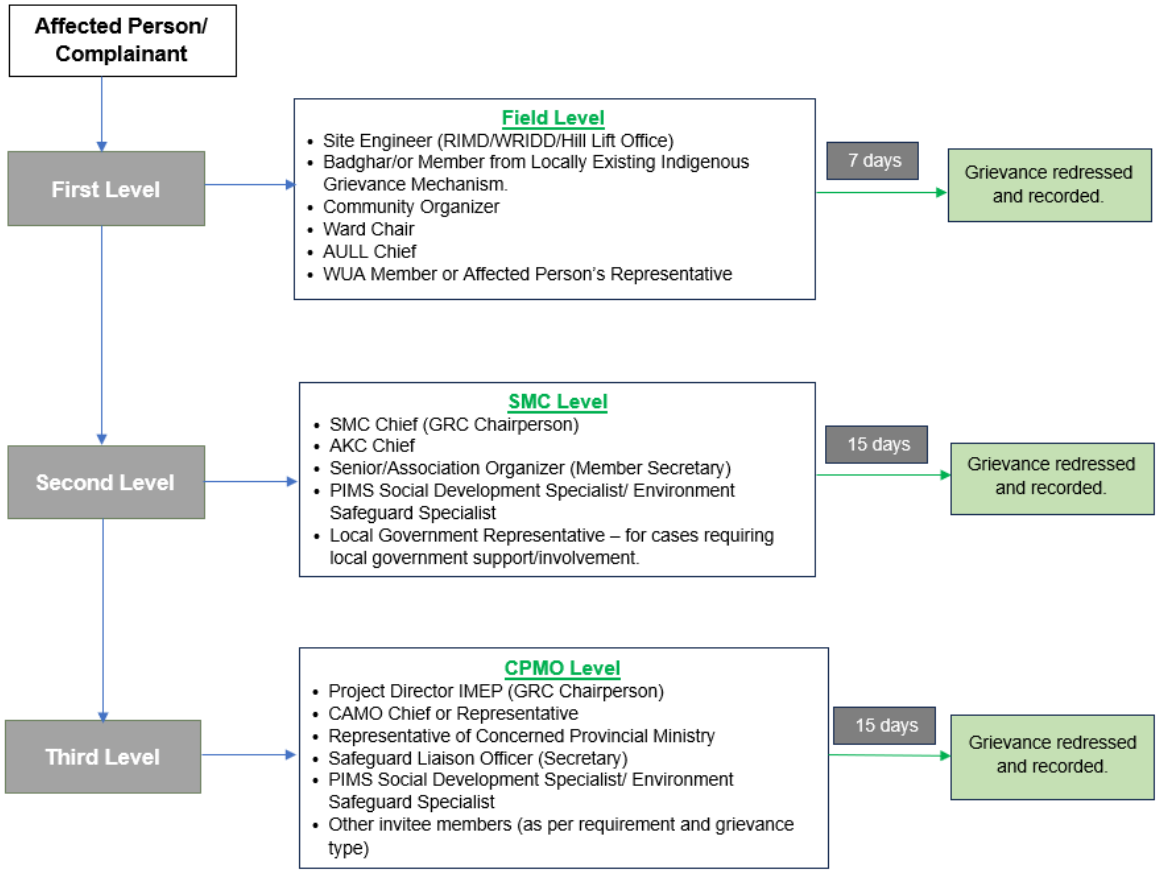
(iv) **Anonymity and Security**. To remain accessible, open, and trusted, the GRM ensures that the identities of those complaining are kept confidential. This encourages people to participate and file grievances openly. Careful documentation of the name of the complainant, date of receipt of the complaint, address/contact details of the person, location of the problem area, and grievance details will be maintained by the project. The project will ensure a grievance tracking and monitoring system; response accorded resolution status, and closure. SMC, together with CPMO's Social Development Specialists, will have the joint responsibility for timely grievance redressal on safeguards and gender issues and registration of grievances, related disclosure, and communication with the aggrieved party.

(v) **Institutional Capacity Building.** Through the GRM, the SMC and CPMO will strengthen communication channels and mechanisms for grievance redress at the community/project area level.

C. Grievance Redress Arrangements and Role Functions

240. The GRM is a three-tier arrangement (Figure 34) that facilitates time-bound grievance resolution at each level. Responsible persons and agencies/offices are identified to address grievances and seek appropriate advice at each stage, as required. Institutional arrangements, including the constitution of grievance redress committees (GRC) at various levels, will be ensured to function throughout the project duration. The CPMO shall ensure the constitution of these committees and oversee the implementation of grievance redress processes, including adherence to time limits, record keeping, and documentation at each level.

Figure 35: Grievance Redress Mechanism



241. **Field Level:** The first level of the GRM will function at the project location/site. The field-level arrangement will consist of ground implementation staff led by the project's Site Engineer, a Community Organizer, a Badghar or a member from a locally existing Indigenous grievance settlement mechanism, and a representative of the affected persons. All minor issues and those perceived as immediate and urgent by the complainant will be resolved at the field level itself (within 7 days). For cases requiring input and involvement of local bodies, the field-level grievance cell will be strengthened by including a Ward Chair (at least one female member and one representative from the local Indigenous community. In cases of larger issues that cannot be resolved at the field level, the matter will be escalated to the district/subproject level GRC, the second level arrangement. The Community Organizer will be responsible for documentation and record-keeping. A summary of grievance records will be submitted to the CPMO monthly. The province-based PIMS Social Development Specialist will monitor and provide guidance and support to the field staff in grievance redress and record-keeping.

242. **SMC Level:** A GRC will be established at the SMC level and headed by the SMC chief**. The** Senior/Association Organizer of the Institutional Development section of WRIDD/SD/RIMD will function as the member secretary of the GRC, supported by the PIMS Social Development Specialist/Environmental Safeguard Specialist. The committee will include a Central Agriculture Development Office (CAMO) Chief, as per the nature of the grievance. All grievances that cannot be resolved at the field level and those directly registered at this level will be addressed by this body within 15 days of complaint receipt. Proper documentation of grievances (including records of grievances redressed at the field level) will be maintained by the Institutional

Development unit of WRIDD/RIMO and offices responsible for hill lift schemes. In cases where the GRC at this level cannot resolve a grievance within the stipulated period, the case will be escalated to a higher level for resolution. The SMC level will also maintain follow-up for each grievance, periodically disseminate information to complainants on the status of their grievance and record their feedback (satisfaction/dissatisfaction and suggestions).

243. **CPMO Level**: The arrangement at the highest level will involve the constitution of a project-level committee headed by the CPMO PD as the chairperson. The committee will receive support from the Social Development Specialist/Environmental Safeguard Specialist or technical experts relevant to grievances, the CAMO Chief or representative, the representative or senior officer from the concerned provincial ministry, and other members as required based on the type of grievance. All grievances that cannot be resolved by the SMC level GRC will be brought to the attention of this body, seeking its advice or referral for resolution at this level. Grievances received or referred to this committee will be resolved within 15 days. Periodic information will be provided to complainants on the status of their grievance resolution. The Safeguard Liaison Officer will act as the secretary for the CPMO-level committee and will also be responsible for compiling grievance redress records, including project-level documentation and reporting.

244. The affected person/complainant shall have access to the country's legal system at any stage. Further, accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM.

245. **ADB Accountability Mechanism.** Suppose the established GRM is not able to resolve a grievance. In that case, the affected person can also use the ADB Accountability Mechanism by directly contacting (in writing) the Complaint Receiving Officer at ADB headquarters or the ADB Nepal Resident Mission (NRM). Before submitting a complaint to the Accountability Mechanism, the affected/aggrieved person/s should make a good-faith effort to solve the problem by working with the concerned ADB operations department and/or NRM. Only after doing so, and if they are still dissatisfied, will the Accountability Mechanism consider the complaint eligible for review.[12] The complaint can be submitted in any of the official languages of ADB's developing member countries. The ADB Accountability Mechanism information will be included in the project-relevant information to be distributed to the affected communities as part of the project GRM.

246. **Consultation arrangements and information dissemination**. The GRM will adopt a consultative and participatory approach to grievance resolution, which may sometimes require one-to-one consultation with individual complainants or the aggrieved community. Furthermore, the CPMO and the PIMS Social Development Specialist/Environmental Safeguard Specialist will be responsible for disseminating information to affected persons on the grievance redressal procedure, ensuring that the host community understands the grievance redress process, and encouraging them to register complaints. Adequate consultations, meetings, and public awareness campaigns will be conducted to achieve this objective. Information on grievances received and responses provided will be documented and reported to the affected persons. All grievances will be treated with utmost confidentiality, and the complainant's identity will not be disclosed. A sample grievance registration form is provided in **Appendix 7.**

247. **Record Keeping.** Records of all grievances received, including contact details of the complainant, date the complaint was received, nature of the grievance, agreed corrective actions and the date these were taken, and the outcome would be maintained by the CPMO

[12] Accountability Mechanism. http://www.adb.org/Accountability-Mechanism/default.asp.

(with the support of PIMS Social Development Specialist/Environmental Safeguard Specialist). As part of record-keeping and reporting practices, information on grievance tracking will also be maintained. Grievance reporting by SMC and CPMO at their respective levels will include information for the reporting period and the cumulative data on select parameters such as total grievances received, redressed, pending, etc., since the project's inception. Summarized information will be included as part of the CPMO's periodic reporting, with support from PIMS and ADB.

248. **Periodic review and documentation of lessons learned**. The CPMO will periodically review the functioning of the GRM and record information on the mechanism's effectiveness, particularly in preventing and addressing grievances within the project.

249. **Costs**. The project will bear all costs involved in resolving the complaints (meetings, consultations, communication, and reporting/information dissemination).

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

250. The Environmental Management Plan (EMP) for the Rajapur Irrigation Project is the synthesis of all proposed mitigation and monitoring actions as well as institutional measures, set to a time frame with duly assigned responsibility and defined follow-up actions for DWRI, RIMO, the contractor, and the regulatory agencies to implement to avoid, minimize and mitigate adverse environmental impacts and enhance positive impacts. The major components of EMP are:

(i) Mitigation of potentially adverse environmental impacts;
(ii) Monitoring of mitigation measures, plans, and actions during pre-construction, construction, and operation phases; and
(iii) Institutional arrangements for implementation and monitoring of EMP.

B. Objectives of Environmental Management Plan

251. The main objectives of EMP are as follows:

(i) Ensure compliance with ADB's SPS 2009, IFC EHS, and regulatory requirements of government at the national and provincial levels;
(ii) Avoid, mitigate, and compensate anticipated adverse environmental impacts via measures, actions, and plans during pre-construction, construction, and operation phases;
(iii) Stipulate monitoring actions, supervision, and institutional measures for safeguards compliance; and
(iv) Ensure that environmentally sound, sustainable, and good practices are adopted so that the project development is environmentally sustainable.

252. The EMP is drafted for different stages of activity, including preparatory works planning phases. The EMP is a live document that can be detailed immediately during the accomplishment of the activities following the monitoring outcomes or other practical terms. Any changes or corrections to this EMP will be done based on the formal agreement between DWRI and the ADB.

253. The EMP document will be incorporated in the work tender documents, and the participants will be able to specify their environmental protection duties in their proposals. After the onset of the construction works, the EMP will be part of the agreement between the client and the construction contractor, and it will be necessary to accomplish during the construction works.

C. Mitigation Measures

254. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision, and monitoring have been provided in a matrix format in Table 15. These mitigation measures will be implemented as part of this project.

255. The EMP is necessary on the grounds that it will manage the environment by offsetting the negative impacts with possible mitigation measures and enhancing the positive impacts within the allocated funds from the project. Thus, the main objectives of the EMP are to:

(i) Display a range of measures to mitigate potential impacts to minimal or insignificant levels;
(ii) Identify measures that could optimize beneficial impacts;

(iii) Establish a method of monitoring environmental management practices during all phases of development;
(iv) Ensure project implementation and operational phases are within the principles of ADB SPS 2009 and national environmental policies;
(v) Ensure that the health and safety recommendations are complied with;
(vi) Propose mechanisms for monitoring compliance with the EMP and reporting thereon; and
(vii) Specify time periods within which the measures contemplated in the final environmental management plan must be implemented, where appropriate.

D. Environmental Monitoring Program

256. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. An effective environmental monitoring plan must be designed and followed to ensure the effective implementation of mitigation measures and environmental management plans during the construction and operation phase of the RIP subproject components.

257. The environmental monitoring program has the underlying objective of ensuring that the intended environmental mitigations are realized and that these result in desired benefits to the target population, causing minimal deterioration of the environmental parameters. Such a program targets the proper implementation of the EMP. The broad objectives are:

(i) To evaluate the performance of mitigation measures proposed in the EMP.
(ii) To evaluate the adequacy of environmental assessment.
(iii) To suggest ongoing improvements in the management plan based on the monitoring and to devise fresh monitoring based on the improved EMP.
(iv) To enhance environmental quality through the proper implementation of suggested mitigation measures.
(v) To meet the requirements of the existing environmental regulatory framework and community obligations.

258. **Performance Indicators**. The significant physical, biological, and social components affecting the environment at critical locations serve as wider/overall Performance Indicators. However, the following specific environmental parameters can be quantitatively measured and compared over a period of time and are, therefore, selected as specific Performance Indicators (PIs) for monitoring because of their regulatory importance and the availability of standardized procedures and relevant expertise.

(i) Air Quality with respect to PM2.5, PM10, CO, NO_x and SO_2 at selected location.
(ii) Water Quality with reference to DO, BOD, Oil and grease, COD, Suspended Solids and Turbidity, and Alkalinity at crossing points on rivers/streams at selected points.
(iii) Noise levels at sensitive receptors (schools, hospitals, community/religious places).
(iv) Survival rates of trees planted as compensatory plantation to compensate for lost forestlands and compensatory plantation raised for removal of roadside trees.

259. ***Ambient Air Quality (AAQ) Monitoring***. Ambient air quality parameters recommended for monitoring the RIP subproject are PM2.5, PM10, Carbon Monoxide (CO), Oxides of Nitrogen (NOx), and Sulphur Dioxide (SO_2). These are to be monitored right from the commencement of construction activity at selected locations, such as plants and machinery, crushers on sites, excavation works, etc. Data should be generated once in a season, excluding monsoon, at the monitoring locations in accordance with the revised National Ambient Air

Quality Standards.

260. ***Water Quality Monitoring.*** The physical and chemical parameters recommended for water quality analysis relevant to construction projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, Chloride, Lead, Zinc, and Cadmium. The location, duration, and pollution parameters are to be monitored, and the responsible institutional arrangements are given in the environmental monitoring plan. The monitoring of the water quality is to be carried out at locations identified in and around the project areas during the construction and operation phases.

261. ***Noise Level Monitoring.*** Measurements for monitoring noise levels will be carried out at sensitive receptors and construction sites around the subproject components. Sound pressure levels would be monitored on a 24-hour basis. Noise should be recorded at “A” weighted frequency using a “slow time response mode” of the measuring instrument.

262. ***Success of Re-vegetation.*** The project involves constructing irrigation structures; hence, these will require the felling of trees. Such lost vegetation will be required to be replaced by compensatory plantation. These compensatory plantations will have to be monitored by the implementing agency with the help of the Forest Department. Such monitoring will be conducted through random samples. Such sampling should cover at least 5% of the area planted.

E. Environmental Reporting System

263. The monitoring plan covering various performance indicators, frequency, and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in Table 16.

264. The reporting system will operate linearly with the contractor at the lowest rank of the implementation system reporting to the PIMS, who in turn shall report to the CPMO. All reporting by the contractor and PIMS shall be on a quarterly basis. The PMU shall be responsible for preparing targets for each of the identified EMP activities.

265. CPMO will monitor the overall progress of EMP implementation of the entire components of IMEP. The CPMO, PIMS, and contractor safeguard team will undertake their respective roles in site inspections and document reviews to verify compliance with the EMP and SEMP and progress toward the final outcome. The contractor will conduct day-to-day implementation of the SEMP.

266. The contractor will submit monthly reports to the CPMO. The monthly reports will include a compilation of copies of monitoring sheets accomplished and duly signed by the contractor’s Environmental Safeguard /Occupational Health and Safety Officers on a daily basis. This monitoring sheet is indicative and can be further enhanced depending on the actual situation at the subproject construction site.

267. The PIMS will submit quarterly environmental monitoring reports to CPMO, which will include a summary of the contractor's monthly monitoring activities and results of any independent monitoring or inspection activities of the project. In the conduct of these independent inspection activities, CPMO will be supported by a PIMS consultant. A sample inspection checklist is in **Appendix 8**. This checklist is indicative and can be further enhanced depending on the actual situation at the project component construction site.

268. CPMO, with support from the PIMS, shall accomplish semi-annual environmental monitoring reports (SEMRs) starting from the effectivity date up to the end of the construction phase, which shall be submitted to ADB for review and disclosure on the ADB website. The suggested outline of the SEMR is provided in **Appendix 9**. The CPMO shall prepare and submit

an annual environmental monitoring report during the operation phase until ADB issues a project completion report. Submission of these reports to ADB will be within thirty (30) days from the end date of the reporting period.

Table 15: Environmental Management Plan Matrix Applicable to Rajapur Irrigation Project

