ENVIRONMENTAL IMPACT ASSESSMENT OF RANGAMATI MEDICAL COLLEGE AND HOSPITAL AND NURSING COLLEGE, RANGAMATI SADAR, RANGAMATI

ABSTRACT: The Proposed Rangamati Medical College and Hospital and Nursing College Project Is A Government Initiative To Develop Healthcare And Education Infrastructure, Aimed At Strengthening Medical Education, Improving Tertiary Healthcare Services, And Enhancing Human Resource Capacity In The Chattogram Hill Tracts Region, Particularly In Rangamati District. The Project Includes the Construction and Operation Of A 100-Seat Medical College, A 600-bed Medical College Hospital, A 100-Seat Nursing College, Academic Buildings, Hostels, Dormitories, Staff Accommodations, Emergency Facilities, Utility Structures, And Associated Infrastructure Within An Acquired Land Area Of Approximately 25.95 Acres

December -2025

Declaration

This Environmental Impact Assessment (EIA) Report has been prepared for the proposed **Rangamati Medical College and Hospital and Nursing College Project** in compliance with the provisions of the **Bangladesh Environmental Conservation Act, 1995 (amended 2010)**, the **Environmental Conservation Rules, 2023 (as amended)**, and relevant guidelines, circulars, and instructions issued by the **Department of Environment (DoE), Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh**.

We hereby declare that this EIA Report is the outcome of a comprehensive and systematic environmental assessment carried out in accordance with **DoE Red Category project requirements**, including:

- Approved **Terms of Reference (ToR)** issued by the Department of Environment;
- Baseline environmental data collection through field survey, site investigation, and secondary sources;
- Identification, prediction, and evaluation of potential **physical, biological, chemical, and socio-economic impacts** during the construction and operation phases;
- Consideration of environmental sensitivity, natural hazards, emergency preparedness, and climate resilience.

This EIA Report has been prepared using:

- Authentic project information provided by the project proponent, including layout plans, engineering designs, and Development Project Proforma (DPP);
- Scientific literature, national standards, and internationally accepted environmental assessment methodologies;
- Professional expertise, judgment, and experience of qualified environmental specialists.

We further certify that:

- All information presented in this report is accurate, correct, and complete to the best of our knowledge;
- No significant environmental impact has been intentionally omitted, concealed, or misrepresented;
- The assessment reflects actual site conditions and realistic project activities;
- The proposed mitigation measures, including installation of **Effluent Treatment Plant (ETP)** with **Sewage Treatment Plant (STP)**, **Medical Waste Management System,** Retaining Wall, and **lake protection measures**, are technically viable and environmentally appropriate.

We also declare that if the project is implemented strictly in accordance with the recommendations, mitigation measures, and environmental management provisions outlined in this EIA Report, the project will comply with all applicable environmental laws, rules, and DoE clearance conditions, and will not result in unacceptable adverse ecological impacts.

This EIA Report is submitted to the **Department of Environment (DoE)** for review and approval to obtain an **Environmental Clearance Certificate (ECC)** under the **Red Category** classification.

DECLARATION BY THE CONSULTANT

Name of Consulting Organization: Global Environmental and textile Technological Services
Address: West Agargaon, Shere-E-Bangla Nagar, Dhaka -1207
Name of Team Leader: Professor Md. Mostafizur Rahman, PhD
Qualification & Experience: Professor of the Department of Environmental Sciences, Jahangirnagar University

Signature:
Date:

DECLARATION BY THE PROJECT PROPONENT

We hereby confirm that all project-related information, design data, and operational details provided to the EIA study team are accurate and complete. We commit to implementing all environmental mitigation and monitoring measures as prescribed in this EIA Report and any additional conditions imposed by the Department of Environment.

Name of Project Proponent / Implementing Agency:
Authorized Representative:
Designation:

Signature:
Date:

Abstract

The proposed Rangamati Medical College and Hospital and Nursing College Project is a government initiative to develop healthcare and education infrastructure, aimed at strengthening medical education, improving tertiary healthcare services, and enhancing human resource capacity in the Chattogram Hill Tracts region, particularly in Rangamati District. The project includes the construction and operation of a 100-seat medical college, a 600-bed medical college hospital, a 100-seat nursing college, academic buildings, hostels, dormitories, staff accommodations, emergency facilities, utility structures, and associated infrastructure within an acquired land area of approximately 25.95 acres.

As the project falls under the Red Category under the Environmental Conservation Rules (ECR), 1997, a comprehensive Environmental Impact Assessment (EIA) has been conducted in compliance with the Bangladesh Environmental Conservation Act, 1995, relevant rules, and the Department of Environment (DoE) guidelines. The EIA study includes a baseline environmental assessment, an ecological sensitivity investigation, identification and evaluation of potential impacts during both the construction and operation phases, and the formulation of appropriate mitigation and management measures.

The baseline assessment indicates that the project area is characterized by mixed institutional and semi-natural land use, moderate ecological sensitivity due to nearby water bodies (a lake), and hilly terrain typical of the Rangamati region. No nationally protected areas or critically endangered species were identified within the immediate project footprint. Potential environmental impacts identified include land-use change, air and noise pollution, surface and groundwater contamination, construction waste, medical and hazardous waste, sewage discharge, traffic congestion, and occupational health and safety risks.

To address these impacts, the project incorporates robust environmental management measures, including the installation of an Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP) with an estimated budget of BDT 75.00 million, and a comprehensive Medical Waste Management System with an estimated budget of BDT 165.00 million, as outlined in the Development Project Proforma (DPP). Additional mitigation measures include lake protection buffers, erosion control, dust and noise suppression, solid waste segregation, emergency preparedness, and energy-efficient systems.

The study concludes that, with the effective implementation of the proposed Environmental Management Plan (EMP), Environmental Monitoring Plan, and compliance with DoE conditions, the project will generate significant positive socio-economic impacts, including improved healthcare access, employment generation, regional development, and enhanced medical education. In contrast, adverse environmental impacts will remain manageable, localized, and non-significant.

This EIA Report is submitted to the Department of Environment (DoE) to obtain the Environmental Clearance Certificate (ECC) under the Red Category, and to ensure environmentally sustainable implementation of the project.

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

Date: 03/11/2025

Record No: 22.02.8400.216.072.003.25.2

Subject: Approval of Terms of Reference (ToR) for the EIA of the Rangamati Medical College and Hospital and Nursing College at Rangamati Sadar, Rangamati

Reference: Your application on 18.09.2025

With reference to the subject mentioned above, the Department of Environment hereby gives approval of the Terms of Reference (ToR) for the Environmental Impact Assessment (EIA) of the **Rangamati Medical College and Hospital and Nursing College** at Rangamati Sadar, Rangamati, subject to fulfilling the following terms and conditions:

A. The project authority shall conduct a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the ToR submitted to the Department of Environment (DoE). The EIA study shall be conducted as per the provisions laid down in the Environmental Conservation Rules, 2023.

B. The EIA report shall be prepared in accordance with the guidelines provided in Schedule-11 and Rules-15, 16 of the ECR, 2023.

C. Hence, the Department of Environment issues additional ToR to include in the Environmental Mitigation, Management and Monitoring Plan as follows:

1. The STP/ ETP design and calculation shall be prepared in accordance with the guidelines provided in Schedule 12 and Rule 33 of the ECR, 2023.
2. Treatment of wastewater from OT/ dialysis/ labour department, extending the recycling and reuse of wastewater for different purposes shall be included. Complete scheme of STP/ ETP including drawing (flow diagram of STP/ ETP units showing pipe, drain and instrument/ equipment, architectural plan, X-sections, list of equipment with quantity and capacity), design with calculation. Characteristics of untreated and treated effluent to meet the national discharge standard.
3. Details of hazardous medical waste generation and their storage, utilization and management;
4. EMP should include 3R concept (reduce, Reuse & Recycle);
5. Total cost and recurring cost/ annum for environmental pollution control measures;
6. Emergency management plan.

D. Multidisciplinary experts are required in the study team to prepare the EIA report.

E. As per Rule 16 of the ECR'23, a soft copy of the draft EIA report shall be sent to the DoE (mimshameem@gmail.com and nrahmanasif@gmail.com) in order to publish the report on the DoE's website for public comments.

F. The project authority shall submit the final EIA report to the Head Office of DoE in Dhaka.

G. Without approval of the EIA report by the Department of Environment, the project authority shall not make any land and infrastructure development.

03-11-2025
Masud Iqbal Md Shameem
Director
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Ms. Sharmi Chakma, Executive Engineer, PWD, Rangamati
Rangamti Medical College and Hospital and Nursing College, Sadar Rangamati, Rangamati.

Record Number: 22.02.8400.216.072.003.25.2/1 (2) Date: 03/11/2025

A Copy for has been sent consideration and necessary (if applicable) action (Not in order of seniority):

1. Director, Department of Environment, Chattogram Regional Office, Chattogram and
2. Assistant Director, Department of Environment, Rangamati District Office, Rangamati.

03-11-2025
Masud Iqbal Md Shameem
Director

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ABBREVIATION

IEE	Initial Environmental Examination
ECC	Environmental Clearance Certificate
NEQS	National Environmental Quality Standards
BOD	Biochemical Oxygen Demand
CDM	Clean Development Mechanism
COD	Chemical Oxygen Demand
CP	Cleaner Production
DO	Dissolved Oxygen
DoE	Department of Environment
EC	Electrical Conductivity
ECR	Environmental Conservation Rules
EMP	Environmental Management Plan / Environmental Monitoring Plan
EMS	Environmental Management System
SAARC	South Asian Association of Regional Cooperation
EIA	Environmental Impact Assessment
EQ	Equalization
ETP	Effluent Treatment Plant
GETTS	Global Environmental and Textile Technological Services
GoB	Government of Bangladesh
UNCED	United Nation Conference on the Environment and Development
AQI	Air Quality Index
KW	Kilowatt
HSE	Health & Safety Executive
OSHA	Occupational Safety and Health Administration
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forest
NEMAP	National Environmental Management Action Plan
NGO	Non-Government Organization
MSDS	Material Safety Data Sheet
PPE	Personal Protective Equipment
P^H	Potential of Hydrogen
ppm	Parts Per Million
PVC	Polyvinyl Chloride
PRSP	Poverty Reduction Strategy Paper
OWS	Oil Water Separator

GLOSSARY

- **Adverse impact:** An impact that is considered undesirable.
- **Ambient air:** Surrounding air.
- **Aquatic:** Growing or living in or near water.
- **Bangla:** Bengali language.
- **Baseline (or existing) conditions:** The „baseline" essentially comprises the factual understanding and interpretation of existing environmental, social, and health conditions of where the business activity is proposed. Understanding the baseline shall also include the trends within it, and primarily how changes could occur regardless of the presence of the project, i.e., the „No-development Option".
- **Bazar:** Market.
- **Beel:** A „back swamp" or depression. It can be either perennial or seasonal.
- **Beneficial impacts:** Impacts that are considered to be desirable and valuable.
- **Biological diversity is the variety of life forms, the different plants, animals, and microorganisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity,** and ecological diversity.
- **Ecosystem:** A dynamic complex of plant, animal, fungal and microorganism communities and associated non-living environments interacting as an ecological unit.
- **Emission:** The total amount of solid, liquid or gaseous pollutant emitted into the atmosphere from a given source within a given time, as indicated, e.g., in grams per cubic meter of gas or by a relative measure, upon discharge from the source.
- **Endangered species:** Species in danger of extinction and whose survival is unlikely if the existing conditions continue to operate. Among those are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to suffer from immediate danger of extinction.
- **Environmental effects are the measurable changes in the natural system of productivity and environmental quality** resulting from a development activity.
- **Environmental impact assessment (EIA) / Environmental assessment:** The systematic, reproducible, and interdisciplinary identification, prediction, evaluation, mitigation, and management of impacts from a proposed development and its reasonable alternatives, sometimes known as environmental assessment.
- **Environmental Impact:** An estimate or judgment of the significance and value of environmental effects for natural, socio-economic, and human receptors. Environment Management Plan (EMP): A Plan to undertake an array of follow-up activities that provide for the sound environmental management of a project/ intervention so that adverse environmental impacts are minimized and mitigated; beneficial ecological effects are maximized; and sustainable development is ensured.
- **Environmental Management:** Managing the productive use of natural resources without reducing their productivity and quality.
- **Erosion:** A Process in which wind and water remove materials from their original place; for instance, soil washed away from an agricultural field.
- **Evaluation:** The process of looking back at what has been really done or accomplished.
- **Fauna:** A collective term denoting the animals occurring in a particular region or period.

- **Field Reconnaissance:** A field activity that confirms the information gathered through secondary sources. This field study is essentially a rapid appraisal.
- **Flora:** All of the plants found in a given area.
- **Green Building:** The project of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment over the entire life cycle of the building.
- **Habitat:** The natural home or environment for a plant or animal.
- **Household:** A household is a dwelling unit where one or more persons live and eat together in a joint cooking arrangement. Persons living in the same dwelling unit with separate cooking arrangements constitute an individual household.
- **Important Environmental Component (IEC):** These are environmental components of biophysical or socio-economic importance to one or more interested parties. Using critical environmental components helps to focus the environmental assessment.
- Initial Environmental Assessment / Evaluation: A preliminary analysis undertaken to ascertain whether there are sufficient likely significant adverse impacts to warrant a „full" EIA. In some countries, initial assessments form a means of "screening" proposed projects.
- **Lake:** A large body of water surrounded by land.
- **Mauza:** A Bangla word for the smallest government administrative area corresponding to a village revenue unit.
- **Mitigation:** An action that may prevent or minimize adverse impacts and enhance beneficial impacts.
- **Negative Impact:** Negative change from the existing situation due to the project.
- **Public involvement / Public consultation:** A range of techniques that can be used to inform, consult, or interact with stakeholders" affected / to be affected by a proposal." Reversible impact: An environmental impact that recovers either through natural processes or with human assistance (e.g., cutting off fish migration by an embankment might be reversible at a later stage if a proper regulator is built).
- **Stakeholders:** Those who may be potentially affected by a proposal, e.g., Local people, the proponent, government agencies, NGOs, donors, and others, all parties who may be affected by the project or take an interest in it.
- **Taka:** Unit of Bangladeshi currency.
- **Terrestrial:** Living on land.
- **Thana:** Sub-district level of government administration, comprising several unions under a district.
- **Union:** Smallest unit of local self-government comprising several villages.
- **Upazila:** Sub-district name. Upazila was introduced in 1982.
- **Zila:** Bengali word for a district.

CHAPTER 1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The proposed project involves the construction and operation of a **Medical College Hospital along with Medical College and Nursing College facilities** at Rangamati. The project has been undertaken to improve regional healthcare services, medical education, and nursing training facilities, particularly for the hill districts and surrounding regions. Considering the scale of the project and its potential interaction with the natural and socio-environmental setting, an **Environmental Impact Assessment (EIA)** has been carried out in accordance with the **Environment Conservation Act, 1995 (amended 2010)**, **Environment Conservation Rules, 2023 (amended)**, and relevant guidelines of the **Department of Environment (DOE), Bangladesh**.

The EIA aims to identify, predict, and evaluate potential environmental impacts during both **construction and operation phases** and to propose appropriate mitigation and management measures to ensure environmentally sustainable project implementation.

To achieve the Sustainable Development Goals (SDGs), particularly Universal Health Coverage (UHC), and to decentralize medical education and specialized healthcare services at the district level, the Government of Bangladesh has undertaken an initiative to establish six medical college hospitals in Netrokona, Nilphamari, Noakhali, Habiganj, Magura, and Rangamati.

The Institute of Health Economics at the University of Dhaka conducted feasibility studies for the infrastructure development of these six medical college hospitals. This feasibility study report evaluates the suitability and feasibility of constructing the physical infrastructure of Rangamati Medical College and Hospital at the proposed site.

1.2 PROJECT DESCRIPTION

The project includes the development of:

- A fully functional **Medical College Hospital**
- **Medical College academic buildings**
- **Nursing College facilities**
- Residential hostels, staff quarters, utilities, internal roads, drainage, and ancillary services

The hospital will provide inpatient, outpatient, diagnostic, laboratory, surgical, and emergency medical services. The project will generate both **domestic and medical wastewater**, solid waste, medical waste, air emissions from backup generators, and traffic movement.

Key infrastructure components include:

- Sewage Treatment Plant (STP)
- Effluent Treatment Plant (ETP)
- Medical Waste Management System

- Stormwater drainage network
- Rainwater harvesting and RCC/retaining wall
- Power backup systems
- Water supply and storage facilities

1.3 BASIC PROJECT INFORMATION TABLE

Sl. No.	Item	Description
1	Name of the Project	Construction and Operation of Medical College Hospital, Medical College, Nursing College, and Associated Facilities
2	Type of Project	Healthcare and Educational Infrastructure Project
3	Project Proponent	Government of Bangladesh / Concerned Implementing Authority
4	Project Location	Rangamati Sadar, Rangamati District, Bangladesh
5	Geographic Coordinates	As per approved land records and survey maps
6	Total Land Area	25.95 acres (Land acquisition completed by August 2024)
7	Project Category (DOE)	Red Category
8	Requirement of EIA	Full-scale Environmental Impact Assessment (EIA)
9	Project Components	Medical College Hospital, Academic Buildings, Nursing College, Hostels, Staff Quarters, Utility Buildings, Internal Roads, Drainage
10	Hospital Capacity	100-bed Medical College Hospital
11	Medical College	1 Medical College with 100 seats
12	Nursing College	1 Nursing College with 100 seats
13	Major Buildings	Hospital, Academic Buildings, Nursing College, Student Hostels, Intern Doctors' Dormitories, Staff Nurse Dormitory, Emergency Staff Dormitory, Senior Teacher Accommodation
14	Construction Period	July 2024 – June 2028
15	Operational Start	After June 2028
16	Total Manpower	Construction Phase: 500 persons; Operation Phase: 2,641 persons
17	Water Requirement	Potable, domestic, medical, laboratory, and cleaning purposes
18	Source of Water	Approved water supply sources
19	Wastewater Generation	Domestic sewage and hospital effluent
20	Wastewater Treatment	Installation of Effluent Treatment Plant (ETP) + Sewage Treatment Plant (STP)
21	Total Project cost	**1. During Implementation:** Estimated cost BDT 1,293.213 crore. **2. Post-Implementation**: After completion, the project will be transferred to the revenue budget. No post-implementation cost estimates have been prepared.
22	**Medical Waste Management Budget**	BDT 165,000,000

23	**STP Estimated Budget**	BDT 75,000,000
24	Solid Waste Types	Domestic waste, medical waste,
25	Medical Waste Management	Segregation, on-site handling, authorized disposal, Incinerator
26	Air Emission Sources	Standby generators, construction equipment
27	Noise Sources	Construction machinery, generators
28	Power Supply	National Grid with Generator Backup
29	Environmental Monitoring	Water, wastewater, air quality, noise, waste
30	Environmental Management Plan	Construction and Operation Phase EMP
31	Applicable Laws	ECA 1995, ECR 1997, Medical Waste Rules 2008, The Medical Practice and Private Clinics and Laboratories (Regulation) Ordinance, 1982, Chittagong Hill-tracts (Land Acquisition) Regulation, 1958, etc
32	Environmental Benefits	Improved healthcare, education, and employment
33	Social Benefits	Enhanced medical services and skill development
34	Clearance Authority	Department of Environment (DOE) and Director General of Health Services of Bangladesh

1.4 DEMAND ANALYSIS

1.4.1 Problem Identification

Rangamati Medical College was established in 2013 and began admitting students from the 2014–2015 academic session. At present, the college has a total of **249 students** across **five batches**, with **51 students per batch** (from the second year onwards).

The temporary campus of Rangamati Medical College Hospital is located in the **Coronary Care Unit (CCU) building** of the Rangamati General Hospital. Due to the lack of permanent infrastructure:

- The first batch of students completed their internship at **Chattogram Medical College Hospital (CMCH)**;
- Subsequent students have been permitted to complete internships at the **100-bed Rangamati General Hospital**.

The Medical College currently has **61 faculty members**, all appointed on **deputation**, as there are no sanctioned posts under the revenue budget. Additionally:

- Three administrative staff are deputed from the Civil Surgeon's Office;
- Sixteen support staff are engaged on a temporary basis with special approval from the Ministry.

The institution faces an **acute shortage of space** for academic, clinical, and residential purposes. Temporary accommodation arrangements include:

- General hospital staff quarters;
- Newly constructed tin-shed dormitories under the Chittagong Hill Tracts Development Board;
- Junior officers' dormitories used as student hostels.

Without resolving these space constraints, continuation of academic activities and quality healthcare service delivery will not be feasible. Additional infrastructure, including student hostels, faculty residences, administrative offices, and support facilities, is essential.

1.5 RELEVANCE AND JUSTIFICATION OF THE PROJECT

To achieve **Universal Health Coverage (UHC)** and **Sustainable Development Goal (SDG) 3** by 2030, a substantial increase in the number of doctors, nurses, and other technical health personnel is required.

In alignment with:

- **Vision 2021** (attainment of middle-income country status),
- **Vision 2041** (transition to a developed country), and
- **Perspective Plan (2021–2041),**

The Government of Bangladesh has emphasized improvements in life expectancy, reductions in maternal and child mortality, and the total fertility rate (TFR) (Perspective Plan, pp. 55–56).
The **Five-Year Plan (2021–2025) highlights human resource development in the health, population, and nutrition sectors, with targets to reduce maternal and child mortality** and TFR (p. 586).
Furthermore, the project directly contributes to **SDG 3,** which focuses on ensuring healthy lives and promoting well-being for all at all ages through expansion and accessibility of healthcare services (SDG Targets and Indicators, Bangladesh Planning Commission, pp. 18–21).
Implementation of the project will facilitate:

- Production of qualified doctors and nurses;
- Provision of improved and specialized healthcare services;
- Development of a healthy, productive population; and
- Measurable progress against national planning frameworks and health-sector indicators.

Health Situation Analysis and Project Rationale
Despite relatively better performance in **Maternal Mortality Ratio (MMR: 420)** and **Neonatal Mortality Rate (NMR: 3.7)** in Rangamati, the district exhibits the **lowest level of health service coverage (14.70%)** among comparable districts of the Chattogram Division.
Moreover, compared to Chattogram and Khagrachhari districts, Rangamati recorded a **higher Crude Death Rate (6.0),** which exceeds the **national average (5.1)**. Consequently, Rangamati continues to demonstrate **consistently poorer health outcomes** among the four hill districts of the region.
These indicators clearly highlight the urgent need for strengthening healthcare infrastructure and human resources in Rangamati and its surrounding districts.

1.6 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

The EIA has been prepared in compliance with:

- Environment Conservation Act (ECA), 1995
- Environment Conservation Rules (ECR), 1997 (amended)
- DOE EIA Guidelines for Industrial and Infrastructure Projects
- National Environmental Policy, 2018
- Bangladesh Medical Waste Management Rules, 2008
- WHO guidelines for healthcare waste and wastewater management

The project falls under the **Red Category**, requiring a full-scale EIA and Environmental Clearance Certificate (ECC) from the DOE.

1.7 DESCRIPTION OF THE EXISTING ENVIRONMENT

1.7.1 Physical Environment

The project area is characterized by hilly terrain typical of Rangamati, with nearby surface water bodies, seasonal streams, and high annual rainfall. Ambient air quality is generally good, and noise levels are within permissible limits due to the absence of heavy industries in the immediate vicinity.

1.7.2 Biological Environment

The surrounding area includes mixed vegetation and limited wildlife typical of semi-urban hill tracts. No ecologically critical areas (ECA) or protected forests were found within the immediate project footprint.

1.7.3 Socio-economic Environment

The project area supports local communities dependent on agriculture, trade, and services. The proposed hospital and educational institutions are expected to significantly enhance access to healthcare, employment opportunities, and skill development.

1.8 ENVIRONMENTAL SUSTAINABILITY, CLIMATE RESILIENCE, AND DISASTER RISK ANALYSIS

1.8.1 Environmental and Climate Risk Analysis

(a) Environmental Hazards and Climate Change Risks

1. **Landslide Risk**: High due to rainfall of **3,031 mm**, exceeding the national annual average of **2,200 mm**.
2. **Potential Impact on Environmental Balance**: Construction may affect local ecology and biodiversity.
3. **Seismic Zone**: Medium-risk earthquake-prone area.
4. **Impact on Aquatic Habitats**: Rivers, canals, wetlands, and floodplains host diverse aquatic flora and fauna, supporting livelihoods, food, and economic benefits for local communities. Key species include: **Catla, Bacha, Puntius, Punti, Bais, Mola, Chela, Tengra, Magur, Air, Batas, and Kajri**. Water pollution is a potential environmental concern.

(b) Risk Mitigation Measures

1. **Landslide Risk**: Construct retaining walls along pond and lake edges; plant trees and grass; implement emergency preparedness and relocation plans.
2. **Environmental Balance**: Reduce impact by preserving trees and water bodies; conduct afforestation.
3. **Seismic Area**: Use **earthquake-resistant construction techniques**.
4. **Aquatic Habitat Protection**: Preserve water bodies during construction; avoid encroachment.

(c) Environmental Impact Assessment (EIA)

The EIA analysis indicates that the proposed project is **environmentally friendly**. If proper management is followed, it **will not cause long-term damage to the surrounding environment.**

Environmental Management Measures Include:

- Proper operation and maintenance
- Environmental Management System (EMS)
- Staffing for environmental management and monitoring cell
- Regular environmental monitoring and reporting

(d) Compensation, Rehabilitation, and Resettlement

- Only **four households** exist on the proposed site. Local authorities confirmed that the land is largely **fallow**, so **resettlement is minimal**.
- **Compensation** has been paid to landowners as per **government-determined rates**. (See Annexure–D of DPP)

1.9 DISASTER RESILIENCE ASSESSMENT

- **Construction Phase Impacts**:
  - Excavation may trigger **landslides** and generate dust.
  - Nearby vegetation and Kaptai Lake water may be affected.
  - Temporary reduction in water quality may occur due to excavation and the use of fuel and lubricants.
- **Mitigation**:
  - Impacts are **temporary and site-specific**.
  - Can be controlled with **proper mitigation measures and monitoring systems**.

1.10 CONSTRUCTION PHASE MITIGATION, POST-CONSTRUCTION IMPACTS, AND FINANCIAL & ECONOMIC ANALYSIS

1.10.1 Construction Phase Mitigation Measures

- The project design must **preserve existing ponds and lakes.**
- Excavation work should use **backhoe excavators.**

- During excavation, **water spraying** and **air barriers** should be used to control dust.
- **Retaining structures** must be constructed to prevent soil erosion.
- Small-scale architectural adjustments should be made to **preserve existing trees**.
- **Local labor** should be prioritized for construction work to increase positive employment impacts.
- A **professional health and safety plan** must be in place for construction workers.

1.10.2 Post-Construction Impacts

- Limited movement of heavy vehicles after construction will **minimize air quality deterioration due to dust.**
- Existing natural water bodies will be preserved, ensuring **no disruption to natural drainage.**
- There will be **no localized waterlogging** in surrounding areas.
- No underground infrastructure is planned that would affect groundwater.
- Improper management of **medical waste** could negatively impact **Kaptai Lake and the environment.**
- Minimal noise or air pollution is expected due to the nature of medical and educational activities.
- No activities are planned that could negatively affect **local biodiversity.**
- The likelihood of large-scale accidents or hazards is low.

1.10.3 Post-Construction Mitigation Measures

- Regular monitoring of **wastewater and drainage systems** within the campus and surrounding areas.
- Ensure that **contaminated water does not enter ponds or Kaptai Lake**.
- **Segregated waste management systems** for infectious, anatomical, and chemical waste.
- Installation of a **modern waste management plant** to significantly reduce negative impacts.
- Fire protection and professional **occupational health safety measures** must be implemented.

1.10.4 Construction Phase Impacts

- Temporary increase in dust and noise levels
- Soil erosion and sediment runoff

- Generation of construction wastewater and solid waste
- Increased traffic and occupational health risks

1.10.5 Operation Phase Impacts

- Generation of medical and domestic wastewater
- Medical and hazardous waste generation
- Air emissions from generators
- Increased demand for water and energy
- Risk of surface water and groundwater contamination if unmanaged

1.10.6 Analysis of Alternatives

Alternatives were considered in terms of:

- Site selection
- Building layout and orientation
- Wastewater treatment technologies
- Waste management practices

The selected option was found to be the most suitable in terms of environmental compatibility, accessibility, service delivery, and sustainability.

1.11 ENVIRONMENTAL MANAGEMENT AND MITIGATION MEASURES

A comprehensive **Environmental Management Plan (EMP)** has been developed covering construction and operation phases.

1.11.1 Water Environment Management

- Installation of **ETP and STP** to treat hospital and domestic wastewater
- Reuse of treated water for toilet flushing, gardening, and road washing
- Total budget allocation:
  - Medical Waste Management System: **BDT 165,000,000**
  - Sewage Treatment Plant (STP): **BDT 75,000,000**

1.11.2 Medical and Solid Waste Management

- Segregation at source following color-coded bins
- On-site treatment and safe storage
- Disposal through authorized waste management facilities
- Compliance with Medical Waste Management Rules, 2008

1.11.3 Air and Noise Pollution Control

- Use of low-noise equipment
- Acoustic enclosures for generators
- Regular maintenance and emission control systems

1.11.4 Occupational Health and Safety

- Provision of PPE
- Safety training and emergency response plans
- Infection control protocols for hospital operations

1.12 ENVIRONMENTAL MONITORING PLAN

A detailed monitoring plan has been proposed, including:

- Effluent quality monitoring (pH, BOD, COD, TSS, pathogens)
- Noise and air quality monitoring
- Waste management audits
- Compliance reporting to DOE

An **Environmental Management Unit (EMU)** will oversee implementation and monitoring.

1.13 PUBLIC CONSULTATION AND DISCLOSURE

Stakeholder consultations were conducted with residents, community representatives, and relevant authorities. Key concerns related to wastewater management, employment opportunities, and public health were addressed and incorporated into the project design.

1.14 INSTITUTIONAL ARRANGEMENT AND CAPACITY BUILDING

Clear institutional responsibilities have been defined for:

- Environmental compliance
- Operation of ETP, STP, and waste systems
- Reporting and corrective actions

Training programs will be conducted for staff involved in environmental and waste management.

1.15 CONCLUSION

The Environmental Impact Assessment concludes that the proposed Medical College Hospital, Medical College, and Nursing College Project is **environmentally feasible,** provided that the recommended mitigation and management measures are fully implemented. With adequate budget allocation, modern treatment facilities, and strict monitoring, the project will deliver significant **social and health benefits** while maintaining compliance with environmental standards.

CHAPTER 2 GENERAL INFORMATION

2.1 BACKGROUND OF THE PROJECT

To achieve the Sustainable Development Goals (SDGs), particularly Universal Health Coverage (UHC), and to decentralize medical education and specialized healthcare services at the district level, the Government of Bangladesh has undertaken an initiative to establish six medical college hospitals in Netrokona, Nilphamari, Noakhali, Habiganj, Magura, and Rangamati.