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
1. Pre-Construction Phase					
Consents and Permits Requirements	Failure to obtain necessary consents, permits, and clearances can result in design revisions and/or stoppage of the Works.	• The project shall obtain all the necessary consents and permits from the National Park Authority and the local government stakeholders before the start of civil works. • The local government and the National Park jointly initiate community development activities and manage natural resources in the buffer zones.	Counterpart funding and contract budget	CPMO, DWRI	EA, ADB
Integration of safeguards-related aspects into the bidding documents	Lack of awareness by contractors on ADB SPS requirements may result in insufficient budget and non-implementation of EMP	• Include all safeguards-related clauses and integrate IEE and EMP into the bidding documents	Counterpart funding and contract budget	Procurement Officer, CPMO	EA, ADB
EMP Implementation Requirements	If the contractors and construction supervision engineers are not aware of the requirements of this EMP, the project may not proceed and comply with ADB and GoN environmental policies.	• The CPMO, RIMO, and contractors will be required to undergo training on EMP implementation.	Counterpart funding and PIMS budget	CPMO, PIMS	EA, ADB
Update IEE and EMP	IEE and EMP are out of date due to changing conditions or design.	• The CPMO shall update the IEE in case of a change in design/based on the final detailed design and submit the same for review and clearance of ADB.	PIMS budget	CPMO, PIMS	EA, ADB
Community awareness of project activities	Lack of community awareness of project activities may result in potential community health and safety concerns and complaints.	• Before the start of project construction, a meaningful consultation with the affected communities will be conducted. • Meaningful consultation will aim to engage community stakeholders, listen to their views, and arrive at a common understanding of how to implement the project.	Counterpart funding and PIMS budget	RIMO, Municipalities, CPMO	DWRI
2. Construction Phase					
Construction Planning	Inadequate planning could lead to the non-implementation of EMP during the construction	• Appoint a Senior Safeguard Officer and a Senior Safety officer (EHS) Supervisor;	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
	phase, which would result in significant environmental impacts and non-compliance with ADB's environmental safeguard requirements.	• Develop a Site-Specific Environmental Management Plan (SEMP) and Occupational Health and Safety Management Plan (including COVID-19 H&S guidance) and get it approved by the Client; • Conduct training on the rationale for and implementation of the SEMP and EMP to enhance general understanding and clarify responsibilities regarding implementation, including monitoring and reporting, which must also be provided to all relevant staff of contractors; • No works can commence prior to approval of SEMP.			
Impact on Air Quality	Construction activities, including transporting and storing raw materials, will likely create dust and emissions that could deteriorate ambient air quality in the area. Construction work in the Budhi Kulo intake near the Bardiya National Park can negatively impact air quality and the local ecosystem.	• Take every precaution to reduce the levels of dust at construction sites and not exceed the pre-project ambient air quality standards; • Fit all heavy equipment and machinery with air pollution control devices that are operating correctly; • Construction vehicles must travel at speeds that minimize dust generation; • Reduce dust by spraying water on stockpiled soil, excavated materials, and spoils • Cover with tarpaulin vehicles transporting soil and sand; • Cover stockpiled construction materials with tarpaulin or plastic sheets; • Water spraying to access roads, campsites, and work sites to reduce dust emissions; • Machines and vehicles must be regularly examined and maintained to comply with requirements of technical specifications; • All vehicles, equipment, and machinery used for construction will be regularly maintained to ensure that pollution emission levels comply with the relevant standards; • prohibit burning firewood in work and labor camps (promote liquified petroleum gas for cooking purposes and electric heaters for heating purposes;	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		• prohibit open burning of solid waste; • Monitor air quality according to the environmental monitoring plan.			
Impact on Noise	Noise generation may disturb nearby sensitive receptors	• Arrive at the construction schedule upon discussions with the nearby stakeholders, especially when works are carried out near sensitive receptors such as hospitals, schools, places of worship, etc.; • Install noise barriers between the source and receptor, where necessary; • Enclose and locate generators away from sensitive receptors; • Operate construction machines/conduct noise operations sequentially rather than all together; • spread out the schedule of material, spoil, and waste transport; • minimize drop heights when loading and unloading coarse aggregates; • avoid the use of horns unless necessary; • Use modern vehicles and machinery with standard adaptations to reduce noise and exhaust emissions and ensure they are maintained to manufacturers' specifications; • Noise-generating equipment must be fitted with silencers; • Optimize the use of noisy construction equipment and turn off any equipment if not in use; • Regular maintenance of all equipment and vehicles; • Stop all construction activities at night; • Implement a complaint handling system; • Workers should be provided with Ear muffs / protective hearing equipment in noise-critical areas; • Place visually clear instructions in areas where noise levels are significant; • Measure noise levels periodically as per the Environmental Monitoring Plan.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
Impact on Surface Water Quality	Silt-laden run-off from stockpiled materials, solid wastes, and domestic wastewater from the construction camp, and leaks from chemical storage areas and machinery may contaminate or result in water pollution if disposed of or discharged to nearby receiving bodies of water. Solvents, vehicle maintenance fluid (oil, coolant), and diesel fuel may contaminate surface and groundwater if spilled on the ground, disposed of directly, or washed into the Budhi kulo channel. Human wastes from construction workers may also contaminate surface water and groundwater without adequate sanitary facilities.	• Provision of temporary sedimentation canals and/or silt traps along construction areas, particularly alignments that are adjacent to receiving bodies of water or canals; • The measures to address soil erosion at the proposed facilities will consist of measures per design or as directed by the PIMSC to control sedimentation and water pollution in Rajapur Components. All temporary sedimentation, pollution control works, and maintenance thereof will be deemed incidental to the earthwork or other items of work; • All temporary discharge points shall be located, designed, and constructed in a manner that will minimize erosion in the receiving channels; • Avoid scheduling of excavation work during the monsoon season; • Confine the construction area, including the material storage (sand and aggregate), so that runoff will not enter the site; • Ensure that drains are not blocked with excavated soil or other materials; • Stockyards at least 50 meters (m) away from watercourses; • Fuel and other petroleum products stored at storage areas away from water drainage and protected by impermeable lining and bunded; • Effective maintenance of machinery and vehicles to avoid leakages; • For effluents from workplaces, camps, and offices, provide treatment arrangements such as retention ponds and septic tanks, which should be incorporated in the facility designs; provide proper systems for collection, treatment, and safe disposal of wastewater from construction camps and facilities; no pit latrines shall be allowed; toilets.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		Septic tanks should be sealed from the bottom and sides to prevent seepage; • Solid waste management, as detailed in the approved SEMP, should be implemented throughout the construction period; • Monitor water quality according to the environmental monitoring plan			
Impact on Groundwater	Increased groundwater demand for construction and consumption use can deplete the Groundwater table; Unscientific Solid Waste and Construction Waste Disposal can lead to groundwater contamination.	• Use the groundwater resources judiciously with prior approval from the competent authority; • All tube wells, test holes, and monitoring wells that are no longer in use or needed shall be properly decommissioned; • Storage of lubricants and fuel at least 50 m from water bodies and in double-hulled tanks; • Effective maintenance of machinery and vehicles to avoid leakages; • Effective management of solid waste and construction debris as per an approved SEMP; • Provide uncontaminated water for dust suppression.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS
Drainage Management	Construction material entering surface runoff or uncontrolled disposal may cause drainage congestion, flooding, or waterlogging in neighboring areas.	• The contractor shall dispose of debris/waste soil only in designated and pre-approved locations by the Rajapur Irrigation Management Office; • Wastes and construction debris will not be disposed of in a manner that ends up in drainage canals. • Excessive on-site storage of unwanted spoil and aggregate materials should be avoided. Where storage is necessary, the Contractor shall ensure heaps and stockpiles are located at sites that do not permit direct runoff into watercourses. • All heaps shall be of a size and stability that will minimize the risk of mass movement during periods of heavy rainfall.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS
Construction Waste Management	Inadequate management of construction wastes will negatively impact the soil, the area's aesthetic beauty,	• Prepare Construction Waste Management Plan as per the SEMP; • Identify and seek approval for the areas where construction waste could be disposed;	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
	and workers' health and safety.	• The contractors should take every opportunity to reduce the waste generated and collect recyclable material for processing by local operators. • Contractor shall implement waste segregation on site. • Receptacles for solid waste should be provided for the use of workers, and their contents should be disposed of properly; • Clean construction waste such as excess soil or rubble should be used in landscaping on site or given to landowners and developers seeking fill material. • Waste auditing. The contractor will record the quantity in tons and types of waste and materials leaving the site during the construction phase; • Waste fuels/oils may be generated from on-site equipment during construction and classified as hazardous waste. Such wastes will be stored in a secure, bunded area on-site prior to collection by relevant parties; • All construction waste should be managed as per the approved SEMP.			
Impact on Flora/Fauna	The proposed scope of work of the RIP is within the existing canal system structures, so there is no loss of vegetation. RIP intake site is located adjacent to the Bardiya National Park and within the Buffer Zone, the likelihood of the presence of large mammals in the nearby forest areas.	• Noise, vibration, dust, and other harmful substances and emissions into the ambient air shall be limited during the construction phase. • Construction work at the intake area shall be done during the day only and shall limit noise and vibration. • The long-term operation of machines and vehicle movement at the intake sites during the construction works can disturb and frighten animals in the BNP and forest area downstream of Budhi Kulo. • It is prohibited to dump or spill waste in an uncontrollable manner during construction works to avoid environmental pollution. • Trenches with earth excavation work during the canal upgrade work shall be completed in a timely	Counterpart funding and contract budget, BAP budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		manner to minimize the risk to small mammals, who may fall into the trenches, injure themselves, or die. • Training on good environmental practices and prohibited activities for the workforce engaged at the project site. • Employment agreements should specify heavy penalties for illegal hunting, fishing, trapping, and wildlife trading – all other ancillary works should also agree not to participate in such activities. • Strict anti-poaching surveillance measures will be implemented, especially during the project construction phase. • Implementation of biodiversity action plan Appendix 4.			
Impact on Aquatic Ecology	There is a certain risk of getting the sediment load and machinery works at the embankment, construction wastes, or harmful substances into the water, which will be harmful to all species living in the water.	• Work at the intake site near the Karnali River shall be performed shortly so that the risks of getting water pollution from the construction are minimized; • Store spoils away from the side of the river/irrigation channels; • Implement proper storage/disposal of materials, chemicals, and waste • Implement mitigation measures for excavation, soil erosion and sediment mobilization, surface water pollution, and construction waste generation; • Construction activities should be carried out during non-breeding periods of fishes, if fishes in the canal, and consultation with the community; • Strict Monitoring of the daily activities of workers; • Provision of temporary but well-equipped toilets; • Restriction to workers from fishing in the water bodies; • Adopt measures for solid waste management • Civil construction works on water bodies either in dry periods or are limited in the lean phase of water flow.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		• Conduct sampling and analysis of the surface water near the construction sites as part of the Environmental Monitoring Plan. • Implementation of biodiversity action plan Appendix 4.			
Impacts on protected areas and critical habitats	Screening with the Integrated Biodiversity Assessment Tool (IBAT) confirms the presence of Bardiya National Park within 1km. However, the rehabilitation works are limited within the existing canal structures, and the project scope will not encroach upon protected areas and their buffer zones or sensitive ecosystems.	• Construction work at the intake area shall be done during the day only and shall limit noise and vibration. • The long-term operation of machines and vehicle movement at the intake sites during the construction works can disturb and frighten animals in the BNP and forest area downstream of Budhi Kulo. • Build awareness amongst the workers to prevent any impact on the protected areas and key biodiversity arising from their actions during the construction period. • prevent workers from removing/damaging any other flora and fauna found in the project vicinity; • Contractor should ensure that a No Poaching policy is implemented throughout the construction period to cover the protected and key biodiversity areas; • Wildlife information boards should be installed at the project site near the forest and BNP area. • If any wild animal (except birds) comes within the vicinity of 100m from the construction site, construction works must immediately stop and resume only after the wild animals have moved away. • Project staff and work crews should not be allowed to have firearms and animal traps, etc., in the work zone near BNP and forest area. • Strict anti-poaching surveillance measures will be implemented, especially during the project construction phase.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		• An emergency response plan must be prepared for any incident that could negatively impact protected areas and key biodiversity areas. • Implementation of biodiversity action plan Appendix 4.			
Occupational Health and Safety	Construction activities could create health and safety risks to construction workers	• Access and use of PPE and first aid equipment with an adequate supply of sterilized dressing materials and appliances • A health and Safety Plan, including first aid, emergency procedures, training, PPE, labelling, and more, will be developed and implemented throughout the project • Provide adequate space and lighting, temporary fences, reflectorized barriers, and signages at the work site • Ensure the contractor has a Health and Safety Officer trained in emergency procedures • Accident recording and reporting system maintained until handover to the GA • Sanitary facilities provided to the workers • Safe areas for breaks provided to the workers • Training and awareness of health and safety measures among workers • Person(s) on site that are fully trained in first aid • Clear demarcation and preventing access to unauthorized personnel • Good international practices for water, air, noise, vibration, and dust management. • Suitable transport will be provided to facilitate the transfer of injured or ill persons to the nearest hospital.	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS
Community Health and Safety	Construction activities could create health and safety risks for the community.	• Code of conduct for workers includes restricting workers in designated areas, no open defecation, no littering, no firewood collection, no fire except designated places, no trespassing, no residence at	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		construction sites, and no obligation to potentially dangerous work; • Follow International best practices on community health and safety, such as those in Section 4.3 of World Bank Environmental Health and Safety (EHS) Guidelines on Construction and Decommissioning Activities. • Follow established community health and safety protocols on emerging infectious diseases such as COVID-19; • Implement measures to prevent the proliferation of vectors of diseases at the work site; • Maintain a complaint logbook in the worker's camp and take action promptly of complaints. Follow the established GRM of the overall project (IMEP); • Schedule transportation activities by avoiding peak traffic periods; • Clean wheels and undercarriage of haul trucks prior to leaving the construction site; • Educate drivers: limit speed not more than 30 km/h in settlements and avoid the use of horns; • No parking shall be allowed on the roads that may disturb traffic movement.			
Post-construction clean-up and reinstatement	Construction debris, spoils, and excess construction materials may pose hazards to properties, the community and the environment if left unattended after construction.	• Remove all spoils wreckage, rubbish, or temporary structures (such as camp shelters and latrines) which are no longer required; • All excavated materials shall be reinstated to their original condition; • All disrupted utilities restored; • All affected structures rehabilitated/compensated; • The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc., and these shall be cleaned up; • All hardened surfaces within the construction camp area shall be ripped; • All imported materials removed, and the area shall be top soiled and regressed using guidelines set out	Counterpart funding and contract budget	Contractor	RIMO, CPMO, PIMS

Activities	Environmental Impacts	Mitigation Measures	Budget Source / Mitigation Cost (NR)	Institutional Responsibility	
				Implementation	Monitoring/ Supervision
		in the re-vegetation specification that forms part of this document; • The contractor must arrange the cancellation of all temporary services; • Request CPMO to report in writing that worksites and camps have been vacated and restored to pre-project conditions before acceptance of work.			
3. Operation Phase					
Hazards associated with the use of toxic chemicals and fertilizers	Soil and water pollution from increased fertilizer and other agricultural chemicals use results in an increase in the risk of soil contamination and water pollution from fertilizers and pesticides	• Sustainable use of water and appropriate use of fertilizer and pesticides. • Use Integrated Pest Management techniques to control pests. • Use the recommended dose of inorganic fertilizers. • Provide training to farmers.	Counterpart funding and contract budget	Farmers	CAMO, RIMO, CPMO, PIMS

Table 16: Environmental Monitoring Program

Activities or Items to Monitor	Location	Responsible for Activities	Monitoring Method and Parameters	Monitoring Frequency	Budget Source/ Mitigation Cost (NR)	Monitoring Responsibility
1. Pre-Construction Phase						
IEEs and EMPs are included in bid and contract documents	CPMO office	CPMO, PIMS	Copies of bid and contract documents	Before approval tender document	Counterpart funding and contract budget	CPMO, PIMS
Site-specific EMP (SEMP) submitted by Contractor for approval by CPMO	CPMO office	Contractor, RIMO	Copy of approved SEMP	Before construction activities commence	Contract budget	CPMO, PIMS
Spoil management plan (SMP) submitted by Contractor for approval by PIU	CPMO office	Contractor, RIMO	Copy of approved SMP	Before construction activities commence	Contract budget	CPMO, PIMS
Secure all other necessary permits and licenses from relevant government agencies		Contractor, CPMO	Copies of permits and licenses	Before construction activities commence	Counterpart funding	CPMO, PIMS
2. Construction Phase						
Conduct baseline ambient air quality monitoring	Project site	Contractor	Site visits and field monitoring for PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO. Field observations, Contractor records, and Results of Air Quality Sampling.	Before construction activities commence	Contract budget 100,000	CPMO, RIMO, PIMS
Conduct of baseline noise level monitoring	Project site	Contractor	Site visits and field monitoring of daytime and nighttime noise levels. Field observations, Contractor records, Results of Air Quality Sampling and Noise Level measurements.	Before construction activities commence	Contract budget (50,000)	CPMO, RIMO, PIMS
Conduct baseline surface water and groundwater quality monitoring	Project site	Contractor	Site visits and sampling are required for all physical and chemical properties as per GoN requirements. Field observations, Contractor records, and Results of laboratory analyses.	Before construction activities commence	Contract budget (100,000)	CPMO, RIMO, PIMS

Activities or Items to Monitor	Location	Responsible for Activities	Monitoring Method and Parameters	Monitoring Frequency	Budget Source/ Mitigation Cost (NR)	Monitoring Responsibility
Conduct baseline soil quality monitoring	Project site	Contractor	Site visits and sampling are required for all physical and chemical properties as per GoN requirements. Field observations, Contractor records, and Results of laboratory analyses.	Before construction activities commence	Contract budget (75,000)	CPMO, RIMO, PIMS
Implementation of SEMP; including implementation of community and occupational health and safety measures.	Project site	Contractor	Site visits, Contractor records,	Weekly or as needed	Contract budget	CPMO, RIMO, PIMS
Implementation of SMP	Project site	Contractor	Site visits, Contractor records,	Weekly or as needed	Contract budget	RIMO, PIMS
Conduct of ambient air quality monitoring	Project site	Contractor	Site visits and field monitoring for PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO. Field observations, Contractor records, and Results of Air Quality Sampling.	Quarterly or as needed	Contract budget (350,000)	CPMO, RIMO, PIMS
Conduct of ambient noise level monitoring	Project site	Contractor	Site visits and field monitoring of daytime and nighttime noise levels. Field observations, Contractor records, Results of Air Quality Sampling, and Noise Level measurements.	Quarterly or as needed	Contract budget (100,000)	CPMO, RIMO, PIMS
Conduct of surface water quality monitoring	Project site	Contractor	Site visits and sampling are required for all physical and chemical properties as per GoN requirements. Field observations, Contractor records, and Results of laboratory analyses.	At least semi-annual or as needed	Contract budget (350,000)	CPMO, RIMO, PIMS

Activities or Items to Monitor	Location	Responsible for Activities	Monitoring Method and Parameters	Monitoring Frequency	Budget Source/ Mitigation Cost (NR)	Monitoring Responsibility
Conduct baseline soil quality monitoring	Project site	Contractor	Site visits and sampling are required for all physical and chemical properties as per GoN requirements. Field observations, Contractor records, and Results of laboratory analyses.	Before construction activities commence	Contract budget (150,000)	CPMO, RIMO, PIMS
Provide EHS training for all personnel	Project site	Contractor	Contractor records; Interviews with workers	Monthly	Contract budget (2,000,000)	RIMO, PIMS
Keep accident reports and records	Project site	Contractor	Contractor records; Interviews with workers and community people	Monthly	Contract budget	RIMO, PIMS
Employ workforce from communities near sites	Project site	Contractor	Contractor records	Monthly	Contract budget	RIMO, PIMS
Implementation of EHS measures at construction camps	Construction campsite	Contractor	Site visits; Interviews with workers at camp	Monthly	Contract budget	RIMO, PIMS
Wildlife incidents	Bardiya National Park (BNP) close to project components	Contractor	No. of wildlife accidents Cases of poaching	Monthly	Contract budget	RIMO, PIMS, BNP Authorities
3. Operation Phase						
Accidents, Health and Safety	Project site	RIMO	No. of accidents or near misses involving workers/staff.	Monthly	O&M budget	CPMO
Wildlife	Bardiya National Park (BNP) close to project components	RIMO	No, if wildlife accidents		O&M budget	CPMO, BNP Authorities

F. Institutional Arrangement

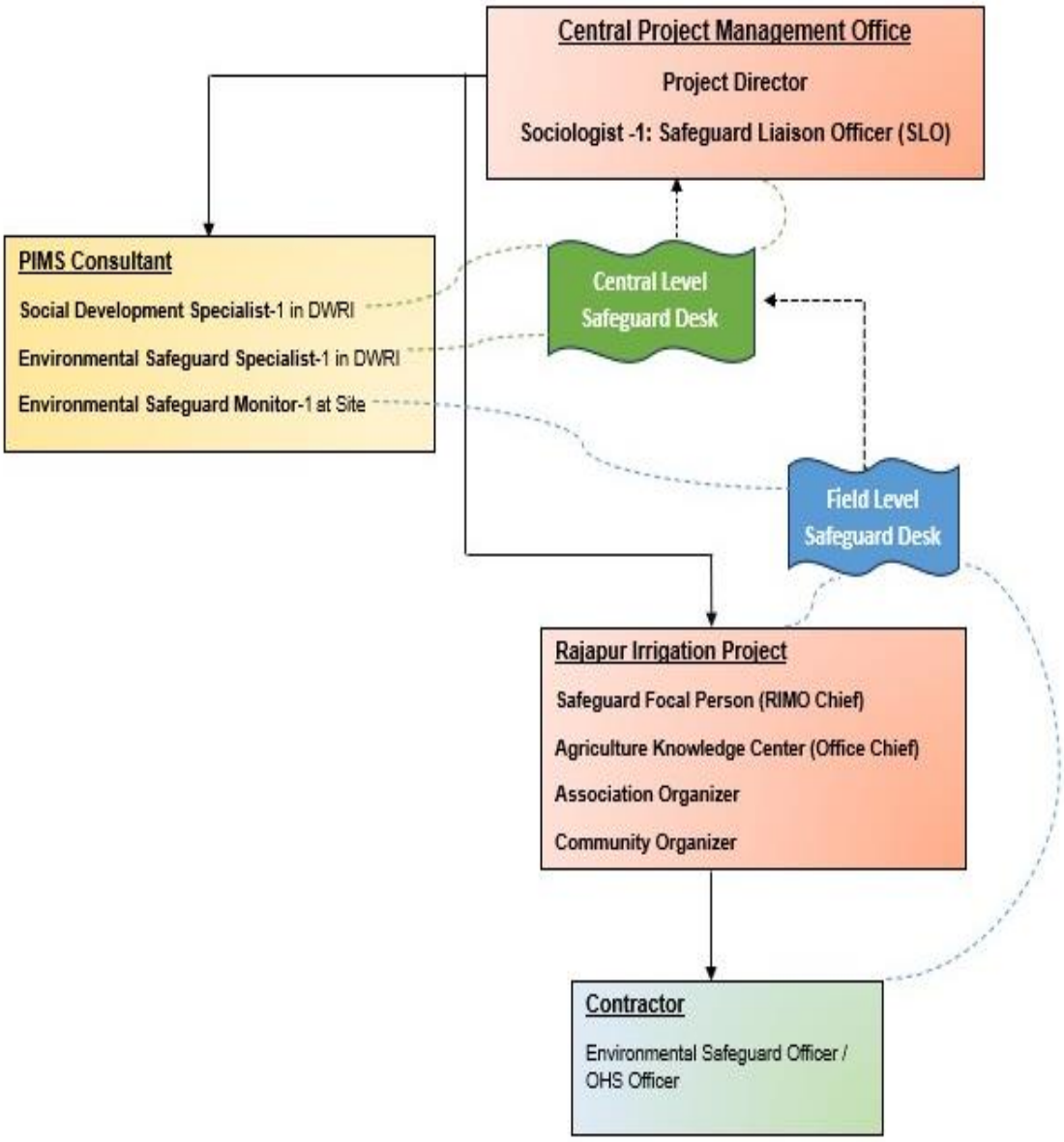
269. The Ministry of Energy, Water Resources and Irrigation (MEWRI) will be the Executing Agency (EA) and the Department of Water Resources and Irrigation (DWRI) will be the implementing agency of the project. The Central Project Management Office (CPMO) will be responsible for the overall implementation of the project and ensuring compliance with ADB's environmental safeguards requirements. The PIU is the Rajapur Irrigation Management Office (RIMO), which is presently in the Bardiya district near the project area.

270. The CPMO will establish a "Central Safeguard Desk" (CSD) and comprise a Safeguard Liaison Officer (SLO) supported by an Environmental Safeguard Specialist (ESS) of PIMS. The SLO will ensure full compliance with the overall environmental and social safeguards requirements of the project. The SLO will work closely with the environment and social development focal points of RIMO. The provincial office shall work under the guidance of CSD and report to them safeguard and safety details. The safeguard focal person of the RIMO - Office Chief and Central Agriculture Development Office - Chief will be supported by one safeguard field monitor, one Association Organizer, and six community mobilizers for safeguard implementation in RIP. Figure 35 below represents the safeguard implementation arrangements for RIP.

271. The Chief of the PIU or Engineer designated as site in-charge will act as safeguard focal person (SFP) at PIUs. The SFP will be supported by the Senior/Association Organizers of PIU and social mobilizers deployed at the subproject level. The contractor will appoint a safeguard and safety assurance officer in each contract package, as provisioned in the contract. PIMS provincial social development specialists and environment monitors will provide technical assistance while implementing safeguard-related activities. The safeguard desk at PIU will be responsible for the following:

(i) Lead the implementation of IPP/RIP/EMP and monitor compliance with project safeguard requirements on a day-to-day basis. Provide timely corrective measures to address any issues.
(ii) Support PIMS social development consultant by providing field-level information to consolidate safeguard monitoring reports.
(iii) Organize or support organizing periodic consultations with beneficiaries/affected persons.
(iv) Form GRM at PIU, support/facilitate beneficiary farmer in registration grievance, if any.
(v) Collect/ maintain project-induced beneficial impacts.

Figure 36: Safeguard Implementation Arrangements in RIP



272. **Project Implementation and Management Support Consultants (PIMS).** The PIMS-ESS will support SLO in CPMO and DWRI. The ESS will have intermittent inputs of 15 months. The specialist will support the CPMO and field offices in maintaining overall environmental safeguards and OHS requirements in the project. The ESS will prepare an e-MIS and support the safeguarding of field monitors at field offices in monitoring environmental and OHS activities. The CPMO will mobilize a full-time Environmental Safeguard Monitor (ESM) at the project site. ESM will work under the guidance of ESS of PIMS. The monitor will coordinate with the RIMO and CAMO field teams and monitor the safeguard compliance of the contractors in project implantation activities. They will support field offices and the PIU field team in overall safeguards assurance monitoring, undertake corrective actions, and report to the senior environment specialist at CPMO.

273. **Civil Works Contract and Contractor**. The IEE with EMP will form part of the bidding and

contract documents and be verified by CPMO. The contractor supporting civil works under DWRI shall include the cost for preparing and implementing site-specific environmental management and OHS plan (SEMP) along with mobilizing a full-time senior safeguard officer and a senior safety officer and include the cost in their BOQ. The inclusion of sufficient cost for EMP and safeguard/OHS staff shall be verified and assured by the senior environment specialist at CPMO. The integrated SEMP will be approved by the employer prior to their field mobilization. The contractor will submit the resume of the proposed senior safeguard officer and senior safety officer at least 15 days prior to their mobilization at the site. The SEMP shall include (i) the proposed locations and specification of workers' camp and associated facilities; (ii) operation of quarry; (iii) transport and storage of construction materials (aggregates, fabricated structural components, fuel, lubricants, paints etc.); (iv) spoil management and waste disposal site; (v) OHS and emergency plan; (vii) budget for SEMP/OHS implementation; and (vi) template of daily safeguards reporting checklist. No work shall commence prior to the approval of the integrated SEMP and resume of the senior safeguard officer and a senior safety officer by the Employer. The contractor will fill daily safeguard assurance checklist and report to the safeguard monitors in the respective field offices.

274. A copy of the approved SEMP will be kept at the site at all times during construction. Non-compliance with, or any deviation from, the conditions set out in the SEMP shall constitute a failure in compliance and will require corrective actions. Prolonged non-compliance upon repeated notices to correct may lead to financial punishment through deducting an agreed percentage of the claim in the interim bills up to termination of the contract if required. Such provision shall be clearly stated in the contract agreement. Any non-compliance with the EMP would be a breach of the contract and trigger penalties associated with the breach in accordance with the terms and conditions of the contract.

G. Capacity Development Training

275. The PIMS Consultant Environmental Safeguard Specialist will train the CPMO, RIMO, and contractors. Training modules will need to cover safeguards awareness and management in accordance with both ADB and government requirements as specified below.

(i) sensitization on ADB’s safeguard policy on the environment;
(ii) introduction to environment and environmental considerations in urban infrastructures;
(iii) review of IEEs and integration into the project's detailed design;
(iv) improved coordination within nodal departments; and
(v) monitoring and reporting system. The contractors will be required to conduct environmental awareness and orientation of workers prior to deployment to work sites.

276. **Methodology.** Capacity-building activities will be achieved through a combination of practical methodologies available, such as lecture and workshop training by experts, on-the-job training and mentoring, and continuing team meetings and exercises. The PIMS Consultant Environmental Safeguard Specialist will spearhead the designing of specific programs appropriate for the target participants or stakeholders, including the execution of these programs during the different implementation phases of the IMEP, which includes the RIP. Pre-training and post-training assessment will be an integral part of the overall program to measure its effectiveness and identify any other interventions needed to improve effectiveness, if necessary.

277. As a fundamental component of the capacity building program, basic lectures and seminar training sessions will be provided by the PIMS Environmental Safeguard Specialist to strengthen the awareness of project stakeholders on the requirements of ADB SPS and government environmental laws, rules, and regulations. Modules will be prepared and customized based on the skill set and needs of the different stakeholders. The entire training will cover basic principles of

environmental assessment and management mitigation plans and programs, implementation techniques, monitoring methods, and tools. A proposed lecture and seminar training program, along with the frequency of sessions, is presented in Table 17 below.

Table 17: Sample Lecture and Seminar Training Program for Environmental Management

Items	Pre-construction	Construction	
Training Title	Orientation workshop	Orientation program/ workshop for contractors and supervisory staff	Experiences and best practices sharing
Purpose	To make the participants aware of the environmental safeguard requirements of ADB and the Government of Nepal and how the project will meet these requirements	To build the capacity of the staff for effective implementation of the designed EMPs aimed at meeting the environmental safeguard compliance of ADB and the Government of Nepal	Improving the implementation of EMP
Contents	Module 1: Orientation ADB Safeguards Policy Statement Government of Nepal Environmental Laws and Regulations Module 2: Environmental Assessment Process ADB environmental process, identification of impacts and mitigation measures, formulation of an environmental management plan (EMP), implementation, and monitoring requirements Review of environmental assessment report to comply with ADB requirements Incorporation of EMP into the project design and contracts	Roles and responsibilities of officials/contractors/consultants towards the protection of the environment Environmental issues during construction Implementation of EMP Monitoring of EMP implementation Reporting requirements	Experiences on EMP implementation – issues and challenges
Duration	1day	1day	Best practices followed
Participants	CPMO and RIMO staff (technical and environmental) involved in the project implementation	CPMO, RIMO, Contractors	CPMO, RIMO, Contractors

H. EMP Implementation Cost

278. Most environmental mitigation and enhancement measures are integrated into the design, and costs are included as part of the civil works contract. Some items need to be incorporated in the Bill of Quantities (BOQ) of this project component, including the environmental monitoring costs. The environmental costs presented in Table 18 below are tentative provisions based on experience of undertaking similar works under different DWRI projects. For the details of environmental costs under civil works contracts, individual contract package bid documents may be consulted. Contractors will bear the direct costs of all mitigation measures during construction, which will be included in the tender and contract documents; this includes features built into facility designs to prevent environmental impacts from arising. The project office CPMO will bear the costs of mitigation measures during operation. Costs related to environmental supervision during construction will be borne by the CPMO (for the activities of the environmental consultants) and by the contractors (for monitoring work carried out by the OHS Officer/s).

Table 18: Indicative Environmental Management Plan Budget for Bill of Quantities (BOQ)

S. N.	Particulars	Stages	Unit	Total Number	Rate (NPR)	Cost (NPR)	Costs Covered By
A.	**Mitigation Measures**						
1	Obtaining and submitting copies (to PMU) of all consents, permits, clearances, no objection clearances or NOCs, and other relevant permits from various authorities/stakeholders before the start of construction	Pre-Construction & Construction	Lump sum	-	-	1,000,000	Civil works contract
2	Insurance Cover for the following: (a) Workmen's Compensation and (b) Damages to Third Party	Pre-Construction & Construction	Lump sum	-	-	1,000,000	Civil works contract
3	Provision of all requisite facilities (i.e., accommodation, drinking water supply, sanitation facilities, soak pits, domestic solid waste collection & disposal, fuel supply, etc.) at construction camps.	Construction & Operation	Lump sum	-	-	2,500,000	Civil works contract
4	Personal Protective Equipment (PPE) to the entire satisfaction of the engineer-in-charge (at RIP construction Sites) and barricade with green nets at construction sites	Construction & Operation	Lump sum	-	-	2,000,000	Civil works contract
5	Water sprinkling for dust suppression in the access road to the construction sites and truck covers for transporting construction materials	Construction	Lump sum	-	-	3,500,000	Civil works contract
6	Establish and maintain a first aid box and fire extinguisher at the campsite to the satisfaction of the engineer in charge.	Construction	Lump sum	-	-	1,500,000	Civil works contract
7	Separate male/female toilet facilities for camp and worksite to the entire satisfaction of the engineer-in-charge	Construction	Lump sum	-	-	2,000,000	Civil works contract
8	Implementation of additional occupational health and safety measures related to the prevention of COVID-19/other pandemic preparation	Construction	Lump sum	-	-	1,000,000	Civil works contract
9	Establish a temporary shelter for the workers to rest and eat their lunch. Provide drinking water, first aid, and safety gear at the resting place (local shade).	Construction	Lump sum	-	-	2,000,000	Civil works contract

S. N.	Particulars	Stages	Unit	Total Number	Rate (NPR)	Cost (NPR)	Costs Covered By
10	Installing clear warning signs at the construction sites to alert the public to the potential risks	Construction & Operation	Lump Sum	-	-	2,000,000	Civil works contract
11	Conduct consultations with affected people and communities	Construction & Operation	Lump Sum	-	-	1,000,000	Civil works contract
12	Budget for grievance redress mechanism	Construction & Operation	Lump Sum	-	-	1,000,000	Civil works contract
13	Implementation of sub-plans - Traffic management plan - Community Health and Safety plan (e.g., IFC Health and Safety Guidelines) - Emergency response plan - Water-saving management plan - Spoil management plan (construction areas) - Hazardous waste management plan - Biodiversity Action Plan	Construction & Operation	Lump Sum	-	-	4,000,000	Civil works contract
Subtotal (A)						**24,500,000**	
B.	**Monitoring Activities (with Monitoring Parameters)**						
1	Air quality monitoring (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO)	During Construction	Per sample	30	15,000	450,000	Civil works contract
2	Ambient Noise monitoring (Day time and nighttime noise levels)	During Construction	Per sample	30	5,000	150,000	Civil works contract
3	Surface water monitoring- Colour, Turbidity, Conductivity, pH, Total Suspended Solids, Total Dissolved Solids, Sand & Silt, Total Hardness, Calcium Hardness, Magnesium Hardness, Calcium, Magnesium, Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Ammonia, Chloride, Nitrate, Nitrite, Sulphate, Iron, Manganese, Arsenic, Copper, Zinc, Sodium, Potassium, Phosphate, Total Nitrogen, Sodium Absorption Ratio, Organic Matter, E. coli and Total Coliforms	Construction & Operation	Per sample	30	15,000	450,000	Civil works contract
4	Soil quality monitoring (Soil constituents test- pH, Salinity, Electrical conductivity, Organic Carbon (%), Nitrogen (kg/ha), Phosphorus (kg/ha), Potassium (kg/ha)	Construction & Operation	Per sample	15	15,000	225,000	Civil works contract

S. N.	Particulars	Stages	Unit	Total Number	Rate (NPR)	Cost (NPR)	Costs Covered By
5	Environmental Safeguard /Biodiversity Expert	Construction	Per Month (12 PM)	1	95,000	1,140,000	Civil works contract
6	Safety Officer (Full time)	Construction	Per Month (24 PM)	1	65,000	1,560,000	Civil works contract
Subtotal (B)						**3,975,000**	
C.	**Capacity Building for Workers and Community Level**						
1	Training on EMP implementation, health & safety inductions to workers, and awareness & empowerment programs to the community in the project area Municipality and Rural Municipality	Pre-construction & Construction	Lump sum	-	-	2,000,000	Civil works contract
Subtotal (C)						**2,000,000**	
Total (A+B+C)						**30,475,000**	
Miscellaneous, provisional sum, and contingency @ 5% of the subtotal						**1,523,750**	
Grand Total						**31,998,750**	**USD 242,415**

IX. CONCLUSIONS AND RECOMMENDATIONS

279. The environmental risks and impacts associated with implementing the proposed Rajapur Irrigation System components in Nepal have been assessed and described in the previous sections of this document. All potential impacts were identified in relation to pre-construction, construction, and operation phases. Potential environmental impacts were assessed using secondary data, stakeholder consultations, and field visits.

280. The findings establish that the main anticipated impacts and risks of the subproject components relate to the short term and are mostly construction-related. The project will not encroach upon protected areas, their buffer zones, sensitive ecosystems, and ancient heritage sites. The project's key activities that attract environmental concerns are intake rehabilitation for surface water diversion, river bank protection, strengthening irrigation infrastructure, labor camps, and quarry operations. The environmental impacts predicted during implementation are mainly restricted to the construction stage. They will be site-specific, short in duration, local in extent, temporary and reversible, and of low significance, such as dust during construction, sediment flow from river construction, noise pollution, and camp operation. In the event of unanticipated environmental impacts not considered as significant during implementation and not considered in the IEE and EMP, the CPMO shall prepare a corresponding time-bound and budgeted corrective action plan acceptable to ADB and ensure that these are implemented by the contractor/s and reported accordingly in environmental monitoring reports to ADB.

281. An EMP that defines the mitigation measures to be implemented across all project phases and the institutions responsible for its implementation and monitoring has been developed. One of the key mitigation measures includes reducing the sediment entry to the irrigation canals and command area by constructing the electro-mechanical gated structures, flood flushing sluice structure, desilting basin in branch canals, and head regulator structures. Additionally, an environmental monitoring program has been proposed and incorporated as part of the EMP to monitor the impacts of the project on the environmental quality, viz., air, noise, and surface water during the construction period and operation stages.

282. The EMP will assist the CPMO, PIMS, and contractors in mitigating the environmental impacts and guide them in the environmentally sound execution of the proposed project. The EMP will also ensure efficient lines of communication between clients, consultants, and contractors. A copy of the EMP shall always be kept on-site during the construction period. The EMP shall be binding on all contractors operating on the site and will be included in the contractual clauses. Non-compliance with, or any deviation from, the conditions set out in this document shall constitute a failure in compliance.

179. Public consultation was conducted as part of the environmental assessment process. The stakeholders expressed support for the proposed subproject site. The consultation results were documented and considered when formulating the project and environmental management plan. Public consultation will continue throughout the project implementation. The IEE will be made available at public locations and disclosed to a wider audience via the CPMO and ADB websites.

180. The project's Grievance Redress Mechanism (GRM) will provide citizens with a platform for redressing their grievances and describe the channels, time frame, and mechanisms for resolving complaints about environmental performance.

181. CPMO, with support from RIMO and PIMS, will be responsible for monitoring the project implementation and compliance with the EMP. The periodic reporting requirements would also enable the disclosure needs to be met as per ADB SPS 2009.

182 Therefore, as per ADB SPS, 2009, this project component is classified as environmental

category B and does not require further environmental impact assessment. This IEE has been prepared based on preliminary designs of the RIP. The CPMO, with support from PIMS, shall update this draft IEE based on the final detailed design and submit it to ADB for review, clearance, and disclosure. This will be obtained before the invitation to bids is sent. This IEE is considered adequate to justify the environmental and social feasibility of the project.

184. The following recommendations are proposed to ensure the project complies with the findings of the IEE:

(i) Obtain all the necessary consents and permits shall be obtained from the National Park Authority and the local government stakeholders;
(ii) Include this IEE in the bid and contract documents;
(iii) Ensure the protection of the protected areas and key biodiversity areas through appropriate designs and implementation of recommended mitigation measures during both the construction and operational phases of the project;
(iv) Update/revise this IEE based on detailed design and/or change in scope of the components and location;
(v) Conduct safeguards induction to the contractor upon award of the contract;
(vi) Strictly supervise EMP implementation;
(vii) Ensure contractor appointed qualified Environmental Safeguard and OHS officer prior to start of works;
(viii) Documentation and reporting regularly as indicated in the IEE;
(ix) Continuous consultations with stakeholders;
(x) Timely disclosure of information and establishment of grievance redressal mechanism (GRM);
(xi) Involvement of contractors, including subcontractors, in first-level GRM; and
(xii) Commitment from CPMO, PIMS, and Contractors to protect the environment and the people from any impact during project implementation.

Appendix 1:Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Safeguards Division (SDSS) for endorsement by the Director, SDSS and approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's: (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title: Nepal: Irrigation Modernization Enhancement Project (Subproject - Rajapur Irrigation Project)

Sector Division: Environment, Natural Resources and Agriculture (SAER)

Screening Questions	Yes	No	Remarks
A. Project Siting Is the Project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural Heritage site		X	Proposed subproject is not located within any cultural, heritage sites or nearby physical cultural resources. As part of subproject site selection process, cultural, heritage sites or nearby physical cultural resources are avoided.
▪ Legally protected area (core zone or buffer zone)	X		The rehabilitation works of two intakes with strengthening the gabion works protecting the intakes from river flood. Geruwa River which is the border line of the National Park and the settlement area. However considering the nature of proposed work, no impacts are anticipated.
▪ Wetland		X	Project components are not located in any wetland.
▪ Mangrove		X	Project components are not located along coastal zones.
▪ Estuarine		X	Project components are not located along coastal zones.
▪ Special area for protecting biodiversity	X		One of the project component is located within Bardiya National Park (BNP) which is a legally protected areas. However considering the nature of proposed work, no impacts are anticipated.
B. Potential Environmental Impacts Will the Project cause…			

Screening Questions	Yes	No	Remarks
▪ impairment of historical/cultural areas; disfiguration of landscape or potential loss/damage to physical cultural resources?		X	It is unlikely to affect historical/cultural areas. Project components will not encroach directly on any historical/cultural sites. Also, the project will not damage any physical or cultural resources.
▪ disturbance to precious ecology (e.g sensitive or protected areas)?	X		One of the project components is located within Bardiya National Park (BNP), which is a legally protected area. However, considering the nature of the proposed work, no impacts are anticipated.
▪ alteration of surface water hydrology of waterways resulting in increased sediment in streams affected by increased soil erosion at construction site?	X		Infrastructure development is highly likely to alter surface water hydrology. Soil erosion is expected during the construction of the irrigation system infrastructure, but this will be at a moderate level.
▪ deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	X		It is possible to affect water quality due to worker-based camps, but not from chemicals. Small-scale siltation is expected during the construction of the irrigation infrastructure. However, this will be at a minimum-moderate level.
▪ increased air pollution due to project construction and operation?	X		There will likely be a decrease in air quality. Small-scale air pollution (i.e., mostly dust and particulate) is expected from the exhaust of vehicles used for material transportation. There are no sensitive receptors of air pollution at the actual target subproject site.
▪ noise and vibration due to project construction or operation?	X		Likely impact. Noise and vibration increases are expected due to the operations of small-batch concrete mixers and other construction machines and equipment.
▪ involuntary resettlement of people? (physical, displacement and/or economic displacement)		X	Highly unlikely. The proposed pondage area of the irrigation system infrastructure does not have any habitations.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	Highly unlikely. No disproportionate impact is expected.
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STIs and HIV/AIDS) from workers to local populations?	X		Possible to occur. There will be generation of solid wastes from construction camps, works on existing embankment structures and ground excavations. There is a potential risk of the transmission of diseases as well (i.e. COVID-19).
▪ creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?		X	Unlikely to affect people. The subproject sites are remote areas where people are away from the irrigation system infrastructure.
▪ social conflicts if workers from other regions or countries are hired?		X	It is an unlikely scenario for the project's implementation. The construction workforce for irrigation system infrastructure will be small, so it will not create a burden on social infrastructures and services. Workers from other regions or countries are not expected to be hired. The project will promote local employment.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	

Screening Questions	Yes	No	Remarks
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?	X		Likely risks for workers. Physical accidents may not be ruled out. However, no chemicals or other hazardous materials will be used.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		X	Unlikely risk to community health and safety. No explosives or chemicals will be used during construction or operation.
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	Unlikely community safety risk. There are no nearby community at subproject areas, and they will not be allowed to access construction sites.
▪ generation of solid waste and/or hazardous waste?	X		Possible. Solid waste will be generated from construction. No hazardous waste will be utilized or produced.
▪ use of chemicals?		X	Unlikely. The use of hazardous chemicals is not expected.
▪ generation of wastewater during construction or operation?	X		Likely but temporary. Wastewater will be generated during the construction phase only from workers' camps.

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: Nepal: Irrigation Modernization Enhancement Project (Subproject - Rajapur Irrigation Project)

Sector: Agriculture, Nature Resources and Rural Development

Subsector: Agriculture, Land Based Natural Resources Management

Division/Department: Environment, Natural Resources and Agriculture (SAER)

Screening Questions		Score	Remarks[1]
Location and Design of project	Is the siting and/or routing of the project (or its components) likely to be affected by climate conditions, including extreme weather-related events such as floods, droughts, storms, and landslides?	0	Climate conditions do not affect the selection of subprojects. The location of subprojects is based on the needs of beneficiaries and the feasibility of infrastructure designs.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	2	Infrastructure designs will greatly rely on the hydro-meteorological parameters, where the amount of river flow is a key consideration.
Materials and Maintenance	Would weather, current, and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	1	Current and future climate conditions affect the selection of project inputs. This is to ensure that the project structures can endure high rainfall and run-off events.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	0	At this stage of the project, maintenance (scheduling and cost) of the project outputs is difficult to determine. However, climate conditions are a major factor to consider.
Performance of project outputs	Would weather, climate conditions and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design lifetime?	2	Long periods of dry weather due to extreme drought can result in an imbalance in water cycles, with changes in precipitation and soil moisture availability. This results in decreased water volumes in rivers.

Options for answers and corresponding scores are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which includes providing a score of 1 in all responses) or a 2 in any single response will be categorized as a high-risk project.

Result of Initial Screening (Low, Medium, High): High

Other Comments: Detailed climate risk vulnerability assessment is required.