The Institute of Health Economics, University of Dhaka, conducted feasibility studies for the infrastructure development of these six medical college hospitals. This feasibility study report evaluates the suitability and feasibility of constructing the physical infrastructure of Rangamati Medical College and Hospital at the proposed site.

2.1.1 Project Context

Item	Description
Establishment of Rangamati Medical College	The medical college was established in 2028.
Current Campus Status	The college is currently operating from a temporary campus located within the premises of Rangamati District Hospital.
Academic Operation	Academic activities have been continuing since the 2014–2015 academic session despite severe space constraints.
Temporary Infrastructure	The temporary campus is located in a building previously used as the Coronary Care Unit (CCU) of the General Hospital.
Student Intake	The college currently has 5 batches with 51 students per batch, totaling 249 students (from 2nd year onwards).
Faculty Strength	A total of 61 teachers are serving on deputation.
Internship Arrangement	Due to a lack of facilities, the first batch completed their internship at Chattogram Medical College Hospital. Current students are completing internships at Rangamati General Hospital.
Identified Constraints	Inadequate academic space, insufficient clinical facilities, lack of residential accommodation, and absence of specialized healthcare infrastructure.

2.1.2 Feasibility Justification

Aspect	Feasibility Consideration
Infrastructure Feasibility	The proposed site is suitable for the construction of a full-fledged medical college, hospital, and nursing college.

Academic Feasibility	Permanent academic infrastructure will enable expansion from a limited intake to full capacity.
Healthcare Feasibility	The establishment of a 600-bed hospital will significantly improve access to specialized healthcare in the hill districts.
Regional Importance	Rangamati, Khagrachhari, and Bandarban districts will benefit from decentralized healthcare and medical education.
Social Feasibility	Improved health services and employment opportunities will enhance socio-economic conditions in this underserved region.

2.2 OBJECTIVES, SCOPE, AND METHODOLOGY OF THE FEASIBILITY STUDY

As the estimated cost of the proposed project exceeds BDT 50 crore, a feasibility study is mandatory under Government regulations before project implementation. In addition, the feasibility study plays a critical role in assessing whether public investment in such a project will be viable and effective.

The specific objectives of the feasibility study are as follows:

Sl. No.	Objectives
1	To assess the necessity of establishing a Medical College Hospital at the proposed location.
2	To analyze the potential economic impacts of the project.
3	To assess the social and environmental impacts associated with the proposed project.
4	To identify and analyze potential risks and threats related to the establishment of the Medical College Hospital at the proposed site.

Scope and Methodology of the Feasibility Study

The feasibility study report has been prepared through an in-depth analysis of opportunities, risks, and challenges associated with establishing the Rangamati Medical College Hospital at the proposed site.

Both **primary and secondary data** were used to assess the potential **economic, social, and environmental impacts** of establishing the Medical College and Hospital at the proposed location.

To ensure a comprehensive assessment of all aspects of feasibility, the following approaches were adopted:

Method	Description
Review of Secondary Data	Analysis of existing reports, statistical data, policies, and sectoral documents.

Community Surveys	Collection of primary data through structured community-level surveys.
Key Informant Interviews (KII)	Interviews with relevant officials and stakeholders.
Focus Group Discussions (FGD)	FGDs conducted with landowners, local government representatives, and affected persons.
Institutional Consultations	Consultative meetings held with the Deputy Commissioner, Additional Deputy Commissioner (Revenue), Land Acquisition Officer, Department of Agriculture, Public Works Department, and other relevant government offices.
Academic Consultation	Meetings with Medical College administration and faculty members to assess institutional needs and expectations.
Field Investigation	Physical inspection of the proposed project site and surrounding areas.

RANGAMATI MEDICAL COLLEGE AND HOSPITAL AND NURSING COLLEGE intends to build a 600-bed hospital at Rangamati Sadar, Rangamati. Geographically, the project lies between 22°39'05.0"N & 92°09'56.1"E.

Item	Description
Project Name	Rangamati Medical College & Hospital and Nursing College
Sponsoring Ministry / Division	Health Services Division, Ministry of Health and Family Welfare
Implementing Agency	Directorate General of Health Services (DGHS)
Sector / Sub-Sector	Socio-Economic Infrastructure Sector – Health
Project Type (as per ECR2023)	Red Category
Estimated Project Cost	BDT 1,295.013 crore
Project Duration	From 01 July 2024 to 30 June 2028
Project Location	Southwest of Rangamati General Hospital, near the town
– Division	Chattogram
– District	Rangamati
– Upazila	Rangamati Sadar
–Municipality	Rangamati Sadar Municipality
Outputs	One (1) Medical College Hospital with 600 beds was constructed

	One (1) Medical College with a capacity for 500 students was established
	One (1) Nursing College with 100 seats was established.
	Construction of nursing hostel, male and female student hostels, intern doctors' dormitory, emergency staff dormitory, nurses' dormitory, and senior teachers' accommodation
	Medical and surgical equipment, furniture, and required manpower were procured.
Mouza	102 Rangapani
Total Area	25.95 acres
Land Type	Fallow hilly land, but some is flat land.
Wetlands	Total 7.78 acres (ponds and small lakes)
Mosque	None
Temple	None
Archaeological Sites	None
Graveyard / Crematorium	None
Land Acquisition Status	Completed and handed over to the Project Director
Land Value	Bazar Rate: BDT 227,000 per unit
Total Cost of Land Acquisition	As per the valuation

2.3 STEPS IN THE EIA PROCESS

EIA steps are shown in the flowchart:

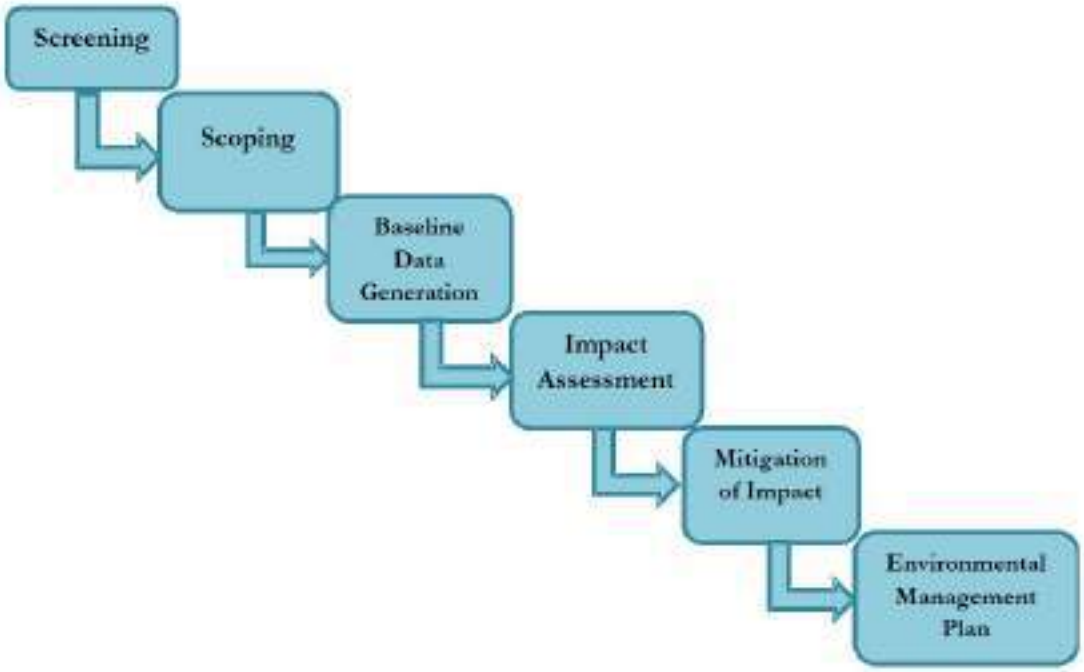


Figure 2-1 Flowchart of EIA Steps

2.4 RANGAMATI MEDICAL COLLEGE AND HOSPITAL AND NURSING COLLEGE COMMITMENTS

We adhere to the rules and regulations governing land use, guided by government regulations and various codes. We always uphold the basic code of conduct that is stated below-

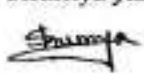
- Child labor is strictly prohibited.
- Providing pure drinking water to the customers.
- No Discrimination for hiring people;
- First aid treatment and legal minimum wages;
- Strictly maintained overtime hours and payments, as well as safety.
- Deliver the social-economic benefits to employees and our dependents to uplift their livelihood.
- Complying with applicable environmental legislation and regulations;
- Conservation of natural resources through responsible management of energy and water use;
- Adopting cost-effective measures in the prevention of pollution from our processes;
- Motivating and preparing all employees to take personal accountability for protecting the environment;
- Planning, implementing, and reviewing environmental objectives and targets;

2.5 EIA TEAM

A good, qualified, knowledgeable, and energetic Global Environmental and Textile Technological Services team has contributed to the preparation of this EIA report. They are experts in different fields of engineering, science, and sociology. During the preparation of this report, they have sat

together, held roundtable meetings, conducted field visits, and had conversations with clients and people near the project.

Table 2-1 EIA Team

S. L.	Profile	Details		Expertise sector
1	**Professor Md. Mostafizur Rahman, PhD**	Designation	Professor Department of Environmental Sciences	• Pollution Control, Prevention, and Monitoring. • Pollution Control and Prevention (ETP, STP) and Monitoring. • Waste Management • General Environmental Management,
		Title	Tam leader	
		Qualification	PhD, Environmental Science	
		Experience	20 years	
		Institution	Jahangirnagar University	
		Mail ID	Env.mustafiz@yahoo.com	
3	**SK. Abdul Latif** 	Designation	Mechanical Engineer	• Pollution Control and Prevention (ETP, STP) and Monitoring. • General Environmental Management,
		Title	Team Member	
		Qualification	Mechanical Eng.,	
		Experience	12 years	
		Institution	DUET	
		Mail ID	latif_pintu@yahoo.com	
4	Md. Mizanur Rahman 	Designation	Civil Engineer	• Control and Prevention (ETP, STP) and Monitoring. • Land Use Planning • Waste Management • Groundwater and Hydrology
		Title	Team Member	
		Qualification	Dip. in Civil Engr. PPI	
		Experience	12 years	
		Mail ID	mizanglobal14@gmail.com	
5	**Md. Shaik Hassan Ashik** 	Designation	Team Member	• Modeling and Prediction of Pollution Control and Prevention (ETP, STP) and Monitoring. • Waste Management • General Environmental Management, • Social Impact Assessment • Risk Assessment and Hazard Management • Health Impacts assessment
		Title	Environmental Chemist	
		Qualification	MSc. In Chemistry	
		Experience	6 Years	
		Institution	Jagannath University, Dhaka	
		Mail ID	ashik111955@gmail.com	
6	**Shumya Jannat** 	Designation	Environmental Executive	• Ecology and Biodiversity • Land Use Planning • General Environmental Management, • Social Impact Assessment
		Title	Team member	
		Qualification	B.Sc. & M. Sc. in Environmental Sciences	
		Experience	5 years	
		Institution	Jahangirnagar University	

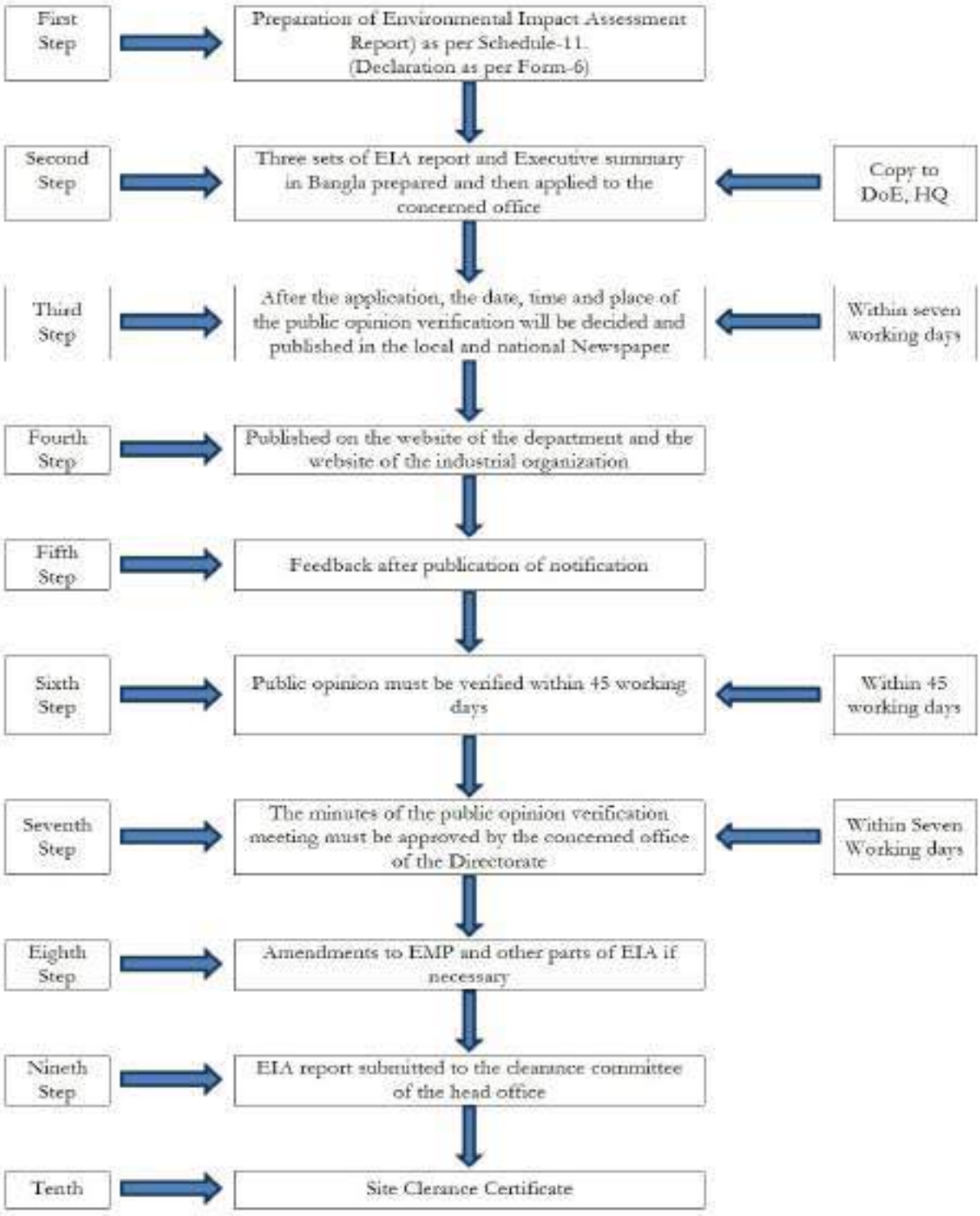
		Mail ID	shumya.getts@gmail.com	
5	**Joy Barua**	Designation	Team Member	• Project responsible
		Title	Civil Construction	
		Qualification	B.S.C. in Civil Engineering Experience:11 years in construction-related works	
		Experience	11 Years	
		Mail ID	joybarua089@gmail.com	
6	**Mohammad Taukir Hossain.**	Designation	Mechanical Works. Qualifications: B.S.C. in Mechanical Engineering Experience: 4 years in construction-related work. Email: taukirhossain280@gmail.com	• Project Responsible

2.6 PROCEDURE FOR OBTAINING SITE/ENVIRONMENTAL CLEARANCE

All industries and projects in the red category must conduct EIAs, which help understand the potential extent of environmental changes and identify mitigation measures by considering available experience or standard operating practices. The steps for conducting EIAs are:

- Collection of baseline information with respect to the project and the environmental setting of the project and its site.
- Setting boundaries of an IEE by identifying the significant issues.
- Impact assessment suggesting mitigation measures, Environmental Management Plan (EMP), or alternative sites or other project modifications.
- If the IEE of the project or industry reveals that further investigation is to be carried out, the sponsors will have to carry out a detailed EIA.

2.6.1 Procedure



After completion of the EIA Report, the project proponent should apply to the DOE in the prescribed format for site/ environmental clearance. The application for environmental clearance for the project classified in the Red Category should be accompanied by the following documents:

- Feasibility Study Report of the industry (project)
- IEE report
- An NOC (No Objection Certificate) from the local authorities concerned
- Pollution minimization plan, including an emergency plan for mitigation of adverse environmental impacts

- Outline of relocation plans (where applicable)
- Other information as deemed necessary

Environmental Conservation Rules-2023 ensure the right of any aggrieved party to appeal against the notice order or decision to the appellate authority. The appeal should be made to the appellate authority with clear justification and the attested copy of the DoE office against which the appeal is to be made. The focus of the ECR, 2023, lies with the classification of industries into three main categories, i.e., Green, Orange, and Red, based on their pollution potential. Documents required by respective DoE divisions for different categories are as follows:

2.7 NATIONAL ENVIRONMENTAL STANDARDS/GUIDELINES

Bangladesh Environmental standards and guidelines relevant to the construction and operation of the project cover the following issues:

- Water Quality
- Atmospheric emissions and ambient air quality;
- Liquid effluent discharges
- Noise emissions and ambient noise levels.

2.7.1 Water Quality

Table 2-2 Standard for Inland Surface Water

Best practice-based classification		Parameter											
		pH	DO mg/l	BOD mg/l	NO$_3$-N mg/l	NH$_4$-N mg/l	PO$_4$-P mg/l	Total Cr mg/l	Pb mg/l	Hg mg/l	Total Coliform Number/100 ml	TDS mg/l	COD mg/l
1.	Source of drinking water for supply only after disinfecting	6.5 - 8.5	≥6	≤2	7	0.1	0.1	0.02	0.03	0.001	≤100	1000	10
2.	Water usable for recreational activity	6.5 - 8.5	≥5	≤3	7	0.3	0.5	0.2	0.05	0.001	≤50	1000	10
3.	Source of drinking water for supply after conventio	6.5 - 8.5	≥5	≤3	7	0.3	0.5	0.02	0.03	0.001	≤5000	1000	25

	nal treatment												
4.	Water usable by fisheries	6.5 - 8.5	≥5	≤6	7	0.3	0.5	0.05	0.1	0.004	≤5000	1000	50
5.	Water usable by various process and cooling industries	6.5 - 8.5	≥1	12	-	2.7	-	0.1	0.1	0.05	-	1000	100
6.	Water usable for irrigation	6.5 - 8.5	-	≤12	5	1.5	2.0	0.1	0.1	0.002	≤50000	1000	100

Source: Schedule 2, Environmental Conservation Rules-2023, Inland surface water parameter

Notes:

1. Electrical conductivity for irrigation water –2250 µmhoms/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

Table 2-3 Standards for Drinking Water

S.N.	Parameter	Unit	Standards
1.	Fecal Coliform	CFU/100 ml	0
2.	Total Coliform	"	0
3.	Free Residual Chlorine	mg/l	0.20
4.	Nitrate (NO_3)	mg/l	45
5.	Arsenic (As)	mg/l	0.05
6.	Turbidity	NTU	5
7.	Aluminum	mg/l	0.20
8.	Ammonia (NH_3)	"	1.50
9.	Barium (Ba)	"	0.70
10.	Benzene (C_6H_6)	"	0.01
11.	Boron (B)		1.0
12.	Cadmium (Cd)	"	0.003
13.	Calcium	"	75
14.	Chloride	"	250*
15.	Carbon Tetra-chloride (CCL_4)	mg/l	0.005
16.	1,1 Dichloro Ethylene (1,1 $C_2H_4Cl_2$)	"	0.03
17.	1,2 Dichloro Ethylene (1,2 $C_2H_4Cl_2$)	"	0.03
18.	Tetrachloro Ethylene ($C_2H_4Cl_2$)	"	0.04
19.	Trichloro Ethylene ($C_2H_3Cl_3$)	"	0.02
20.	Pentachlorophenol	mg/l	0.09
21.	2,4,6 trichlorophenol	"	0.20
22.	Chloroform	"	0.09
23.	Total Chromium (Total Cr)	"	0.05
24.	Color	Hazen Unit	15

25.	Copper	mg/l	1.5
26.	Cyanide (CN)	"	0.05
27.	Fluoride	"	1.0
28.	Hardness (as $CaCO_3$)	"	500
29.	Iron (Fe)	"	0.3-1.0
30.	Total Kjeldhl Nitrogen	"	1.0
31.	Lead (Pb)	"	0.01
32.	Magnesium (Mg)	"	30-35
33.	Manganese (Mn)	"	0.4
34.	Mercury (Hg)	"	0.001
35.	Nickel (Ni)	"	0.05
36.	Nitrite (NO_2)	"	1.0
37.	Odor	-	Odorless
38.	Oil and grease	mg/l	0.01
39.	p^H	-	6.5-8.5
40.	Phenolic compounds	mg/l	0.002
41.	Potassium (K)	"	12
42.	Radioactive materials (gross alpha activity)	Bq/l	0.1
43.	Radioactive materials (gross beta activity)	"	1.0
44.	Selenium (Se)	mg/l	0.01
45.	Silver	"	0.02
46.	Sodium (Na)	"	200
47.	Suspended Solid (SS)	"	10
48.	Sulfide as H_2S	"	0.05
49.	Sulfate (SO_4^{-2})	"	250
50.	Total dissolved solids (TDS)	"	1000
51.	Temperature	°C	20-30
52.	Tin (Sn)	mg/l	2.0
53.	Zinc (Zn)	mg/l	5.0
54.	Aldrin/Dieldrin	µg/l	0.03
55.	Anionic detergent	mg/l	0.2

Source: Environmental Conservation Rule-2023, Schedule-2, Standards for drinking water

Note

*For estuarine area 1000 mg/l

Table 2-4 Standard for Sewage Discharge

Parameter	Unit	Standard Limit
Temperature	Degree Centigrade	30
pH	-	6-9
BOD_5 at 20°C	mg/l	30
COD	mg/l	125
Suspended Solids (SS)	mg/l	100
Oil & Grease	mg/l	10
Nitrate (NO_3)	mg/l	50
Phosphate (PO_4)	mg/l	15
Total Coliform	Number/100 ml	1000

Source: Environmental Conservation Rule-2023, Schedule-6, Standards for sewage discharge

Note: 1. The limit shall apply to discharges into surface and inland water bodies.

2. Sewage shall be chlorinated before final discharge.

2.7.2 Ambient Air Quality

Table 2-5 Standards for Air

S.N.	Categories of Area	Suspended Particulate Maters (SPM)	Sulphur-dioxide (SO_2)	Carbon Monoxide (CO)	Oxides of Nitrogen (NOx)
		৵g/m³	৵g/m³	৵g/m³	৵g/m³
a.	Industrial and mixed	500	120	5000	100
b.	Commercial and mixed	400	100	5000	100
c.	Residential and rural	200	80	2000	80
d.	Sensitive	100	30	1000	30

Source: Schedule 2, Environmental Conservation Rules, 1997, and Air Pollution Control Rules 2022

Notes:

1. At the national level, sensitive area includes monuments, health center, hospitals, archeological sites, educational institutions, and government-designated areas (if any).
2. Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas specified at Sl. nos. c and d above.

Suspended Particulate Matter means airborne particles of a diameter of 10 micron or less.

Table 2-6 Standard for Odor

Sl. No.	Parameter	Unit	Value
1	Acetaldehyde	Ppm	0.5-5
2	Hydrogen sulfide	Ppm	0.02-0.20
3	Methyl disulfide	Ppm	0.009-0.10
4	Methyl mercaptan	Ppm	0.02-0.20
5	Methyl sulfide	Ppm	0.01-0.20
6	Styrene	Ppm	0.4-2.00
7	Tri-methyl-amine	Ppm	0.005-0.07
8	Ammonia	Ppm	1-5

Source: Air Pollution Control Rules, 2022, Standards for odor.

Table 2-7 Standard for Emissions from Motor Vehicles

Parameter	Unit	Standard Limit
Black Smoke	Hartridge Smoke Unit (HSU)	**65**
CO	gm/km	**24**

	percent area	04
Hydrocarbon	gm/km	02
	ppm	180
NOx	gm/km	02
	ppm	600

Source: Environmental Conservation Rule-1997 and Air Pollution Control Rules, 2022, Schedule-6, Standards for emission from motor vehicles *As measured at two-thirds of maximum rotating speed.

2.7.3 Ambient Noise Standards

Table 2-8 Standards for sound

SN	Category for sound	Standards determined (dBA)	
		Day	Night
a.	Silent Zones (Sensitive areas such as parks, schools, hospitals, and mosques)	50	40
b.	Residential areas	55	45
c.	Mixed areas (mainly residential areas, and also simultaneously used for commercial and industrial purposes)	60	50
d.	Commercial areas	70	60
e.	Industrial areas	75	70

Source: Schedule 1, Sound Pollution Rules, 2025

Notes: *The time from 6 a.m. to 9 p.m. is counted as daytime.*

- *The time from 9 p.m. to 6 a.m. is counted as nighttime.*
- *Area up to a radius of 100 meters around hospitals, educational institutions, or special institutions/ establishments identified/ to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers is prohibited.*

CHAPTER 3 PROJECT DESCRIPTION

3.1 GENERAL INFORMATION

The proposed project titled "Establishment of Rangamati Medical College and Hospital and Nursing College, Rangamati" is a Government of Bangladesh (GoB) initiative undertaken under the Ministry of Health and Family Welfare (MoHFW). The project was approved through the Development Project Proposal (DPP) in June 2024 to strengthen medical education, healthcare delivery, and research facilities in the Chattogram Hill Tracts (CHT) region. The project is designed as an integrated medical education and healthcare complex comprising a medical college, a teaching hospital, and a nursing college, supported by essential academic, residential, and utility infrastructure.

The establishment of this institution is strategically essential, as there is currently no medical college in the CHT region, and the nearest public medical college hospital is approximately 80 km from Rangamati. The project is therefore expected to significantly improve access to quality healthcare services for the local population and create opportunities for higher medical education within the region.

- To establish a full-fledged government medical college and teaching hospital in Rangamati district.
- To improve access to quality and specialized healthcare services for the people of the Chattogram Hill Tracts.
- To enhance medical education, clinical training, and research facilities in a geographically underserved region.
- To produce skilled medical doctors, nurses, and allied healthcare professionals in line with national healthcare goals.
- To contribute to the achievement of Sustainable Development Goals (SDG) 3 (Good Health and Well-being) and SDG 4 (Quality Education).
- To generate direct and indirect employment opportunities during construction and operation phases.

Geographically, the project is between **22°39'05.0"N & 92°09'56.1"**E. The total area of the proposed project will be **25.96 acres, with Wetlands Totaling 7.78 acres (ponds and small lakes).**

Rangamati Medical College and Hospital and Nursing College proposed the establishment of this project. According to the ECR 2023, the project is categorized as **RED** under **Schedule 1, Serial Number 69**; therefore, it requires an EIA study for its Site Clearance Certificate. this EIA report on this project is as per the DoE guideline. Accordingly, this EIA report has been prepared.

3.2 NECESSITY OF THE PROJECT, REASONS FOR SETUP, AND BENEFITS

3.2.1 Necessity of the Project

The establishment of the **Rangamati Medical College and Hospital and Nursing College, Rangamati** is a critical necessity arising from the long-standing inadequacy of advanced healthcare

facilities and medical education institutions in the Chattogram Hill Tracts (CHT) region. Rangamati district and the surrounding hill districts are geographically remote, environmentally sensitive, and socio-economically lagging compared to other parts of Bangladesh. At present, there is **no government medical college or tertiary-level teaching hospital within the CHT region**, compelling patients to travel long distances—often more than 80 km to Chattogram city—to access specialized medical care. This situation results in delayed treatment, increased healthcare costs, and, in many cases, preventable morbidity and mortality.

From an educational perspective, aspiring medical and nursing students from the region face significant barriers due to the absence of nearby institutions, leading to reduced enrollment from local communities and limited availability of trained healthcare professionals willing to serve in the hill districts. The project is therefore essential to address regional disparities in healthcare access and medical education, in line with national equity and inclusive development objectives.

Reasons for Setup

The key reasons for setting up the proposed medical college, hospital, and nursing college include the following:

- **Regional Healthcare Gap:** The existing healthcare infrastructure in Rangamati district is insufficient to meet the growing demand for secondary and tertiary healthcare services for a diverse and scattered population living in rugged terrain.
- **Absence of Medical Education Facilities:** The lack of medical and nursing education institutions in the CHT region has resulted in a chronic shortage of locally trained doctors, nurses, and paramedical staff.
- **Government Policy Priority:** The project aligns with the Government of Bangladesh's policy priorities under the Ministry of Health and Family Welfare to expand medical education capacity and strengthen public healthcare delivery, particularly in underserved and remote regions.
- **Sustainable Development Goals (SDGs):** The project directly supports SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education) by improving access to healthcare services and higher education opportunities.
- **Population Growth and Service Demand:** With increasing population and disease burden, existing district-level health facilities are under pressure, making the establishment of a teaching hospital and medical college both timely and necessary.
- **Strategic Regional Development:** Development of a significant institutional facility, such as a medical college, acts as a catalyst for overall regional development, including infrastructure improvement, service sector growth, and human capital development.

Benefits of the Project

The proposed project is expected to generate wide-ranging benefits at local, regional, and national levels, as outlined below:

Healthcare Benefits:

- Improved access to quality preventive, curative, and emergency healthcare services for the people of Rangamati and the wider CHT region.
- Availability of specialized diagnostic and treatment facilities within a reasonable travel distance.
- Strengthening of public health preparedness and response capacity in a geographically vulnerable region.

Educational and Human Resource Benefits:

- Creation of a permanent institutional platform for medical and nursing education in the CHT region.
- Increased production of qualified doctors, nurses, and healthcare professionals, with a higher likelihood of local retention.
- Enhancement of clinical training, research, and academic collaboration opportunities.

Socio-Economic Benefits:

- Generation of direct and indirect employment opportunities during construction and operation phases.
- Stimulation of the local economy through demand for goods, services, housing, and transport.
- Improved quality of life and social well-being for local communities through better healthcare access.

Environmental and Institutional Benefits:

- Planned development with integrated environmental management systems, ensuring compliance with national environmental regulations.
- Opportunity to demonstrate environmentally responsible healthcare infrastructure development in a sensitive hill ecosystem.

In summary, the proposed Rangamati Medical College and Hospital and Nursing College is not only a necessary intervention to address critical healthcare and educational gaps in the Chattogram Hill Tracts but also a strategically important project that will contribute to sustainable regional development, social equity, and national healthcare objectives.

3.3 OBJECTIVES OF THE PROJECT

The primary objective of the **Rangamati Medical College and Hospital and Nursing College, Rangamati** project is to establish a comprehensive, government-owned medical education and healthcare institution that will address the critical shortage of quality healthcare services and trained medical professionals in the Chattogram Hill Tracts (CHT) region. The project is designed to function as an integrated hub for education, clinical services, research, and community health development.

The specific objectives of the project are as follows:

- **To establish a full-fledged medical college and teaching hospital** in Rangamati district that meets national standards for medical education and clinical training under the Ministry of Health and Family Welfare.
- **To develop a nursing college** with modern academic and practical training facilities to strengthen the nursing workforce and allied healthcare services in the region.
- **To improve access to secondary and tertiary healthcare services** for the population of Rangamati and surrounding hill districts by providing timely, affordable, and quality medical care.
- **To enhance human resource development in the health sector** by producing competent doctors, nurses, and healthcare professionals capable of serving both local and national needs.
- **To promote medical research and evidence-based practice**, particularly focusing on region-specific health issues prevalent in hilly and remote communities.
- **To strengthen referral and emergency healthcare systems** within the CHT region, reducing dependency on distant urban hospitals.
- **To ensure environmentally sound and sustainable infrastructure development**, integrating pollution control, waste management, occupational health and safety, and disaster preparedness measures.
- **To support national development goals and public health policies**, including alignment with Sustainable Development Goals (SDG 3 and SDG 4) and national health strategies.

To improve human health by producing qualified doctors and nurses to meet the national health manpower demand, and by providing enhanced general and specialized healthcare services to the people of Rangamati and its surrounding districts through the facilities created under the project.

3.4 SPECIFIC OBJECTIVES

Sl. No.	Specific Objectives
1	To produce qualified doctors and nurses to meet the growing demand for health manpower in the country.
2	To create necessary modern and specialized healthcare facilities for the general population of Rangamati and adjacent districts.
3	To provide improved general and specialized medical services to the people of Rangamati and neighboring districts through the developed facilities.
4	To reduce morbidity and mortality and improve overall quality of life through the provision of modern healthcare services.

Project Outcomes

Upon successful implementation and operation, the project is expected to achieve the following tangible and intangible outcomes:

Healthcare Service Outcomes:

- Establishment of a modern teaching hospital capable of delivering comprehensive outpatient, inpatient, emergency, diagnostic, and specialized healthcare services.
- Significant reduction in patient travel time and healthcare-related financial burden for residents of Rangamati and adjacent districts.
- Improved health indicators through early diagnosis, timely treatment, and enhanced preventive healthcare services.
- Strengthened the capacity of the public healthcare system in the CHT region to respond to medical emergencies, disease outbreaks, and public health challenges.

Educational and Institutional Outcomes:

- Operational medical college and nursing college providing accredited education and clinical training programs.
- Increased enrollment of students from the CHT region in medical and nursing education, promoting regional inclusion and equity.
- Development of a sustainable pipeline of trained healthcare professionals with higher retention potential in hill districts.
- Establishment of academic and clinical research activities contributing to national medical knowledge and policy formulation.

Socio-Economic Outcomes:

- Creation of substantial direct employment opportunities for medical, academic, administrative, and support staff.
- Indirect employment generation through construction activities, service provision, logistics, and local businesses.
- Stimulation of regional economic growth through increased demand for housing, transport, utilities, and commercial services.
- Improved social well-being and quality of life resulting from accessible healthcare and educational opportunities.

Environmental and Governance Outcomes:

- Implementation of environmentally compliant healthcare infrastructure with effective management of medical waste, wastewater, air emissions, and noise.
- Strengthened institutional capacity for environmental management, occupational health and safety, and emergency response within the facility.

- Demonstration of best practices in environmentally responsible public healthcare and educational infrastructure development in a sensitive hilly ecosystem

Project Inputs

The key inputs required for project implementation include:

Input Category	Details
Land	Land acquisition
Human Resources	Recruitment of project manpower and hospital staff
Infrastructure	Construction of the Medical College Hospital building
Academic Facilities	Construction of an academic building
Nursing Education	Construction of Nursing College building
Residential Facilities	Construction of nursing hostel, male and female student hostels, intern doctors' dormitory, emergency staff dormitory, nurses' dormitory, and senior teachers' accommodation
Equipment & Furniture	Procurement of medical and surgical equipment, furniture, and fixtures
Financing	Allocation of project funds

Project Outputs

Upon completion, the project will deliver the following outputs:

Sl. No.	Outputs
1	One (1) Medical College Hospital with 600 beds was constructed
2	One (1) Medical College with a capacity for 500 students was established
3	One (1) Nursing College with 100 seats was established
4	Construction of nursing hostel, male and female student hostels, intern doctors' dormitory, emergency staff dormitory, nurses' dormitory, and senior teachers' accommodation
5	Medical and surgical equipment, furniture, and required manpower were procured

3.5 BASIC INFORMATION

The basic data of **Rangamati Medical College and Hospital and Nursing College** is furnished in below Table.

The proposed project, Rangamati Medical College and Hospital and Nursing College, is a 600 bed hospital located at Ranamati Sadar, Rangamati.

The proposed project shall not be contrary to any development plan, policy, or decision of the Government.

3.6 BASIC DATA OF THE PROPOSED PROJECT

Table 3-1 Basic Project Information

Sl. No.	Item	Description
1.	Project Title	Rangamati Medical College & Hospital and Nursing College
2.	Project activities	• **600-bed Hospital services** • **1000 Outdoor patients per day.** • **Admission capacity increased to 100 medical students/year (from 51)** • **Admission capacity of 100 nursing students/year**
3.	Sponsoring Ministry / Division	Health Services Division, Ministry of Health and Family Welfare
4.	Implementing Agency	Directorate General of Health Services (DGHS)
5.	Concerned Sector of the Planning Commission	Socio-Economic Infrastructure Division (Health Wing)
6.	Overall Objective	To produce qualified doctors and nurses to meet national health manpower demand and to provide improved general and specialized healthcare services to the people of Rangamati and surrounding districts, thereby improving human health.
7.	Specific Objectives	• Production of qualified doctors and nurses •Development of modern and specialized healthcare facilities •Provision of improved general and specialized medical services in Rangamati and adjacent districts •Reduction of morbidity and mortality and improvement of quality of life
8.	Project Targets / Outputs	Construction of healthcare, academic, hostel, and residential facilities; procurement of equipment and furniture; recruitment of manpower, as detailed below
9.	Medical College Hospital	One 7-storied building with 600 beds; total floor area 50,706.00 sq. m
10.	Medical College Academic Building	One 7-storied building; total floor area 30,239.69 sq. m

11.	Nursing College Building	One 6-storied building; total floor area 6,191.94 sq. m
12.	Nursing Students' Hostel	One building; total floor area 3,948.35 sq. m
13.	Students' & Doctors' Dormitory (Male)	One 6-storied building for students, intern doctors, and unmarried doctors; total floor area 9,940.54 sq. m
14.	Female Students' Hostel	One 6-storied building for female medical students; total floor area 5,041.81 sq. m
15.	Intern Doctors' Dormitory (Female)	One 6-storied building; total floor area 4,642.33 sq. m
16.	Emergency Staff Dormitory	One 6-storied building (male & female); total floor area 7,974.73 sq. m
17.	Staff Nurses' Dormitory	One 6-storied building (male & female); total floor area 3,987.37 sq. m
18.	Senior Teachers' Accommodation	Two 6-storied buildings (male & female); each with floor area 2,329.25 sq. m
19.	Procurement of Equipment & Furniture	To be completed by May 2028
20.	Manpower Recruitment	Recruitment of 2,641 personnel by June 2028
21.	Project Implementation Period	July 2024 – June 2028
22.	Project Start Date	01 July 2024
23.	Project Completion Date	30 June 2028
24.	Estimated Project Cost	BDT 129,331.27 lakh
25.	Funding Source	Government of Bangladesh (GoB) – 100%
26.	Exchange Rate	USD 1 = BDT 117.95 (Bangladesh Bank, dated 27 June 2024)

Table 3-2 Project Background and Administrative Basis

Item	Description
Project Title	Establishment of Rangamati Medical College & Hospital and Nursing College
Proponent	Directorate General of Health Services (DGHS)
Ministry	Ministry of Health and Family Welfare
Purpose of Report	Determination of probable construction cost and documentation for DPP and EIA

Initial Cost Estimate Basis	PMO Memorandum No. 03.001.0000.00.00.01.2018-10, dated 03 April 2018
Planning Approval Reference	MoHFW Memorandum No. 30000.153.014.007.2017-48, dated 19 April 2018
DGHS Reference	Memorandum No. Ma.Aa./Pari. & Gabesh./203/2012/490, dated 09 May 2018
PEC Meeting	Held on 03 April 2024
DPP Restructuring	As per Planning Commission Memo No. 20.02.0000.052.14.129.23.31, dated 08 May 2024

3.6.1 Type and Source of Financing

Table 3-3 Project Financing

Source of Fund	Type of Financing	Amount (BDT in Lakh)
Government of Bangladesh (GoB)	Public Investment	129,331.27
Own Source	Not Applicable	0.00
Others	Not Applicable	0.00
Total		**129,331.27**

3.6.2 Estimated Year-wise Project Cost

Fiscal Year	GoB Fund (BDT in Lakh)	Own Fund (BDT in Lakh)	Total Cost (BDT in Lakh)
2024–2025	8,725.82	0.00	8,725.82
2025–2026	25,874.73	0.00	25,874.73
2026–2027	28,130.79	0.00	28,130.79
2027–2028	66,599.92	0.00	66,599.92
Total	**129,331.27**	**0.00**	**129,331.27**

3.6.3 Medium-Term Budget Framework (MTBF) and Financing Plan

Item	Description
MTBF Consideration	The project has been proposed in line with the Medium-Term Budget Framework (MTBF) and the required allocation for ADP-enlisted ongoing projects.
Total Financing Requirement	**BDT 129,331.27 lakh**
Source of Financing	Government of Bangladesh (GoB)

3.6.4 Project Area

Sl. No.	Division	District	Upazila / City Corporation / Municipality
1	Chattogram	Rangamati	Rangamati Sadar Municipality

3.6.5 Justification for Selection of Project Area

Sl. No.	Justification

1	The distance from Chattogram to Rangamati is approximately 80 km, which is the distance to the nearest medical college hospital. Therefore, the establishment of a medical college, hospital, and nursing college in Rangamati is justified.
2	The catchment area of Rangamati Medical College is extensive. Geographical analysis shows that Khagrachhari and Bandarban districts are adjacent, allowing students from these districts to access medical and nursing education.
3	Opportunities for higher education in hilly regions are limited; hence, establishing a medical college and a nursing college is necessary.
4	The hill districts have relatively few healthcare facilities. For advanced treatment, residents currently need to travel to Chattogram or Dhaka, which is costly and time-consuming. The project will provide access to quality healthcare for nearby residents.
5	In addition to producing doctors and nurses, the project will generate employment opportunities for other healthcare and support personnel, contributing to local socio-economic development.
6	The establishment of the medical college hospital and nursing college will reduce pressure on healthcare facilities in Chattogram and Dhaka and help decongest other district-level hospitals.
7	There are no private medical colleges or tertiary hospitals in the hilly region. In emergency or complex cases, the disadvantaged population must travel long distances, which is difficult and often impractical.
8	The region's geographical and economic importance is growing due to agricultural and tourism growth, making access to advanced healthcare services increasingly important.
9	The region's population is increasing steadily; therefore, proportional growth in medical and nursing manpower and healthcare infrastructure is essential, which will be addressed through the establishment of the medical college hospital and the nursing college.

Logical Framework Matrix (LFM)

Project Start Date (Planned): 01 July 2024
Project Completion Date (Planned): 30 June 2028

Narrative Summary (NS)	Objectively Verifiable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions (IA)
Goal	• By 2030, improved access to healthcare for people of all ages in Rangamati and adjacent districts in line with SDG-3 • Daily outpatient service capacity of approx. 1,000 patients • Inpatient services for 600 beds	• National & Local Health Bulletin • SDGs Progress Reports • Health Facility Survey Reports	• Political and economic stability maintained • No major public health or natural disasters
Purpose	• Establishment of modern and specialized healthcare facilities • Increased availability of qualified doctors and nurses • Improved doctor-population and nurse-doctor ratios • Decentralization of medical education and healthcare	• Directorate of Health Services Reports • Directorate of Nursing Reports • District Health Statistics (SDRS)	• Continued government support • Availability of trained manpower • Stable public health conditions

	services • Reduction in malaria-related mortality	• Ministry of Health Reports	
Outputs	• Admission capacity increased to 100 medical students/year (from 51) • Admission capacity of 100 nursing students/year (from 0) • 600-bed Medical College Hospital operational • Maternal and child mortality reduced by approximately 20% in Rangamati district • Hospital bed ratio increased from 6.75 to 19.32 per 10,000 population	• Project Completion Report (PCR) • Annual Progress Reports • Health Bulletins • Hospital Service Records	• Timely construction and procurement • Effective coordination among implementing agencies
Key Infrastructure Outputs	• Construction of 1 Medical College Hospital (50,706.00 sq. m, 600 beds) • Construction of Academic Building (30,239.69 sq. m) • Nursing College & Hostel completed • Student, intern, staff, and teacher residential facilities completed • Medical & surgical equipment and furniture installed	• PWD Reports • Construction Completion Certificates • Equipment Procurement Records	• No legal or land-related disputes • Contractors perform as scheduled
Inputs / Activities	• Acquisition of 25.95 acres of land (by Aug 2024) • Construction of hospital, academic, nursing, and residential buildings • Procurement of medical & surgical equipment by May 2028 • Recruitment of 2,641 hospital personnel by June 2028 • Appointment of project staff (6 persons)	• Land Acquisition Documents • Tender & Contract Documents • Recruitment Orders • Financial Disbursement Records	• Timely fund release • Inflation remains within manageable limits • Availability of logistics and materials
Financial Input	• Total estimated project cost: BDT 129,331.27 lakh • Entirely funded by the Government of Bangladesh (GoB)	• Approved DPP • Ministry of Finance Release Orders	• Continuous budget allocation ensured

3.7 PROPOSED PROJECT MANAGEMENT STRUCTURE

Table 3-4 Project Management and Implementation Arrangement

Item	Description
Project Office	A temporary Project Office will be established at the project site.
Project Director (PD)	One full-time Project Director will be appointed for overall project management and coordination.
Deputy Project Director (DPD)	One Deputy Project Director will be deputed to assist the PD.
Core Project Staff	One Accountant and one Computer Operator will be appointed on a direct basis for the duration of the project.
Outsourced Staff	One Diploma Engineer (Civil) and one Office Support Staff will be engaged on an outsourcing basis.
Procurement Consultant	One Procurement Consultant will be appointed at the end of the third year of project implementation to ensure efficient procurement, reporting directly to the PD.
Technical Consultant	One Consultant of Executive Engineer / Senior Assistant Architect rank will be attached to the Project Office for technical supervision.
Project Implementation Committee (PIC)	A PIC will be formed to monitor implementation progress and provide operational guidance.
Project Steering Committee (PSC)	A PSC will oversee policy-level guidance and strategic decision-making.
Monitoring Mechanism	PIC and PSC will meet quarterly; project progress will be inspected by IMED to ensure proper implementation.
Reference	Detailed implementation structure provided in Annexure-2 (Pages 22–23).

3.7.1 Project Implementation System

Component	Implementation Arrangement
Procurement of Medical Equipment, Furniture & Supplies	All procurement will be carried out in compliance with the Public Procurement Act (PPA), 2006, and Public Procurement Rules (PPR), 2008.
Basis of Cost Estimation	Cost estimates are prepared based on the Ministry of Health price schedule (2017), prevailing market rates, and comparison with recently approved similar projects.
Final Cost Determination	Final quantities, specifications, and prices will be determined at the time of procurement, taking into account technological suitability, market prices, and the foreign exchange rate.
Civil Works	Construction will be carried out under the supervision of the Public Works Department (PWD) and the Department of Architecture, in accordance with the approved Master Plan.
Construction Standards	The PWD Schedule of Rates 2022 will be followed along with full compliance with PPA-2006 and PPR-2008.

3.7.2 Post-Project Operation and Revenue Budget Requirement

Table 3-5 Post-Project Operation and Revenue Budget Requirement

Item	Description
Need for Revenue Budget Transfer	Yes, required after project completion.

Asset Transfer	All facilities created under the project will be transferred to the Revenue Budget after completion.
Manpower Creation	Posts for Medical College, Medical College Hospital, and Nursing College will be created under the Revenue Budget following due process.
Approval Authority	Proposals will be submitted to the Ministry of Public Administration and Finance Division for approval.
Salary & Operational Cost	Salaries, allowances, and operational expenses will be borne from the Revenue Budget.
Maintenance Arrangement	Operation and maintenance costs will be borne from the Ministry of Health and Family Welfare's annual revenue budget through the Public Works Department (PWD).

3.7.3 Alternative Arrangement (If Revenue Transfer Not Required)

Item	Status
Requirement for Alternative Arrangement	Not Applicable

3.7.4 Environmental Monitoring Plan

Parameter	Location	Frequency	Method	Responsibility
Flow (Inlet & Outlet)	ETP inlet/outlet	Continuous	Flow meter	ETP operator
pH, TSS, BOD, COD	ETP inlet/outlet	Daily	Laboratory	Environment Chemist
Color, TDS	ETP outlet	Weekly	Spectrophotometer	QA Lab
Noise Level	Near ETP & dyeing	Quarterly	Sound meter	HSE Officer
Sludge Quantity	Sludge drying bed	Monthly	Volume measurement	ETP Supervisor

3.8 LOCATION MAP OF THE PROJECT:

The project will be developed at Rangamati Sadar, Rangamati, 22°39'05.0 N & 92°09'56.1 E. This project will be rich in natural variety. Rangamati Medical College & Hospital and Nursing College. The developing authority will develop it totally in a planned way. A well-planned road network will be designed to improve transportation in the project area, enabling people to move easily throughout Bangladesh.

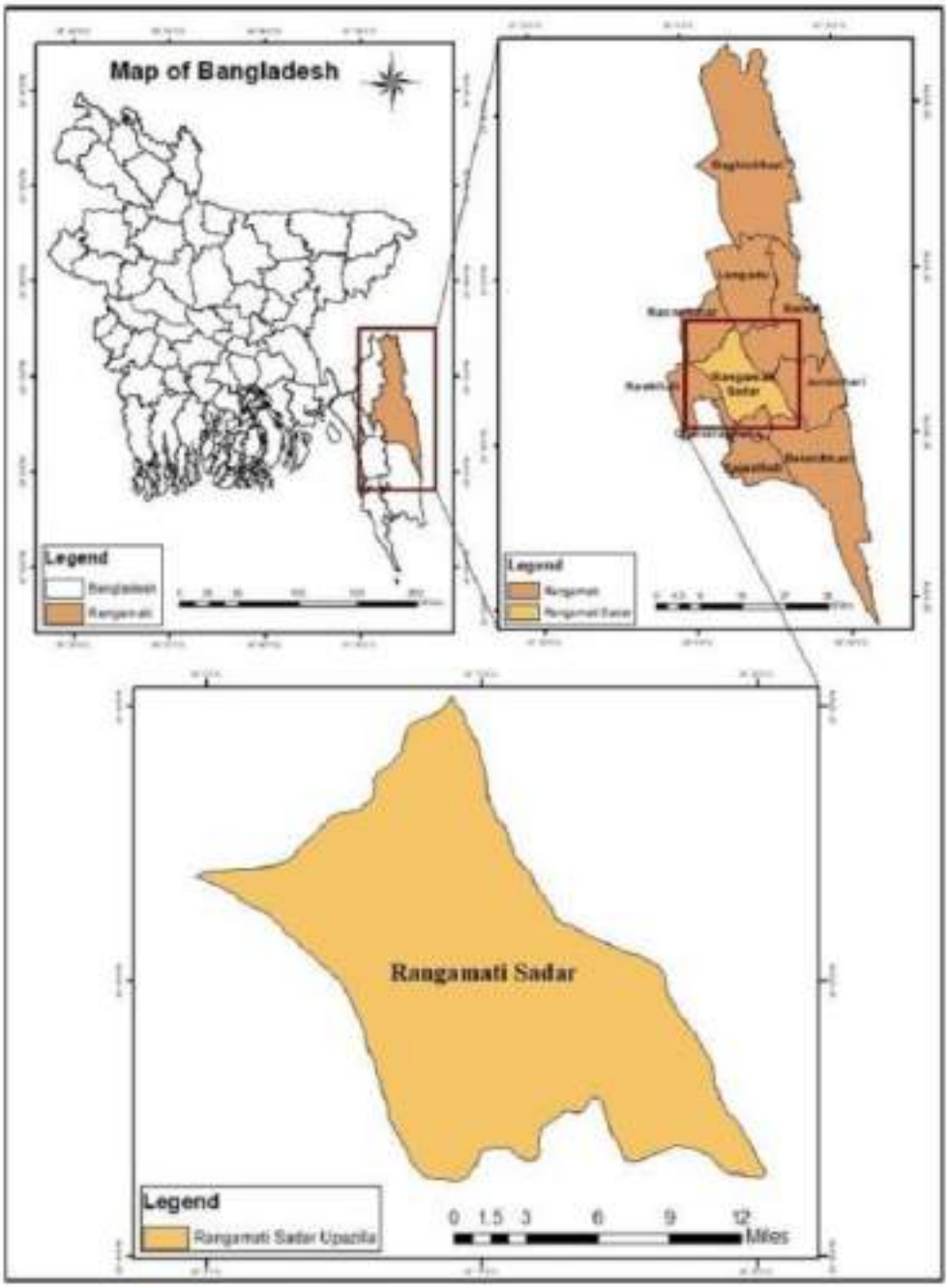


Figure 3-1 District Map

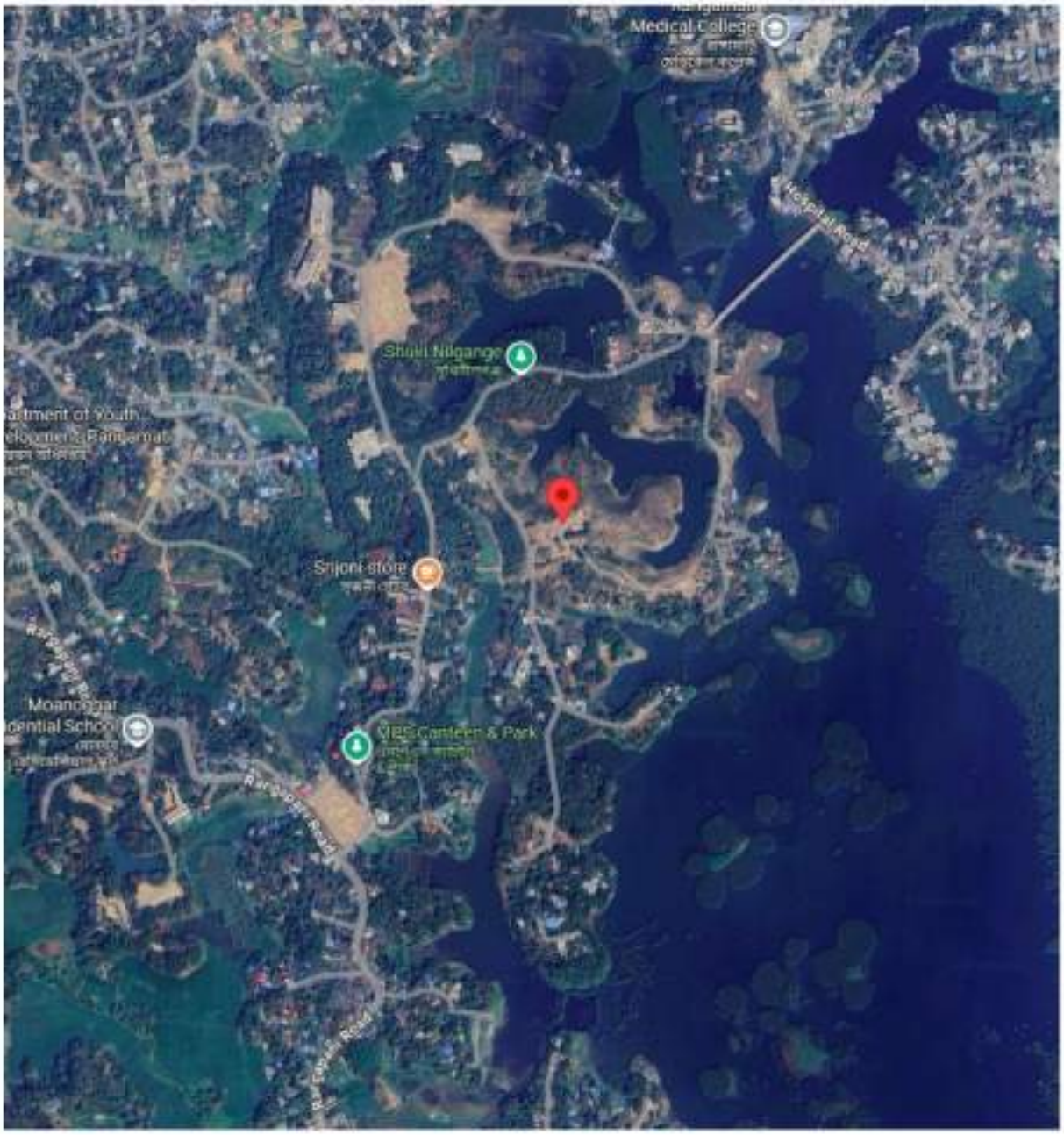


Figure 3-2 Location Map from Google Earth

Figure 3-3 Location with Master Lay-out Plan

Figure 3-4 The east side of the project.

Figure 3-5 Entry Road of the project site

Figure 3-6 Inside the water body

Figure 3-7 West Side of the project

Figure 3-8 The Medical College and Hospital building place

Figure 3-9 Medical College and Hospital building place

Figure 3-10 academic building, substation building, place

Figure 3-11 Inside the water body

Figure 3-12 Entry Road of the project

Surroundings of the project;

North, South, East, West	Description of the Project Area within a 1 km Radius The proposed site for the Rangamati Medical College Hospital and Nursing College is located in Rangamati Sadar Upazila. The land use pattern and surrounding environment within a 1 km radius of the project site are described based on the four cardinal directions as follows: North Within the northern side of the project area, the land is predominantly characterized by urban and semi-urban settlements associated with Rangamati town. Existing facilities include Rangamati General Hospital, residential houses, small commercial establishments, local roads, and public service infrastructure. The area is well connected by road networks and has access to basic utilities, including electricity, water supply, and communication facilities. South Natural features, including Kaptai Lake, Fallow hilly terrain, scattered vegetation, and open land, mainly dominate the southern side of the

	project area. Human settlements are comparatively sparse in this direction. The presence of the lake and surrounding hills contributes to ecological and scenic value. No major industrial establishments are located within this zone. East To the east of the project site, the area consists of a mix of land uses, including residential areas, small-scale commercial activities, educational institutions, and local marketplaces. Road connectivity in this direction is moderate to good, linking the site with Rangamati town and nearby administrative and service centers. Some low-lying areas and natural drainage channels are also present. West The western side of the project area is primarily characterized by hilly and semi-hilly terrain, covered with vegetation and scattered rural settlements. Agricultural activities are limited due to the topography. The area remains relatively less developed compared to the northern and eastern sides and does not contain any major environmentally sensitive installations within the 1 km radius.


N
TBM R.L=100.00(m)
BRIDGE TOP LEVEL
ROAD
LAKE
LAKE
LAKE
REFERENCE R.L=117.489(m)
ROAD SIDE EP
REFERENCE R.L=117.311(m)
ROAD SIDE EP
LEGEND
This symbols may be found in the drawing
Unit Convert
1 Katha = 720.00 Sqft.
1 Decimal = 435.60 Sqft.
1 Gonda = 864.00 Sqft.
1 Acre = 43560 Sqft.
Total Area Calculation
Square Foot = 10899/3.28
Katha = 1513.85
Decimal = 2502.23
Gonda = 1261.54
Acre = 25.02
TOPOGRAPHY & MASTER PLAN CORRESPONDING DRAWING
Area Digital Survey
CLIENT
EXECUTIVE ENGINEER
PWD, RANGAMATI DIVISION.
TECHNICAL TEAM
SURVEY ENGR: MD. Salim
CAD BY: MD. Salim
DATE & TITLE
SURVEY DATE: 03/04/2023
SUBMISSION: 09/08/2023
DWG TITLE:
PAGE NO
06

3.9 REQUIREMENT OF THE PROJECT

The successful implementation and operation of the **Rangamati Medical College Hospital and Nursing College** project will require the following key resources:

3.9.1 Major Building Components and Specifications

Table 3-6 Major Building Components and Specifications

Sl. No.	Facility	Floors & Foundation	Total Floor Area (sq.ft.)	Key Facilities
1	Hospital Building	7-storied with 7-storied foundation (3 basements)	545,800.00	11 lifts, 2 pairs of escalators, sewerage, water supply, electrification
2	Academic Building	7-storied with 7-storied foundation	325,500.00	2 lifts, sewerage, water supply, electrification
3	Student Hostel + Male Intern Doctors' Dormitory + Male Single Doctors' Accommodation	6-storied with 6-storied foundation	107,000.00	4 lifts, sewerage, water supply, electrification
4	Female Student Hostel	6-storied with 6-storied foundation	54,270.00	2 lifts, sewerage, water supply, electrification
5	Female Intern Doctors' Dormitory & Female Single Doctors' Accommodation	6-storied foundation, built up to 4 floors	49,970.00	2 lifts, sewerage, water supply, electrification
6	Staff Nurses' Dormitory	6-storied with 6-storied foundation	42,920.00	1 lift, sewerage, water supply, electrification
7	Emergency Staff Dormitory (Male/Female)	6-storied with 6-storied foundation	85,840.00	2 lifts, sewerage, water supply, and electrification
8	Senior Teachers' Accommodation (2 Buildings)	6-storied with 6-storied foundation	25,072.00 (each)	1 lift per building, sewerage, water supply, and electrification
9	Nursing College Building	6-storied with 6-storied foundation	66,650.00	2 lifts, sewerage, water supply, and electrification
10	Student Nurses' Hostel	6-storied with 6-storied foundation	42,500.00	2 lifts, sewerage, water supply, and electrification
11	Principal & Director Building	3-storied with 3-storied foundation	10,738.20	Parking (GF), residential (2nd–3rd), utilities
12	Mosque Building	2-storied with 2-storied foundation	7,322.92	Sewerage, water supply, and electrification

13	Sub-Station Buildings (3 units)	2-storied with 2-storied foundation	5,982.92 (each)	Electrical infrastructure

3.9.2 Special Facilities and Utilities

Table 3-7 Special Facilities and Utilities

Sl. No.	Facility	Specification
14	Amphitheater	10,000.00 sq.ft.
15	Public Toilet	Single-storied, 580.00 sq.ft.
16	Sewage Treatment Plant (STP)	450 m³/day capacity, 3,000.00 sq.ft., single-storied
17	Medical Waste Management Unit	1,200.00 sq.ft., single-storied
18	Vehicular Bridge	100 meters length
19	Pedestrian Bridge	240 meters length
20	Public Toilet (Additional)	Single-storied, 1,200.00 sq.ft.
21	Sub-Station Building (Additional)	2-storied, 5,000.00 sq.ft.