Prepared by: Brando M. Angeles

[1] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

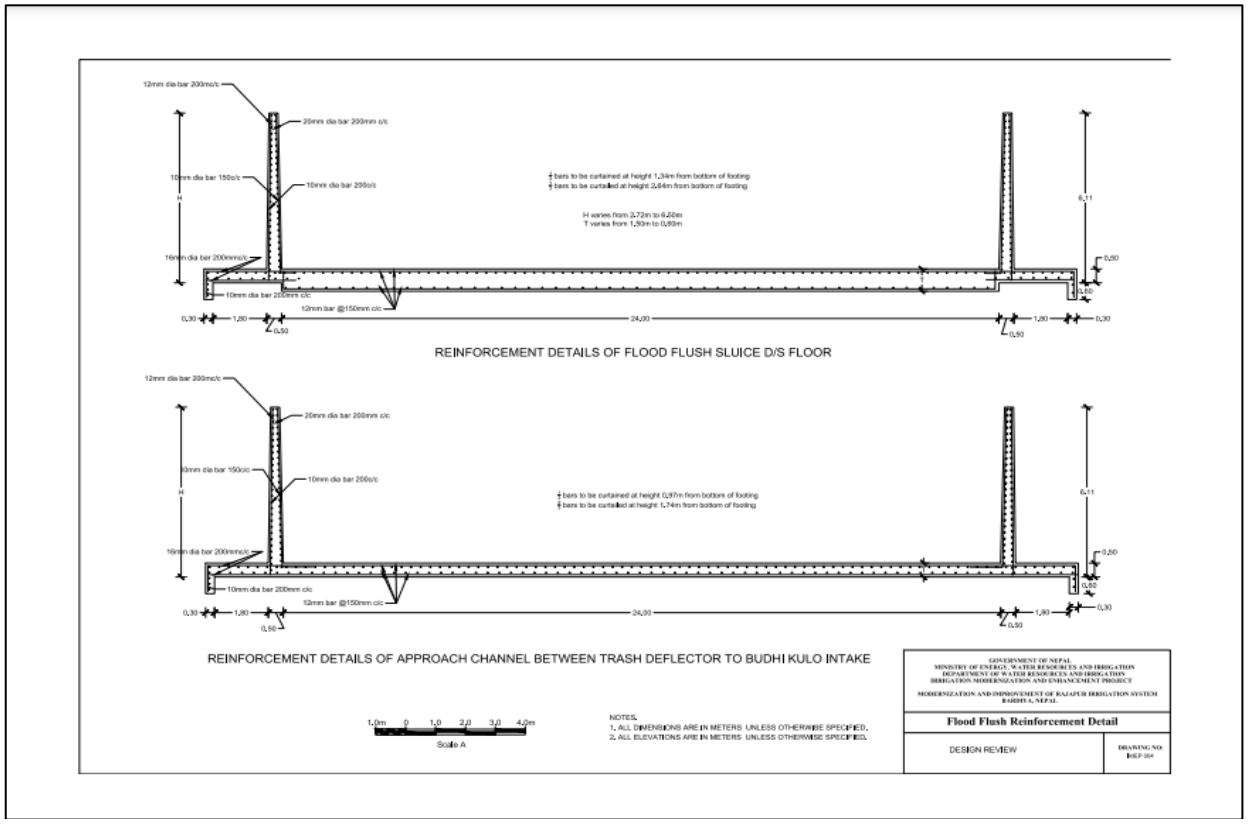
Appendix 2: Design of RIP Information

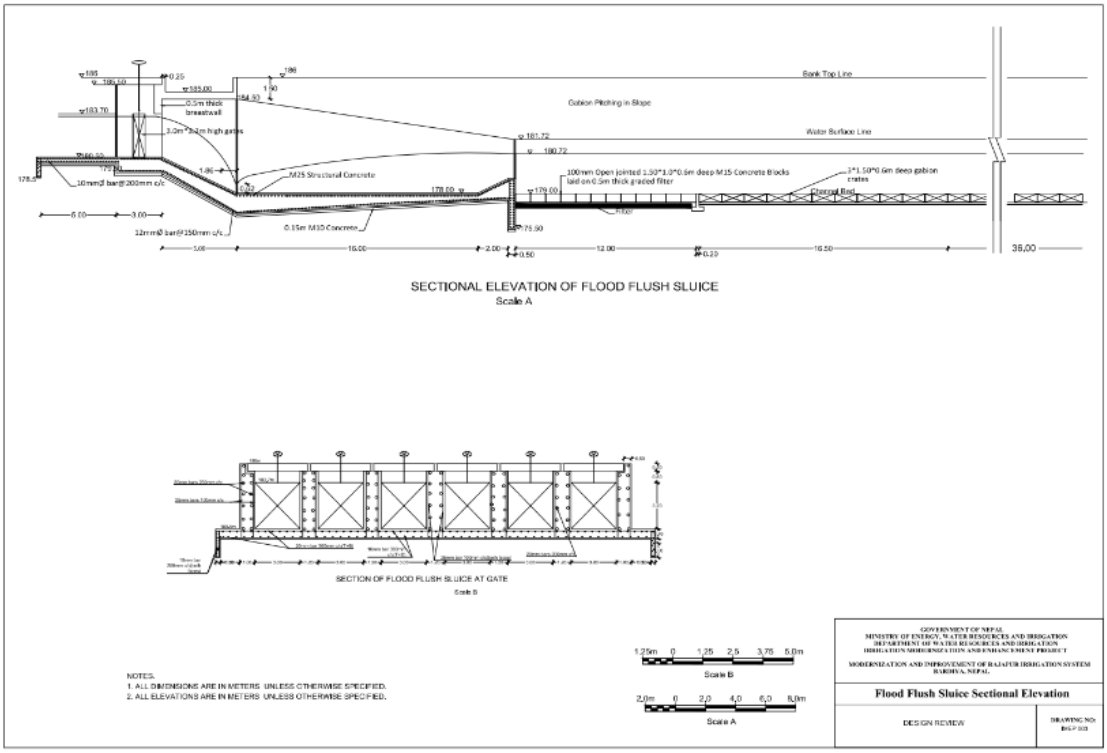
A. FLOOD SLUICE AT BUDHIKULO INTAKE

Modified Design Parameters of Flood Flush Escape

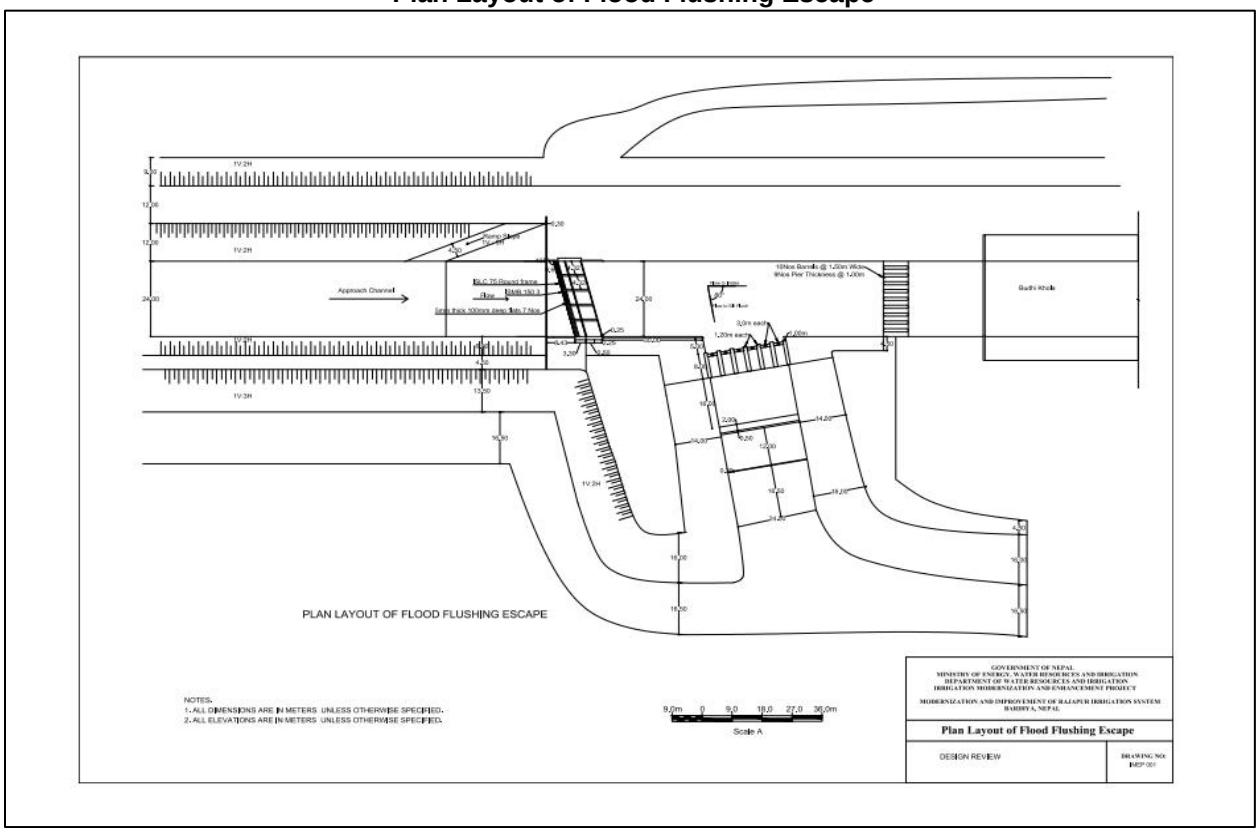
Hydraulic Parameters	Adopted Values	Remarks
Design Discharge	150.00m^3/s	at full gate opening
Manning's coefficient	0.018	for Concrete
Silt factor f	1.5	for river and approach channel
Safe exit gradient	1:5	
Safe bearing capacity of soil	100KN/m2	
Angle of repose	32 ^{0}	
Total length of weir	24.00m	
No. of span	6	
No of pier	5	
Width of pier	1.20m	
Clear length of span single span	3.00m	
Clear waterway	18.00m	
Total water way	24.00m	
Size of gate	3.00x 3.20m	5Nos overflow type(3-way frame)
Size of gate groove	800mm*400mm	openings for gate fitting
Crest level	180.50m	
D/s bed level	179.00m	after retrogression 0.50m
Bottom of d/s cut-off	176.00m	
Gate top level	183.70m	0.20m free board at gate
Abutment top level	186.00m	
Stilling basin length	16.00m	USBR Type-IV
Depth of cut-off below d/s floor	3.00m	
Floor Thickness at the toe of the glacis	1.50m	
Floor Thickness at the end of glacis	0.60m	
70mm open jointed concrete block	12.00m	1.50x1.00x0.60m deep over 0.70m graded filter
Loose protection 3x1.5x0.8 m	15.00	thickness at slope 0.3m
Bank Slope length	13.50m	At 1V:2H

Flood Flush Sluice Reinforcement Detail and Sectional Elevation

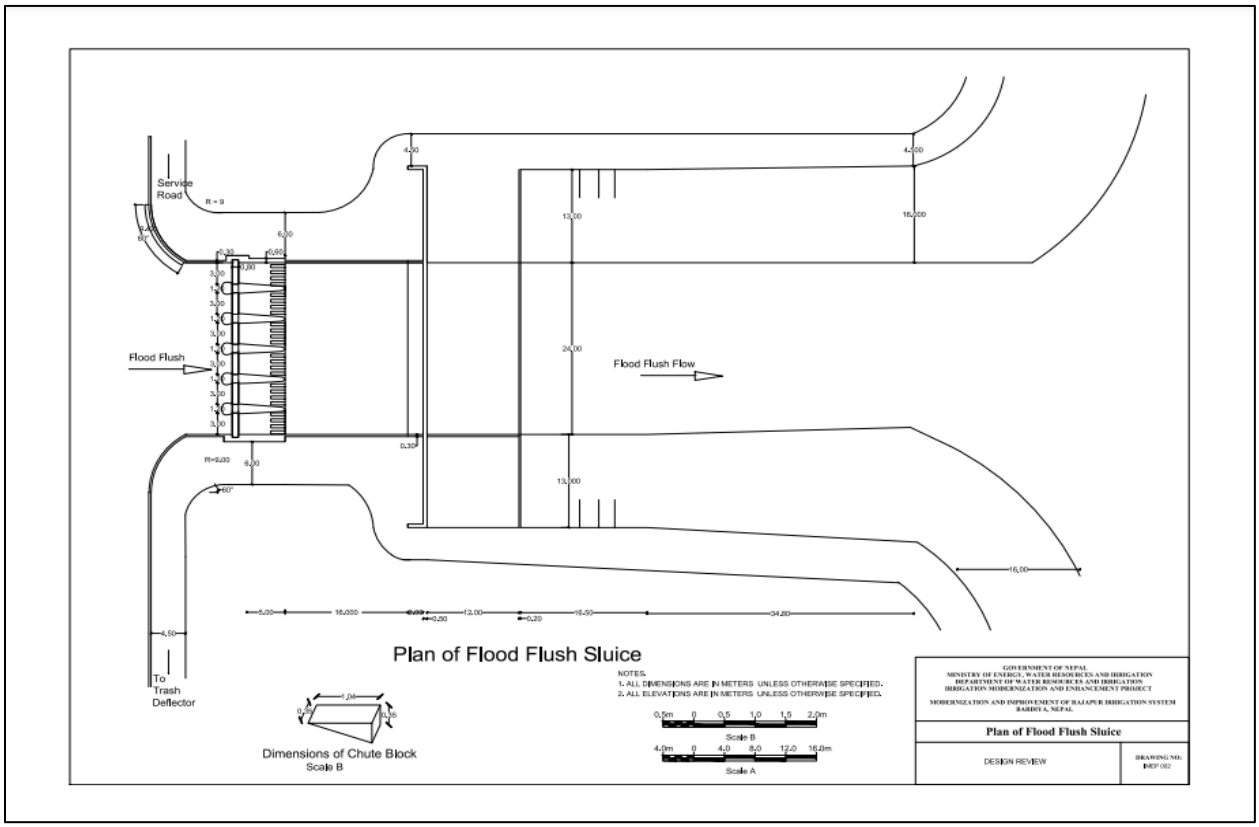




Plan Layout of Flood Flushing Escape



Plan of Flood Flush Sluice



B. JANAKNAGAR OFFTAKE

Design of Janaknagar Head Regulator Ch 0+750

Canal d/s		
Bed width B=	4.00 m	
Depth D=	0.52 m	
Side slope m	0	
Area A = BxD +1/2*2*m*D*D	2.0774 m^2	
Wetted perimeter P=2*sqrt((1+m^2))*D+B	5.04 m	
Hydraulic Radius R=A/P	0.41 m	
Manning's n=	0.018	
Bed Slope S=1 in 800	0.001333	
Velocity V=1/n*R^2/3*s^0.5	1.12 m/s	
Discharge Q1=V*A	**2.33** m3/s	

Design of Regulator

S. N.	Descriptions	Unit	Design	
1	Discharge, Q	m3/s	1.800	
2	U/s bed width of canal	m	3.995	
	D/s bed width	m	4.00	
3	U/s Bed Level	m	179.000	Budhi Kulo Bed
4	U/s water depth	m	0.47	
	Canal bed slope u/s		1/750	
	Canal bed slope d/s		1/750	
5	Crest level to be raised by	m	0.35	
6	Crest Level		179.4	
7	U/s water surf. Elv.	m	180.25	Budhi Kulo Water level
8	D/s Bed Level	m	178.00	Janaknagar
9	D/s water depth	m	0.52	
10	D/s water Surf. Elv.	m	178.52	
11	Piers contraction coefficient		0.01	rounded
12	Abutment contraction coefficient		0.1	rounded
13	Q=CBeHe^3/2	m3/s		Be=Effective length of crest
14	C=Discharge coefficient			He=Head over crest

Design of Janaknagar Head Regulator Ch 0+750

15	hd=u/s TEL-d/s TEL	m	1.73
16	He=u/s FSL - crest level	m	0.90
17	hd/He		1.92
18	Rounded as		1.92
19	Cs/C		0.98 sharp crested
20	C=		1.84
21	Thus value of discharge coefficient =		1.8
22	Effective length of the crest (m)	m	2.6194
23	Provide Crest length		4.000
22	No of bays	No.	2
24	No of piers	No.	1
25	Pier thickness	m	1
26	Total length of crest	m	3.82
27	Width of crest	m	3.995
28	Effective bed Width B	m	2.62
29	Discharging Capacity of HR	cumec	3.82
30	Discharge Intensity, q	cumec/m	0.96
31	Head Loss, H_L	m	1.73
32	Pre-jump depth, y_1	m	0.130
33	Froude No., F_1		6.540
34	Post jump depth, y_2	m	1.136
35	E_{f1}	m	2.90
36	E_{f2}	m	1.17
37	Min. length of Cistern=jump length	m	6.04
38	Cistern Level	m	177.35
39	End Sill depth	m	0.65
40	Adopted depth of end sill	m	0.65
41	Adopted length of cistern	m	6.00
42	H. Length of sloping		
43	Glacis (1H to 3V)	m	4.00

Design of Janaknagar Head Regulator Ch 0+750

44	Adopted length hor. length of glacis	m	4.00
45	Length of Floor from d/s end of		
46	Crest to d/s end of impervious floor	m	10.00
47	***Total length of impervious floor***		
48	***from exit gradient consideration***		
49	Exit Gradient		0.20
50	Length of d/s cut-off	m	0.91
51	Adopted length of d/s cut-off	m	1.40
52	Depth of scour, R =1.35(q^2/f)$^{1/3}$	m	1.48
53	R.L. of d/s scour hole=d/s WSE-1.25*R	m	176.31
54	Depth of d/s cut-off (incl. floor thickness), d_2 =	m	1.69
55	Adopted=		2.00
56	λ		3.21
57	α		5.32
58	Total length of impervious floor	m	10.64
59	Adopted total length of floor	m	20.00
60	***Breakdown of total length of floor:***		
61	Length of cistern	m	6.00
62	Horizontal length of d/s glacis	m	4.00
63	Remaining length for u/s floor	m	10.00

Design of Janaknagar Head Regulator Ch 0+750

Pressure Calculations for maximum static head:

Assume floor thickness at the u/s end=	m	0.5
Assume floor thickness at the d/s end=	m	0.3

(1) Upstream cut-off (neglecting thickness of cut-off)

R.L. of u/s scour hole=u/s WSEL-1.25*R	m	178.41
Depth of u/s cut-off (incl. floor thickness), d_1 =	m	0.59
Adopted cutoff depth d_1	m	1.40
Adopted length of impervious floor, b =		20.00
α1=b/d2 =		10.00
Therefore, λ =		5.52
From Khosla's theory, Φ D1=		80.55 % of H
Φ C1=		72.02 % of H
Φ D1-Φ C1=		8.52 % of H
Φ C1, Correction for d/s cut-off, C=19*[(d+D)/b]*sqrt(D/b')		
where, b=		20.00
D=(u/s B.L.-u/s thickness)-scour level of d/s cut-off=	m	-0.50
If D is negative it should be taken as 0.		
Therefore, D =	m	0.00
for only two u/s and d/s cut-offs, b'=	m	20.00
d1=	m	1.40
Therefore, Φ C1, Corr. for interference =		0.00 % of H
Φ C1, Correction for depth (ϕD1-ϕC1)t/d1=		3.04 % of H
Therefore, Φ C1, corrected =		75.07 % of H

Design of Janaknagar Head Regulator Ch 0+750

and Φ D1 = 80.55 % of H

(2) Downstream cut-off (neglecting thickness of cut-off)

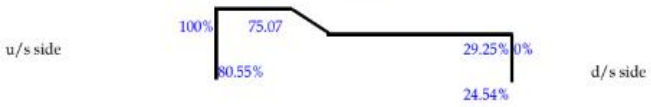
Depth of scour, $R = 1.35(q^2/f)^{1/3}$	m	1.48	
Cut off depth below u/s FSL 1.5*R	m	2.21 Adopted=	179.00
Provided d/s cutoff depth d_2	m	2.00	
Total floor length, b=	m	20.00	
α2=b/d2=		10.00	
Therefore, λ =		5.52	
From Khosla's theory, Φ E=		27.98 % of H	
Φ D=		19.45 % of H	
Φ E-Φ D=		8.52 % of H	

Φ C, Correction for d/s cut-off, C=19*[(d+D)/b]*sqrt(D/b')

where, b=	m	20.00	
D=(d/s B.L.-d/s thickness)-scour level of u/s cut-off=	m	177.70	

If D is negative, it should be taken as 0.