3.9.3 Ancillary Infrastructure and Site Development

Table 3-8 Ancillary Infrastructure and Site Development

Category	Included Components
Medical Utilities	Oxygen tank, medical gas pipeline
Structural & Safety	Boundary wall, retaining walls, slope stability works
Transportation	Internal roads, footpaths, connecting roads
Drainage & Water	Internal compound drains, deep tube-wells, water bodies
Environmental	Arboriculture, land development
Buildings	Pump house and associated facilities

3.9.4 Electrical and Mechanical Installations

Table 3-9 Electrical and Mechanical Installations

Item	Quantity / Capacity
Electrical Sub-Stations	1 × 33 kV, 1 × 2000 kVA, 2 × 1600 kVA, 1 × 1250 kVA, 1 × 500 kVA
Generators	3 × 500 kVA, 1 × 400 kVA, 1 × 250 kVA
Elevators	30 units
Systems	HVAC, pumps & motors, lightning protection
Safety & Security	Fire-fighting, CCTV, security lighting
Renewable Energy	Solar power system
Communication	PABX, computer networking
Waste Treatment	A-Type Medical Waste Treatment Plant, STP
Others	Stage lighting & sound system, consultancy services

3.9.5 Cost Estimate and Financial Summary

Table 3-10 Cost Estimate and Financial Summary

Item	Amount
Schedule of Rates Applied	PWD Schedule of Rates (Revised) 2022
Total Civil Construction Cost	**BDT 107,145.76 lakh**
Revenue Expenditure (DPP)	BDT 0.00 lakh
Capital Expenditure (DPP)	**BDT 107,073.26 lakh** (including procurement plan)

3.9.6 a. Human Resource

The project will require a skilled and unskilled workforce for both the **construction phase** and **operational phase**:

Construction Phase:

- Project Director (Full-time)
- Sub-Project Director
- Civil, Electrical, and Mechanical Engineers
- Skilled construction workers (masonry, carpentry, plumbing, electrical work)
- Unskilled laborers for excavation, transport, and general site work
- Security personnel for site protection
- Health and safety officers

Operational Phase:

- Doctors (specialists and general physicians)
- Nurses (registered and trainee)
- Laboratory technicians
- Pharmacists
- Administrative staff (accountant, HR, registrar, clerks)
- Maintenance staff (electrician, plumber, carpenter, drivers)
- Housekeeping and cleaning staff
- Security personnel
- IT staff for hospital management systems
- Academic staff for Medical College and Nursing College

3.9.7 Materials

The construction and operation of the project will require the following materials:

Construction Materials:

- Cement, steel, bricks, sand, gravel
- Structural and finishing materials for hospital and college buildings
- Plumbing and sanitary fittings
- Electrical wiring, panels, and fixtures
- Roofing and flooring materials
- Glass and aluminum for windows and partitions

Medical and Academic Equipment:

- Medical and surgical equipment for various specialties
- Diagnostic equipment (X-ray, CT scan, ultrasound, lab analyzers)
- Hospital furniture (beds, stretchers, chairs, desks)
- Nursing and academic teaching materials
- Laboratory instruments for teaching and research

Other Materials:

- Stationery and office supplies
- IT and communication equipment
- Vehicles for patient transport, administrative purposes, and emergency services
- Waste management equipment (bio-medical waste bins, autoclaves)

All details are described in the project's Development Project Proposal (DPP).

3.9.8 WATER REQUIREMENT CALCULATION

(Construction Phase & Operation Phase)

1. Basis of Water Demand Estimation

Water demand has been estimated based on:

- **Bangladesh National Building Code (BNBC)**
- **WHO norms for hospitals**
- **DoE EIA Guidelines (1997)**
- Comparable government medical college hospitals in Bangladesh

The calculation considers:

- Hospital beds
- Medical college and nursing college students
- Academic and administrative staff
- Residential facilities (hostels, dormitories, staff housing)
- Ancillary services (laundry, kitchen, cleaning, landscaping, firefighting reserve)

2. Water Requirement During Construction Phase

2.1 Sources of Water

- Groundwater (tube wells) / authorized water supply
- Water tankers (if required)

2.2 Components of Water Use

- Construction activities (curing, mixing, dust suppression)
- Domestic use by construction workers
- Equipment washing

2.3 Construction Workforce

- Average workforce: **300 persons/day**
- Water demand norm: **45 litres/person/day (lpcd)**

2.4 Construction Phase Water Demand Calculation

Purpose	Quantity	Rate	Water Demand (m^3/day)
Construction works (curing, mixing, dust control)	—	Lump sum	30.0
Domestic use (workers)	300 persons	45 lpcd	13.5
Equipment & site cleaning	—	Lump sum	6.5
Total Construction Phase Demand			**50.0 m^3/day**

3.9.9 WATER REQUIREMENT CALCULATION (Hospital Operation Phase – Detailed Recalculation)

1. Basis of Revised Calculation

The revised hospital water demand has been calculated considering:

- **600 hospital beds**
- **1 attendant per bed**
- **1000 outdoor (OPD) patients/day**
- **Laundry load including bed sheets & pillows**
- **Autoclave and pathology water use**
- **Doctor & nurse apron/gown washing**
- DoE, WHO, CPHEEO, and BNBC standard water-use norms

3.9.10 Proposal For ETP+STP (Wastewater Treatment Plant)

CLIENT NAME:	Rangamati Medical College Hospital & Nursing College.
ADDRESS:	Rangamati Sadar, Rangamati, Bangladesh.
TREATMENT TYPE:	ETP+STP
CAPACITY:	30.0m3/hr. or 720.0 m3/day

MEDICAL WASTEWATER AND GREY WATER GENERATION CALCULATION

Hospital Process Wastewater Generation

Sl. No.	Source of Wastewater	Quantity / Basis	Water Consumption (Liters/day)
1	Operation Facilities	30 operations/day × 100 L	3,000
2	Autoclaving (Sterilization)	Estimated	1,000
3	Bed Sheet Washing	600 pcs/day (240 kg × 80 L/kg)	19,200
4	Pillow Cover Washing	600 pcs/day (60 kg × 80 L/kg)	4,800
5	Doctors' & Nurses' Apron Washing	210 pcs/day (52.5 kg × 80 L/kg)	4,200
6	Dialysis Unit	20 persons/day × 200 L	4,000
7	Pathological Laboratory	Estimated	1,000
8	Floor Washing & Cleaning	Estimated	2,000
Total	**Hospital Process Wastewater**		**39,200**

Sewage Wastewater Generation

Sl. No.	Category	Population	Water Use (L/Capita/Day)	Wastewater (Liters/day)
1	Non-residential Staff, Doctors & Nurses	1,450	40	58,000
2	Residential Staff, Doctors & Nurses	1,200	135	162,000
3	Patients & Attendants	600 + 600 = 1,200	135	162,000
4	Outdoor Patients	1,000	40	40,000
5	Residential Medical & Nursing Students	500 + 400 = 900	135	121,500
Total	**Sewage Wastewater**			**543,500**

Total Wastewater Generation and Design Capacity

Description	Quantity
Hospital Process Wastewater	39,200 L/day
Sewage Wastewater	543,500 L/day
Total Wastewater Generation	**582,700 L/day**
Additional Freeboard (20%)	116,540 L/day
Final Design Flow	**699,240 L/day**
Equivalent Hourly Flow	29,135 LPH
Operating Hours	24 hours/day
Less Contaminated Effluent	0%
Proposed STP Design Capacity	**30,000 LPH**

Less Contaminated effluent is 0%
Operated continuously for 24 hours a day
The final design envisaged is 30,000 lit/hr

ECR -2023 Standard:

তফসিল-৩
পয়ঃনির্গমন মানমাত্রা
(বিধি ৩২ দ্রষ্টব্য)

ক্রমিক নং	স্থিতিমাপ	একক	উপস্থিতির সর্বোচ্চ সীমা পিএইচ ব্যতীত
(১)	(২)	(৩)	(৪)
১।	উষ্ণতা (Temp)	ডিগ্রি সেন্টিগ্রেড	৩০
২।	পিএইচ (pH)	-	৬-৯
৩।	বিওডি$_5$ ২০° সেন্টিগ্রেড (BOD_5 at 20°C)	মি.গ্রা./লি.	৩০
৪।	সিওডি (COD)	মি.গ্রা./লি.	১২৫
৫।	প্রলম্বিত কঠিন বস্তু (SS)	মি.গ্রা./লি.	১০০
৬।	তৈল ও গ্রিজ (Oil & Grease)	মি.গ্রা./লি.	১০
৭।	নাইট্রেট (NO_3)	মি.গ্রা./লি.	৫০
৮।	ফসফেট (PO_4)	মি.গ্রা./লি.	১৫
৯।	সার্বিক কলিফর্ম (Total Coliform)	সিএফইউ/১০০ মি. লি.	১০০০

শর্তাবলি :

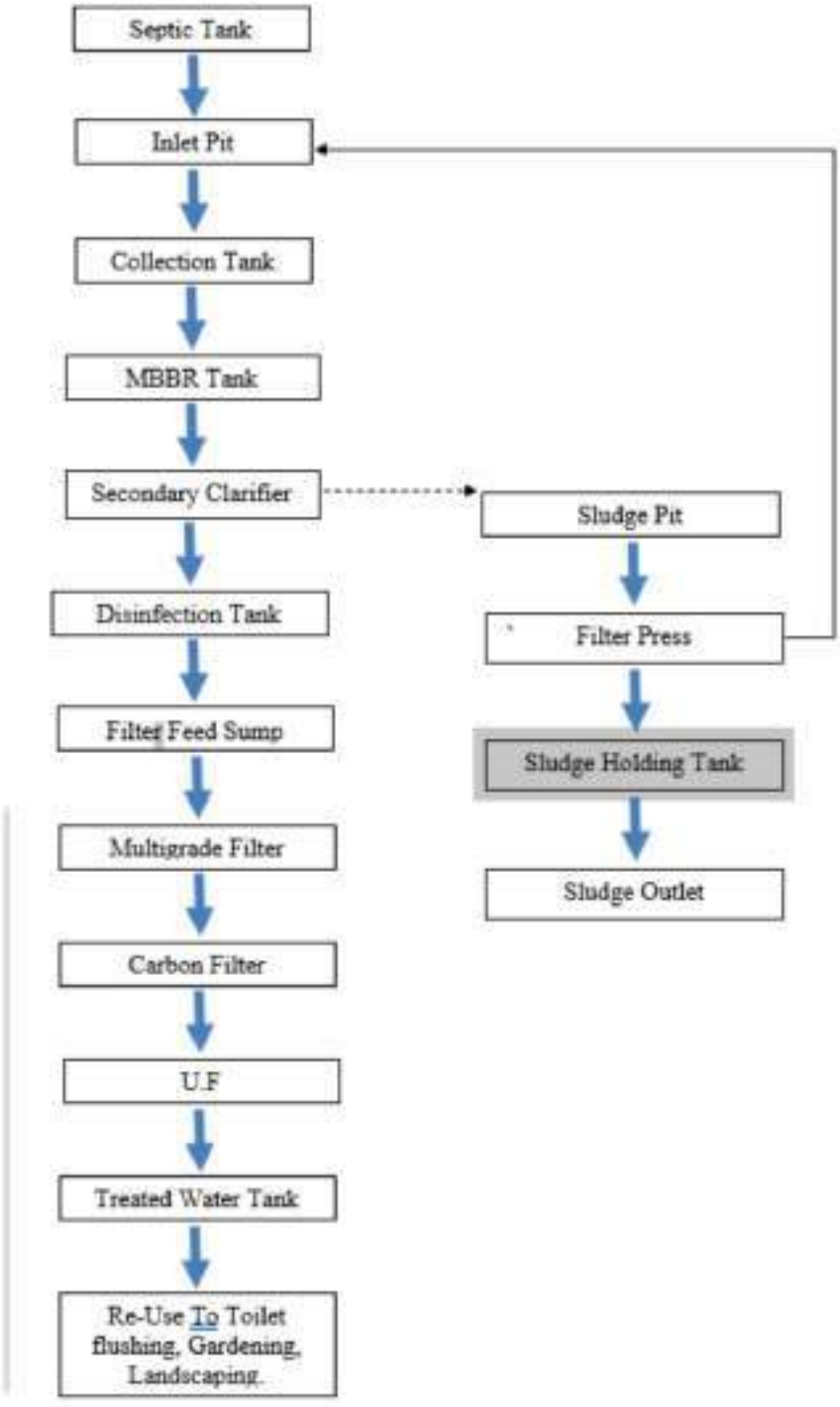
(১) এই মানমাত্রা ভূপৃষ্ঠস্থ পানি প্রবাহে নির্গমনের ক্ষেত্রে প্রযোজ্য।

(২) চূড়ান্ত নির্গমনের পূর্বে পয়ঃনির্গমনকে ক্লোরিন দ্বারা পরিশোধিত করিতে হইবে। Residual Chlorine (ক্লোরিন) ০.২ মি.গ্রা./লি. বেশি হওয়া যাইবে না।

PARAMETER (GURANTEED)

SL.	Parameter	Unit	Value
1.	BOD	ppm	30
2.	COD	ppm	125
3.	Nitrate	ppm	50
4.	Phosphate	ppm	15
5.	SS	ppm	100
6.	Temperature	Degree Celsius	30
7.	Fecal Coliform	ppm	1000

PROCESS CHART



6. Wastewater Management Strategy

- Entire wastewater will be treated through:
  - **Sewage Treatment Plant (STP)**
  - **Effluent Treatment Plant (ETP)** for hospital effluent

- Treated water reuse:
    - Toilet flushing
    - Gardening
    - Road washing
    - HVAC make-up water
- No untreated discharge to **Kaptai Lake** or surface water bodies

7. Conclusion

Based on revised parameters, the **total operational water requirement of the 600-bed Rangamati Medical College Hospital is approximately 700 m³/day.**

6. Wastewater Management Strategy

- Entire wastewater will be treated through:
    - **Sewage Treatment Plant (STP)**
    - **Effluent Treatment Plant (ETP)** for hospital effluent
- Treated water reuse:
    - Toilet flushing
    - Gardening
    - Road washing
    - HVAC make-up water
- No untreated discharge to **Kaptai Lake** or surface water bodies

7. Conclusion

Based on revised parameters, the **total operational water requirement of the 600-bed Rangamati Medical College Hospital is approximately 720 m³/day.**

With adequate **ETP + STP capacity**, water reuse, and conservation measures, the project will operate in an **environmentally sustainable and DOE-compliant manner** without causing adverse impacts on local water resources

3.9.11 Pollution Potential of the Project

The project involves activities that are classified under the **Red Category (Schedule-1, Serial No. 69)** as per the environmental classification of industrial projects in Bangladesh. The significant sources of pollution associated with this project include:

3.9.12 Water Pollution

Construction Phase:

- Runoff carrying suspended solids, soil, oil, grease, and construction debris.
- Possible contamination of nearby ponds, lakes, or drainage channels if not correctly managed.

Operational Phase:

- Generation of wastewater from hospital wards, laboratories, operation theaters, kitchens, laundries, and toilets.
- Risk of contamination from untreated sewage or laboratory effluents.
- Potential impact on nearby surface water bodies, including Kaptai Lake, if wastewater is not treated correctly.

Pollution Potential: Moderate without treatment; low with proper wastewater management systems.

3.9.13 Soil Pollution

Construction Phase:

- Spillage of fuel, lubricants, paints, and chemicals.
- Disposal of construction waste and excavated materials.

Operational Phase:

- Improper disposal of solid waste or biomedical waste.
- Leakage from fuel storage areas or waste storage facilities.

Pollution Potential: Low to moderate and site-specific.

3.9.14 Biomedical Waste Pollution

Operational Phase (Major Concern):

- Infectious waste (bandages, swabs, blood-stained materials)
- Pathological waste (human tissues, organs)
- Sharps (needles, syringes, blades)
- Pharmaceutical and chemical waste
- Laboratory reagents and disinfectants

If not properly segregated, treated, and disposed of, biomedical waste can cause:

- Soil and water contamination

- Spread of infectious diseases
- Public health risks

Pollution Potential: High if unmanaged; low with proper biomedical waste management.

3.9.15 Solid Waste Pollution

Construction Phase:

- Construction debris (bricks, concrete, wood, metal scraps).
- Packaging materials and excavated soil.

Operational Phase:

- General municipal waste from patients, staff, and visitors.
- Kitchen waste from hospital cafeterias.
- Office waste from academic and administrative buildings.

Pollution Potential: Moderate without segregation; low with proper solid waste management.

3.9.16 Hazardous and Chemical Pollution

Operational Phase:

- Laboratory chemicals and reagents.
- Disinfectants and sterilizing agents.
- Pharmaceuticals and expired medicines.
- Radiological materials (if diagnostic imaging facilities are present).

Improper handling may cause:

- Soil and water contamination
- Health risks to staff and the surrounding community

Pollution Potential: Moderate but manageable with standard protocols.

3.9.17 Light Pollution

Operational Phase:

- Use of high-intensity lighting for hospital buildings, emergency areas, and campus security.
- May cause mild disturbance to nearby residential areas and wildlife if unregulated.

Pollution Potential: Low.

3.9.18 Traffic-Related Pollution

Construction Phase:

- Increased movement of trucks and heavy vehicles causing dust, noise, and congestion.

Operational Phase:

- Increased traffic due to patients, staff, students, and emergency vehicles.
- Associated air and noise pollution along access roads.

Pollution Potential: Moderate but localized.

3.9.19 Conclusion

While the project has moderate to high pollution potential, especially from water and air pollutants, **adequate mitigation measures**, including a high-capacity ETP+STP, cleaner fuel use, emission control systems, and waste management protocols, have been incorporated to minimize environmental impact and ensure compliance with regulatory standards.

3.10 ROADS

Roads should be designed to transport all the vehicles likely to be used during construction and the project's life. Roads and pavements must be under the National Building Code of Practice or equivalent.

3.11 GENERATOR BUILDING

The dimensions of all buildings must be such that they provide a generous space for the safe installation and proper operation and maintenance of the project. In particular, a generous space must be provided immediately in front, behind, and next to all the floor elements. The design of all cottages must guarantee that the noise, vibration, and temperature levels are within the allowed limit.

3.12 OPERATION PHASE

3.12.1.1 Traffic

The entrance to the project has been designed to facilitate easy exit from the Rangamati Sadar and Rangamati-Dhaka highways and to prevent traffic congestion at the entrance.

3.12.1.2 Water demand

The total estimated water demand by the project during operation will be approximately 100 **m^3/hr.** This will be sourced from their own Deep Tube Well and will reuse the treated wastewater.

3.12.2 WATER POLLUTION POTENTIAL AND MITIGATION MEASURES

(With Implementation of Zero Liquid Discharge – ZLD Program)

The proposed **600-bed Medical College Hospital Project** is categorized as **Red Category** under the Department of Environment (DoE), Bangladesh, due to its potential to generate **medical**

wastewater, sewage, laboratory effluent, and chemical residues. However, the **Project Authority has committed to implementing a comprehensive Zero Liquid Discharge (ZLD) Program,** ensuring that **no untreated or partially treated wastewater is discharged into surrounding water bodies, drains, or the adjacent lake.**

2. Potential Sources of Water Pollution

2.1 Construction Phase Water Pollution Sources

Source	Pollution Characteristics
Construction runoff	Suspended solids, turbidity
Equipment washing	Oil & grease
Temporary labor camps	Domestic sewage
Concrete & mortar wash	High pH, solids
Fuel storage areas	Hydrocarbon contamination

2.2 Operation Phase Water Pollution Sources

Source	Pollutants
Hospital sewage	BOD, COD, nutrients, pathogens
Medical wastewater	Blood, pharmaceuticals, disinfectants
Laboratories & pathology	Chemicals, reagents, heavy metals (trace)
Laundry wastewater	Detergents, surfactants
Autoclave & CSSD	High temperature, chemical residues
Kitchen wastewater	Oil & grease
Stormwater runoff	Suspended solids

3. Water Pollution Impact Without Mitigation (Risk Scenario)

If untreated, hospital effluent could result in:

- Contamination of **surface water bodies and nearby lake**
- Degradation of **aquatic ecosystems**
- Increased **BOD, COD, and pathogen load**
- Potential health risk to surrounding communities

- Non-compliance with **ECR 1997 discharge standards**

4. Zero Liquid Discharge (ZLD) Program – Commitment of Project Authority

The **Project Authority will implement a full-scale ZLD Program**, ensuring:

"No wastewater generated from the hospital will be discharged outside the project boundary."

Key Features of the ZLD Program:

- **100% wastewater collection**
- **ETP + STP integration**
- **Advanced tertiary treatment**
- **Maximum water reuse**
- **Zero discharge to lake, drain, or environment**

5. Proposed Wastewater Treatment & ZLD System

5.1 Treatment Infrastructure

Facility	Purpose
Effluent Treatment Plant (ETP)	Medical & laboratory wastewater
Sewage Treatment Plant (STP)	Domestic & sanitary wastewater
Equalization tanks	Flow & load stabilization
Disinfection unit	Pathogen control
Sludge management system	Safe disposal
Treated water storage	Reuse system

5.2 Treatment Process Flow (ZLD)

1. **Source segregation**
2. **Pre-treatment (screening, oil & grease trap)**
3. **Primary treatment**
4. **Biological treatment (MBR/MBBR/SBR)**
5. **Tertiary treatment (filtration + disinfection)**

6. **Treated water reuse**
7. **Zero discharge**

6. Treated Water Reuse under ZLD Program

Reuse Area	Percentage
Toilet flushing	Major portion
Gardening & landscaping	Seasonal
Road washing	Regular
HVAC cooling make-up	As required
Firefighting reserve	Emergency

No treated or untreated wastewater will be released into the lake or nearby surface water bodies.

7. Water Pollution Mitigation Measures

7.1 Construction Phase Mitigation Measures

Potential Impact	Mitigation Measure
Silt runoff	Temporary drains & sediment traps
Oil & grease contamination	Designated maintenance zones
Camp sewage	Temporary septic tanks
Concrete wash	Controlled wash areas
Fuel leakage	Bunded fuel storage

7.2 Operation Phase Mitigation Measures (ZLD-Based)

Impact Source	Mitigation Measure
Medical wastewater	Dedicated ETP
Domestic sewage	STP with tertiary treatment
Laboratory effluent	Neutralization & chemical treatment
Laundry effluent	Biological + tertiary treatment
Pathogens	UV/Chlorination
Excess sludge	Authorized disposal

Stormwater contamination	Separate drainage

8. Protection of Adjacent Lake and Water Bodies

To protect the lake and surrounding water environment:

- **No outfall or discharge point** connected to the lake
- **Peripheral drainage system** around the campus
- **Green buffer zone** between lake and project area
- **Rainwater harvesting system**
- **Continuous water quality monitoring**

9. Monitoring & Compliance

Parameter	Frequency
Influent & effluent quality	Monthly
BOD, COD, TSS	As per DoE
Pathogens	Quarterly
Sludge quality	Bi-annually
Reuse water quality	Regular

All treated effluent will comply with:

- **ECR 2023 standards**
- **WHO hospital wastewater guidelines**

10. Residual Impact Assessment

Aspect	Residual Impact
Surface water quality	Negligible
Lake ecosystem	No adverse impact
Groundwater	Protected
Regulatory compliance	Fully compliant

With the implementation of a **comprehensive Zero Liquid Discharge (ZLD) Program**, the proposed hospital project will **not cause any significant water pollution.** All wastewater will be **treated, reused, and managed within the project boundary**, ensuring

full compliance with DoE regulations and protection of the lake and the surrounding water environment

3.12.3 Noise

As vessels are constructed on many levels, falling objects are a hazard. In addition, personnel can be struck by falling or moving objects during fabrication, resulting in failures of fixtures and conveyance gantries.

Confined spaces

Many areas on a vessel are designated as confined spaces, which can lead to vapor buildup.

Poor management of materials, waste, and discharges from production presents a potential risk of soil contamination. Accidental discharges from ETP may also contaminate groundwater in areas where soils beneath the site are permeable.

Contamination could arise from deteriorating drainage networks.

Other Potential Environmental, Health and Safety Risks/Liability Issues

Machinery

All equipment should have safety guarding, and workers should be issued with appropriate personal protective equipment to protect against unavoidable sharp items and edges. Particular attention should be paid to metal-cutting equipment.

Occupational Dermatitis

This can occur due to contact with antioxidants, chromates, and solvents.

To protect workers and surroundings from noise pollution, the authority changes in the workplace that reduce or eliminate worker exposure to noise hazards, such as:

- Operate noisy machines during shifts when fewer people are exposed;
- By applying the job rotation policy;
- Limit the amount of time a person spends near a noise hazard;
- Provide quiet areas where workers can gain relief from noise hazards;
- Restrict how close a worker can get to a noise hazard. Therefore, controlling noise hazard exposure by maintaining a distance from the noise hazard is often an effective, simple, and inexpensive administrative control
- Provide workers with PPE

3.13 PROTECTION ACROSS THE LAKE (LAKE PROTECTION MEASURES)

The proposed Medical College Hospital project is located near a natural lake system. Considering the ecological, hydrological, and socio-environmental importance of the lake, comprehensive protection measures have been incorporated into the project planning, design, construction, and operation phases to ensure no adverse impacts **on lake water quality, aquatic ecology, or the surrounding environment.**

1. Protection Measures During Construction Phase

1. **No Direct Discharge Policy**
   - No untreated wastewater, construction runoff, or liquid waste shall be discharged into the lake under any circumstances.
   - Temporary drainage channels will be constructed to divert stormwater away from the lake.
2. **Sediment and Erosion Control**
   - Silt traps, sedimentation pits, and temporary retention ponds will be installed to prevent soil erosion and sediment-laden runoff from entering the lake.
   - Excavated soil will be stockpiled away from the lake edge and covered during the rainy season.
3. **Buffer Zone Maintenance**
   - A green buffer zone will be maintained between the construction area and the lake boundary.
   - No construction activity, material storage, or vehicle parking will be allowed within the buffer zone.
4. **Fuel and Chemical Management**
   - Fuel, lubricants, paints, and chemicals will be stored in secured, impermeable areas with secondary containment.
   - Refueling and maintenance of machinery will be strictly prohibited near the lake.
5. **Waste Management**
   - Construction waste will be collected, segregated, and disposed of at approved disposal sites.
   - No solid waste dumping will be permitted near or into the lake.
6. **Noise and Vibration Control**
   - Construction activities will be restricted to daytime hours to minimize disturbance to aquatic fauna and nearby communities.

2. Protection Measures During the Operation Phase

1. **Installation of ETP and STP**
   - A **combined Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP)** will be installed to treat all hospital wastewater and domestic sewage.
   - **Zero direct discharge to the lake** will be ensured.
2. **Treated Water Reuse**
   - Treated effluent from the STP/ETP will be reused for:
     - Toilet flushing
     - Gardening and landscaping
     - Road and pavement washing
   - This will significantly reduce wastewater discharge and freshwater extraction.
3. **Medical Waste Management**

- All infectious, hazardous, and pathological wastes will be segregated at source.
- Medical waste will be treated and disposed of through authorized facilities as per Medical Waste Management Rules, 2008.
- No medical waste will be allowed to reach the lake or its catchment area.

4. **Stormwater Drainage System**
   - A separate stormwater drainage system will be developed to prevent contaminated runoff from reaching the lake.
   - Drainage outfalls will include oil traps and silt chambers.
5. **Green Belt and Lake Buffer Zone**
   - Native tree species and vegetation will be planted along the lake-facing boundary.
   - The green belt will act as a physical and ecological barrier against pollution.
6. **Emergency Spill Response**
   - An emergency response plan will be implemented for accidental spills of chemicals, fuel, or medical waste.
   - Spill kits will be maintained on-site at critical locations.

3. Monitoring and Compliance

1. **Water Quality Monitoring**
   - Regular monitoring of lake water quality upstream and downstream of the project area will be conducted.
   - Parameters will include pH, DO, BOD, COD, TSS, nutrients, and microbiological indicators.
2. **Regulatory Compliance**
   - All activities will comply with:
     - Environmental Conservation Act, 1995
     - Environmental Conservation Rules, 2023
     - Air Pollution Control Rules, 2022
     - Sound Pollution Control Rules, 2025
     - DOE clearance conditions
     - Medical Waste Management Rules, 2008, etc
3. **Reporting**
   - Environmental monitoring results will be documented and submitted to the Department of Environment as required.

4. Overall Environmental Safeguard Statement

With the implementation of the above lake protection measures, the project will **not degrade lake water quality, aquatic habitats, or the ecological balance**. The proposed mitigation and

management measures ensure long-term environmental sustainability while supporting essential healthcare and educational services.

3.14 ALTERNATIVE ANALYSIS

There is no scope for considering alternatives.

3.15 UTILITIES

All the utilities and materials used in this project are described in detail in the project's DPP (approved), including price estimates. No alternative proposals were considered. The selected site is optimal in terms of location, accessibility, and environmental suitability.

3.16 SWOT ANALYSIS

Strengths

- Strong government policy support
- Support and social acceptance from local residents and stakeholders
- Land acquisition completed and handed over to the Project Director
- No displacement of people required
- No risk of waterlogging due to proximity to Kaptai Lake
- Good road connectivity with Rangamati town and the surrounding upazilas
- Project site located adjacent to Rangamati town and District Hospital (approximately 0.25 km)
- Ongoing academic activities
- Proximity to police and military establishments

Weaknesses

- Inadequate water supply facilities
- Limited usable land due to hilly terrain surrounded by lakes and water bodies
- Narrow access road to the proposed campus
- Shortage of basic science and para-clinical faculty members
- Distant location of high-capacity power transmission lines required for heavy equipment
- Difficult mobility for elderly and sick people due to hilly terrain
- Restrictions on high-rise buildings due to landslide and earthquake risks

Opportunities

- High demand for medical education
- High demand for specialized healthcare services
- Potential to develop as an attractive health tourism destination
- Increased educational opportunities for the local population, especially women
- Expansion of technical and professional education opportunities
- Socio-cultural development through the concentration of educated professionals

- Planned urban development and economic activities due to proximity to the city
- Improved market access for agricultural products from surrounding areas
- Opportunity for power connectivity once transmission lines are extended nearby

Threats

- Ongoing conflicts among armed ethnic political groups
- Risk of abduction of construction workers and theft of construction materials
- Potential risk of landslides
- Possible adverse impacts on environmental and cultural balance
- Unplanned urbanization and construction around Kaptai Lake and adjacent areas
- Risk of environmental pollution, including contamination of Kaptai Lake due to improper medical waste management

3.17 TECHNICAL, TECHNOLOGICAL, AND ENGINEERING ANALYSIS

The proposed site for the **Rangamati Medical College and Hospital** is located in **Mouza No. 102, Rangapani**, under **Rangamati Sadar Upazila**. The site is situated approximately **2.6 km southwest of Rangamati town**. Once the bridge under construction over **Kaptai Lake** is completed, the distance to the District Hospital will be only 0.25 km, improving road connectivity with Rangamati town, other upazilas, and neighboring districts. This will enable the local population to access healthcare services easily.

The population of this area is **rapidly increasing**, and the **agriculture and tourism sectors** are growing in economic and geographic significance. In this context, access to healthcare services becomes a priority. There is currently **no private medical college or tertiary hospital** in this hilly region. The establishment of the Rangamati Medical College and Hospital, along with the Nursing College, will help **reduce pressure on the healthcare system** in Chittagong and Dhaka, while producing doctors, nurses, and other health professionals. This will also create **employment opportunities** for the local population.

The total land area of the proposed site is **25.95 acres**, including **7.78 acres of wetlands**, primarily **fallow hilly land**. Detailed information of the site is shown in **Table 1**.

Table 1: Detailed Description of the Proposed Site

Parameter	Details
Mouza	102 Rangapani
Upazila	Rangamati Sadar
Total Area	25.95 acres
Land Type	Fallow hilly land and some plain land
Location	Southwest of Rangamati General Hospital, near town
Land Acquisition / Resettlement	None required
Wetlands	Total 7.78 acres (ponds and small lakes)

Mosque	None
Temple	None
Archaeological Sites	None
Graveyard / Crematorium	None
Land Acquisition Status	Completed and handed over to the Project Director
Land Value	Bazar Rate: BDT 227,000 per unit
Total Cost of Land Acquisition	As per the valuation

3.18 TECHNICAL DESIGN AND PROJECT ACTIVITIES

Project Activities:

- Civil infrastructure construction
- Equipment procurement
- Furniture procurement
- Vehicle acquisition
- Recruitment of personnel

Technical Design:

- Detailed design attached in **Annexure–D**
- Civil works for academic and hospital buildings should use **low-noise, low-emission, energy-efficient equipment** and **environmentally-friendly technologies.**
- Wherever possible, **renewable energy** (e.g., solar panels) should be installed in the medical college.

Land Acquisition:

- Total area required for construction: **25.15 acres**

External Electrical and Mechanical Works:

- A dedicated **33/11 kV power line** must be constructed from the **national grid** to ensure uninterrupted electricity for the medical college hospital.
- A **4.5 km transmission line** will be required.
- For backup, two **diesel generators** (600 kVA and 320 kVA) will be installed to maintain a continuous power supply.
- Continuous electricity is critical for **advanced clinical and diagnostic equipment.**

Water Supply:

- Daily demand: **10.0 KLD**
- Water supply will be ensured through **municipal water tankers** and **deep tube wells** within the campus.

Sanitation and Waste Management:

- A properly designed **sewage disposal system** is essential.
- The hospital must have its **own waste management plant**.

Housekeeping and Laundry Facilities:

- The housekeeping department requires **5 staff**.
- Laundry unit will include **two 50 kg capacity washing machines** and **one dryer**.

Fire Safety:

- **Fire alarm and hydrant systems** will be installed in both hospital and college buildings.
- Direct connection to **firefighting systems** is required for emergency response.

3.19 OUTPUT PLANNING, COST ESTIMATES, AND ENVIRONMENTAL & DISASTER RISK ANALYSIS

Output Planning

- Efficient use of land;
- Provision of **primary and specialized healthcare services** in a **600-bed medical college hospital**;
- Delivery of **medical education** through a distinguished **medical college**;
- Provision of **nursing education** through a **nursing college building** and a **nursing hostel**;
- Construction of **accommodation buildings** for male and female students and staff;
- Total **employment on-site** will be approximately **3641 people**.

Cost Estimates

- **During Implementation**: Estimated cost **BDT 1,293.213 crore**.
- **Post-Implementation**: After completion, the project will be **transferred to the revenue budget**. No post-implementation cost estimates have been prepared.

3.20 ENVIRONMENTAL SUSTAINABILITY, CLIMATE RESILIENCE, AND DISASTER RISK ANALYSIS

3.20.1 Environmental and Climate Risk Analysis

(a) Environmental Hazards and Climate Change Risks

5. **Landslide Risk**: High due to rainfall of **3,031 mm**, exceeding the national annual average of **2,200 mm**.

6. **Potential Impact on Environmental Balance**: Construction may affect local ecology and biodiversity.
7. **Seismic Zone**: Medium-risk earthquake-prone area.
8. **Impact on Aquatic Habitats**: Rivers, canals, wetlands, and floodplains host diverse aquatic flora and fauna, supporting livelihoods, food, and economic benefits for local communities. Key species include: **Catla, Bacha, Puntius, Punti, Bais, Mola, Chela, Tengra, Magur, Air, Batas, and Kajri**. Water pollution is a potential environmental concern.

(b) Risk Mitigation Measures

5. **Landslide Risk**: Construct retaining walls along pond and lake edges; plant trees and grass; implement emergency preparedness and relocation plans.
6. **Environmental Balance**: Reduce impact by preserving trees and water bodies; conduct afforestation.
7. **Seismic Area**: Use **earthquake-resistant construction techniques**.
8. **Aquatic Habitat Protection**: Preserve water bodies during construction; avoid encroachment.

(c) Environmental Impact Assessment (EIA)

The EIA analysis indicates that the proposed project is **environmentally friendly**. If proper management is followed, it **will not cause long-term damage to the surrounding environment**.

Environmental Management Measures Include:

- Proper operation and maintenance
- Environmental Management System (EMS)
- Staffing for the environmental management and monitoring cell
- Regular environmental monitoring and reporting

(d) Compensation, Rehabilitation, and Resettlement

- Only **four households** exist on the proposed site. Local authorities confirmed that the land is fallow mainly, so **resettlement is minimal**.
- **Compensation** has been paid to landowners as per **government-determined rates**. (See Annexure–D)

3.20.2 Disaster Resilience Assessment

- **Construction Phase Impacts**:
  - Excavation may trigger **landslides** and generate dust.
  - Nearby vegetation and Kaptai Lake water may be affected.
  - Temporary reduction in water quality may occur due to excavation and the use of fuel and lubricants.
- **Mitigation**:
  - Impacts are **temporary and site-specific**.
  - Can be controlled with **proper mitigation measures and monitoring systems**

CHAPTER 4 BASELINE ENVIRONMENT

4.1 BASELINE ENVIRONMENTAL CONDITION AND ITS RELEVANCE TO THE PROJECT

Baseline Environmental Condition

The proposed project site is located in Rangamati Sadar Upazila, Rangamati District, at **22°39'05.0"N and 92°09'56.1"E**, within the **Chattogram Hill Tracts (CHT)** region of Bangladesh. This region is characterized by **hilly terrain, complex geomorphology, rich biodiversity, high rainfall, and significant surface water bodies**, notably **Kaptai Lake**.

The baseline environmental condition refers to the **existing physical, biological, and socio-economic environment** of the project area **before any project-induced intervention**. It includes ambient air quality, noise levels, surface and groundwater quality, soil characteristics, land-use patterns, **hydrology, ecology, climate, and socio-economic setting** within the project influence area.

In Rangamati Sadar, the environment is particularly **sensitive and dynamic** due to:

- Steep slopes and fragile hill soils prone to **erosion and landslides**;
- High annual rainfall (significantly above the national average);
- Proximity to **Kaptai Lake**, which functions as a critical aquatic ecosystem, transportation route, and livelihood source;
- Presence of **mixed forest cover, scattered water bodies, and indigenous communities** with strong socio-cultural ties to natural resources.

Need for Baseline Study for This Project

The establishment of a **Medical College Hospital and Nursing College** is a **large-scale, long-term institutional development** involving extensive land modification, construction activities, increased population influx, and continuous operational activities. In such an environmentally sensitive hill tract region, a detailed baseline study is essential for the following reasons:

1. **Environmental Sensitivity of the Location:** Rangamati's hilly topography, coupled with intense monsoon rainfall, increases the risk of **landslides, soil erosion, sediment runoff, and slope instability**. Understanding baseline soil stability, drainage patterns, and slope conditions is critical to designing safe and sustainable infrastructure.
2. **Protection of Surface and Groundwater Resources**: The proximity of the site to **Kaptai Lake and local ponds** necessitates a clear understanding of existing water quality and hydrological connectivity to prevent contamination from construction runoff, sewage discharge, and biomedical waste during operation.
3. **Biodiversity and Ecosystem Preservation:** The area supports terrestrial and aquatic ecosystems that are vulnerable to habitat disturbance, noise, light, and water pollution. Baseline ecological data allow identification of sensitive receptors and formulation of mitigation strategies.

4. **Public Health and Environmental Carrying Capacity:** As a healthcare facility, the project will generate **wastewater, biomedical waste, chemical waste, and traffic emissions**. Baseline environmental conditions serve as reference points to evaluate future changes and ensure that pollution loads remain within acceptable limits.

5. **Regulatory and Planning Requirements:** Baseline data are a fundamental requirement under **Department of Environment (DoE) guidelines**, Environmental Impact Assessment (EIA) regulations, and international development standards. They enable informed decision-making, impact prediction, and compliance monitoring.

6. **Long-Term Environmental Monitoring and Management:** Establishing baseline conditions allows for **comparative assessment** during construction and operational phases, helping to distinguish project-related impacts from natural environmental variability.

In summary, the baseline environmental condition study provides the **scientific foundation** for identifying ecological impacts, planning mitigation, and ensuring the sustainability of the proposed project.

Objectives of the Baseline Study

The primary objective of the environmental baseline study is to establish a **comprehensive, accurate, and site-specific ecological profile** of the project area before project implementation. The specific objectives are outlined below:

1. **To Document Existing Environmental Conditions:** To systematically assess and document the current status of:
    - Air quality and ambient noise levels
    - Surface water and groundwater quality
    - Soil characteristics and land stability
    - Climatic and meteorological conditions
    - Ecological resources (flora, fauna, aquatic habitats)
    - Land use and human settlement patterns
2. **To Identify Environmentally Sensitive Receptors:** To identify natural and human receptors such as **water bodies, forest patches, residential areas, indigenous communities, and ecological hotspots** that may be affected by project activities.

3. **To provide a Reference Benchmark for Impact Assessment:** To establish quantitative and qualitative baseline data against which **potential environmental impacts** during construction and operation can be predicted, assessed, and monitored.

4. **To Support Design Optimization and Risk Reduction:** To inform engineering and architectural design by integrating environmental constraints such as **slope stability, drainage patterns, flood risk, and ecological sensitivity**, thereby reducing environmental and disaster risks.

5. **To Facilitate Environmental Management Planning:** To guide the preparation of effective **Environmental Management Plans (EMP)**, including pollution control, waste management, slope protection, and biodiversity conservation measures.

6. **To Ensure Regulatory Compliance and Stakeholder Confidence:** To meet national environmental clearance requirements and enhance transparency and acceptance among regulators, local communities, and other stakeholders.

7. **To Enable Long-Term Environmental Sustainability:** To support sustainable development of the healthcare facility by ensuring that environmental quality, public health, and ecological integrity are maintained throughout the project life cycle.

4.2 STUDY AREA

RANGAMATI MEDICAL COLLEGE AND HOSPITAL AND NURSING COLLEGE will be located at **Ranamati Sadar, Rangamati.**

Baseline study records are required for environmental settings against which potential impacts from the project's construction and operational phases can be compared. In the present study, the different ecological components were examined to set the baseline.

S. No.	Point	Date	Day	Night
01	22°39'3.40"N, 92° 9'59.43"E	12/11/2025	46.6	20.0
02	22°39'2.09"N, 92°10'2.89"E	12/11/2025	55.6	25.0
03	22°39'3.57"N, 92°10'6.25"E	12/11/2025	60.6	28.7
04	22°39'6.24"N, 92° 9'57.47"E	12/11/2025	50.6	21.5
05	22°39'9.82"N, 92° 9'52.41"E	12/11/2025	43.6	20.0
06	22°39'3.90"N, 92° 9'54.44"E	12/11/2025	60.6	18.0
07	22°39'13.59"N, 92°10'3.52"E	12/11/2025	62.5	15.5
08	22°39'8.38"N, 92°10'4.08"E	12/11/2025	59.0	20.0

The noise test report is attached below.

Rangamati Medical College & Hospital and Nursing College require water to be collected from the ground for all purposes. The groundwater level is at a moderate depth (generally below 8.0 m) and

is recharged primarily by rainfall infiltration. According to the Bangladesh Water Development Board, the groundwater level of Dhaka is about 35.5 m. The groundwater zoning map is shown in Figure 26.

Groundwater is the source of water for domestic use in this area. Water from underground sources is assumed to be available because the area remains underwater for most of the year, and a canal passes by the site. That means the recharge capacity of the groundwater level appears adequate.

4.3 WATER TEST REPORT OF THE SITE

4.3.1 Background and Sampling Overview

Surface water quality assessment was conducted to establish the **baseline condition of the lake water** near the proposed Rangamati Medical College & Hospital and Nursing College project site. The lake is environmentally and socio-economically significant, serving as a **major freshwater body** for fisheries, navigation, and ecological balance in the Rangamati region.

Water samples were tested by **TÜV SÜD Bangladesh (Pvt.) Ltd.**, an internationally recognized laboratory, ensuring analytical reliability and credibility for EIA submission

Two types of samples were analyzed:

- **Sample-A:** Flowing water
- **Sample-B:** Detention (relatively stagnant) water

4.3.2 Parameter-wise Interpretation (EIA Perspective)

pH Value

- Observed pH values (6.6–6.7) indicate **slightly acidic to near-neutral conditions**.
- These values fall within the **acceptable range for inland surface waters** and are suitable for:
    - Aquatic life
    - Domestic use after treatment
    - Recreational and ecological functions

EIA implication: The lake water shows **no signs of chemical stress or contamination** from acidic or alkaline sources at baseline condition.

Total Suspended Solids (TSS)

- TSS values are:
    - 10 mg/L (flowing water)
    - 13 mg/L (detention water)

These values are **very low**, indicating:

- Clear water
- Minimal sediment load
- Absence of significant erosion or upstream disturbance at the time of sampling

EIA implication: Low TSS confirms that the lake currently experiences **limited sedimentation pressure**, which is critical for aquatic habitat health. Any increase in TSS during construction would therefore be **easily detectable and attributable**, strengthening the monitoring framework.

Chemical Oxygen Demand (COD)

- COD values are **below detection limit (<5 mg/L)** for both samples.

Interpretation:

- Indicates **very low levels of chemically oxidizable organic and inorganic pollutants**
- Reflects absence of industrial or chemical waste inputs

EIA implication: The lake water is **chemically clean**, making it environmentally sensitive to any future discharge. This strengthens the need for strict wastewater control during project implementation.

Biochemical Oxygen Demand (BOD_5)

- BOD_5 values are **<5 mg/L** for both samples.

Interpretation:

- Indicates **low biodegradable organic pollution**
- Suggests minimal sewage or organic waste contamination

EIA implication: The water body supports good dissolved oxygen conditions, which are essential for fish and aquatic organisms. Any untreated hospital or domestic effluent discharge could significantly alter this baseline, highlighting the importance of effective ETP/STP operation.

Total Coliform

- **Not detected** in either sample.

Interpretation:

- Absence of fecal contamination
- Indicates good sanitary quality at the time of sampling

EIA implication: The lake is **microbiologically safe** in baseline condition. This is particularly important for a healthcare-related project, as hospital wastewater carries a high risk of microbial contamination if not properly treated.

4.3.3 Comparative Analysis: Flow Water vs. Detention Water

- Slightly higher TSS in detention water (13 mg/L) compared to flowing water (10 mg/L) is **expected and natural**, as stagnant zones allow limited sediment settling.
- No deterioration in organic or microbial parameters is observed in detention water.

Conclusion:

Hydraulic conditions influence sediment behavior slightly, but **overall water quality remains consistently good** across both sample types.

4.3.4 Baseline Environmental Status of the Lake

Based on the analytical results:

- The lake water can be classified as **clean to very clean**
- The water body shows:
    - Low turbidity
    - Negligible organic pollution
    - No microbiological contamination

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This establishes a **high-quality baseline**, which is critical for impact prediction.

4.3.5 EIA Impact Significance and Sensitivity

4.3.5.1 Environmental Sensitivity

Because baseline water quality is good:

- The lake is **susceptible to pollution**
- Even small increases in:
  - TSS
  - BOD
  - Pathogens

  could cause **measurable degradation**

4.3.5.2 Project Implementation Implications

The following potential impacts must be carefully managed:

- Construction-phase runoff carrying sediments
- Accidental discharge of wastewater
- Improper handling of construction materials

Residual Impact Assessment

With proper implementation of:

- Sediment control measures
- ETP/STP for hospital and domestic wastewater
- Zero direct discharge into the lake

The **residual impact on lake water quality is expected to remain negligible**.

EIA-Focused Conclusion

The laboratory analysis of lake water near the project site indicates **excellent baseline water quality**, characterized by low suspended solids, negligible organic pollution, and absence of microbial contamination. This confirms that the receiving water body is environmentally sensitive and of high ecological value. While the proposed project may affect surface water quality during construction and operation, adherence to strict environmental management measures will ensure the lake's water quality remains protected. From an EIA perspective, the baseline condition supports the **project's ecological acceptability**, provided that all recommended mitigation and monitoring measures are effectively implemented.

Test Report No: BD/T(W)/25/042307
Dated: 2025-12-18

Applicant	:	**KAPTAI LAKE** Rangamati, Chittagong
Attention	:	Mr. Sk. Abdul Latif
Sample Description	:	(A) Flows Water (B) Detention water
Sample Quantity	:	In Two Plastic Bottle (2.0 Litre)
Sampled by	:	Not available as sample submitted by client
Client's Representative	:	Mr. Sk. Abdul Latif
Sample Type	:	Not available as sample submitted by client
Sampling Protocol	:	Not available as sample submitted by client
Sample condition	:	Good
Date of Sample Receipt	:	07/12/2025
Test Analysis Started	:	08/12/2025
Test Analysis Completed	:	18/12/2025

Laboratory:
TÜV SÜD Bangladesh (Pvt.) Ltd.
Level 7 & 8, Update Tower,
81 Shahjalal Avenue, Sector -06,
Uttara Model Town,
Dhaka - 1230, Bangladesh

Phone : + 88-02-58954115, 58954120
Fax : +88-02-58950724
E-mail: tajmul.islam@tuvsud.com
Web: www.tuvsud.com.bd

Regd. Office:
TÜV SÜD Bangladesh (Pvt.) Ltd.
Level 7 & 8, Update Tower,
81 Shahjalal Avenue, Sector -06,
Uttara Model Town,
Dhaka - 1230, Bangladesh

Test Report No: BD/T(W)/25/042307
Dated: 2025-12-18

SUMMARY OF TEST RESULTS		
TEST REQUESTED	**RESULT**	
	(A)	(B)
pH value	■	■
Total Suspended Solids (TSS)	■	■
Chemical Oxygen Demand (COD)	□	□
Biochemical Oxygen Demand (BOD)	□	□
Total Coliform	○	○

Note/ Key:
— ■ — Detected
— □ — Not Detected
— - — Not Tested

Authorized By:

Md Shafikul Islam
Authorized Signatory

Please Contact
For Any Technical Issues: Md. Shafikul Islam
E-Mail - Shafikul.Islam@tuvsud.com
For Any Complaint: Md. Kamruzzaman at Kamruz.zaman@tuvsud.com

Laboratory:
TÜV SÜD Bangladesh (Pvt.) Ltd.
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Uttara Model Town,
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Phone : + 88-02-58954115,
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Uttara Model Town,
Dhaka - 1230, Bangladesh

Test Report No: BD/T(W)/25/042307
Dated: 2025-12-18

Test Results: Sample-A- Flows Water

1.0 Conventional Parameters

SL. No.	Parameters	Test Method	Test Results	Limit of Quantification (LOQ)
1	pH Value	USEPA 150.1	6.6	-
2	Total Suspended Solids (TSS) (mg/l)	APHA 23rd Edition 2017 (2540 D)	10	5
3	Chemical Oxygen Demand (COD) (mg/l)	APHA 23rd Edition 2017 (5220 D)	<5	5
4	Biochemical Oxygen Demand (BOD) (For 5 days at 20 °C) (mg/l)	APHA 23rd Edition 2017 (5210 B)	<5	5
5	Total Coliform # (CFU/100mL)	Membrane Filter	ND	-

Remark: Here; (mg/l): milligram per litre; °C: Degree Celsius
#Test have been subcontracted to other competent Laboratory

Laboratory:
TUV SUD Bangladesh (Pvt.) Ltd.
Level 8,12 & 14 Update Tower,
01 Shahjalal Avenue, Sector -06,
Uttara Model Town,
Dhaka - 1230, Bangladesh

Phone : + 88-02-58954115,
58954120
Fax : +88-02-58956724
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Regd. Office:
TUV SUD Bangladesh (Pvt.) Ltd.
Level 8,12 & 14 Update Tower,
01 Shahjalal Avenue, Sector -06,
Uttara Model Town,
Dhaka - 1230, Bangladesh

Test Report No: BD/T(W)/25/042307
Dated: 2025-12-18

Test Results: Sample-B- Detention Water

1.0 Conventional Parameters

SL. No.	Parameters	Test Method	Test Results	Limit of Quantification (LOQ)
1	pH Value	USEPA 150.1	6.7	-
2	Total Suspended Solids (TSS) (mg/l)	APHA 23rd Edition 2017 (2540 D)	13	5
3	Chemical Oxygen Demand (COD) (mg/l)	APHA 23rd Edition 2017 (5220 D)	<5	5
4	Biochemical Oxygen Demand (BOD) (For 5 days at 20 °C) (mg/l)	APHA 23rd Edition 2017 (5210 B)	<5	5
5	Total Coliform # (CFU/100mL)	Membrane Filter	ND	-

Remark- Here; (mg/l): milligram per litre; °C: Degree Celsius
#Test have been subcontracted to other competent Laboratory

Laboratory:
TUV SUD Bangladesh (Pvt.) Ltd.
Level 8,12 & 14 Update Tower,
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Uttara Model Town,
Dhaka - 1230, Bangladesh

Test Report No: BD/T(W)/25/042307
Dated: 2025-12-18

PICTURE OF THE SAMPLE

-END OF THE TEST REPORT-

Laboratory:
TUV SUD Bangladesh (Pvt.) Ltd.
Level 8,12 & 14 Update Tower,
01 Shahjalal Avenue, Sector -06,
Uttara Model Town,
Dhaka - 1230, Bangladesh

Phone : + 88-02-58054115,
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Dhaka - 1230, Bangladesh

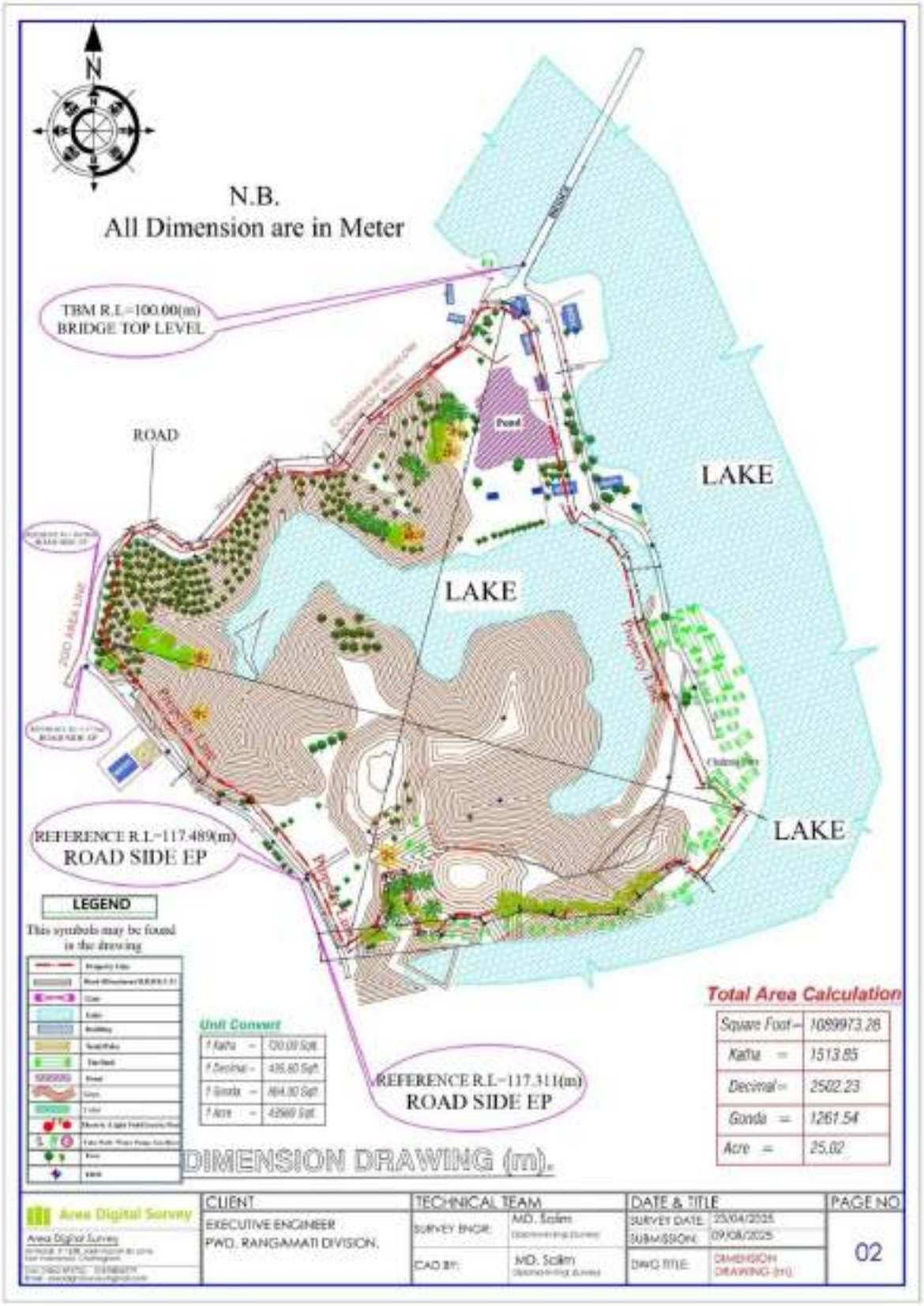


Figure 4-1 Topography map of Rangamati Sadar, Rangamati district

4.4 AIR QUALITY & METEOROLOGY (Reference Ambient Air Quality Bangladesh Clean Air and Sustainable Environment Project Department Of Environment Ministry Of Environment, Forest And Climate Change Government Of The People's Republic Of Bangladesh, September 2018)

4.4.1 Meteorology

4.4.1.1 Wind roses

Monthly wind roses of Chittagong (Rangamati) (Figure 41) differ slightly from those of Dhaka, especially for October and for the winter season. Northern and northeastern winds prevail in October and throughout the winter season (November–January) in Chittagong (Rangamati). However, the wet seasonal wind resembles that in Dhaka – blows from the south and southeast directions.

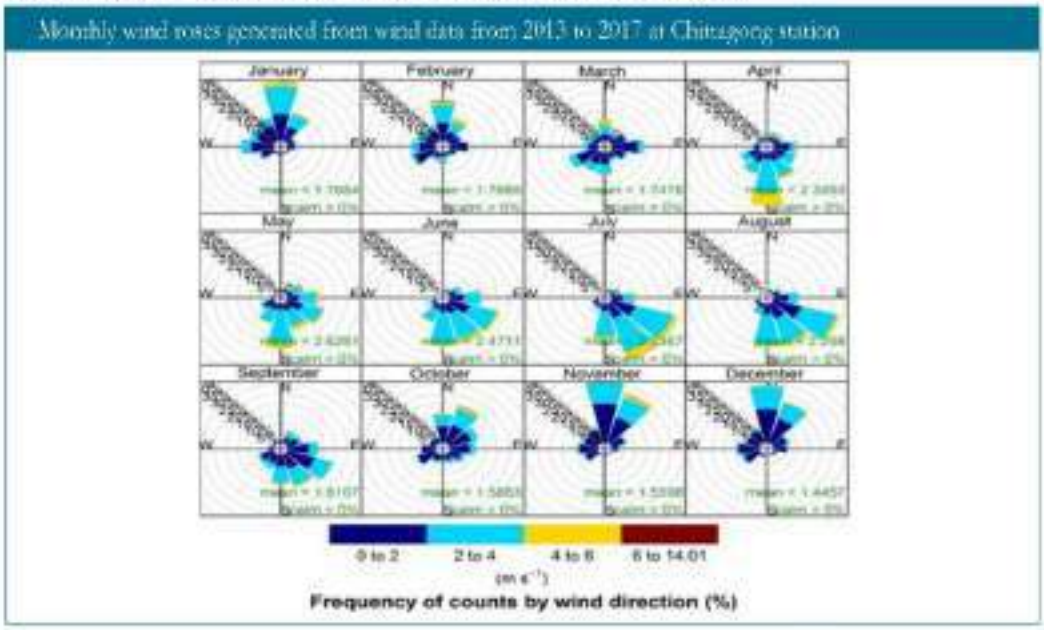


Figure 4-2 Monthly wind roses generated from wind data from 2013 to 2017 at Chittagong station

4.4.1.2 Temperature and Relative Humidity

Figure 42 shows the trends in temperature and relative humidity at the Chittagong (Rangamati) station. The weather in Chittagong (Rangamati) is a little comfortable due to its proximity to the sea.

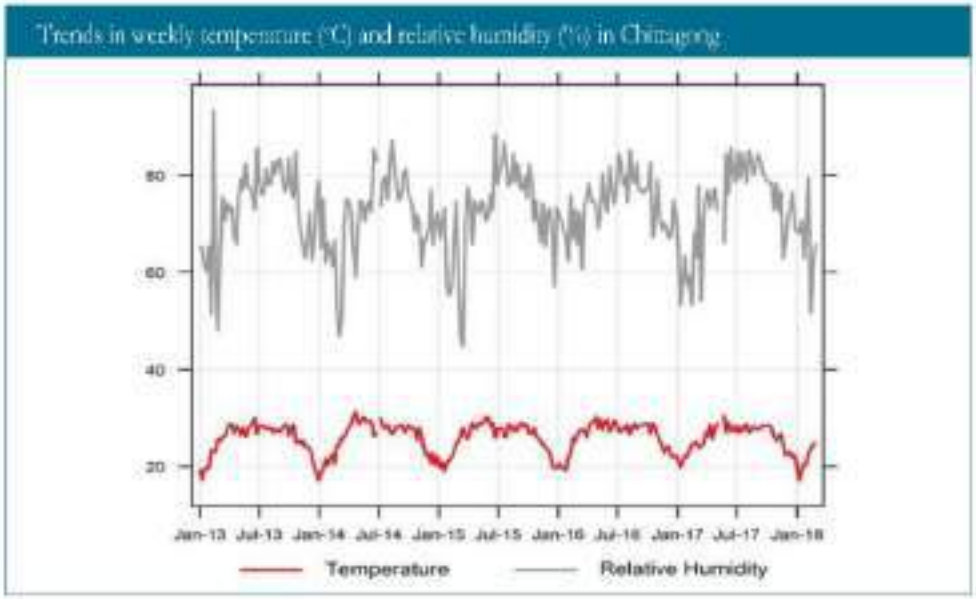


Figure 4-3 Trends in weekly temperature (oC) and relative humidity (%) in Chittagong

4.4.2 Criteria Air Pollutants: Particulate Matter

Seasonal changes also influence the trend in PM concentrations in Chittagong (Rangamati): a high pollution level prevails in the dry season. In contrast, in the wet season, levels are compliant with national standards. However, the intensity of PM pollution throughout the year in Chittagong (Rangamati) is, to some extent, lower than that in and around Dhaka city. January tops the list of high PM10 concentrations, followed by February and December, while for PM2.5 concentrations, January is followed by December and February (Figure 44). The city of Chittagong (Rangamati) is situated by the Bay of Bengal, and sea salt is expected to have a good share in PM10 concentration in the city. The land-

Sea breeze motion and relatively warm winter may play a good role in the characteristics of atmospheric pollution in Chittagong (Rangamati).