Therefore, D =	m	177.70	
and b'=	m	20.00	
d2=	m	2.00	
Therefore, Φ D, Corr. for interference. =		5.09 % of H	
Φ E, Correction for depth=		1.28 % of H	
Therefore, Φ D, corrected=		24.54 % of H	
and Φ E, corrected =		29.25 % of H	



The levels of hydraulic gradients at the key points for the cases stated above are summarized as:

Design of Janaknagar Head Regulator Ch 0+750

Pressures at key points:

Upstream Water Surface Elevation= 180.25 m

Downstream bed Level (datum) 178.00 m Bed

Static head 2.25 m

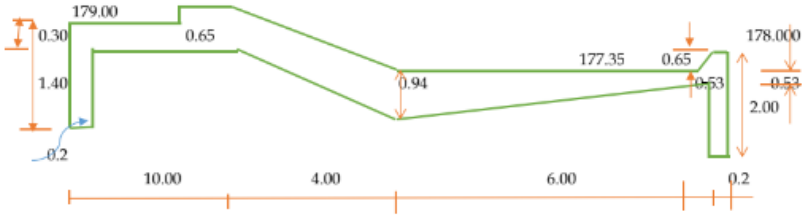
Elevation of H.G. Line above datum	Pressures, %		Head, m	Levels, m
Upstream cut-off				
Φ E1	100.00	% of H	2.25	180.250
Φ D1	80.55	% of H	1.81	179.812
Φ C1	75.07	% of H	1.69	179.689
Downstream cut-off				178.000
Φ E	29.25	% of H	0.66	178.658
Φ D	24.54	% of H	0.55	178.552
Φ C	0.00	% of H	0.00	178.000
At toe of glacis			0.97	178.967

Determination of floor thickness at various sections:

Section at	Distance from upstream end	pressure head due to static condition		pressure head for design	floor thickness t=h/(2.24-1) =h/1.24	Adopted floor thickness
	m	m		m	m	m
Upstream end of the impervious floor	0.00	2.25		2.25	1.81	0.50
Upstream end of glacis	10.00			0.00	0.00	0.50
Downstream end of the glacis	14.00	0.97		1.16	0.94	0.94
Downstream end of floor	20.00	0.66		0.66	0.53	0.53

(At the upstream nominal thickness of floor is provided; the uplift pressure there is counter balanced by the weight of water above it) 179.35

Design of Janaknagar Head Regulator Ch 0+750

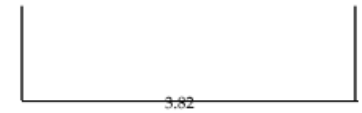


Launching apron required

U/s protection = (1.5*cutoff depth) m3/m		
Therefore volume required	2.1 m^3	
3*1.5*0.60m gabion box	4.5 m	
Total Volume	2.7 m^3	OK
D/s protection=(2.5*cutoff depth) m^3/m		
Therefore volume required	5 m^3	
Provide 1.5*1.0*0.60m concrete block	4.5 m	
Provide 3.0*1.5*0.60m concrete block	6.00 m	
Total Volume	6.3 m3	OK
Assume thickness of floor =	0.50 m	

RCC floor design for uplift

Maximum unbalanced head at toe of		
Sloping glacis = Unbalanced head +slab thickness	1.661 m of water	
	16610 N/m_2	
Dead load of floor =	12000 N/m^2	
Net upward pressure =	4610 N/m^2	



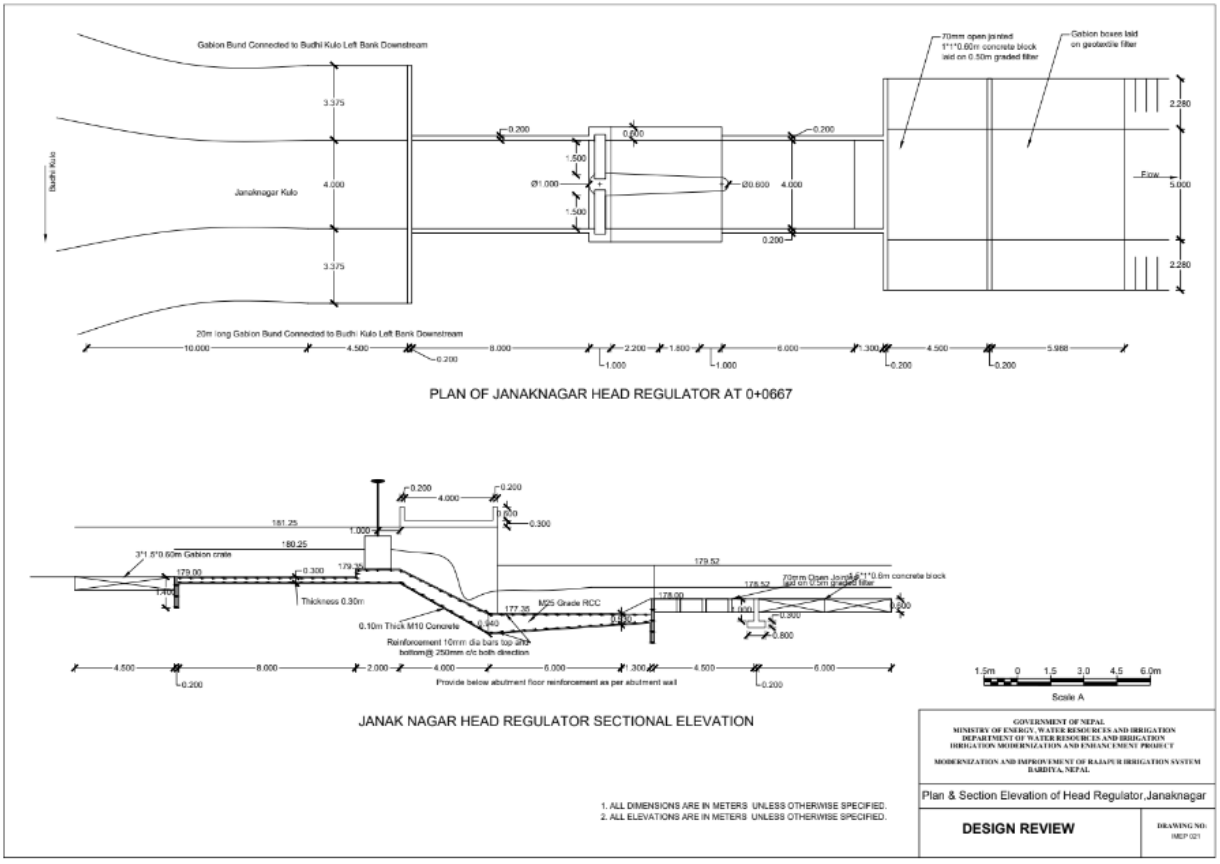
Adopt as shown in drawing

fy 415	M15
230	fst
	5 fcb
	0.29 n
	0.9 j
	0.65 Q

Design of Janaknagar Head Regulator Ch 0+750

BM at B = wl2/10	6726523 N-mm	
Thickness required =	101.73 mm	
Provided overall thickness =	500 mm	
Effective depth =	450 **mm**	
Area of steel required		
At portion B (Top layer)	72.21 mm^2	
Provide	10 mm dia @	provide nominal reinforcement 250 mm C/C both way

Plan of Janaknagar Head Regulator at 0+0667



Quantity

Rajapur Irrigation System
Janaknagar Head Rgulator

Ch. 0+667 of Janaknagar Kulo

S.N.	Description	Unit	Quantity	Remarks
A. Civil Works				
1	Earthwork in excavation for all types of foundations in any type of soil including excavation of wet soil and/or excavation under water and disposal of excavated earth as per drawing and engineers instruction.. (Using Machine)	m^3	381.54	
2	PCC M10 for blinding in the foundation	m^3	8.19	
3	Cement concrete M15 (1:2:4) in foundation and wall including supply of material and haulage dist. Up to 30m as per drawing and engineers instruction.	m^3	70.27	
4	Cement concrete M25 in foundation and wall and slabs including supply of material and haulage dist. Up to 30m as per drawing and engineers instruction.	m^3	278.71	
5	Making wooden forms including supply and material, fixing, nailing, placing, dismantling of forms and hauling upto 30m all complete as per drawing and engineers instruction.	m^2	406.20	
6	Supply,bending,cutting and placement of Reinforcement Steel(Fe-415) for monolithic hooks in precast block and tie hook all complete as per drawing and engineers instruction.	Ton	16.41	
7	230 mm Wide Rubber Seal Including Joints Seale with Bond Braker Tape	R. m.	75.00	
8	Earth work in filling for Construction of Embankment including dressing all complete as per design, drawing and specification Using excavated material from Foundation work as per drawing and engineers instruction.	m^3	1,332.00	
9	Supply and filling of Stone into gabion boxes including placing, packing & tying all complete as per drawing and engineers instruction.	m^3	533.73	
10	Supply of HZC SWG GI wire Machine fabricated and mechanically selvedged Gabion Boxes having mesh size 10cm*12cm double twisted hexagonal mesh type of 3.00 mm mesh wire dia, 3.90 mm Selvedge wire dia, 2.40 mm lacing wire dia of the box sizes and nos as directed by the Engineer including construction of boxes, placing in proper position and lacing etc. all complete. (Gabion with 2 diaphrams) as per drawing and engineers instruction..	m2	2,980.80	
11	Supply and laying of geo-textile (TS-30) filter under gabion boulder filling including at least 50 cm laps at joints as per drawing and engineers instruction..	m^2	889.55	
12	Supplying and laying of well graded filter material as per specification and approval of engineer.	m^3	42.78	
13	Supply fabrication, fitting and fixing and installations of (1.5mx1.20m) gates as per instructed by the Engineer all complete	Nos	2.00	
14	Site Clearance, Dewatering, Diversion etc all complete	job	1.00	
			Total of A	

C. PATABHAR SETTLING BASIN

Design of settling basin_PATABHAR Branch Canal

Material data

Unit weight of reinforced concrete (Sr)	=	24.00	KN/m^3
Unit weight of plain concrete (Sp)	=	23.00	KN/m^3
Unit weight of water (Sw)	=	10.00	KN/m^3
Unit weight of saturated earth (Sse)	=	21.50	KN/m^3
Unit weight of earth (Se)	=	19.00	KN/m^3
Bulk density of settling material (BDs)	=	20.00	KN/m^3
Angle of internal friction (ϕ)	=	25°	
Coefficient of friction between concrete and soil μ	=	0.577	
Kinematics viscosity of water at 20°C (v)	=	0.00000102	m^2/s
Specific gravity of the settling material Ss	=	26.50	KN/m^3
Kinematics viscosity of water at 20°C	=	0.00000102	m^2/s
Specific density (density of particle/density of water)	=	2.65	

Main canal d/s of settling basin

Qcanal	=	8.8	m^3/s
Bed width, Bd	=	7.50	m
Average Bed slope (S_0)	=	0.00100	(= 1 / 1,000)
Manning's n	=	0.025	
Side slope (Z)	=	1 : 1.5	(H : V)
Normal water depth (Mannng's equation)	=	0.84	m
Mean flow velocity (V)	=	1.01	m/s
Flow area (A)	=	8.82	m^2
Wetted perimeter (P)	=	10.53	m
Hydraulic radius (R = A/P)	=	0.84	m
Canal bed level at the start of Settling Basin	=	171.72	(at chainage 5+242 km)
Full supply level d/s of discharge regulator		**171.87**	(assuming same slope in the d/s also)
Canal bed level (u/s of Discharge regulator)	=	**171.03**	m (at 5+442km)

Main canal discharge regulator d/s of Settling Basin

Design discharge of left Main Canal	=	8.8	m^3/s

The Patabhar Branch Canal has a discharge capacity of 8.8 m^3/s only and additional discharge for flushing can not be withdrawn. Hence, there will be no provision of continuous flushing.

Let the Driving head provided	h_d	=	0.15	m
Upstream water level		=	172.02	m
Let head over crest	H_1		0.69	m
Degree of submergence (h_d/H_1)			0.22	
Corresoponding recuction in discharge coefficient	f		0.98	
Using discharge equation	$Q = fCB_c H_1^{\frac{3}{2}}$			
Where C for sharp crested weir is			1.84	
Crest width (Bc)			8.56	m
Say Crest width (Bc)			7.50	m
Provide nos of gates			3.00	
Width of each gate			1.80	m
Number of piers			2.00	
Pier width			1.00	m
Total crest width			7.40	m
Approach canal width (rectangular)			8.88	m
Let crest height above upstream bed			0.40	m
Approach velocity			0.91	m/s
Velocity head			0.04	m
Total upstream head (neglect velocity head)			0.69	m
Let Pier contraction coefficient (use rounded nose pier)			0.01	

Abutment contraction coefficient (rounded abutment)			0.10			
Effective length of crest (Be)			5.23	m	(< 6.5m hence OK)	
Crest level		=	171.33	m		

Patabhar canal u/s of Settling Basin

Width	Bc	=	7.50	m		
Bed level		=	171.72	m		
Full supply level		=	172.56	m		
Normal water depth	hn	=	0.79	m		
Side slope			1 : 1.5			
Water surface slope during normal canal operation	S	=	1 : 600			
Flow velocity in the canal (trapezoidal)	V	=	1.25	m/s		
Length of canal		=	2088.00	m		

Settling basin size (preliminary design)

Discharge into the basin	Q	=	8.8	(m^3/s)		
D_{20} (m)		=	0.00015	m	= 0.15	mm
D_{50} (m)		=	0.0003	m	= 0.3	mm
Geometric Standard deviation of sediment size		=	1.2	(assumed)		
The average sediment concentration entering the canal intake is (assumed)		=	1800	ppm		
From Fig.11.25, PDSP D2 Vol 1, for d_{20} size						
Settling velocity		=	0.015	m/s		
for D_{20} size Q/A_s		=	0.003	=> A_s =	2933.33	m^2 (Required Surface Area)
If length (L) to width (W) ratio is taken as 10; then A_s		=	$10B^2$	=> B =	17	m
Then,				L =	183	m
Provide	**B**	=	**16**	m		
and	**L**	=	**200**	m	(at least 10 x B)	
Provided Surface Area		=	3200	m^2		

Sediment carrying capacity of Patabhar canal

The settling basin will be designed such that more than 90% of the particles larger than d_{20} size is trapped i.e., most particles of size larger than 0.15 mm will be deposited in the Settling Basin hence representative sediment size (d_{50}) will be lower in the Main Canal d/s of Settling Basin.

Hence, assume size of sediment (d_{50}) d/s of Settling Basin = 0.1 mm

Sediment transport capacity in ppm using Engelund and Hansen method is given by:

$$C = \frac{0.05\, V R^{1.5} S_0^{1.5} s * 10^6}{(s-1)^2 g^{0.5} d_{50} h}$$

Where

S_0 = bed slope

V = mean flow velocity (m/s)

s = specific density

h = mean flow depth (m)

d_{50} = representative sediment size (m)

R = hydraulic radius (m)

	C	=	2140	ppm
Similarly using other methods				
Brownlie's method:	C	=	1900	ppm
Say	C	=	1900	ppm

(For details, refer ***Loose Boundary Hydraulics*** (1990) by A.J. Raudkivi)

The existing canal downstream of the Settling Basin has carrying capacity more than 1300 ppm. Since the canal slope and discharge vary after 3+386 km, let's assume that the carrying capacity of the canal system is at least 400 ppm.

Length of basin		=	200.00	m
Entrance length =3 x (B - b-entry) = 3 x (16-7.5)		=	25.50	m

Since the exit transition is not so important comparing the entrance transition and also by taking into consideration the length available for the desilting basin, the exit transition length is calculated as follows (PDSP M7 pg.110):

Bed width near the discharge regulator crest		=	8.88	m
Entrance length	say	=	26.00	m
Exit length = 2 *(B-b exit) = 2 * (16-8.88)		=	14.24	m
Exit length	say	=	14.00	m
Length of settling zone		=	160.00	m
Total length of the Settling Basin		=	**200.00**	**m**

Storage Volume,

Sv = (Q*Smax*Effi.*FI*3600*24)/(BDs*10^5)

Sediment concentration to be settled	Smax.	=	1400	mg/l
Trap efficiency	Effi.	=	90	%
Maximum interval between flushing	FI	=	7.00	day
Then, required storage volume	Sv	=	2531	m^3
Sediment deposited in triangular part corresponding to a depth of	1.50 m	=	1920	m^3
Additional volume to be managed		=	611	m^3
Storage depth, Sd =Sv/(W*L)	hs =	=	0.24	m
his depth is provided below the normal flow depth,	say	=	**0.24**	**m**

Arrangement for hydraulic flushing

Initiation of Suspension

As per van Rijn (1984), the particles will be in suspension when $\theta'_{cr} \geq \frac{16\omega_s^2}{D_*^3(s-1)gd_{50}}$

Fall velocity $\omega_s = \frac{(s-1)gd_{50}^2}{18\nu}$	=	0.079	m/s	
Mobility parameter for suspension θ'_{cr}	=	1.479		
Corresponding shear stress $\tau_{cr} = (s-1)\rho g d_{50}\theta'_{cr}$	=	7.18	N/m2	
Critical velocity for suspension $V_{cr} = \frac{R^{\frac{1}{6}}\tau_{cr}^{0.5}}{n\sqrt{\rho g}}$	=	1.60	m/s	
Manning's roughness coefficient during flushing		0.025		(due to formation of bed forms)
Critical velocity for suspension during flushing		0.91		
Let, scouring velocity, Vsc	=	1.5	m/s	
Allow scouring flow, Qs = Qdesign	=	8.80	m^3/s	
Provide 1 divider walls, thus the width of one bay	=	8.00	m	
Scour flow/unit width (q_s)	=	0.55	m^3/s-m	
Scour depth of flow, h_s = qs/Vsc	=	0.37	m	
Hydraulic mean radius (R) of scouring flow	=	0.34	m	
Bed slope,Sc = $(n_b Vsc)^2$ x $(1/Rs)^{4/3}$	=	0.0047	m/m	= 1 in 214
Provide a slope of basin from particle mobility consideration, Sc	=	0.0087	m/m	= 1 in 115
Hydraulic radius for scouring flow	=	0.35	m	

Flusing interval and duration of flushing

Daily Flushing				
Let flushing interval	=	7	days	
Deposited volume	=	2531	m^3	
For a slope of 1 in 115				(for this slope, the carrying capacity of flow is more than
If Concentration during flushing	=	20,000	ppm	20,000 ppm)
Water flow rate	=	8.80	m^3/s	
Sediment outflow rate	=	0.0664	m^3/s	
Time required to flush all the deposited material	=	10.58	hrs	

It is proposed to flush the basin once in 7 days for a period of 11 hrs. It should be noted that the maximum demand of 8.8m^3/s and a average concentration of 1,800 ppm is unlikely to remain for a prolonged period. Hence, the periodic flushing could be differed depending upon the requirement.

Flushing sluice gates

Bed level at the start of expansion transition	=	171.72	m+msl	
Bed level at the end of expansion transition and beginning of main basin	=	171.49	m+msl	
Bed level at the end of main basin and start of contraction transition	=	170.10	m+msl	(1 in 115)
Bed level at the end of contraction transition	=	169.98	m+msl	
Let, crest level of the sluice		169.98	m+msl	
Let provide flushing gates as per the followings:				
Gate span (Lg)	=	**1.5**	m	
No of gates (Ng)	=	**3**	no	
Over all clear span (L)	=	4.50	m	
Thickness of pier	=	1.00	m	
Overall width of sluice regulator	=	6.50		
Flushing discharge (Q)	=	11.00	m^3/s	
Discharge intensity through gate (q_g = Q/L)	=	2.44	m^2/s	q_g = Qs /(Lg x Ng)
Water depth required u/s of sluice gate (h_g)	=	1.27	m	$h_g = \{q_g/1.71\}^{2/3}$
Head loss within the flushing tunnels	=		m	
Water level	=	**171.25**	m+msl	
Required crest level of the sluice	=	**169.98**	m+msl	
Provide crest level of the sluice	=	**169.90**	m+msl	
Gate opening, H_g	=	1.77	m	

Calculation of transition losses

Length of expansion transition	L_1	=	26.00	m
Depth of water	h_2	=	0.79	m
Velocity after transition	V_2	=	0.70	m/s
Length of contraction transition	L_2	=	14.00	m
Depth of water	h_3	=	2.29	m
Velocity before starting contraction	V_3	=	0.24	m/s
Water depth at the end of contraction transition	h_4	=	2.29	m
Velocity at the end of contraction transition	V_4	=	0.43	m/s

Losses due to gradual expansion, $h_{ge} = f_{ge}\frac{\left(V_1^2 - V_2^2\right)}{2g} + L_1\frac{\left(S_1 + S_2\right)}{2}$

The coefficient for expansion	f_{ge}	=	0.30	
Expansion loss	h_{ge}	=	0.016	m

Losses due to gradual contraction, $h_{gc} = f_{gc}\frac{\left(V_4^2 - V_3^2\right)}{2g} + L_2\frac{\left(S_3 + S_4\right)}{2}$

Coefficient for contraction	f_{gc}	=	0.20	
Contraction loss	h_{gc}	=	0.001	m
Losses due to Expansion and Contraction			0.018	m
Friction loss			0.003	m
Total loss			0.021	m

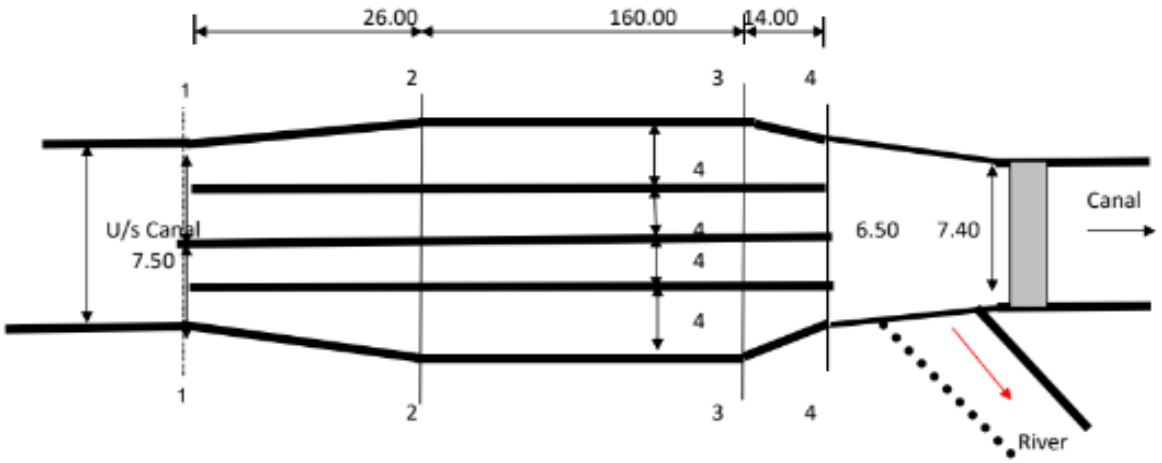
Design of flushing canal

<u>At the end of desilting basin</u>

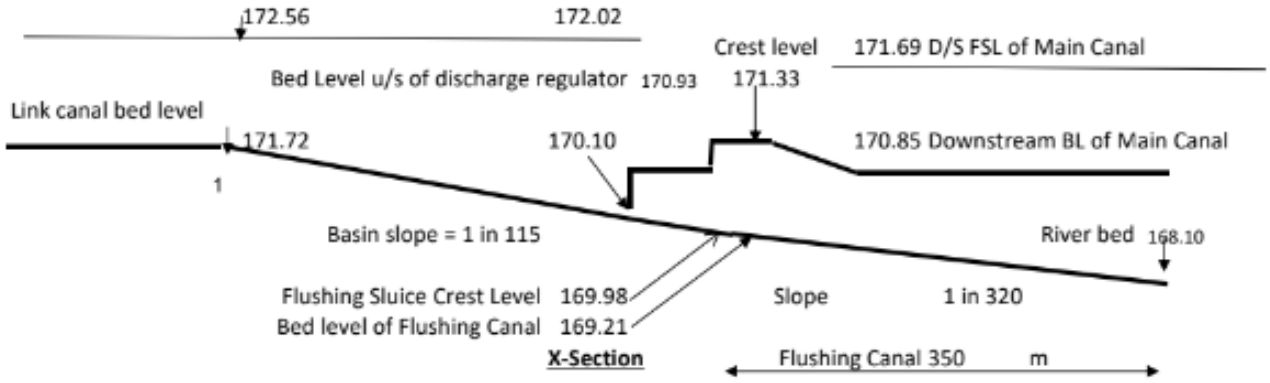
Bed level of flushing canal	=	169.21	m
Length of flushing canal	=	350.00	m
River bed where the flushing canal ends	=	168.10	m
Available slope	=	0.00317	1 in 315
Provided slope	=	0.00333	1 in 300
Provide width (Bs)	=	6.50	m
Side slope (Z) (Vertical)	=	1 : 0.0	
Water depth in the flushing sluice (for n = 0.017)	=	0.58	m
Required slope to transport 12,000 ppm sediment concentration flow	=	0.00333	1 in 300
Required bed level at the end of flushing canal		168.04	
Flow velocity	=	1.99	m/s
Water surface level at the end of flushing canal	=	168.62	

Section of Flushing Canal

Carrying capacity of the flushing canal = 12,000 ppm



PLAN



Desilting Basin/Flushing Sluice/Main Canal Regulator

C. PATABHAR SETTLING BASIN

Design of settling basin_PATABHAR Branch Canal

Material data

Unit weight of reinforced concrete (Sr)	=	24.00	KN/m^3
Unit weight of plain concrete (Sp)	=	23.00	KN/m^3
Unit weight of water (Sw)	=	10.00	KN/m^3
Unit weight of saturated earth (Sse)	=	21.50	KN/m^3
Unit weight of earth (Se)	=	19.00	KN/m^3
Bulk density of settling material (BDs)	=	20.00	KN/m^3
Angle of internal friction (ϕ)	=	25°	
Coefficient of friction between concrete and soil μ	=	0.577	
Kinematics viscosity of water at 20°C (v)	=	0.00000102	m^2/s
Specific gravity of the settling material Ss	=	26.50	KN/m^3
Kinematics viscosity of water at 20°C	=	0.00000102	m^2/s
Specific density (density of particle/density of water)	=	2.65	

Main canal d/s of settling basin

Qcanal	=	8.8	m^3/s
Bed width, Bd	=	7.50	m
Average Bed slope (S_0)	=	0.00100	(= 1 / 1,000)
Manning's n	=	0.025	
Side slope (Z)	=	1 : 1.5	(H : V)
Normal water depth (Mannng's equation)	=	0.84	m
Mean flow velocity (V)	=	1.01	m/s
Flow area (A)	=	8.82	m^2
Wetted perimeter (P)	=	10.53	m
Hydraulic radius (R = A/P)	=	0.84	m
Canal bed level at the start of Settling Basin	=	171.72	(at chainage 5+242 km)
Full supply level d/s of discharge regulator		**171.87**	(assuming same slope in the d/s also)
Canal bed level (u/s of Discharge regulator)	=	**171.03**	m (at 5+442km)

Main canal discharge regulator d/s of Settling Basin

Design discharge of left Main Canal	=	8.8	m^3/s

The Patabhar Branch Canal has a discharge capacity of 8.8 m^3/s only and additional discharge for flushing can not be withdrawn. Hence, there will be no provision of continuous flushing.

Let the Driving head provided	h_d	=	0.15	m
Upstream water level		=	172.02	m
Let head over crest	H_1		0.69	m
Degree of submergence (h_d/H_1)			0.22	
Corresoponding recuction in discharge coefficient	f		0.98	
Using discharge equation	$Q = fCB_c H_1^{\frac{3}{2}}$			
Where C for sharp crested weir is			1.84	
Crest width (Bc)			8.56	m
Say Crest width (Bc)			7.50	m
Provide nos of gates			3.00	
Width of each gate			1.80	m
Number of piers			2.00	
Pier width			1.00	m
Total crest width			7.40	m
Approach canal width (rectangular)			8.88	m
Let crest height above upstream bed			0.40	m
Approach velocity			0.91	m/s
Velocity head			0.04	m
Total upstream head (neglect velocity head)			0.69	m
Let Pier contraction coefficient (use rounded nose pier)			0.01	

Abutment contraction coefficient (rounded abutment)			0.10		
Effective length of crest (Be)			5.23	m	(< 6.5m hence OK)
Crest level		=	171.33	m	

Patabhar canal u/s of Settling Basin

Width	Bc	=	7.50	m
Bed level		=	171.72	m
Full supply level		=	172.56	m
Normal water depth	hn	=	0.79	m
Side slope			1 : 1.5	
Water surface slope during normal canal operation	S	=	1 : 600	
Flow velocity in the canal (trapezoidal)	V	=	1.25	m/s
Length of canal		=	2088.00	m

Settling basin size (preliminary design)

Discharge into the basin	Q	=	8.8	(m^3/s)		
D_{20} (m)		=	0.00015	m	= 0.15	mm
D_{50} (m)		=	0.0003	m	= 0.3	mm
Geometric Standard deviation of sediment size		=	1.2	(assumed)		
The average sediment concentration entering the canal intake is (assumed)		=	1800	ppm		
From Fig.11.25, PDSP D2 Vol 1, for d_{20} size						
Settling velocity		=	0.015	m/s		
for D_{20} size Q/A_s		=	0.003	=> A_s =	2933.33	m^2 (Required Surface Area)
If length (L) to width (W) ratio is taken as 10; then A_s		=	$10B^2$	=> B =	17	m
Then,				L =	183	m
Provide	**B**	=	**16**	m		
and	**L**	=	**200**	m	(at least 10 x B)	
Provided Surface Area		=	3200	m^2		

Sediment carrying capacity of Patabhar canal

The settling basin will be designed such that more than 90% of the particles larger than d_{20} size is trapped i.e., most particles of size larger than 0.15 mm will be deposited in the Settling Basin hence representative sediment size (d_{50}) will be lower in the Main Canal d/s of Settling Basin.

Hence, assume size of sediment (d_{50}) d/s of Settling Basin = 0.1 mm

Sediment transport capacity in ppm using Engelund and Hansen method is given by:

$$C = \frac{0.05\,V R^{1.5} S_0^{1.5} s * 10^6}{(s-1)^2 g^{0.5} d_{50} h}$$

Where

S_0 = bed slope

V = mean flow velocity (m/s)

s = specific density

h = mean flow depth (m)

d_{50} = representative sediment size (m)

R = hydraulic radius (m)

	C	=	2140	ppm	
Similarly using other methods					(For details, refer ***Loose Boundary Hydraulics*** (1990) by A.J. Raudkivi)
Brownlie's method:	C	=	1900	ppm	
Say	C	=	1900	ppm	

The existing canal downstream of the Settling Basin has carrying capacity more than 1300 ppm. Since the canal slope and discharge vary after 3+386 km, let's assume that the carrying capacity of the canal system is at least 400 ppm.

Hence, the concentration to be trapped in the settling basin		=	1400	ppm	(1800-400)
Maximum flow velocity in Basin during Canal Operation					
Side slope of the basin (Z)		=	1 : 0	(V : H)	
Bed width		=	16	m	
Water depth (basin full)		=	0.79	m	
Flow area		=	12.6	m^2	
Mean flow velocity in the basin, V_b (m/s)		=	0.70		
Critical velocity for the initiation of motion, Vcr					
Dimensionless particle parameter	$D_* = \left[\frac{(s-1)g}{\nu^2}\right]^{1/3} d_{50}$	=	3.74		(d_{50} in this case is taken as 0.15 mm since, the target is to trap 90% of the particles larger than d_{20})
Critical mobility Shield's parameter	$\theta_{cr} = 0.14 D_*^{-0.64}$	=	0.064		
Critical shear stress	$\tau_{cr} = (s-1)\rho g d_{50} \theta_{cr}$	=	0.16		
Manning's n		=	0.016		(Assuming no bed forms during deposition)
Hydraulic radius R		=	0.72		
Critical velocity	$V_{cr} = \frac{R^{\frac{1}{6}} \tau_{cr}^{0.5}}{n\sqrt{\rho g}}$	Vcr =	0.24	m/s	
Since Vb>Vcr, deepen the basin by		=	**1.5**	m	
Total depth		=	2.29	m	
Flow area		A =	36.6	m^2	
Modified Mean Velocity of flow		Vb =	0.24	m/s	$V_b \le V_{cr}$, Hence OK

Adopted plan area of the basin

A minimum length to width ratio of 2 - 3 is can be adopted from hydraulic considerations, provided flow enters and leaves the basin uniformly over its full width. If the site condition permits, a length to width ratio of 6 to 10 is better (PDSP M7 pg.110).

Length of basin		=	200.00	m
Entrance length =3 x (B - b-entry) = 3 x (16-7.5)		=	25.50	m

Since the exit transition is not so important comparing the entrance transition and also by taking into consideration the length available for the desilting basin, the exit transition length is calculated as follows (PDSP M7 pg.110):

Bed width near the discharge regulator crest		=	8.88	m
Entrance length	say	=	26.00	m
Exit length = 2 *(B-b exit) = 2 * (16-8.88)		=	14.24	m
Exit length	say	=	14.00	m
Length of settling zone		=	160.00	m
Total length of the Settling Basin		=	**200.00**	**m**
Storage Volume,				
Sv = (Q*Smax*Effi.*FI*3600*24)/(BDs*10^5)				
Sediment concentration to be settled	Smax.	=	1400	mg/l
Trap efficiency	Effi.	=	90	%
Maximum interval between flushing	FI	=	7.00	day
Then, required storage volume	Sv	=	2531	m^3
Sediment deposited in triangular part corresponding to a depth of	1.50 m	=	1920	m^3
Additional volume to be managed		=	611	m^3
Storage depth, Sd =Sv/(W*L)	hs =	=	0.24	m
This depth is provided below the normal flow depth,	say	=	**0.24**	**m**

Arrangement for hydraulic flushing

Initiation of Suspension

As per van Rijn (1984), the particles will be in suspension when $\theta'_{cr} \geq \frac{16\omega_s^2}{D_*^2(s-1)gd_{50}}$

Fall velocity $\omega_s = \frac{(s-1)gd_{50}^2}{18\nu}$	=	0.079	m/s	
Mobility parameter for suspension θ'_{cr}	=	1.479		
Corresponding shear stress $\tau_{cr} = (s-1)\rho g d_{50}\theta'_{cr}$	=	7.18	N/m2	
Critical velocity for suspension $V_{sc} = \frac{R^{\frac{1}{6}}\tau_{cr}^{0.5}}{n\sqrt{\rho g}}$	=	1.60	m/s	
Manning's roughness coefficient during flushing		0.025		(due to formation of bed forms)
Critical velocity for suspension during flushing		0.91		
Let, scouring velocity, Vsc	=	1.5	m/s	
Allow scouring flow, Qs = Qdesign	=	8.80	m^3/s	
Provide 1 divider walls, thus the width of one bay	=	8.00	m	
Scour flow/unit width (q_s)	=	0.55	m^3/s-m	
Scour depth of flow, h_s = qs/Vsc	=	0.37	m	
Hydraulic mean radius (R) of scouring flow	=	0.34	m	
Bed slope,Sc = $(n_b Vsc)^2$ x $(1/Rs)^{4/3}$	=	0.0047	m/m	= 1 in 214
Provide a slope of basin from particle mobility consideration, Sc	=	0.0087	m/m	= 1 in 115
Hydraulic radius for scouring flow	=	0.35	m	

Flusing interval and duration of flushing

Daily Flushing				
Let flushing interval	=	7	days	
Deposited volume	=	2531	m^3	
For a slope of 1 in 115				(for this slope, the carrying
If Concentration during flushing	=	20,000	ppm	capacity of flow is more than
Water flow rate	=	8.80	m^3/s	20,000 ppm)
Sediment outflow rate	=	0.0664	m^3/s	
Time required to flush all the deposited material	=	10.58	hrs	

It is proposed to flush the basin once in 7 days for a period of 11 hrs. It should be noted that the maximum demand of $8.8 m^3/s$ and a average concentration of 1,800 ppm is unlikely to remain for a prolonged period. Hence, the periodic flushing could be differed depending upon the requirement.

Flushing sluice gates

Bed level at the start of expansion transition	=	171.72	m+msl	
Bed level at the end of expansion transition and beginning of main basin	=	171.49	m+msl	
Bed level at the end of main basin and start of contraction transition	=	170.10	m+msl	(1 in 115)
Bed level at the end of contraction transition	=	169.98	m+msl	
Let, crest level of the sluice		169.98	m+msl	
Let provide flushing gates as per the followings:				
Gate span (Lg)	=	**1.5**	m	
No of gates (Ng)	=	**3**	no	
Over all clear span (L)	=	4.50	m	
Thickness of pier	=	1.00	m	
Overall width of sluice regulator	=	6.50		
Flushing discharge (Q)	=	11.00	m^3/s	
Discharge intensity through gate (q_g = Q/L)	=	2.44	m^2/s	q_g = Qs /(Lg x Ng)
Water depth required u/s of sluice gate (h_g)	=	1.27	m	$h_g = \{q_g/1.71\}^{2/3}$
Head loss within the flushing tunnels	=		m	
Water level	=	**171.25**	m+msl	
Required crest level of the sluice	=	**169.98**	m+msl	
Provide crest level of the sluice	=	**169.90**	m+msl	
Gate opening, H_g	=	1.77	m	

Calculation of transition losses

Length of expansion transition	L_1	=	26.00	m
Depth of water	h_2	=	0.79	m
Velocity after transition	V_2	=	0.70	m/s
Length of contraction transition	L_2	=	14.00	m
Depth of water	h_3	=	2.29	m
Velocity before starting contraction	V_3	=	0.24	m/s
Water depth at the end of contraction transition	h_4	=	2.29	m
Velocity at the end of contraction transition	V_4	=	0.43	m/s

Losses due to gradual expansion, $h_{ge} = f_{ge}\frac{(V_1^2 - V_2^2)}{2g} + L_1\frac{(S_1 + S_2)}{2}$

The coefficient for expansion	f_{ge}	=	0.30	
Expansion loss	h_{ge}	=	0.016	m

Losses due to gradual contraction, $h_{gc} = f_{gc}\frac{(V_4^2 - V_3^2)}{2g} + L_2\frac{(S_3 + S_4)}{2}$

Coefficient for contraction	f_{gc}	=	0.20	
Contraction loss	h_{gc}	=	0.001	m
Losses due to Expansion and Contraction			0.018	m
Friction loss			0.003	m
Total loss			0.021	m

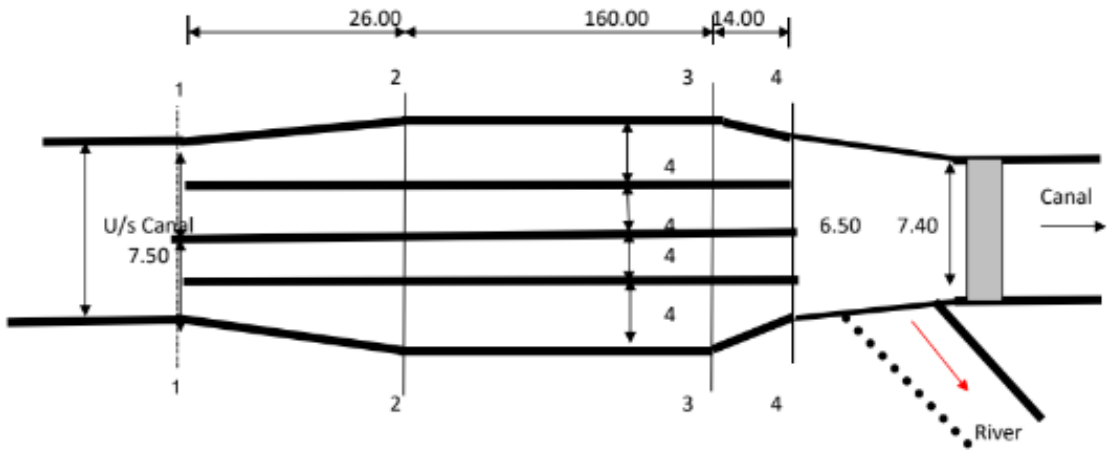
Design of flushing canal

<u>At the end of desilting basin</u>

Bed level of flushing canal	=	169.21	m
Length of flushing canal	=	350.00	m
River bed where the flushing canal ends	=	168.10	m
Available slope	=	0.00317	1 in 315
Provided slope	=	0.00333	1 in 300
Provide width (Bs)	=	6.50	m
Side slope (Z) (Vertical)	=	1 : 0.0	
Water depth in the flushing sluice (for n = 0.017)	=	0.58	m
Required slope to transport 12,000 ppm sediment concentration flow	=	0.00333	1 in 300
Required bed level at the end of flushing canal		168.04	
Flow velocity	=	1.99	m/s
Water surface level at the end of flushing canal	=	168.62	

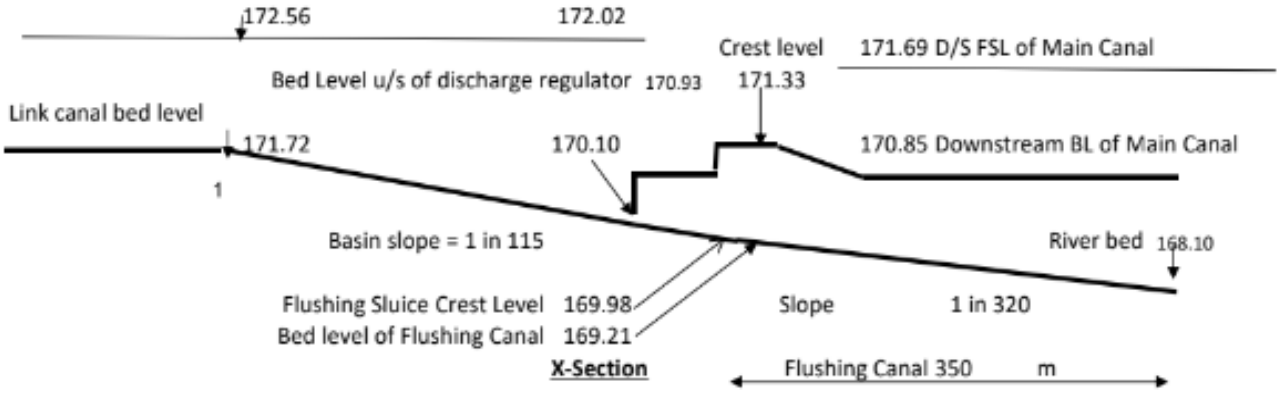
Section of Flushing Canal

Carrying capacity of the flushing canal = 12,000 ppm



PLAN

Design of settling basin_PATABHAR Branch Canal



Desilting Basin/Flushing Sluice/Main Canal Regulator

Appendix 3: List of Species vulnerable, endangered and critically endangered species that may occur in RIP