Diurnal and weekday variations of PM concentrations in Chittagong (Rangamati) (Figure 45) differ little from those in Dhaka and its vicinity. The morning peak in PM2.5 concentration at 9:00 am is not particularly pronounced in Chittagong (Rangamati), and the pollution level during the dry season lessens on Friday, the first official holiday, unlike in and around Dhaka city. The diurnal variations (Figure 45) also reveal that contributions of coarse size particles (PM10 – PM2.5) to PM outdo that of fine particles from the afternoon till 9:00 pm during the dry season, and from noon to midnight during the wet season. At night, fine particles are found to remain at a high proportion (Figure 45). The percentiles and mean values of the daily PM concentrations for each year are shown in the Table

7. Annual daily PM concentrations are calculated when a minimum of 80% hourly data are present in a day, meaning that only those days with a minimum 19 numbers of hourly data are considered for the statistics. The criterion of setting a high threshold value for calculating the daily average forces many days to be

excluded from the determination of yearly statistical parameters in Table 7, which consequently lowers overall data numbers in some years. The trend in PM concentration (Figure 43) is also shown, with days shaded to indicate 80% valid hourly data. Annual daily PM10 and PM2.5

concentrations in Chittagong (Rangamati) are found to be nearly 120 µg m-3 and 80 µg m-3, respectively, which are about 25% and 13% lower than those in Dhaka city.

Table 4-1Overview of daily PM concentrations in Chittagong (Rangamati) in recent years; daily concentrations are determined when a minimum of 80% valid hourly data is available in that day

Overview of daily PM concentrations in Chittagong (Rangamati) in recent years; daily concentrations are determined when a minimum of 80% valid hourly data is available in that day

Year	PM_{10} Conc. (µg m^{-3})					$PM_{2.5}$ Conc. (µg m^{-3})				
	percentile				mean	percentile				mean
	25	50	75	95		25	50	75	95	
2013	46	87	190	297	123	24	52	115	191	75
2014	nc	nc	nc	nc	nc	30	81	128	175	88
2015	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
2016	45	82	162	254	107	21	36	111	175	67
2017	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc

nc-not calculated for inadequate data capture

Trends in daily PM concentration (data threshold 80%) in Chittagong. The red and grey horizontal lines are standards for PM10 and PM2.5 respectively in Bangladesh

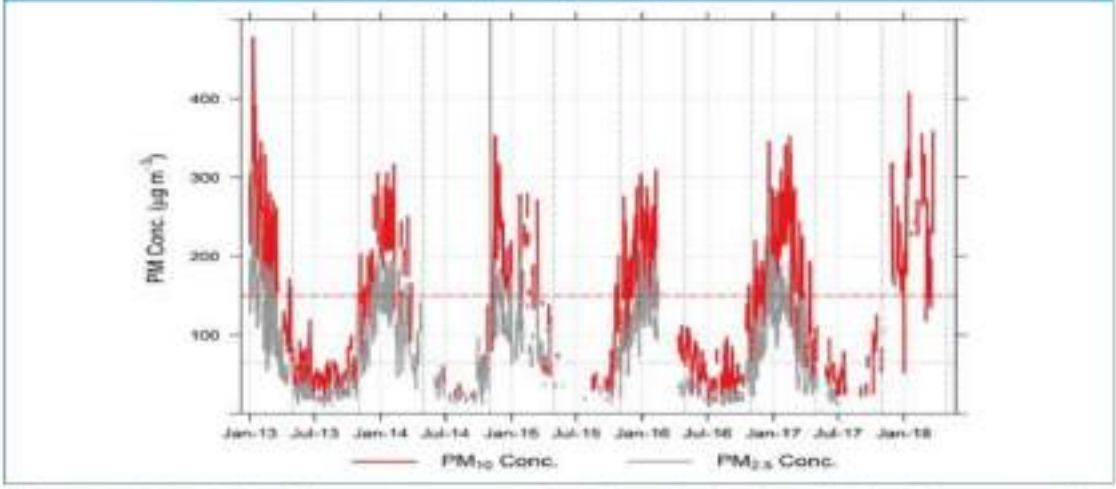


Figure 4-4 Trends in daily PM concentration (data threshold 80%) in Chittagong. The red and grey horizontal lines are standards for PM10 and PM2.5 respectively in Bangladesh

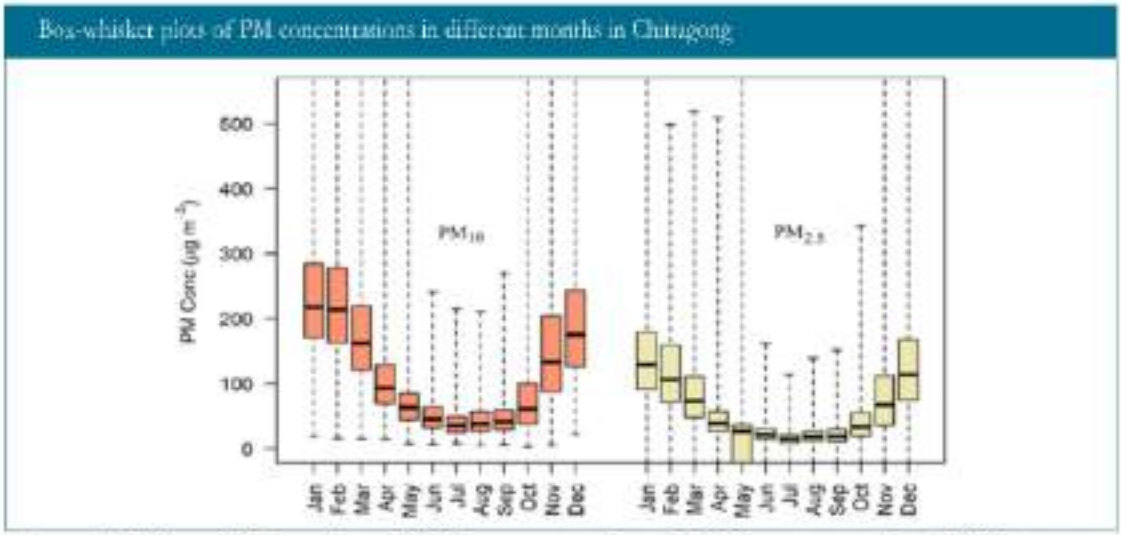


Figure 4-5 Box-whisker plots of PM concentrations in different months in Chittagong

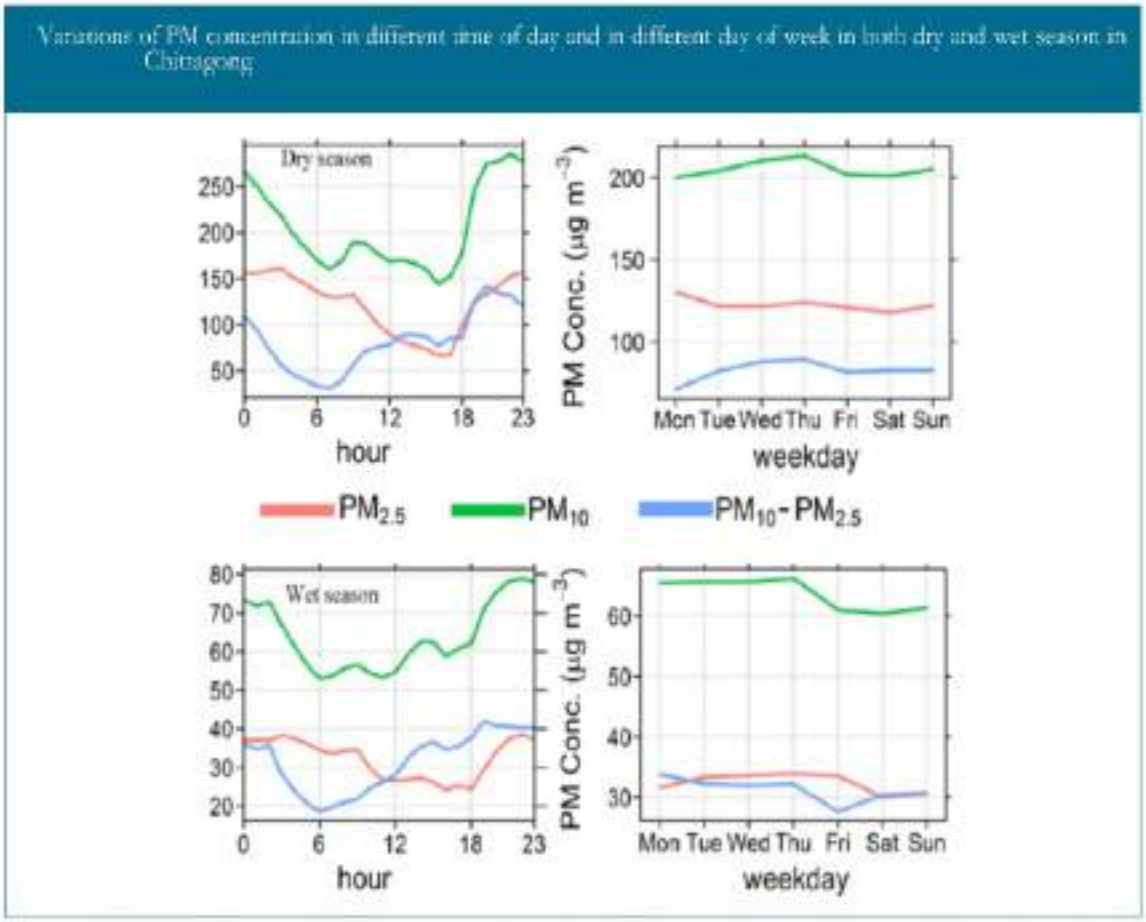


Figure 4-6 Variations of PM concentration in different times of day and in other days of the week in both dry and wet seasons in Chittagong

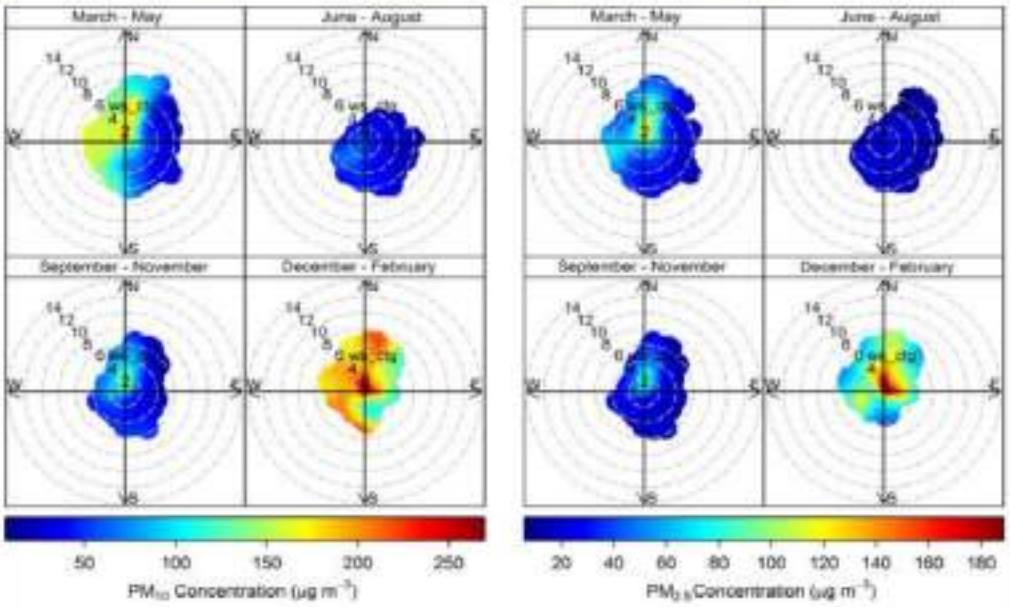
Polar plots of PM_{10} and $PM_{2.5}$ concentrations in different seasons (Figures 4-6) show very high PM concentrations in the wintertime, observed during calm weather, indicating local pollution emitted near the ground. The sources could be dust, cooking, vehicles, and/or open burning. High pollution in the dry season is also experienced from the north and west.

4.4.2.1 Gaseous Pollutants

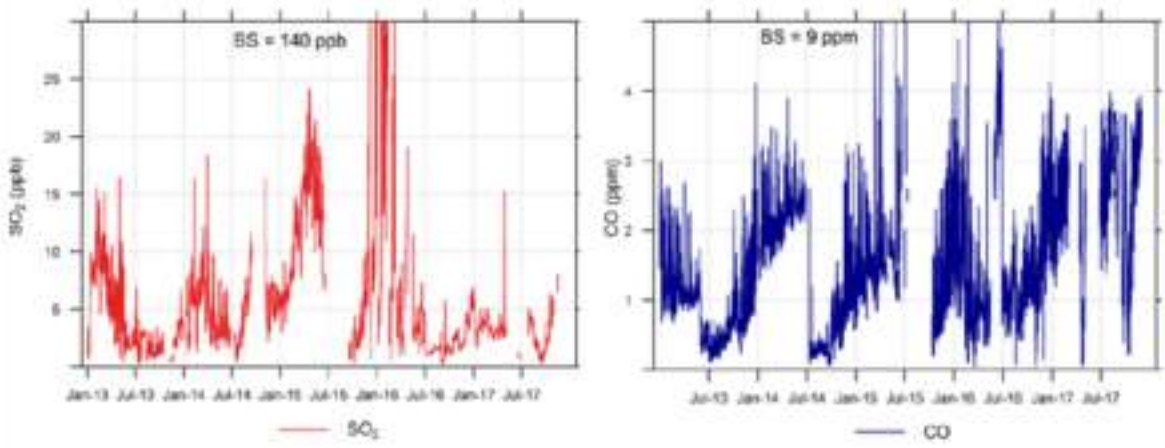
The levels of gaseous pollutants, irrespective of the season, in Chittagong (Rangamati) are well within the respective limit values (Figures 47 and 48), except on some days in the dry season when NO_2 and O_3 concentrations remain very close to the permissible limits. The seasonal trends of gaseous pollutants are, as usual, up during the dry season and down during the wet season.

Diurnal variations of NO_x, NO_2, and NO concentrations (Figure 48a, inset) at the Chittagong (Rangamati) site differ significantly from those in the Dhaka station (Figure 26a). NO_2 concentrations at all times of day exceed NO concentrations at this residential site in Chittagong (Rangamati), presumably because it is located away from vehicular emissions and from any major industries with high thermal activity.

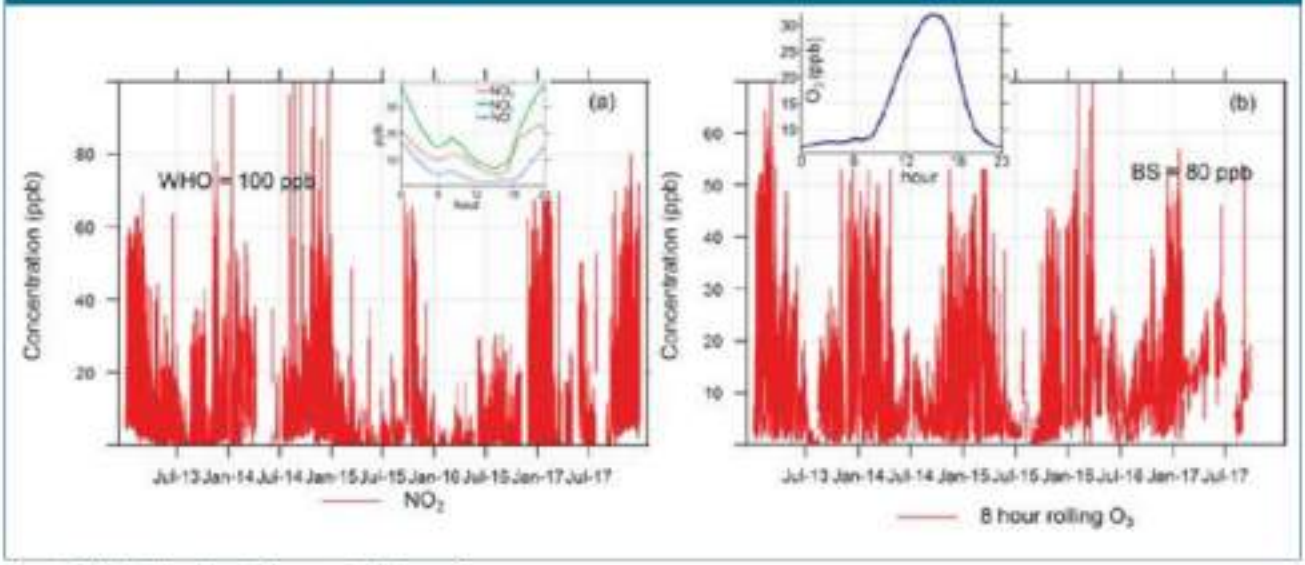
Directional influences on the PM concentrations in different seasons in Chittagong



Trends in daily average SO_2 Conc (left) and 8-h average CO Conc. (right) in Chittagong; BS = Bangladesh Standard



(a) Trends in hourly NO_2 Conc. in Chittagong with the diurnal variations of NO_2, NO, and NO Conc. in dry season shown in inset. (b) Trends in 8-hour rolling average O_3 Conc. in Chittagong with the diurnal variations of O_3 conc. in dry season shown in inset. BS=Bangladesh Standard, WHO=World Health Organization guideline value.



As of 2025, the baseline conditions for

Rangamati Sadar (22°39'05.0"N 92°09'56.1"E) reflects a hill-district environment in which seasonal changes significantly influence pollutant concentrations and dispersion.

4.4.3 Air Quality Parameters

- **Particulate Matter (PM2.5 & PM10):** PM2.5 is the primary pollutant of concern.
  - **Current Levels (Dec 2025):** Recent readings indicate "Unhealthy" or "Poor" levels, with AQI values ranging from **107 to 112** and PM2.5 concentrations around **35.1 µg/m³**.
  - **National Standard:** The 24-hour national limit is **65 µg/m³** for PM2.5 and **150 µg/m³** for PM10.
- **Gaseous Pollutants (SOx & NOx):** Generally remain within national limits.
  - **SO2:** Low baseline, frequently recorded near **1.57 µg/m³** (Standard: 80 µg/m³ per 24h).
  - **NO2:** Similarly low, typically around **1.45–4.03 µg/m³** (Standard: 80 µg/m³ per 24h).

4.4.4 Meteorology & Pollutant Dispersion

Meteorological factors dictate the "wash out" and "scavenging" of pollutants.

- **Wind Speed & Direction (Wind Rose):**
  - Winds are typically light (approx. **1-5 knots** or 5-10 mph) and variable.
  - **Seasonal Pattern:** Winter winds often come from the **north/northwest**, potentially bringing transboundary pollution, while summer/monsoon winds are often from the south.

- **Temperature & Humidity:**
    - **Temperature:** Dec 2025 highs reach **28.5°C** with lows near **14°C**. In warmer months, temperatures peak near **34°C**.
    - **Humidity:** High humidity and rainfall during the monsoon (June–Sept) drastically reduce PM levels through wet deposition.
- **Significance:** Lower wind speeds and low humidity in the dry season (Nov–Feb) lead to poor dispersion and higher pollutant accumulation at ground level.

4.4.5 Summary of Baseline (2025)

Parameter	Recorded Value (Approx.)	National Standard (24h)
PM2.5	35.1 – 50.0 µg/m³	65 µg/m³
PM10	13.96 µg/m³	150 µg/m³
SO2	1.57 µg/m³	80 µg/m³
NO2	1.45 – 4.03 µg/m³	80 µg/m³
Wind Speed	1–5 knots (Light)	N/A

4.4.6 Meteorological Parameters (Dec 2025)

Meteorology in Rangamati is characterized by its hilly terrain, which creates microclimates affecting how pollutants disperse.

- **Temperature:** Ranges from a high of **28.5°C** to a low of **14°C**.
- **Humidity:** The area transitions from hot/humid summers (May–Sept) to drier, cooler winters (Dec–Feb).
- **Wind Speed & Direction:**
    - Winds are typically **light and variable** (6–9 kph).
    - **Wind Rose Significance:** During winter, light north/northwesterly winds prevail, leading to "stagnation" where pollutants are trapped near the surface rather than dispersing upward or outward.

3. Graphical Representation Concepts

Based on 2025 trends, a baseline assessment would visualize the following:

- **AQI Trend:** A "U-shaped" curve where values are high (Unhealthy) from **November to February** and low (Good) during the **Monsoon (June–August)** due to wet scavenging.
- **Pollutant Dispersion:** A direct correlation between wind speed and PM2.5 levels; as wind speed drops in winter, PM2.5 concentrations spike.

Authoritative References:

- **Government Data:** Bangladesh Department of Environment (DoE) Air Quality Reports (Provides daily CAMS-based AQI).

- **Meteorological Data:** Bangladesh Meteorological Department (BMD) (For real-time temperature, wind, and rainfall charts).
- **Global Monitoring:** Wunderground Rangamati Health Profile and AccuWeather Rangamati AQI for real-time 2025 sensor data.

4.5 TOPOGRAPHY, SOIL, AND GEOLOGY

4.5.1 Topography

Puddling of clay soils for rice transplanting causes a loss of soil structure and vertical shrinkage cracks that are hypothesized to hamper sunflower root growth in the following dry season. To alleviate soil constraints for sunflower root growth and yield, we examined the effects of three levels of mulch and two irrigation regimes in the dry season on a clay-textured soil in the coastal zone of Bangladesh. These treatments were no-mulch, rice straw mulch at 5 t ha−1 and 10 t ha−1, irrigation applied to the field capacity (I1) and a water supply double that of the I1 treatment (I2). The rice straw mulch significantly increased soil water content by 3–9% and decreased soil penetration resistance by 28–77% and crack volume by 84–91% at A 0–30 cm soil depth relative to the no-mulch treatment. The better root development with the rice straw mulch increased sunflower yield by 23%. No benefit or further reduction in soil penetration resistance or yield improvement was obtained from increasing the mulch level from 5 to 10 t ha−1 or the volume of irrigation water. It is concluded that ameliorating soil constraints by mulch application led to better root growth in the upper root zone and the increased yield in the clay soil.

4.5.2 Soil Characteristics: Analysis of Soil Investigation Report

Borehole No.: BH-113

Project: Rangamati Medical College & Hospital and Nursing College
Location: Rangamati Sadar, Rangamati
Client: Executive Engineer, PWD, Rangamati Division
Ground Level (RL): 106.07 m
Total Boring Depth: 17.0 m

1. Subsurface Stratification

Based on the bore log, the subsurface profile at the project site is **predominantly sandy**, with increasing density with depth. No clayey or soft cohesive layers were encountered within the investigated depth.

1.1 Layer-wise Soil Description

Depth Range (m)	Soil Description	Relative Density	SPT N-Value
0.00 – 1.50	Brown, loose, poorly graded medium to fine sand	Loose	N ≈ 7
1.50 – 6.00	Brown, poorly graded medium to fine sand	Loose to medium dense	N ≈ 5–11

6.00 – 9.00	Brown, medium dense poorly graded medium to fine sand	Medium dense	N ≈ 14–21
9.00 – 12.00	Brown sand	Dense	N ≈ 50 / 30 cm
12.00 – 17.00	Brown, very dense, poorly graded medium to fine sand	Very dense	N = 50 / 22–30 cm

bh-113

2. Interpretation of SPT Results

2.1 Standard Penetration Test (SPT)

- SPT N-values show a **clear increasing trend with depth,** indicating progressive densification.
- Refusal (N = 50) is encountered from approximately **9.0 m depth onward**, suggesting **very dense sand strata.**

2.2 Engineering Implications

- **Loose sand near the surface (0–3 m)** may be susceptible to:
  - Settlement
  - Erosion during heavy rainfall
- **Dense to very dense sand below −6.0 m** provides **excellent bearing support** for foundations.

3. Soil Characteristics and Engineering Behavior

3.1 Soil Type

- The soil is **poorly graded sand (SP)** as per Unified Soil Classification System (USCS).
- Absence of clay indicates:
  - Good drainage
  - Low plasticity
  - Low compressibility

3.2 Bearing Capacity

- Medium dense to very dense sand layers (N ≥ 21–50) indicate:
  - **High allowable bearing capacity**
  - Suitability for **shallow foundations**, subject to design depth and load
- Lower layers are adequate for **multi-storied hospital and institutional buildings.**

3.3 Settlement Characteristics

- Settlement risk is mainly limited to the **upper loose sand layer.**
- With proper:
  - Compaction
  - Foundation embedment
  - Raft or pile option if required

  total and differential settlements are expected to be **within permissible limits.**

Attachment - III

MRITTIKA ENGINEERING

Client: Executive Engineer, PWD Rangamati Division.
Project: Establishedment Rangamati Medical College and Hospital and Nursing College
Project Location : Rangamati Sadar, Rangamati.

Bore Hole No. : 113
Page No : 1 of 1
RL (EGL) : 106.07m

Date of Field Work	Date of Field Work	Total layer depth (m)	Layer Thickness (m)	STRATA ENCOUNTERED DURING BORING	LOG	Dia. Of Bore	SPT VALUE No. of blows/30cm	SPT Level (m)	Soil Sample ID
5/28/2025	1.5	5.0	5.0	Brown loose poorly graded medium to fine sand		100mm	7	1.5	D-1
	3.0							3.0	D-2
	4.5						5	4.5	D-3
	6.0	9.5	4.5	Brown medium dense poorly graded medium to fine sand			8	6.0	D-4
	7.5						11	7.5	D-5
	9.0						14	9.0	D-6
	10.5	17.0	7.5	Brown very dense poorly graded medium to fine sand			21	10.5	D-7
	12.0						50 Blows /30cm	12.0	D-8
	13.5						50 Blows /30cm	13.5	D-9
	15.0						50 Blows /30cm	15.0	D-10
	16.5						50 Blows /22cm	16.5	D-11
							50 Blows /22cm		

DISTURBED SAMPLE——D | UNDISTURBED SAMPLE——UD

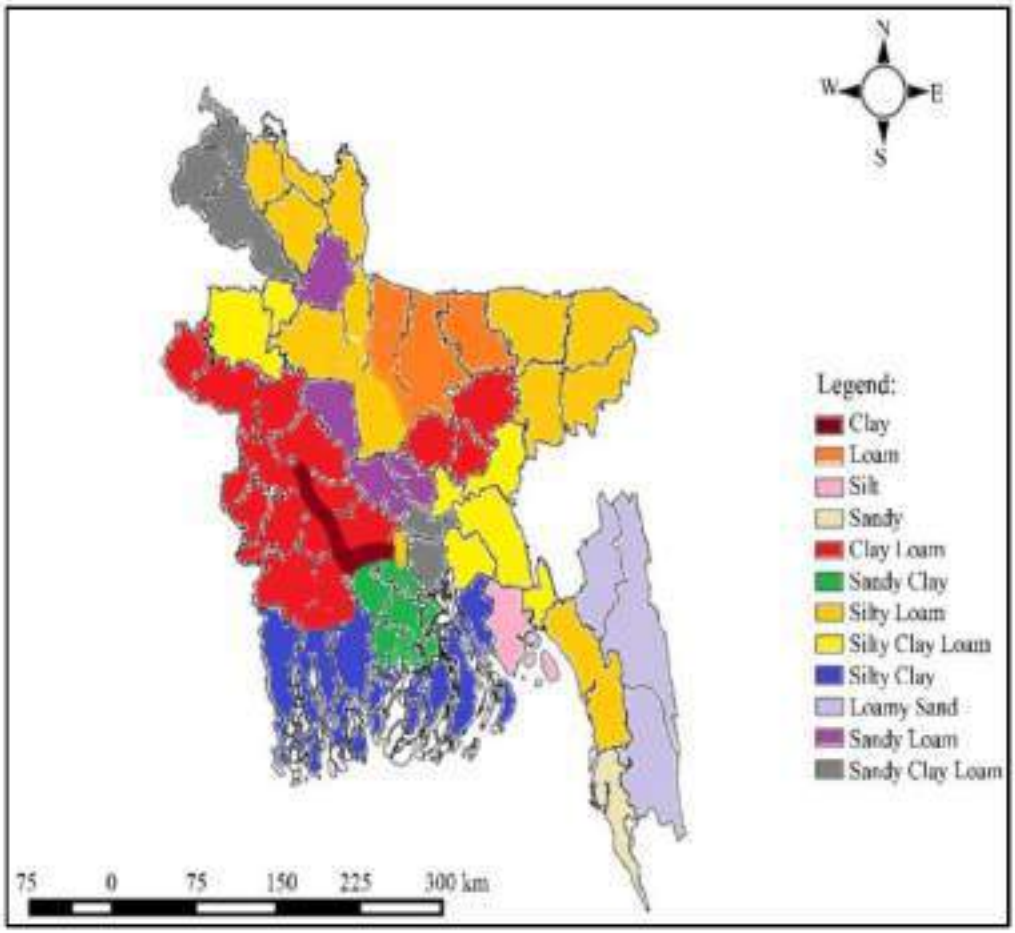


Figure 4-7 Soil Texture of Bangladesh

4.6 LAND USE OF THE STUDY AREA

Groundwater and Infiltration Behavior

Although groundwater level is not explicitly recorded, the **continuous sandy profile** indicates:

- **High permeability**
- Rapid infiltration during rainfall
- Low potential for prolonged waterlogging

Environmental implications:

- Reduced risk of stagnant surface water
- Lower likelihood of slope saturation (important in hilly terrain)
- However, rapid runoff generation during intense rainfall events is possible

Implementation implication:

- Effective surface drainage is essential to prevent:
  - Erosion of loose surface soil
  - Sediment transport into natural drains

4. Soil Stability and Slope Considerations (No Slope Cutting Scenario)

The project explicitly states that **no slope cutting will occur**.

Given this condition:

- The soil profile supports **natural slope stability**
- No weak clay layers exist that could trigger rotational landslides
- Dense sand layers act as a **stable foundation mass**

Residual environmental risk:

- Limited to **surface erosion only**, not structural slope failure

This significantly reduces:

- Landslide risk
- Large-scale geomorphological disturbance
- Long-term soil instability impacts

5. Construction-Phase Environmental Sensitivity

Key Soil-Related Risks During Construction

Based on the soil report, the primary EIA-relevant risks are:

1. **Surface erosion of loose sand**
2. **Sediment-laden runoff during monsoon**
3. **Dust generation during dry weather**

These impacts are:

- Short-term
- Localized
- Reversible

5.2 Why These Risks Are Manageable

- Dense sand layers prevent deep instability
- No slope cutting avoids exposure of deep soil faces
- Soil conditions allow rapid recovery through compaction and revegetation

6. Integration with EIA Mitigation Strategy

The soil investigation directly informs the following EIA commitments:

- Limiting earthworks to essential areas only
- Immediate stabilization of exposed soil
- Preservation of natural ground contours
- Strong emphasis on drainage and runoff control

Because the soil itself is **structurally competent**, environmental mitigation can focus on **surface protection rather than heavy engineering**, which aligns with sustainable development principles.

7. Residual Impact Assessment (Soil Environment)

After implementation of standard mitigation measures:

- Residual soil erosion risk: **Low**
- Residual instability risk: **Negligible**
- Long-term soil impact: **Neutral to positive**

The project will not result in:

- Permanent soil degradation
- Loss of soil productivity beyond the footprint
- Regional geomorphological alteration

8. EIA-Focused Conclusion

The soil investigation at Borehole BH-113 demonstrates that the project site is underlain by **predominantly sandy soil with increasing density at depth**, providing a **stable and environmentally manageable foundation condition**. While the loose surface sand layer is sensitive to erosion, the absence of slope cutting and the presence of dense subsurface strata significantly reduce environmental risks. With proper implementation of soil protection and drainage measures, soil-related impacts during both construction and operation phases are expected to remain **minor, localized, and fully manageable**, confirming the **environmental acceptability of the project from a soil and geotechnical perspective**

4.7 PHYSICAL PROPERTIES OF SOILS

Physical properties describe the **soil index characteristics** that influence their behavior under natural and engineered conditions.

4.7.1 Key Physical Properties

Property	Description	Environmental Significance
Grain size distribution	Proportion of sand, silt, and clay	Controls erosion and permeability
Natural moisture content	Water content in soil	Influences strength and compaction
Bulk density	Mass per unit volume	Affects settlement and bearing
Porosity	Void spaces in soil	Controls infiltration and drainage
Permeability	Ability to transmit water	Influences runoff and groundwater

EIA relevance:
Soils with high permeability and low cohesion (e.g., sands) are prone to erosion but drain well, while fine-grained soils retain water and may cause stability issues.

4.8 ENGINEERING PROPERTIES OF SOILS

Engineering properties govern how soil behaves under **loads, excavation, and environmental stresses**.

4.8.1 Key Engineering Properties

Property	Description	Project Implementation Significance
Shear strength	Resistance to sliding failure	Determines slope and foundation safety
Compressibility	Volume change under load	Controls settlement
Bearing capacity	Load-carrying ability	Governs foundation design
Modulus of elasticity	Deformation behavior	Influences structural response
Angle of internal friction (φ)	Resistance due to particle interlock	Critical for sandy soils
Cohesion (c)	Inter-particle bonding	Important for clayey soils

4.9 CLIMATE AND AVERAGE WEATHER YEAR-ROUND IN

4.9.1 Temperature and Precipitation

The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Rangamati Sadar, Rangamati. Likewise, "mean daily minimum" (solid blue line) shows the average minimum temperature. Hot days and cold nights (dashed red and blue lines) show the average of the hottest day and coldest night of each month of the last 30 years. For

vacation planning, you can expect the mean temperatures, and be prepared for hotter and colder days. Wind speeds are not displayed per default, but can be enabled at the bottom of the graph.

The precipitation chart is useful to plan for seasonal effects such as monsoon climate in India or wet season in Africa. Monthly precipitations above 150mm are mostly wet, below 30mm mostly dry. Note: Simulated precipitation amounts in tropical regions and complex terrain tend to be lower than local measurements.

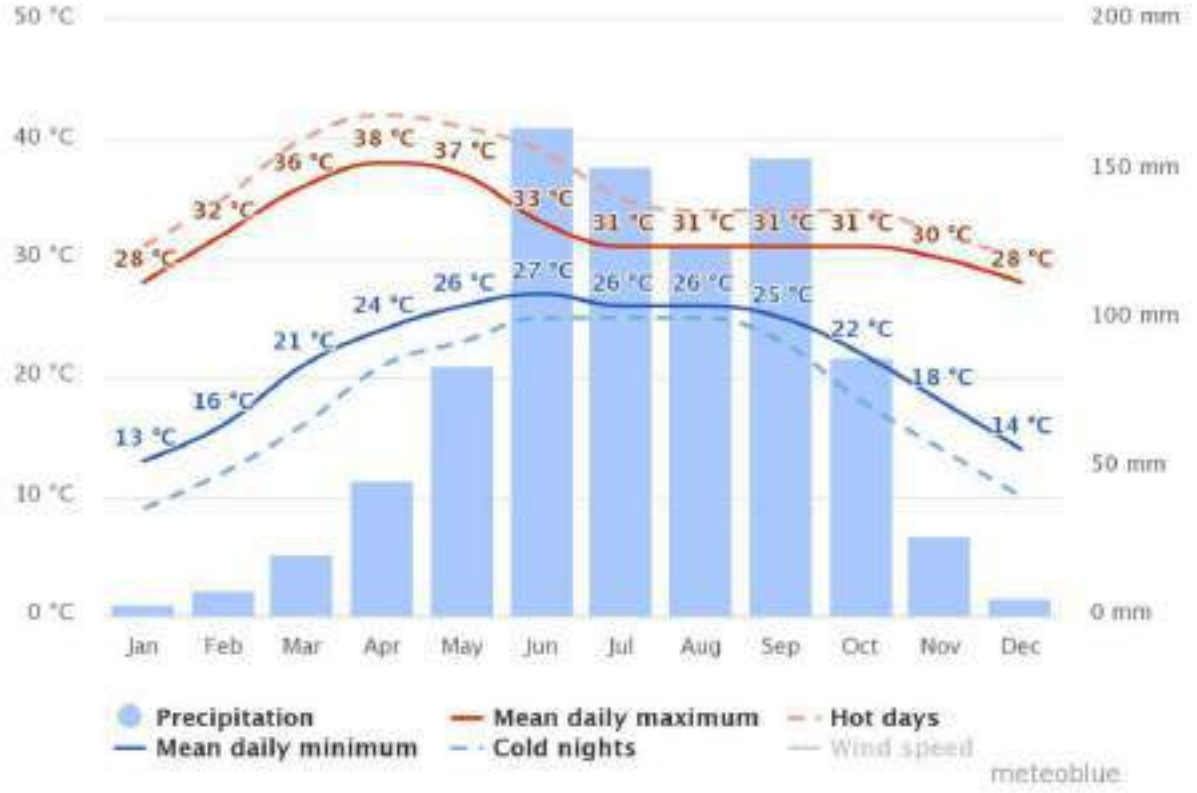


Figure 4-8 Temperature and Precipitation Curve

Bangladesh Meteorological Department, Climate Division, Agargaon, Dhaka-1207

Monthly average Dry-bulb Temperature in degree Celsius of Rangamati Sadar, Rangamati

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
2011	17.3	21.9	26.3	28.5	29.7	29.3	29.3	28.5	28.6	28.7	24.1	19.2
2012	18.8	21.9	27.5	29.5	31.1	31.1	29.3	29.2	29.1	27.5	23.4	18.4
2013	17.5	21.7	27	29.4	28.8	30.1	29.3	28.9	29.1	27.3	23.6	20.1
2014	17.5	21	26.4	31.1	30.8	29.9	29.4	29.2	29.2	27.9	23.8	18.9
2015	18.8	22.5	25.9	28.5	31	29.6	28.2	29.2	29.3	28	24.8	20.6
2016	18.7	24.3	27.6	31	29.7	29.8	28.8	29.2	29.6	28.4	23.8	20.3
2017	18.8	22.5	25.8	29.4	30.6	29.9	28.9	29.4	29.4	27.6	23.8	20.5
2018	16.7	23.1	27.4	28.4	28.9	29.9	29.3	29.7	29.8	27.5	24.2	18.9
2019	18.5	21.7	26.2	29.3	31.1	30.7	29.8	29.6	28.9	27.6	24.5	19.2
2020	18.3	20.6	26.3	28.6	29.4	29.7	29.8	29.4	29.7	29	24.5	19.4
2021	19.1	22	28.2	30.5	30.2	28.9	29.3	29.3	28.8	28.7	24.1	20.3

4.9.2 Rainfall

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Rangamati Sadar, Rangamati varies very significantly throughout the year.

The wetter season lasts 5.0 months, from May 9 to October 7, with a greater than 34% chance of a given day being wet. The month with the most wet days in Rangamati Sadar, Rangamati, and Rangamati Sadar, Rangamati is July, with an average of 20.1 days with at least 0.04 inches of precipitation.

The drier season lasts 7.0 months, from October 7 to May 9. The month with the fewest wet days in Rangamati Sadar, Rangamati, is January, with an average of 0.8 days with at least 0.04 inches of precipitation.

Among wet days, we distinguish between those that experience rain alone, snow alone, or a mixture of the two. The month with the most days of rain alone in Rangamati Sadar, Rangamati, is July, with an average of 20.1 days. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 66% on July 9.

The rainy period of the year lasts for 9.1 months, from March 4 to December 6, with a sliding 31-day rainfall of at least 0.5 inches. The month with the most rain in Rangamati Sadar, Rangamati, is July, with an average rainfall of 16.4 inches.

The rainless period of the year lasts for 2.9 months, from December 6 to March 4. The month with the least rain in Rangamati Sadar, Rangamati, is January, with an average rainfall of 0.2 inches.

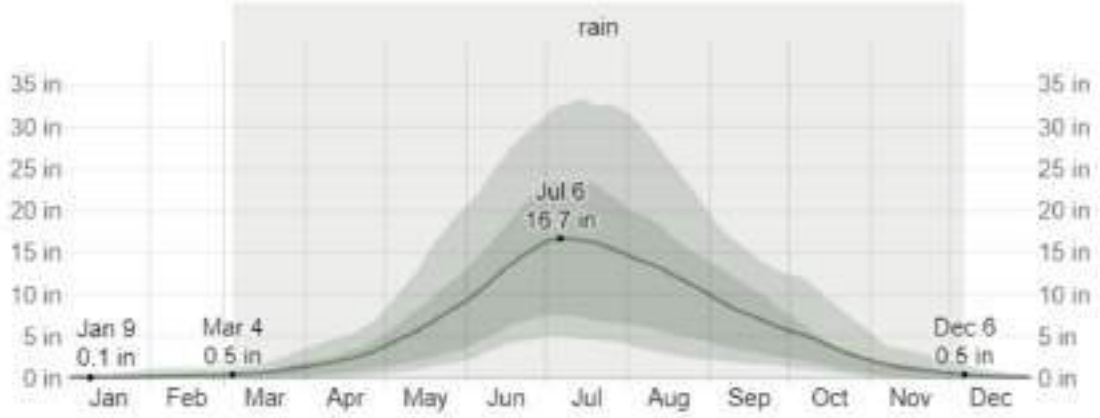


Figure 4-9 Average Monthly Rainfall in Rangamati Sadar, Rangamati

The average rainfall (solid line) accumulated over a sliding 31-day period centered on the day in question, with 25th-75th and 10th-90th percentile bands.

Table 4-2 Average Monthly Rainfall in Rangamati Sadar, Rangamati

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	0.2"	0.4"	0.8"	2.2"	6.3"	13.1"	16.4"	12.6"	7.7"	3.9"	1.2"	0.3"

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Spt.	Oct.	Nov.	Dec.	Annual
2011	0	1	16	28	145	381	387	614	367	3	6	0	1948
2012	66	18	1	52	63	255	391	254	374	89	80	2	1645
2013	1	7	19	62	430	212	313	482	278	260	0	0	2064
2014	0	24	5	0	118	447	394	258	205	10	0	0	1461
2015	41	35	28	107	128	318	922	353	293	83	3	6	2317

2016	0	97	5	54	350	353	413	646	148	81	75	0	2222
2017	0	2	59	99	200	356	690	313	175	322	19	51	2286
2018	0	0	1	64	226	266	264	107	106	36	0	3	1073
2019	0	166	74	102	104	114	335	370	283	187	175	15	1925
2020	30	2	10	179	243	350	223	265	172	90	6	0	1570
2021	0	3	0	2	124	468	525	203	339	234	3	66	1967

4.9.3 Humidity

Lower dew points feel drier, and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night. Rangamati Sadar, rangamati experiences extreme seasonal variation in the perceived humidity. The muggier period of the year lasts for 8.8 months, from March 7 to December 1, during which time the comfort level is muggy, oppressive, or miserable at least 26% of the time. The month with the fewest muggy days in Rangamati Sadar, rangamati is January, with 0.5 days that are muggy or worse.

Figure 4-10 Humidity in Rangamati Sadar, Rangamati

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
2011	76	70	70	72	78	84	84	88	87	79	81	83	79
2012	80	71	73	77	79	84	90	90	90	85	81	87	82
2013	83	77	70	71	82	84	90	91	85	86	75	78	81
2014	81	73	68	66	74	83	86	85	84	79	75	82	78
2015	80	74	68	76	76	83	90	86	85	81	79	84	80
2016	79	77	74	74	77	83	87	85	82	81	80	82	80
2017	77	72	74	74	75	83	87	86	85	86	79	84	80
2018	78	73	71	73	79	82	86	83	83	80	77	76	78
2019	74	72	72	73	76	81	85	84	86	85	82	81	79
2020	80	72	66	72	76	83	84	85	84	82	74	79	78
2021	78	72	69	66	72	84	85	85	85	82	75	80	77

4.9.4 Wind

The diagram for Rangamati Sadar, Rangamati shows the days per month, during which the wind reaches a certain speed. An interesting example is the Tibetan Plateau, where the monsoon creates steady strong winds from December to April, and calm winds from June to October.

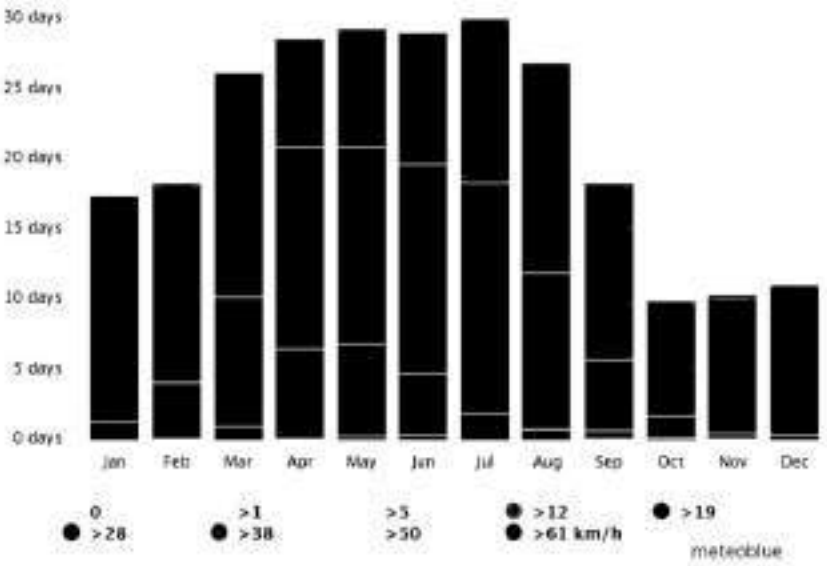


Figure 4-11 Wind speed units can be changed in the preferences (top right).

The wind rose for Rangamati Sadar, Rangamati, shows how many hours per year the wind blows from the indicated direction. Example SW: Wind is blowing from South-West (SW) to North-East (NE).

The average of mean hourly wind speeds (dark gray line), with 25th to 75th and 10th to 90th percentile bands.

Table 4-3 Average Wind Speed in Rangamati Sadar, rangamati

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Speed (mph)	4.5	4.5	4.7	5.1	5.3	6.5	6.6	5.7	4.4	3.8	3.9	4.1

The predominant average hourly wind direction in Rangamati Sadar, rangamati varies throughout the year.

The wind is most often from the west for 1.2 months, from February 16 to March 21, with a peak percentage of 40% on March 5. The wind is most often from the south for 6.6 months, from March 21 to October 10, with a peak percentage of 91% on July 10. The wind is most often from the north for 4.2 months, from October 10 to February 16, with a peak percentage of 59% on January 1.

4.10 ECOLOGICAL BASELINE

4.10.1 Introduction

The ecological baseline is the ecological value of a site before construction works are undertaken. It can be compared to the ecological value of the site after construction works are complete to determine where there have been changes. The survey of the ecological status is the first step of the implementation. This study has two main outputs; In one hand it is a baseline for the monitoring of the ecological result of the project. In the other hand it provides data for the Environmental Impact Assessment (EIA).

The survey covers the whole target area from the Terrestre habitats to the water body, including either the Hungarian or the Croatian side regarding to the fact that the habitats are divided only by the state border.

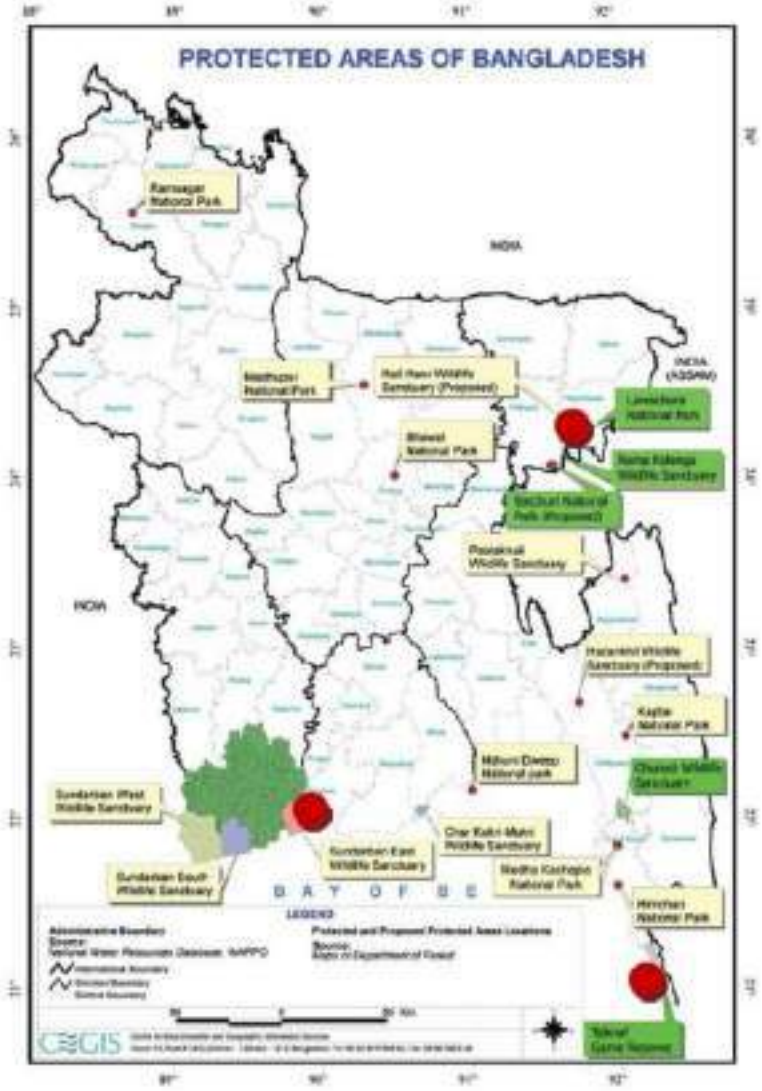


Figure 4-12 Protected Areas of Bangladesh

4.11 ECOLOGICAL AND CONSERVATION DESIGNATIONS

4.11.1 Overview

There are 19 protected areas in Bangladesh, covering 2,458 sq. km and representing 1.68% of the land area (FD record as on July 2007). The Forest Department has the mandate for the

management of these protected areas. The protected areas are declared in the country under the "Bangladesh Wildlife (Preservation) (Amendment) Act, 1974". The protected areas are divided into following categories-

4.11.2 National Parks

National Park is a relatively large area of scenic and natural beauty created for the preservation of scenery, flora, and fauna in a natural state to which access of the public for recreation and educational and research purposes is allowed. There are 10 national parks available in our country.

No National Parks are located near the project site.

4.11.3 Wildlife Sanctuary

Wildlife Sanctuary is an area closed to hunting, shooting or trapping of wild animals and maintained undisturbed for breeding of wildlife and vegetation, soil and water is protected from public interference. There are 8 wildlife sanctuaries present.

No Wildlife Sanctuary is located near the project site.

4.11.4 Game Reserves

Game Reserves are created for protection of wildlife and increasing their number were capturing of wild animals is unlawful. There is only one game reserve present in our country named Teknaf Game Reserve, Cox's Bazar which area is 11,615 ha. and notified on 1983.
No Game Reserve is located near the project site.

4.11.5 Ecologically Critical Area

An Ecologically Critical Area (ECA) is an environmental protection zone in Bangladesh. In 1995, specific areas in Bangladesh could be deemed Ecologically Critical Areas as a result of the Environmental Conservation Act.

Bangladesh has a wide variety of ecosystems that include over 300 rivers that creates marine and fresh water environments. There are a multitude of areas that have been considered ECAs. Cox's Bazar is on the border of Bangladesh and Myanmar in the southeast corner of Bangladesh. The Teknaf Peninsula is 80 km of sandy beach and holds a variety of species as one of the longest beaches in the world. The Sonadia Islands are home to some of the last mangrove forests that house distinct species that can tolerate the high salinity of the mangrove forests in this area. The Sundarbans also contain mangrove forests and was named an ECA because it continues to suffer from over-exploitation and illegal urban development. St. Martin's Island is known for its coral-algal that overwhelms its rocky reefs. The island is a refuge for globally threatened marine species. Finally, the Hakaluki Haor found in greater Rangamati Sadar, Rangamati is an ECA because it has an extensive amount of wetland habitats that support a wide variety of life.

Gulshan-Baridhara Lake was declared an ECA in 2001. In September 2009, the four rivers around the capital city Dhaka—Buriganga River, Labandha connected to Bongshai River, Bongshai River and Balu River—have been declared by the Department of Environment as ECAs.

The project site does not locate in any Ecologically Critical Area.

4.11.6 Eco Park

Eco Park a short form of Ecological Park. It is exploited as an amusement park without hampering its natural environment so that the bio-diversity remains unaffected there. Generally, a particular area of a forest is demarcated and brought under intensive management for this purpose. Sometimes forest areas having special natural features are selected as eco parks. Flora of the concerned area gets preference for such consideration. However, protection and preservation of both flora and fauna get top priority. Beauty offered by the nature is opened to the visitors. Moreover, efforts to attract and entertain the visitors are also visible in the Eco parks.

Eco Park is not only a mere component of forest management. It facilitates to enjoy the beauty of the jungles as well as to acquire firsthand knowledge on its ecology, particularly the growth and development of flora and fauna. Eco Park also helps to increase public awareness about the necessity of maintaining bio-diversity. The Department of forest has set up nine eco parks throughout Bangladesh considering their natural beauty and specific features like geographical location.

The project site does not locate in any Eco Park Area.

4.12 TERRESTRIAL ECOLOGY

4.12.1 Flora

n 2025, the flora of

Rangamati Sadar

(22°39'05.0"N 92°09'56.1"E) is characterized by a mix of tropical evergreen and semi-evergreen hill forests, substantial homestead biodiversity, and the unique aquatic ecosystem of Kaptai Lake.

1. Terrestrial and Aquatic Vegetation

- **Terrestrial Flora:**
    - **Natural Forests:** Dominated by timber-yielding and food-source genera such as *Tectona* (Teak), *Dipterocarpus* (Garjan), and *Artocarpus* (Jackfruit).
    - **Homestead Areas:** Surveys in Rangamati Sadar identify over **163 plant species**, including timber (8%), fruit (20%), medicinal (12%), and ornamental plants (34%). Common domestic species include Mango (*Mangifera indica*), Areca nut, and Coconut.
- **Aquatic Flora:**
    - **Kaptai Lake Ecosystem:** The lake supports various aquatic macrophytes and provides a habitat for freshwater fish and prawns.
    - **Vascular Plants:** Studies of the nearby Karnafuli River identify 128 vascular species, including many Pteridophytes (ferns) and Monocots.

2. Endangered Species (IUCN Red List 2025)

As of late 2024–2025, Bangladesh has released its first comprehensive **Plant Red List** assessing 1,000 species.

- **Critically Endangered (CR):** Five species identified for priority conservation include the **Bulborox orchid** (*Bulbophyllum roxburghii*), **Small-bulb orchid**, **Dwarf date palm**, **Chaulmoogra**, and **Bashpata**.
- **Endangered (EN):** Includes species like *Mangifera sylvatica* (Wild Mango) and *Saurauia armata*.
- **Vulnerable (VU):** Many hill forest species, such as *Colona flagrocarpa*, are categorized as vulnerable due to habitat loss.

3. Biomass and Density Assessment

- **Vegetation Density (NDVI):** Historical data indicates a decline in peak NDVI values from 0.72 to 0.47 in some regions, reflecting a roughly **18–24% decrease** in vegetation cover due to urbanization and land-use change.
- **Biomass Status:**
  - Rangamati remains a vital biomass fuel source, with homestead forests contributing significantly to urban household energy and food security.
  - **Soil Erosion Link:** High erosion risks (34.1% of the area at severe risk) directly impact biomass sustainability by degrading the soil required for dense vegetation growth.

- *Bangladesh is attempting to conserve and nurture five critically endangered flora species to ensure their healthy population in nature. Currently, these plants are present only in some specific places in the country.*
- *The species are the bulborox, small-bulb orchid, dwarf date palm, chaulmoogra and bashpata, which are identified as critically endangered in the latest Plant Red List of Bangladesh.*
- *The Bangladesh Forest Department has taken the initiative to increase the plants' numbers by cultivating them in the National Botanical Garden and the National Herbarium before planting them in suitable habitats.*

Among the Reptiles Slender coral snake (Callophis melanurus), Green pit viper (Trimeresurus gramineus), Banded krait (Bungarus fasciatus), Ring lizard (Varanus salvator are widely available. The amphibian species found in this zone include Ornate microhylid (Microhyla ornata), Bull frog (Hoplobatrachus tigerinus) (Nishat et al., 2002).

Sl. No.	Local Name	Status	Sl. No.	Local Name	Status
1	Tezpata	Common	12	Nankel	Common
2	Amgas	Common	13	Jambura	F. Common
3	Kathal	Common	14	Tetul	F. Common
4	Supari	Common	15	Lukluki	F. Common
5	Lichu	Common	16	Jalpai	Rare
6	Khezur	Common	17	Tal	Rare
7	Satni	Common	18	Kamla	Rare
8	Kalagas	Common	19	Anarosh	Rare
9	Lebu	Common			
10	Bel	Common			
11	Peara	Common			

References for 2025 Data

- **Plant Red List:** IUCN Red List of Plants (2024/2025) for specific species status.
- **Biodiversity Studies:** Recent ResearchGate publications (2025) on homestead biodiversity in Rangamati Sadar.
- **Government Reports:** Bangladesh Forest Department (BFD) and the Department of Environment (DoE).
- The Bangladesh Forest Department has been collaborating with the Bangladesh National Herbarium, National Botanical Garden and IUCN Bangladesh on this work.
- Citation: Raven, P., & Wackernagel, M. (2020). Maintaining biodiversity will define our long-term success. Plant Diversity, 42(4), 211-220. doi:10.1016/j.pld.2020.06.002

4.12.2 Fauna

In 2025, the faunal baseline for **Rangamati Sadar** (22°39'05.0"N 92°09'56.1"E) is defined by its position within the biologically diverse Chittagong Hill Tracts (CHT) and its proximity to the expansive Kaptai Lake ecosystem.

1. Faunal Inventory

The region supports a high diversity of vertebrates, with species richness typically peaking during the winter months.

- **Mammals:** Common species include the Rhesus Macaque (*Macaca mulatta*), Barking Deer (*Muntiacus muntjak*), Wild Boar (*Sus scrofa*), and Small Indian Civet. Endangered species like the **Asian Elephant** and **Western Hoolock Gibbon** inhabit the deeper hilly tracts nearby.
- **Avifauna (Birds):** Over 300 bird species are recorded in the CHT region. Dominant resident species include the Common Myna, Black Drongo, and various woodpeckers. Kaptai Lake is a critical habitat for waterfowl such as the Grey-headed Fish Eagle.
- **Reptiles & Insects:** The area is rich in snakes (e.g., Burmese Python), lizards, and freshwater turtles. Insect diversity is vast, with ongoing efforts in 2025 to update red lists for butterflies and beetles.

2. Migratory Patterns and Breeding Grounds

- **Migratory Birds:** Rangamati serves as a vital stopover for trans-Himalayan migratory birds during winter (November–February). Species like the Lesser Whistling Duck and various sandpipers frequent the lake's banks.
- **Carp Breeding Grounds:** In May 2025, scientists from the **Bangladesh Fisheries Research Institute (BFRI)** discovered a significant new **carp breeding ground** in Kaptai Lake (near Maladwip Point). Spawning success rates at this site were recorded at **90–95%**, though sedimentation remains a threat to its depth.

3. Habitat Connectivity and Fragmentation

- **Fragmentation Status:** Urban expansion and land-use changes in Rangamati Sadar have led to **fragmented patches** of forest. This limits wildlife mobility and increases human-wildlife conflict, particularly involving elephants.
- **Conservation Connectivity:** As of late 2025, major transboundary projects (such as the **Chittagong–Lushai Big Cat Project**) are focused on restoring ecological corridors between Bangladesh and India to facilitate the movement of large mammals like tigers and leopards across these fragmented landscapes.

4. Conservation Significance (IUCN Red List 2025)

Updated assessments highlight several local species at risk:

- **Critically Endangered:** Chinese Pangolin, Asian Elephant (regional populations), and Western Hoolock Gibbon.
- **Vulnerable/Near Threatened:** Indian Roofed Turtle and Grey-headed Fish Eagle.

14 sites

- Impact of Habitat Fragmentation on the Diversity of Flora and Fauna ...

Md Mizanur Rahman ... It is revealed that both population size and species richness decrease with increasing habitat fragmentation...

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- Wildlife - Banglapedia

Wildlife * Asian elephant. * Deer (Sambar) * Wild cow. * Mainland serow. * Bear (Binturong) * Civet. * Mangoose. * Common otter. *

Banglapedia

- 2408-8455 EXPLORING WILDLIFE DIVERSITY AT NOAKHALI

Species Composition and Abundance: Over the study period, a total of 131 wildlife species were observed at the Noakhali Science an...