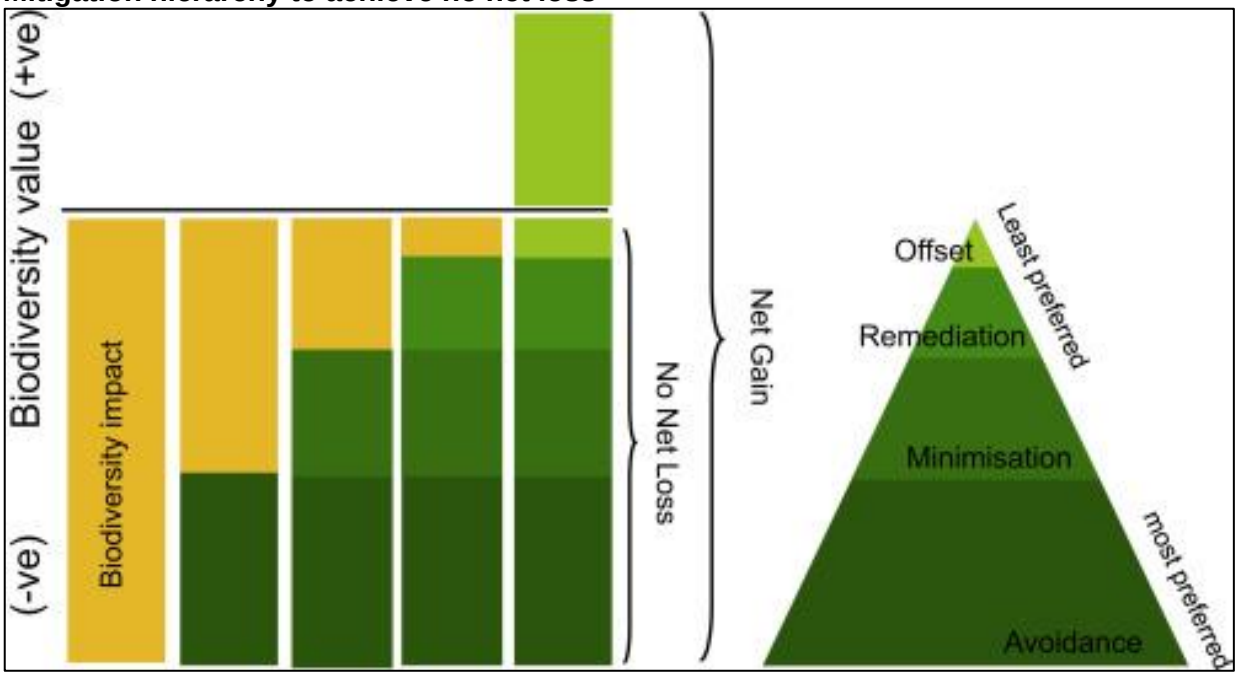
Class	Common Name	Scientific Name	IUCN Red List Level	Global Population	Habitat Locations	Local Population (Lumbini/Nearby Provinces)
Mammals	Nilgai	*Boselaphus tragocamelus*	VU	Approximately 100,000	India, Nepal, and Pakistan	Data not available
Mammals	Common Leopard	*Panthera pardus*	VU	Approximately 250,000	Sub-Saharan Africa, Northeast Africa, Central Asia, India, and the People's Republic of China	Data not available
Mammals	Black Buck	*Antilope cervicapra*	EN	Approximately 50,000	India and Nepal	Found mainly in Bardiya, exact numbers not specified
Mammals	Hog Deer	*Axis porcinusporcinus*	EN	Approximately 20,000	India, Nepal, Pakistan, and Bangladesh	Data not available
Mammals	Asiatic Elephant	*Elephas maximus*	EN	Approximately 40,000 - 50,000	India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and Sri Lanka	Approximately 120 in Bardiya and surrounding areas
Mammals	Bengal Tiger	*Panthera tigris*	EN	Approximately 3,900	India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Cambodia, Vietnam, Malaysia, Indonesia	Approximately 87 in Bardiya (WWF Nepal) (Kathmandu Post)
Mammals	Ganges River Dolphin	*Platanista gangetica*	EN	Approximately 2,500 - 3,000	Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems in India, Nepal, and Bangladesh	Data not available
Reptiles	King Cobra	*Ophiophagus hannah*	VU	Data not precisely known, widely distributed but decreasing	India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and the Philippines	Data not available
Reptiles	Mugger Crocodile	*Crocodilus palustris*	VU	Approximately 5,000 - 10,000	India, Nepal, Pakistan, Sri Lanka, and Iran	Data not available
Reptiles	Gharial Crocodile	*Gavialis gangeticus*	CR	Fewer than 1,000	India and Nepal	Data not available
Reptiles	Indian Softshell Turtle	*Nilssonia gangetica*	VU	Data not precisely known, populations are decreasing	India, Nepal, Bangladesh, and Pakistan	Data not available
Birds	Stork	*Ciconia nigra*	VU	10,000 - 15,000	Europe, Asia, and Africa	Data not available

Appendix 4: Biodiversity Action Plan (BAP)

This section presents the BAP, which outlines the mitigation measures/actions to ensure that the RIP components have no significant adverse impact on wildlife and no net loss in biodiversity and comply with requirements in accordance with government rules and ADB's Safeguards Policy Statement 2009.

Conservation measures (i.e., prevent, minimize, mitigate/remediate, and compensate/offset) are created to guarantee the application of the mitigation hierarchy and address concerns about biodiversity characteristics as a consequence of the proposed works and operations. Below is an outline of the mitigation hierarchy concept. This will protect the integrity, health, and function of the ecological system and biodiversity characteristics while enabling rigorous risk management and the best potential results for the subproject.

Mitigation hierarchy to achieve no net loss[14]



Following are the action plans proposed for RIP:

1. **Actions to avoid, minimize and/or remediate loss/degradation of habitats during construction**
    - Gather data on wildlife populations, habitat conditions, and biodiversity in the construction sites prior to works
    - Engage with local communities and stakeholders, and incorporate feedback in preparing the CEMP
    - Employ local wildlife spotters to monitor and guide construction activities to protect animals in the buffer zone.
    - Marking the construction site's boundaries and disseminating information about civil work areas to construction staff and laborers. Delineate clearing limits in the field using flagging or other means before any land-disturbing activities so only

[14] Figure is sourced from "Net Gain: Seeking Better Outcomes for Local People when Mitigating Biodiversity Loss from Development. One Earth,Volume 1, Issue 2. 195-20" by Jones, J. P. G. and et. al. (2019).

those areas that need to be cleared will be disturbed. Instruct construction workers that they are only authorized to cut or clear any vegetation within the designated clearing limits.

- Tree cutting shall be avoided for the establishment of a labor camp, material storage site, and transferring of any machinery, equipment, and vehicles at the subproject site.
- No objection clearance (NOC) for tree cutting to be obtained by the project proponent before construction. However, the contractor will support the proponent if any NOC is to be obtained for cutting additional trees during the construction stage.
- Prohibition of collecting firewood, plants, etc., to minimize the impact on natural habitats.
- No excavation and earthworks inside the core area of the park.
- Select suitable areas for material storage, quarries, borrow areas, spoil/muck disposal areas, construction laydown areas, access roads, and other facilities to minimize forest clearing and environmental impacts. The locations for material storage, quarrying areas, spoil deposits, muck disposal, construction laydown areas, roads, and others have all been selected based on the minimum likely ecological and environmental impacts.
- The movement of contractor vehicles across the subproject areas will be strictly monitored, and drivers will be required to use designated roads only.
- Implement a Wildlife Shepherding Protocol before any land-disturbing activities. This should involve inspecting the land to be disturbed and identifying the presence of any wildlife species. Any slow-moving species (e.g., amphibians, reptiles, pangolins, and similar species) should be carefully captured by an experienced wildlife specialist and relocated to nearby habitats.

2. Actions to minimize loss/degradation/pollution of river habitat and impact on wildlife population during project construction:

- All construction staff should be informed about the importance of stream/river habitat and the importance of wildlife. The Contractor will prepare and give this information as part of the staff inductions and will display relevant information and maps in the site offices.
- Contractor will be required to ensure the provision of basic amenities of drinking water, adequate number of toilets/mobile or portable toilets, washrooms, sanitation and cleanliness at the labor camp to minimize the pollution, littering, and dumping of wastes in the river
- The contractor will also ensure the provision of septic tanks to treat wastewater discharged from the labor camp. No discharge of untreated wastewater shall be allowed to enter in stream
- Contractor will ensure complete prohibition of fishing and hunting activities
- Speed limits will be imposed, which should also minimize the dust levels. Off-road vehicle movements can cause habitat degradation and loss. Limit speeds for construction vehicles to 30 km/hr to minimize the generation of fugitive dust and to minimize the risk of wildlife strikes. All construction vehicles will be limited to designated access roads, and construction sites with no off-road vehicle use will be permitted.
- With support from DWRI consultants, all construction workers and staff will be informed about areas supporting habitats and species of conservation value, why these features are important, and what activities are allowed and not permitted in

WHS. This will include details of regulations to protect biodiversity as well as staff obligations to comply with norms.

3. **Additional Mitigation Measures for the Protection of Terrestrial & Avi-Fauna (Birds)**

- This will involve an awareness program for contractors and construction staff on the conservation importance of protected animals and the national legislation protecting them, including the fines and imprisonment that are imposed on those who violate the law. Appropriate information will be given to all staff as part of their site induction, and leaflets will be displayed in site offices.
- Avoid tree clearance in the breeding season for priority species (if any) reported and undertake mitigation
- Night work shall be prohibited.
- All the equipment likely to generate high noise shall be appropriately enclosed or inbuilt noise enclosures be provided to meet the ambient noise standards
- Maintain the equipment, as simple maintenance can reduce noise levels. All stationary noise-generating equipment, such as power generators, should be used away from the biodiversity-sensitive area.
- Movement of vehicles should be restricted to working hours only.

4. **Additional Measures for the Protection of River Aquatic Life**
   - Contractor will implement strict controls on wastewater discharge from construction sites, ensuring no harmful pollutants enter river systems.
   - Use sediment barriers and silt screens to prevent construction runoff from increasing sedimentation in rivers, which can affect dolphin habitats.
   - RIMO will encourage local communities to adopt sustainable fishing practices to reduce bycatch and habitat degradation.
   - Implement seasonal restrictions on construction activities near known breeding and nesting sites at the project areas (if any) to avoid disturbance during critical periods.
   - Establish monitoring programs to protect nesting sites from disturbance and predation during the construction phase.
   - Educate construction workers on the presence of crocodiles and proper behavior to avoid conflicts. Train workers to report sightings and avoid nesting areas.

Reporting and Communication:

- RIMO will document all activities, observations, and mitigation measures in detail.
- Submit regular reports to wildlife authorities and other stakeholders, including ADB.
- Secure necessary permits and approvals (if any) from relevant authorities before implementing any actions.

Implementation of BAP

The contractor will be responsible for the ground-level implementation of BAP measures. The Environmental Health and Safety Officer (EHSO), who will look after the day-to-day implementation of EMP and safeguard compliance, will also be responsible for implementing BAP. EHSO will work with the Environmental Specialist of PIMS. The contractor's EHSO will maintain records of BAP implementation and submit the progress to the DPIU as part of their monthly progress reports on environmental safeguard monitoring.

Monitoring & Evaluation

Successful BAP requires continuous monitoring of its actions and periodic evaluation of its effectiveness, complying with the BAP conservation objectives and timeline. RIMO needs to undertake these monitoring activities during construction and the post-construction period. CPMO should reflect the outcomes of implementing BAP and monitoring in its quarterly and environmental monitoring reports.

Offsetting Measures or enhancement of buffer zone

Embankments. The Management Plan of Bardia National Park and its Buffer Zone emphasizes the strategic importance of embankments for flood control and habitat protection. Embankments help manage the flow of water during the monsoon season, preventing the inundation of critical wildlife habitats and human settlements. This control is crucial for maintaining the natural balance of the park's ecosystems and protecting agricultural lands in the buffer zone from flood damage. Additionally, by stabilizing riverbanks and preventing erosion, embankments safeguard the integrity of both terrestrial and aquatic habitats. This is particularly important for species such as the Gangetic dolphin and gharial, which rely on stable riverine environments for breeding and feeding. By mitigating flood impacts and preserving habitat stability, embankments play a vital role in the overall conservation strategy for Bardia National Park.

The 2 km river embankment to be rehabilitated under the RIP will significantly help reduce the impacts of flooding in the buffer zone of Bardia National Park, where this structure will be implemented. By stabilizing riverbanks and controlling the flow of water during the monsoon season, the embankment will reduce overflow into recreation parks, irrigation structures, and local wildlife habitats. This proactive measure will protect both the natural and human-modified environments, enhancing the resilience of the buffer zone to seasonal flooding.

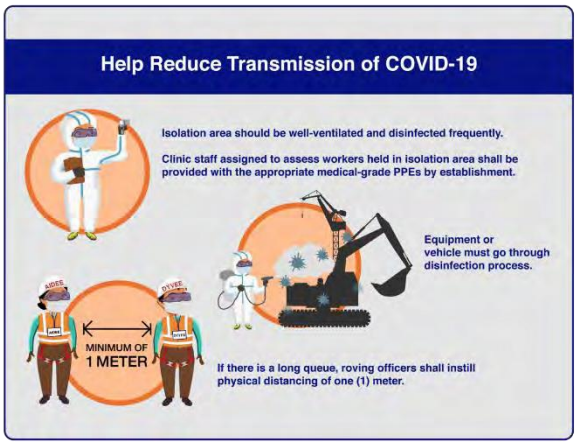
Intakes and Channels. The canal intake of Budhi Khola is designed to regulate the flow of water from the river into irrigation canals, ensuring that agricultural water needs are met without compromising the Karnali River's flow. The management plan stresses the importance of preventing over-extraction of water, as excessive water withdrawal can lead to reduced water levels in rivers and wetlands, adversely affecting the flora and fauna dependent on these habitats. By carefully managing the volume of water diverted for irrigation, canal intakes help preserve the natural flow and health of aquatic ecosystems. Additionally, the dual role of canal intakes in supporting local agriculture while protecting the park's natural resources aligns with the management plan. By balancing the water needs of agriculture with the ecological requirements downstream, the canal intakes play a pivotal role in promoting sustainable development and conservation in the region.

Sediment Control. The RIP places significant emphasis on sediment control as a crucial aspect of its implementation, aligning well with the conservation and management objectives of Bardia National Park. The management plan highlights the importance of maintaining water quality and habitat integrity, which are directly impacted by sediment levels. The RIP includes the design and implementation of sediment control structures such as settling basins, silt traps, and sedimentation ponds. These structures are intended to capture and manage sediments before entering irrigation channels, ensuring that only clean water is used for irrigation purposes. By preventing excessive sediment from being transported through the irrigation system, these measures

Appendix 5: COVID-19 Guidelines

A. PREPARATION BEFORE WORK

- The worksite and camp will be secured with a gated fence
- A Photo Identity Card will be issued to all workers with a unique identification number
- Preparation will be made for daily medical screening (thermal check and symptoms assessment) of all workers and report to H&SO
- COVID Marshal will measure temperature by wearing a facemask and gloves for their gang of workers before leaving the camp
- Workers with high fever and frequent cough will not be allowed to work. The worker will be asked to stay in quarantine (for residential workers) or sent back home (non-residential workers).



COVID-19 लक्षणहरू		
सबैभन्दासामान्यलक्षणहरू:	सामान्यतयाकमैदेखिनेलक्षणहरू:	गम्भीरलक्षणहरू:
– ज्वरोआउने – सुक्खाखोकीलाग्ने – थकाइलाग्ने	– पीडाहुनेवादुख्ने – घाँटीदुख्ने – पखालालाग्ने – आँखापोल्ने – टाउकोदुख्ने – स्वादवागन्धथाहानहुने – छालामादागहुनेवाहातवाखुट्टाकाऔंलाकोरडउड्ने	– सासफेर्नगाह्रोहुनेवापटकपटकसासफेर्नुपर्ने – छातीदुख्नेवाछातीमादबाबपर्ने – बोल्नवाहिँडडुलगर्ननसक्ने –
तपाईंमागम्भीरलक्षणहरूदेखिएमातुरुन्तैचिकित्साजाँचगराउनुहोस्। जहिलेपनिआफ्नोडाक्टरवास्वास्थ्यसुविधाप्रदायककहाँजानुअघिकलगर्नुहोस्		

- COVID Test (PCR Test) will be conducted for the staff and workers who have the symptoms related to COVID-19 (if required)
- Register records will be maintained

- Quarantine and isolation tents will be established at sufficient distance in the camp from regular shelters
- Specific and separate worksites will be assigned to the new group of workers away from regular workers for a minimum of 14 days to minimize risk

- Work will be arranged in shifts to avoid crowding of workers. Teams will be divided based on (i) workers residing in the same camp (ii) workers residing outside the camp, (iii) a new group of workers, etc.
- Consumption of liquor and chewables like Khaini, Surti, Paan, etc. (those generating the urge for frequent spitting) will be strictly restricted inside office and work areas

B. PROCEDURE AT ENTRY

- Guards will be oriented by the H&SO on (i) checking temperature, (ii) observing health symptoms, (iii) recording personal details and travel history, and (iv) taking emergency procedures, if required
- Unauthorized persons and visitors will not be allowed to enter
- All new groups of workers will be allowed to enter the site only after showing a COVID Test certificate from an authorized government hospital issued within the last 7 days, which the Assistant Health Worker will check at the Medical Center
- Guards will wear prescribed PPEs at all times and regularly disinfect their hand
- Visitors having COVID symptoms will be sent back, and immediately call HW from the Medical Center for staff and workers showing symptoms
- Personnel should maintain a distance of 1 meter at all times following the floor-marking wherever queue is required
- Guard will direct vehicles supplying materials to the delivery zone

- The guard will inform the visitors about the full-time use of masks and hand washing/sanitizing

C. MINIMIZEWORKER AND COMMUNITY CONTACT

The Contractor will be fully responsible for ensuring taking all preventive measures and safety precautions for COVID-19 risks such as the following:

- The Project Manager will work closely with the Site Charge and Resident Engineer to plan special measures and expedite work implementation at high-risk areas and areas requiring work in close proximity to the communities
- Physical barricades will be made mandatory to separate and minimize contact between workers and local people

- Arrangements will be made to minimize movement of workers from barricaded work areas and camps and visiting settlement areas

- Work sites will be separated into working zones to keep the groups of workers physically separated. Not more than 20 workers will be allowed to work in one group. A group leader will be identified as a COVID Marshal and given orientation to keep a close watch on workers and trigger emergency protocol in emergency case

- Emphasis will be given to establishing a sufficient size of the labor camp to keep all workers inside the camp to minimize contact with the community.

D. TRAVEL TO WORK SITE

The workers will observe precautions, and the contractor will arrange the following measures for arranging transport for workers to the worksite:

- Travel between sites and labor camps will be arranged through the official vehicle

- All workers will wear facemasks when travelling in a shared vehicle, including the driver, who will wear a mask and glove

- Driver will sanitize had regularly and before & after every trip

- Only 40% capacity of the vehicle will be used, and a seat will be kept empty between passengers

- Windows will be opened for natural ventilation

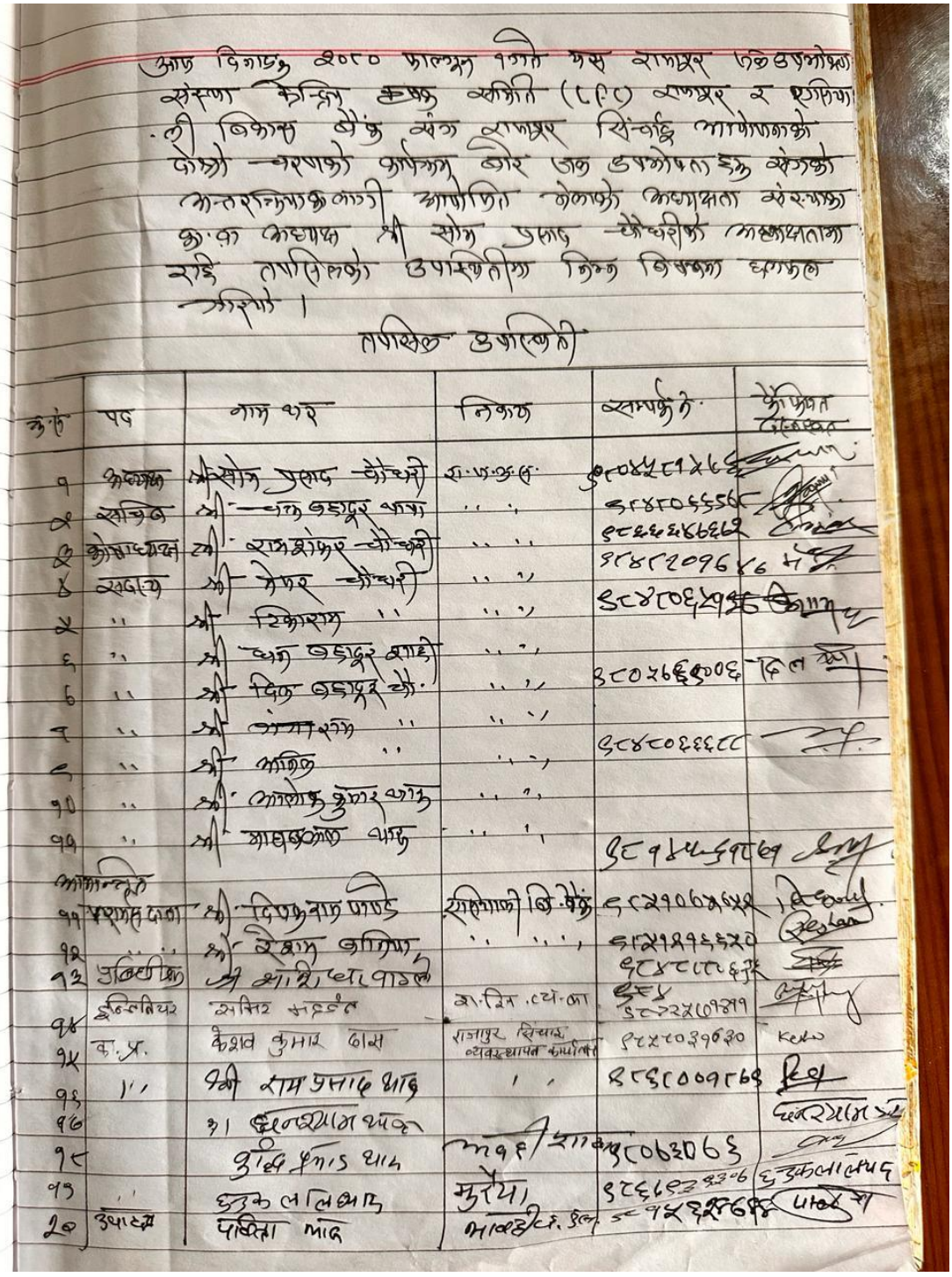
- Workers will stay facing away from each other while in the vehicle

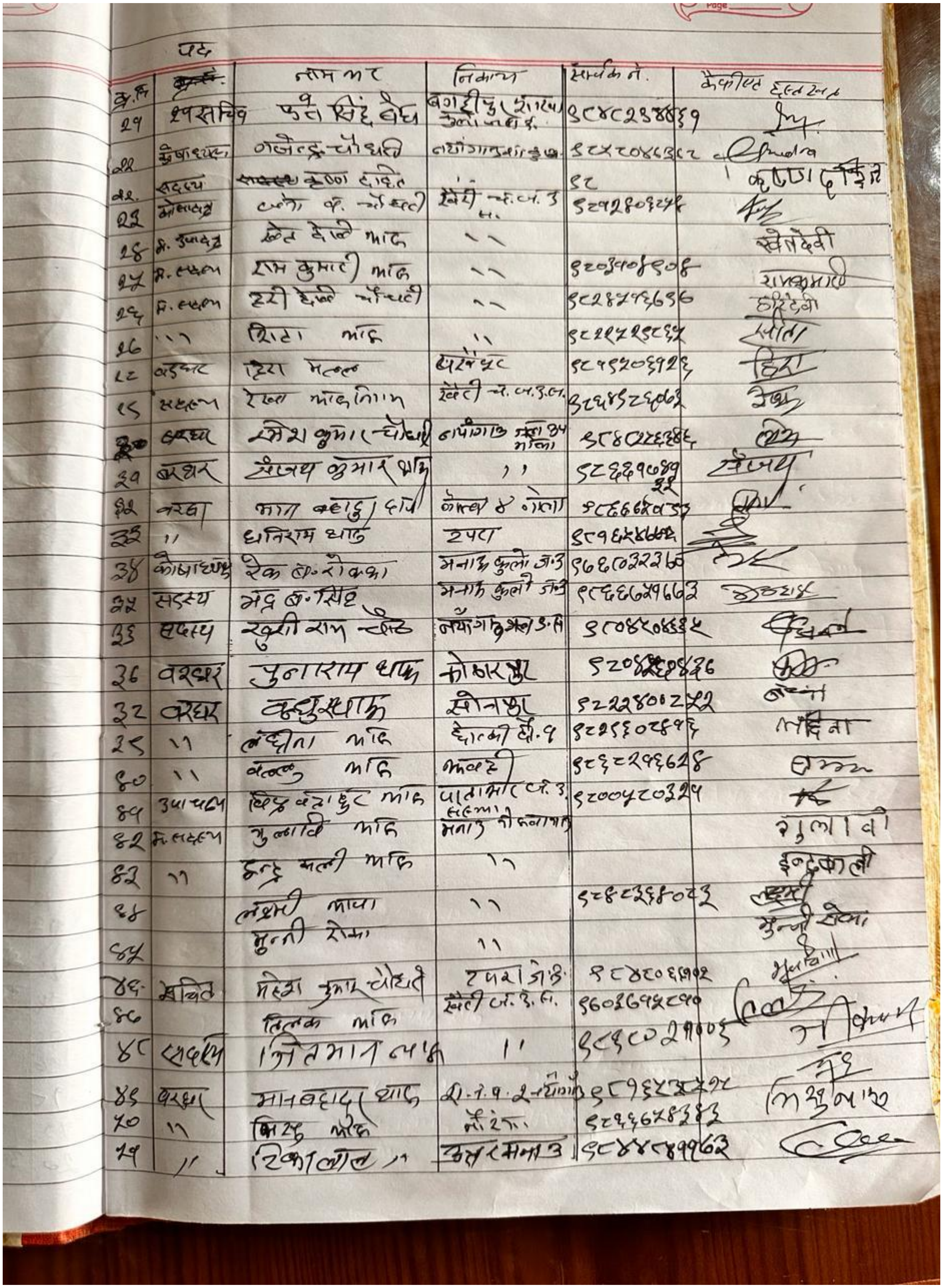
- The vehicle will be cleaned and disinfected thoroughly after every shift, emphasizing the handles, steering wheel, gear,ta etc.

- All workers, prior to entering the vehicle and exiting, will sanitize their hands

- Prior to entering the vehicles, all nonresidential staff and workers must self-certify that they do not have any COVID-19 symptoms.

Appendix 6: Consultation Attendance Sheet for RIP Component





क्र.सं.	पद	नाम थर	निवास	सम्पर्क नं.	कैफीयत दस्तखत
२१	उपसचिव	फत्ते सिंह बैध	बगडीपुर [illegible]	९८४८२३४४६१	[illegible]
२२	कोषाध्यक्ष	गजेन्द्र चौधरी	नयाँगाउँ [illegible]	९८५८०४८३८८	[illegible]
२२	सदस्य	कृष्णा दाहित	,,	९८	कृष्णा दहित
२३	[illegible]	[illegible] क. चौधरी	खैरी [illegible]	९८१२४०६५४६	[illegible]
२४	[illegible]	खेत देवी थारु	,,		खेतदेवी
२५	[illegible]	राम कुमारी थारु	,,	९८०३४०४९०४	रामकुमारी
२६	[illegible]	हरी देवी चौधरी	,,	९८२४५१६६९६	हरिदेवी
२७	,,	[illegible] थारु	,,	९८५५५५९८६५	[illegible]
२८	वडध्यक्ष	हिरा मल्ल	[illegible]	९८४९५०६१२६	हिरा
२९	सदस्य	[illegible]	खैरी [illegible]	३८६४९३८६०६२	[illegible]
३०	[illegible]	[illegible] कुमार चौधरी	नयाँगाउँ [illegible]	९८४०८८६३४६	[illegible]
३१	[illegible]	संजय कुमार थारु	,,	९८६६१०४१ ३२	संजय
३२	[illegible]	[illegible] बहादुर [illegible]	[illegible] ४ [illegible]	९८६६६२५५३	[illegible]
३३	,,	धनिराम थारु	[illegible]	९८१६५४४६७	[illegible]
३४	कोषाध्यक्ष	रेक ब. रोकका	मनाऊ कुलो [illegible]	९६८८०३२३६०	[illegible]
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४२	म. सदस्य	गुलाबी थारु	मनाऊ [illegible]		गुलाबी
४३	,,	इन्द्र मल्ली थारु	,,		इन्द्रकाली
४४		लक्ष्मी [illegible]	,,	९८४८३६४०४३	लक्ष्मी
४५		मुन्नी रोका	,,		मुन्नी रोका
४६	[illegible]	महेश कुमार चौधरी	[illegible]	९८४८०६७१२	[illegible]
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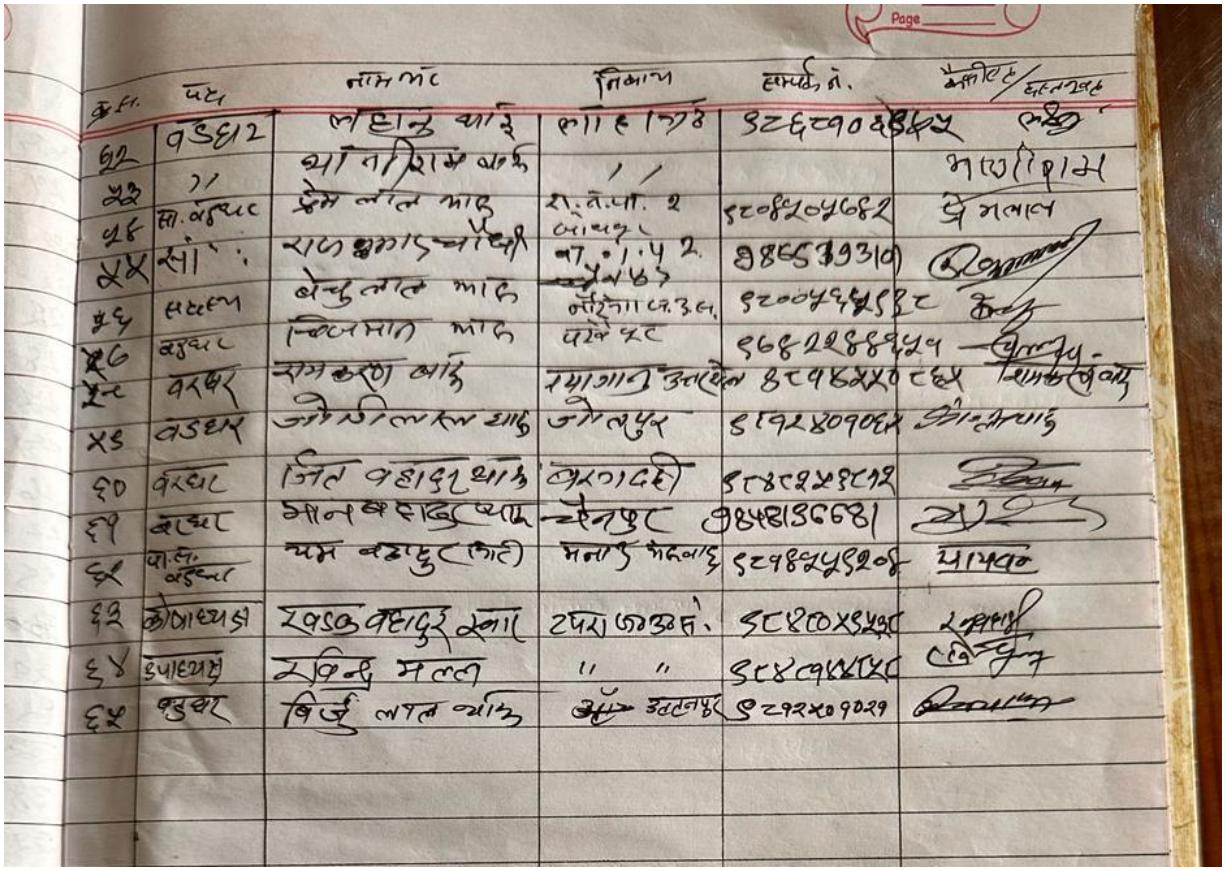
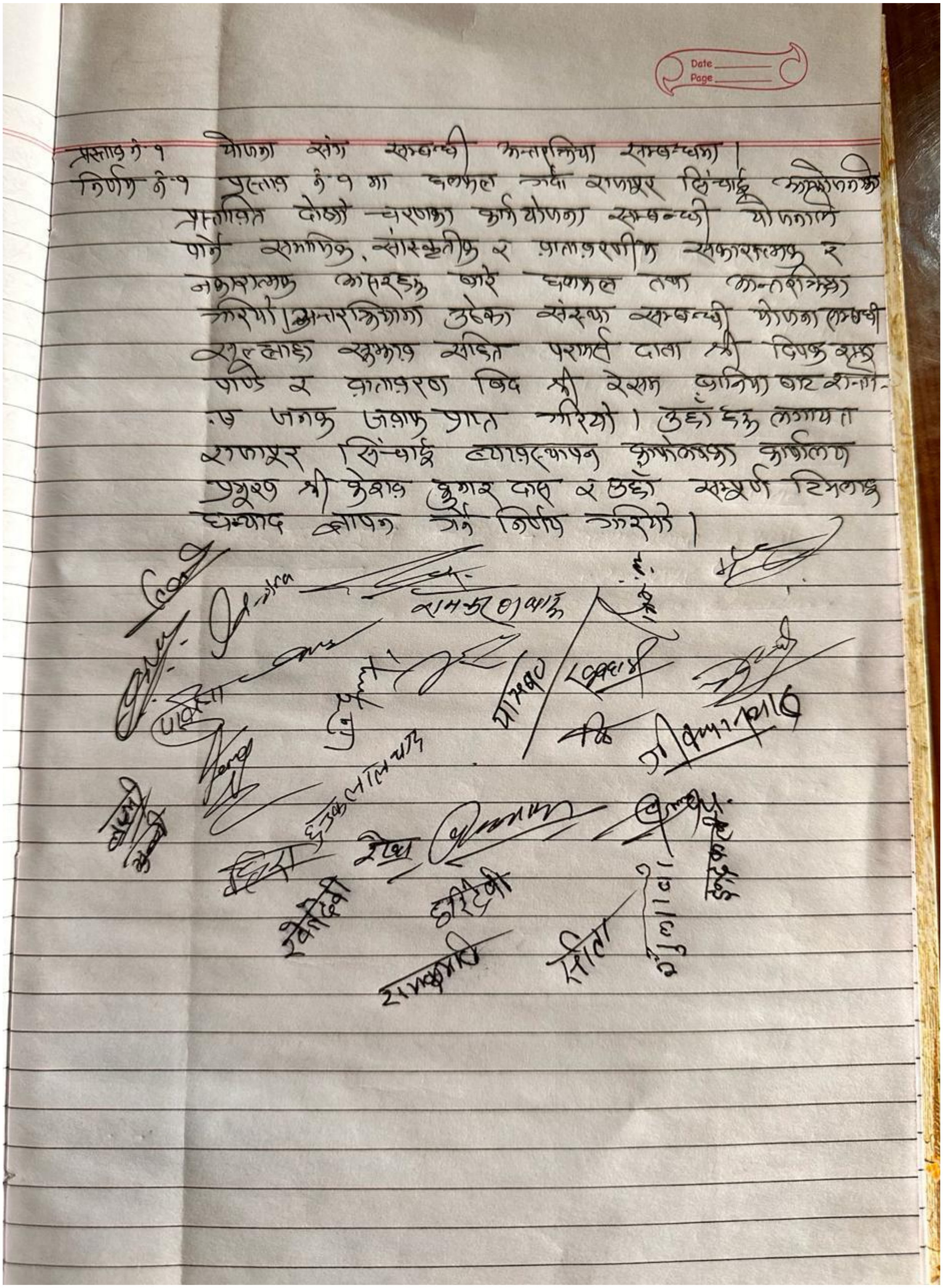
४९	[illegible]	मानबहादुर थारु	[illegible]	९८१६५३५४१८	[illegible]
५०	,,	[illegible] थारु	[illegible]	९८५६६५४३४३	[illegible]
५१	,,	[illegible] ,,	[illegible]	९८४४८४११६२	[illegible]



Meeting Minute Notes *- The Social Expert Deepak Pandey and the Environmental Expert Resham Baniya shared the Rajapur project scope and the assessment findings in the consultation meeting. The key intervention sites by the project were confirmed that canal rehabilitation and improvement works will be limited within the existing irrigation canal systems, the intervention will not impact to any social, cultural and environment of the Rajapur area. Most of the impacts will be site specific, short in duration, local in extent, temporary and reversible, and of low significance. The possible impacts during the construction period were discussed with the community members in the consultation meeting.*



प्रस्ताव नं. १ योजना संग सम्बन्धी अन्तर्क्रिया सम्बन्धमा।

निर्णय नं. १ प्रस्ताव नं. १ मा छलफल गर्दा राजापुर सिंचाई कार्यालयको प्रस्तावित दोस्रो चरणको कार्ययोजना सम्बन्धी योजनाले पार्ने सामाजिक, सांस्कृतिक र वातावरणीय सकारात्मक र नकारात्मक असरहरू बारे छलफल तथा अन्तरक्रिया गरियो। अन्तरक्रियामा उठेका संरचना सम्बन्धी योजना सम्बन्धी सुझाव सहित परामर्शदाता श्री दिपक राज पाण्डे र वातावरणविद श्री रेशम भानिया बाट सन्तोषजनक जवाफ प्राप्त गरियो। उहाँहरू लगायत राजापुर सिंचाई व्यवस्थापन कार्यक्रमका कार्यालय प्रमुख श्री केशव कुमार दास र उहाँ सम्पूर्ण टिमलाई धन्यवाद ज्ञापन गर्ने निर्णय गरियो।

Appendix 7: Sample Grievance Registration Form

(To be available in Nepali and English)

The _____Project welcomes complaints, suggestions, queries, and comments regarding project implementation. We encourage persons with grievance to provide their name and contact information to enable us to get in touch with you for clarification and feedback.
Should you choose to include your personal details but want that information to remain confidential, please inform us by writing/typing *(CONFIDENTIAL)* above your name. Thank you.

Date	Place of registration	Project Town Project:			
Contact information/personal details					
Name		Gender	* Male * Female	Age	
Home address					
Place					
Phone no.					
E-mail					
Complaint/suggestion/comment/question Please provide the details (who, what, where, and how) of your grievance below: If included as attachment/note/letter, please tick here:					
How do you want us to reach you for feedback or update on your comment/grievance?					

FOR OFFICIAL USE ONLY

Registered by: (Name of official registering grievance)	
Mode of communication: Note/letter E-mail	
Reviewed by: (Names/positions of officials reviewing grievance)	
Action taken:	
Whether action taken disclosed:	Yes No
Means of disclosure:	

Appendix 8: Sample Environmental Site Inspection Report

Project Name
Contract Number

NAME: DATE: _____

TITLE: _____ DMA: _____
LOCATION: _____ GROUP: _____

WEATHER:

Project Activity Stage	Survey	
	Design	
	Implementation	
	Pre-Commissioning	
	Guarantee Period	

MONITORING ITEMS	COMPLIANCE
Compliance marked as Yes / No / Not applicable (NA) / Partially Implemented (PI)	
EHS officers/supervisor appointed by contractor and available on site	
Construction site management plan (spoils, safety, schedule, equipment etc.,) prepared	
Traffic management plan prepared	
Dust is under control	
Excavated soil properly placed within minimum space	
Construction area is confined; no traffic/pedestrian entry observed	
Surplus soil/debris/waste is disposed without delay	
Construction material (sand/gravel/aggregate) brought to site as & when required only	
Tarpaulins used to cover sand & other loose material when transported by vehicles	
After unloading, wheels & undercarriage of vehicles cleaned prior to leaving the site	
No chance finds encountered during excavation	
Work is planned in consultation with traffic police	
Work is not being conducted during heavy traffic	
Work at a stretch is completed within a day (excavation, pipe laying & backfilling)	
Pipe trenches are not kept open unduly	
Road is not completely closed; work is conducted on edge; at least one line is kept open	
Road is closed; alternative route provided & public informed, information board provided	
Pedestrian access to houses is not blocked due to pipe laying	
Spaces left in between trenches for access	
Wooden planks/metal sheets provided across trench for pedestrian	
No public/unauthorized entry observed in work site	

MONITORING ITEMS	COMPLIANCE
Children safety measures (barricades, security) in place at works in residential areas	
Prior public information provided about the work, schedule and disturbances	
Caution/warning board provided on site	
Guards with red flag provided during work at busy roads	
Workers using appropriate PPE (boots, gloves, helmets, ear muffs etc.)	
Workers conducting or near heavy noise work is provided with ear muffs	
Contractor is following standard & safe construction practices	
Deep excavation is conducted with land slip/protection measures	
First aid facilities are available on site and workers informed	
Drinking water provided at the site	
Toilet facility provided at the site	
Separate toilet facility is provided for women workers	
Workers camps are maintained cleanly	
Adequate toilet & bath facilities provided	
Contractor employed local workers as far as possible	
Worker's camp set up with the permission of PMU	
Adequate housing provided	
Sufficient water provided for drinking/washing/bath	
No noisy work is conducted in the nights	
Local people informed of noisy work	
No blasting activity conducted	
Pneumatic drills or other equipment creating vibration is not used near old/risky buildings	

Signature

_____

Sign off

_____ _____

Name **Name**
Position **Position**

Appendix 9: Outline of Semi-annual Environment Monitoring Report

The PMU is required to prepare semi-annual monitoring reports that describe progress on implementing the project EMP, compliance issues, and corrective actions (if needed). Below is a sample outline that can be adapted as necessary.

I. Introduction

A. Overall Project Description and Components
B. Location of the Subproject (use maps and pictures)
C. Environmental Category (discuss categorization based on ADB SPS and national law)
D. Project Implementation Progress (summary of activities and construction progress and main civil works during the reporting period)

II. Institutional Arrangement for Environmental Safeguards

A. Institutional Arrangement (description of the project institutional arrangement as a whole; use figure/framework)
B. Environmental Safeguard Staff/Personnel

III. Statutory Environmental Requirements

A. Government Policy Compliance (discuss the status of clearance/s, permit/s, etc., and compliance of the project; include all permits and clearances as appendices)
B. Compliance Issues (indicate any non-compliance on national/state and reason of non-compliance)

IV. Loan Covenants

V. New Schemes and/or Construction Progress

VI. Implementation of Environmental Management Plan

A. Summary of Inspection Activities
B. Compliance with Construction Environmental Management Plan (CEMP).
C. CEMP implementation issues

VII. Summary of Environmental Monitoring

A. Environmental Monitoring Plan (emission and ambient)
   1. Summary of Monitoring
   2. Results
   3. Assessment

B. Other Monitoring Program (if relevant)
   1. Summary of Monitoring
   2. Results
   3. Assessment

VIII. Information Disclosure and Consultations (only applicable if any consultations are performed during the reporting period)

IX. Grievance Redress Mechanism (GRM)

A. GRM Framework, members and access
B. Grievances Received (if any)
C. Status of Current Grievances (if any)

X. Conclusion

A. Overall Progress of Implementation of Environmental Management Measures
B. Unanticipated Environmental Risks and Impacts
C. Corrective Action Plan (footnote 1)

XI. Annexes (as appropriate)

1. Copies of ambient and/or emission monitoring results
2. Clearances and permits
3. Photographs
4. Others