The big deer samber and the small barking deer (Muntiacus mungjak) are found in the forests of Rangamati Sadar, rangamati. Elephants (Elephas maximus) are also seen in these forests. Jungle cat (Felis chaus) and fishing cat (Felis viverrina) are common; the beautiful clouded leopard

(Panthera Pardus) and cats are also found. Wild boar (Sus Scrofa), wild dog, jackals (Canis aureus), fox (Vulpes bengalensis), weasels, honey badger (Arctonyx collaris), hog badger, and scaly anteaters are also found. Rodents are represented by different species of squirrel (Funambulus pennanti), rat (Rattus rattus).

Sl No	Species	Local Name	Status	Sl No	Species	Local Name	Status
1	Reptiles	Anjila	Common	16	Birds	Choroi	Common
2		DhuraShap	Common	17		Doyel	Common
3		MatiaShap	Common	18		Kak	Common
4		Tiktiki	Common	19		Bagari	Common
5		Kari Katta	Common	20		Ghughu	Common
6		DaraishShap	Common	21		Shalik	Common
7		Gokhra	F.Common	22		Kokil	Common
8		Kassap	F. Common	23		Bok	Common
9		GuiShap	Rare	24		Tuntuni	Common
10	Mammals	Babur	Common	25		Badur	Common
11		Idur	Common	26		Chil	Common
12		Shial	Common	27		Machranga	F.Common
13		Chika	Common	28		Tota	F.Common
14		Bagdash	Common	29		Haludakhi	F.Common
15		Khekshial .	F. Common	30		Katthokra	F.Common
Source: Field survey database; F=Fairly				31		Pecha	Rare
				32		Shakun	Rare
				33		Tia	Rare

4.13 SEISMICITY

Bangladesh, a densely populated country in South Asia, is located in the north-eastern part of the Indian sub-continent at the head of the Bay of Bengal. Tectonically, Bangladesh lies in the northeastern Indian Plate near the edge of the Indian carton and at the junction of three tectonic plates – the Indian Plate, the Eurasian Plate, and the Burmese microplate. These form two boundaries where plates converge– the India-Eurasia plate boundary to the north, forming the Himalaya Arc and the India-Burma plate boundary to the east, forming the Burma Arc. The 150 km long Madhupur fault,, trending north-south, is, is situated between the the Madhupur Tract and the Jamuna flood plain, Assam-Rangamati Sadar, Rangamati fault, about 300km long,, trending northeast-southwest, located in the southern Surma basin, and the Chittagong (Rangamati)-Myanmar plate boundary fault, about 800km long, runs parallel to the the Chittagong (Rangamati)-Myanmar coast.

Figure 4-13 Regional tectonic setup of Bangladesh with respect to plate configuration

Based on earthquake epicenters and morpho-tectonic characteristics, Bangladesh is divided into three seismic zones: zone-I, zone-2, and zone-3 (Table 4.15). The northeastern folded regions of Bangladesh are the most active zone, and they belong to Zone i. Zone-II consists of recent uplifted Pleistocene blocks of the Barind and Madhupur Tract and the western extension of the folded belt. Southwest Bangladesh is referred to as zone-III, which is a seismically quiet zone. The Bask coefficients of these three zones are 0.08, 0.05, and 0.04, respectively.

Table 4-4 Seismic zones of Bangladesh

Zoning	Area Mercalli Scale
I	North and eastern regions of Bangladesh (Seismically most active)
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali, and western part of Chattogram Folded belt.
III	Rangamati Sadar, Rangamati division, S-E Bangladesh (Seismically relatively quiet)

The project will be located in Zone II of earthquake zones (Figure 4.9), which is a seismically moderate-risk zone. During seismic or earthquake delineation, ground conditions (firm or soft) have not been considered in Bangladesh. Though the project is located within Zone II, special precautions are needed to account for earthquake risk.

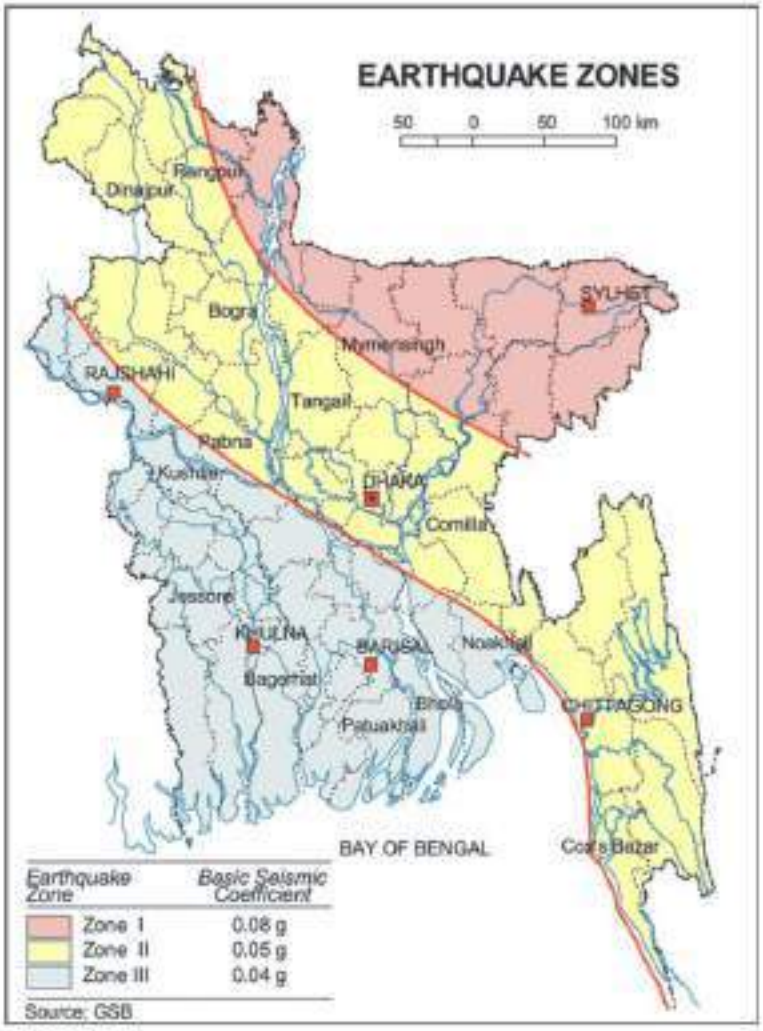

Figure 4-14 Earthquake zones of Bangladesh

4.14 SOCIO-ECONOMIC CONDITION

In 2025, the socio-economic baseline for

Rangamati Sadar

(22°39'05.0"N 92°09'56.1"E) is defined by its role as the administrative and urban hub of the Rangamati Hill District, though it retains a high degree of ethnic and rural-urban complexity.

1. Demographics

- **Population:** According to 2025 updates from the Bangladesh Bureau of Statistics (BBS), Rangamati Sadar has a population of approximately **146,601** across **35,614 households**.
- **Density:** The population density is approximately **228 persons per km²**, significantly higher than the district average of 106 per km².
- **Gender:** The sex ratio is **884 females per 1000 males**. Census data identifies roughly 75,955 males and 70,636 females.

- **Age Structure:** Approximately **19.6%** of the population is under 10 years of age. The 15–64 age group represents the largest demographic segment (roughly 66%).
- **Ethnicity:** The population is diverse, with **47.7%** identifying as tribal (primarily **Chakma**, followed by Marma, Tanchangya, and Tripura) and the remainder largely Bengalee.

2. Livelihood and Occupation

- **Primary Occupations:**
    - **Agriculture & Horticulture:** Agriculture remains a core sector; female participation is high, with 47% of employed women working in agriculture compared to 32% of men. Horticulture (fruit production) is a growing commercial sector.
    - **Fisheries:** Kaptai Lake supports a significant fishing community. BFRI reports high spawning success in local breeding grounds as of 2025, supporting thousands of fishermen.
    - **Service & Trade:** As an urban center, 81.8% of the population lives in urban areas, engaging in government services, small-scale business, furniture making (approx. 4,000 workers), and wood trading.
- **Income Levels:** There is significant disparity; some tribal households earn less than **Tk. 1,000 per month**, well below national averages.

3. Infrastructure and Access

- **Education:** The average literacy rate is **73.2%**, nearly matching the national average. However, rural tribal communities face lower rates due to geographical barriers.
- **Health:** About 85% of residents seek medical help from registered doctors. The Civil Surgeon's Office manages health infrastructure, though remote areas still face "Hard to Reach" (HTR) challenges.
- **Clean Water & Sanitation:**
    - **Drinking Water:** In urban Sadar, 85.6% of households use tube wells. In rural areas, dependency on pond/lake water is high (71%), posing health risks.
    - **Sanitation:** Roughly 91% of urban-adjacent households have well-maintained sanitation facilities.
    - **Energy:** Electricity reaches about 94% of urban-adjacent households, but only 14% in some rural tribal clusters.

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- Rangamati Sadar Upazila - Wikipedia

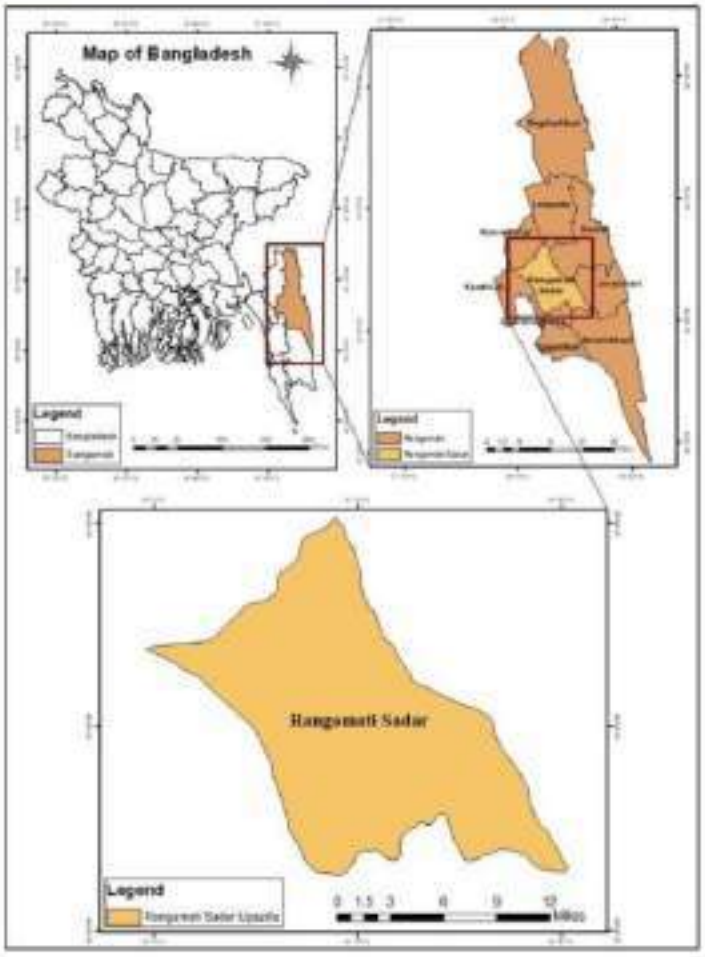
Demographics. ... As of the 2022 Bangladeshi census, Rangamati Sadar upazila had 35,614 households and a population of 146,601. 24.

- (PDF) A Report on Assessing the Socio-economic Conditions ...

May 10, 2024 — Abstract. The present study was carried out to analyze the socioeconomic state of the ethnic community of Asham Bosti, ResearchGate

- Tribal people and their socio-economic characteristics in ...

FAQs * What explains the low educational attainment among tribal people in Rangamati? The study reveals that 54% of men and 62.6%. Academia.edu








CHAPTER 5 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 GENERAL

This study has identified anticipated environmental impacts associated with the unit's proposed project activity. Various activities during the construction and operation phase of the project that are likely to impact multiple ecological components have been listed.

The baseline data generated for environmental parameters presented in Chapter 4 of this report have been utilized to evaluate the impacts of the unit's proposed activities. Changes in environmental parameters and their impact, whether short-term or long-term, positive or negative, are identified and predicted. The reversible nature of these impacts is described in this chapter.

An assessment task is performed for both the construction and operation stages to identify, predict, and quantify the proposed project's impacts. All possible care is taken to assess temporary, short-term, long-term, direct, indirect, reversible, and irreversible consequences. It is also important to remember that the effects of activities during the construction phase will be temporary and limited to the project's construction period. In this chapter, the impact of the proposed project's construction and operational activities is explained. Finally, the description in tabular form, commonly known as the "Impact matrix," is illustrated.

During this assessment, it is revealed that implementing proper Management measures for all significant predicted impacts can eliminate or minimize damage to a negligible extent.

5.2 ENVIRONMENTAL SENSITIVITY INVESTIGATION

An environmental sensitivity investigation is carried out to identify natural and physical vulnerabilities of the project area that may influence project sustainability and ecological risk. The assessment focuses on **natural hazards, seismicity, and landslide susceptibility**, considering regional geology, climate, and historical records.

5.2.1 Natural Hazard

Bangladesh is geographically located in a **multi-hazard prone region**, exposed to natural disasters such as heavy rainfall, flooding, cyclones, earthquakes, and landslides (MoEFCC, 2018; BMD, 2022). The project area, Rangamati district, lies within the **Chattogram Hill Tracts (CHT)**, which has distinct topography characterized by **steep slopes, hilly terrain, high rainfall, and proximity to surface water bodies, including Kaptai Lake**.

The annual average rainfall of Rangamati is approximately **3,000–3,200 mm**, which is significantly higher than the national average (~2,200 mm) (Bangladesh Meteorological Department, 2022). Intense monsoon rainfall increases the risk of:

- Surface runoff and soil erosion
- Landslides and slope instability
- Temporary waterlogging in low-lying pockets

However, the project site is located on **relatively elevated terrain**, and no major flood events have been historically recorded at the site level. According to FAO (2017), hilly regions are less prone to riverine flooding but more sensitive to rainfall-induced slope failure.

Sensitivity level: Moderate

Risk type: Rainfall-induced hazards and surface erosion

5.2.2 Seismicity

Bangladesh is situated near the junction of the **Indian Plate, Eurasian Plate, and Burmese Plate**, making it moderately to highly vulnerable to earthquakes (USGS, 2021; BGS, 2019).

According to the **Bangladesh National Building Code (BNBC 2020)**:

- Rangamati district falls within **Seismic Zone-II**, classified as a **moderate seismic risk zone**
- Expected peak ground acceleration (PGA) ranges from **0.15g to 0.20g**

Historical seismic events affecting the broader Chattogram region include:

- The **1897 Great Assam Earthquake (Mw 8.1)**
- The **1950 Assam–Tibet Earthquake (Mw 8.6)**

Although no major fault line passes directly through the project site, several **regional tectonic structures**, including the **Indo-Burman Fold Belt**, influence the seismic character of the area (BGS, 2019).

Sensitivity level: Moderate

Risk type: Ground shaking and structural vulnerability

Mitigation relevance: Earthquake-resistant structural design is essential for hospitals due to their critical emergency function (WHO, 2014).

5.2.3 Landslide

Landslides are one of the most critical environmental hazards in the Chattogram Hill Tracts. According to the Geological Survey of Bangladesh (GSB, 2018) and UNDP (2019), landslides in Rangamati are primarily triggered by:

- Intense and prolonged rainfall
- Slope cutting and hill excavation, also retaining wall protection
- Deforestation and unplanned construction

Rangamati has experienced several major landslide events, notably in **2017**, resulting in loss of life and damage to infrastructure. The proximity of the project site to **natural slopes and water bodies (Kaptai Lake)** increases sensitivity if proper slope stabilization is not ensured.

The proposed project land is described as **hilly but largely barren**, with no significant history of landslide at the exact footprint; however, **adjacent slopes may be susceptible** without engineering controls.

Sensitivity level: Moderate to High

Risk type: Rain-induced slope failure and erosion

5.3 SLOPE MANAGEMENT MEASURES

1. Background and Rationale

The project site is located within the **Rangamati hilly terrain**, where natural slopes and undulating topography are inherent geomorphological features. Although the project design explicitly avoids **slope cutting**, localized slope instability and surface erosion may still occur due to **rainfall-induced runoff, soil exposure during construction, and increased surface loading** from buildings and internal roads.

To ensure long-term soil stability, structural safety, and environmental protection, the implementing authority has incorporated **engineered slope management interventions**, including the construction of **reinforced cement concrete (RCC) boundary walls** and **retaining walls.**

2. RCC Boundary Wall Construction (Approx. 1,700 m)

The authority has constructed RCC boundary walls along approximately **1,700 meters** of the project perimeter. These walls serve multiple environmental and engineering functions:

- Act as a **physical barrier** to prevent uncontrolled soil movement and surface runoff from entering or leaving the site
- Protect the site from **external erosion sources**, particularly during monsoon rainfall
- Provide **structural demarcation** and controlled access, reducing human-induced disturbance to adjacent slopes
- Enhance **site safety and slope toe protection**, particularly in areas where natural slopes approach the project boundary

From an EIA perspective, the RCC boundary wall contributes to **containment of construction-phase impacts**, ensuring that soil erosion and sediment transport remain confined within the project footprint.

3. Retaining Wall Construction (Approx. 20,403.65 m^2)

Retaining walls covering approximately **20,403.65 square meters** have been constructed at critical locations within the project site. These retaining structures are strategically placed to stabilize natural and filled slopes without altering the original slope geometry.

3.1 Functional Role of Retaining Walls

The retaining walls perform the following key slope management functions:

- Provide **lateral support** to soil masses, preventing downslope movement
- Reduce **shear stress on slope faces**, thereby lowering the risk of localized failure
- Protect adjacent infrastructure, buildings, and internal roads from soil pressure
- Allow controlled drainage of subsurface and surface water through weep holes or drainage layers, preventing hydrostatic pressure build-up

Environmental Significance of Structural Slope Protection

The combined use of RCC boundary walls and retaining walls significantly enhances **environmental stability** at the site by:

- Minimizing soil erosion and sediment yield
- Reducing the likelihood of slope-related hazards such as minor slips or washouts
- Preserving natural landforms by avoiding extensive excavation or slope cutting
- Protecting nearby surface water bodies from sedimentation

These measures are significant in Rangamati, where **high-intensity rainfall during the monsoon season** can rapidly destabilize unprotected slopes.

Construction and Design Considerations

- All RCC and retaining structures have been designed based on **site-specific geotechnical conditions**, including soil type, density, and bearing capacity.
- Structural designs consider **seismic forces**, drainage requirements, and long-term durability.
- Adequate **weep holes and drainage arrangements** have been incorporated to prevent water accumulation behind retaining walls.
- Construction materials and workmanship follow **PWD standards and national building codes**.

Residual Impact Assessment

With the installation of:

- RCC boundary walls along approximately 1,700 m, and
- Retaining walls over approximately 20,403.65 m^2,

The residual impacts related to slope instability and soil erosion are assessed as **low to negligible**. These engineered measures ensure that any potential slope-related environmental impacts during both construction and operation phases remain **localized, controlled, and manageable**.

Conclusion

The slope management strategy adopted for the project integrates **structural engineering solutions with environmentally responsible site planning**. The construction of extensive RCC

boundary walls and retaining walls provides effective stabilization of natural slopes without resorting to slope cutting. From an EIA standpoint, these measures significantly reduce soil erosion risk, enhance site safety, and contribute to the long-term environmental sustainability of the Rangamati Medical College & Hospital and Nursing College project

The following figure shows the vulnerability map of different hazards in Bangladesh. From the figure, it is understood that the study area falls in the storm surge-affected area. Cyclones generally cause storm surges. So, any infrastructure development in this area should be followed by precautions to resist this event. It would help the decision-maker to take decisions during the design period.

Figure 5-1 Hazard Map of Bangladesh

5.4 IDENTIFICATION OF POTENTIAL IMPACTS

5.4.1 Environmental Sensitivity Matrix – Natural Hazards

Table 5-1 Environmental Sensitivity Matrix – Natural Hazards

Sl. No.	Environmental Attribute	Description (Baseline Condition)	Sensitivity Level	Justification

1	Rainfall Intensity	Annual rainfall approx. 3,000–3,200 mm, higher than national average (~2,200 mm)	Moderate	High monsoon rainfall may cause surface runoff, erosion, and slope instability
2	Flooding	Located in hilly terrain; no record of riverine flooding at site	Low	Elevated land reduces flood risk
3	Surface Runoff	Steep slopes and high rainfall contribute to runoff	Moderate	Requires drainage and slope protection measures
4	Soil Erosion	Hilly, partially barren land	Moderate	Earthworks may increase erosion without control measures
5	Climate Change Impact	Increasing rainfall intensity and extreme events	Moderate	IPCC projections indicate higher climate stress in hilly regions

5.4.2 Environmental Sensitivity Matrix – Seismicity

Table 5-2 Environmental Sensitivity Matrix – Seismicity

Sl. No.	Attribute	Baseline Condition	Sensitivity Level	Justification
1	Seismic Zone	Located in BNBC Seismic Zone-II	Moderate	Moderate earthquake risk
2	Regional Tectonics	Influenced by Indo-Burman Fold Belt	Moderate	Regional faults may generate ground shaking
3	Historical Earthquakes	Affected by major Assam and Chattogram seismic events	Moderate	No direct fault at site, but regional influence exists
4	Structural Vulnerability	Hospital buildings are critical infrastructure	High	Requires earthquake-resistant design

5.4.3 Environmental Sensitivity Matrix – Landslide

Table 5-3 Environmental Sensitivity Matrix – Landslide

Sl. No.	Attribute	Baseline Condition	Sensitivity Level	Justification
1	Terrain Type	Hilly, sloping land	High	Natural slope increases landslide susceptibility
2	Rainfall-Induced Risk	Prolonged monsoon rainfall	High	Major trigger for landslides in Rangamati
3	Vegetation Cover	Limited natural vegetation	Moderate	Reduced root binding increases instability
4	Proximity to Water Bodies	Adjacent to Kaptai Lake and small water bodies	Moderate	Saturation may weaken slope materials

5	Historical Landslide Events	Past landslides in Rangamati district (e.g., 2017)	High	District-level vulnerability well documented

5.4.4 Environmental Sensitivity Matrix – Overall Environmental Sensitivity

Table 5-4 Environmental Sensitivity Matrix – Overall Environmental Sensitivity

Environmental Component	Sensitivity Rating	Remarks
Physical Environment (soil, air, water)	Moderate	Impacts are manageable with engineering and EMP
Biological Environment	Low–Moderate	Limited vegetation; no protected areas
Socio-economic Environment	Low	Positive impacts dominate
Disaster Risk (earthquake, landslide)	Moderate–High	Requires disaster-resilient design
Overall Environmental Sensitivity	Moderate	The project is acceptable with mitigation measures

5.4.5 Identification of Potential Impacts Matrix (Summary)

Table 5-5 Identification of Potential Impacts Matrix (Summary)

Project Phase	Environmental Component	Potential Impact	Impact Nature
Construction	Soil	Erosion, slope instability	Negative, short-term
Construction	Air	Dust emission	Negative, short-term
Construction	Noise	Machinery noise	Negative, short-term
Operation	Water	Wastewater discharge	Negative if unmanaged
Operation	Health	Biomedical waste risk	Significant if unmanaged
Operation	Socio-economic	Employment & healthcare access	Positive, long-term
Operation	Biological	Aquatic ecosystem risk (Kaptai Lake)	Moderate
All phases	Disaster Risk	Earthquake and landslide vulnerability	Moderate–High

REFERENCE LIST
(APA / DOE-acceptable format)

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The evaluation of environmental impacts due to the installation of **Rangamati Medical College and Hospital and Nursing College,** considering the baseline status within a radius of 3 km around the proposed plant, and the mitigation measures are as follows:

5.5 IDENTIFICATION OF IMPACTING ACTIVITIES

I. Various activities involved in the proposed project are:
   A. Construction phase activities
   B. Operation phase activities

II. The activities identified for the proposed project under each phase are:

A. Construction phase:

1. Excavation
2. Foundation & Civil work
3. Transportation of construction materials, equipment & machineries
4. Construction of the project.

B. Operation phase:

1. Handling and Transfer of Solid Waste
2. Movement of the Vehicle
3. Operation of Project
4. Sewage Water Management

5.6 LIKELY BENEFICIAL IMPACTS

The project will have a significant, direct, and indirect positive impact on the social well-being of the locality. The likely benefits from the construction and operation of the proposed development project are listed as below:

5.6.1 Construction Phase

5.6.1.1 Employment opportunity in construction and supervision work

Skilled and semi-skilled human resources will be used in the project's construction activities, thereby generating employment. The direct employment during the construction phase has been estimated to be 200-250 (on a daily average basis), which will increase the income level.

The impact will be direct, high magnitude, site-specific, and short-term; therefore, it will be significant.

5.6.1.2 Skill and knowledge development through training and orientation

The human resources involved in the project's construction will gain experience and skills that enhance their capabilities in their respective fields, increasing income-generating activities and employment opportunities.

The impact will be direct, of medium magnitude, local, and long-term; therefore, it will be significant.

5.6.1.3 Increase in economic activities due to the supply of goods and services

Due to the construction works, different commercial activities will increase in the project area. Local suppliers will have the opportunity to supply construction materials, such as cement, steel, bar, gravel, and sand, thereby benefiting the local market and boosting economic activity.

The envisaged direct impact is medium in magnitude, site-specific in extent, and long-term in duration, and is hence significant.

5.6.2 Operation Phase

5.6.2.1 Employment generation and promotion

Several professionals will be involved in the project to provide services to the people. 2700 people will gain direct/indirect employment opportunities during the project's operation.

Construction works under the project include the development of a **Medical College Hospital Building, an Academic Building, and a Nursing College Building**. After **June 2028**, medical education activities will commence in **one (1) Medical College with a capacity of 100 seats**, covering a total floor area of **30,239.69 square meters**, consisting of **seven (7) buildings**.

Following **June 2028**, nursing education will also commence in **one (1) Nursing College with a capacity of 100 seats**, comprising **six (6) buildings** with a total floor area of **6,191.12 square meters**.

By **December 2027**, the following residential and ancillary facilities will be completed:

- **One (1) Nursing Students' Hostel** with a total floor area of **3,948.35 square meters**
- **One (1) six-storied Male Students' Hostel** with a total floor area of **1,940.54 square meters**
- **One (1) six-storied Intern Doctors' Dormitory (Male) and Unmarried Doctors' Dormitory (Male)** with a total floor area of **5,041.81 square meters**
- **One (1) six-storied Female Students' Hostel** with a total floor area of **5,041.81 square meters**
- **One (1) six-storied Intern Doctors' Dormitory (Female)** with a total floor area of **4,642.33 square meters**
- **One (1) six-storied Emergency Staff Dormitory (Male and Female)** with a total floor area of **7,974.73 square meters**
- **One (1) six-storied Staff Nurses' Dormitory (Female)** with a total floor area of **3,987.37 square meters**
- **Two (2) six-storied Senior Teachers' Accommodation Buildings**, each having a floor area of **2,329.25 square meters**, providing residential facilities for senior faculty members

Land acquisition of **25.95 acres** for the project will be completed by **August 2024** (Attachment–Da).

The envisaged direct impact is of high magnitude, local in extent, and long-term in duration, making it highly significant.

5.6.2.2 Increase in revenue generation

With the project's operation, revenue generation is expected to increase at both the district and upazila levels.

The envisaged direct impact is of medium magnitude, local in extent, and long-term in duration, making it highly significant.

5.6.2.3 Promotion of local business

The project operation will increase daily activities, including animal husbandry through the supply of food waste, vegetable and fruit supply to the project, electronics and furniture supply, human resource enrollment, promotion of handicraft shops, vehicle hire services, and other related services, all within the project premises. Demand for local goods, markets, food, and other basic necessities certainly increases at the project site.

The envisaged direct impact is of medium magnitude, local in extent, and long-term in duration, making it significant.

5.6.2.4 Cultural exchange between locals and tourists

The influx of a large number of visitors and other staff will significantly increase economic transactions in and around the vicinity, which will facilitate cultural exchange. The envisaged direct impact is medium in magnitude, local in extent, long-term in duration, and hence significant in nature.

5.7 CONSTRUCTION AND OPERATIONAL PHASE IMPACTS AND MITIGATION MEASURES (Medical College Hospital Project)

5.7.1 Construction Phase Impact and Mitigation Measures

A. Physical Environment:

Impact Source	Potential Environmental Impact	Mitigation Measures
Land Development and Site Preparation	• Temporary loss of topsoil and alteration of land morphology. • Risk of soil erosion due to Slope management and earthworks.	• Strip and store topsoil separately for reuse in landscaping. • Avoid unnecessary hill cutting; use terracing and retaining walls, and slope management • Implement erosion control measures such as slope stabilization and geotextiles. • Retaining walls covering an approximate total area of **20,403.65 square meters** have been constructed at critical locations within the project site • The authority has constructed RCC boundary walls along approximately **1,700 meters** of the project perimeter.
Excavation and Construction Activities	• Increased dust generation affecting ambient air quality. • Reduced visibility and respiratory discomfort for workers and nearby residents.	• Regular water spraying on exposed surfaces and haul roads. • Cover construction materials and vehicles transporting soil. • Use dust screens around construction zones.
Construction Waste Generation	• Generation of debris, excavated soil, cement waste, and scrap materials. • Potential land and water pollution if disposed improperly.	• Segregate reusable and recyclable materials. • Dispose waste at approved dumping sites. • Reuse excavated soil for site leveling and landscaping.
Noise and Vibration	• Noise from heavy machinery and vehicles may disturb nearby communities and wildlife.	• Restrict noisy activities to daytime hours. • Maintain equipment to reduce noise. • Provide PPE (ear protection) to workers.
Surface and Groundwater Pollution	• Runoff containing cement slurry, oil, and grease may contaminate nearby water bodies.	• Provide temporary drainage channels and sedimentation pits. • Prohibit discharge of untreated wastewater into natural drains. • Store fuels and chemicals in impervious areas.

B. Biological Environment

Impact Source	Potential Impact	Mitigation Measures
Vegetation Clearing	• Loss of a limited number of trees and shrubs. • Reduction of local green cover.	• Minimize tree cutting; retain mature trees where possible. • Implement compensatory plantation at a ratio of at least 1:3.
Disturbance to Wildlife	• Temporary disturbance due to noise, human activity, and lighting.	• Avoid construction during nighttime near sensitive zones. • Restore green areas immediately after construction.

C. Socio-economic Environment

Impact Source	Potential Impact	Mitigation Measures
Employment Generation	• Positive impact through short-term employment opportunities for local people.	• Prioritize hiring local labor where feasible.
Traffic Congestion and Safety Risks	• Increased vehicle movement may cause traffic congestion and accidents.	• Prepare and implement a traffic management plan. • Install warning signage and assign traffic controllers.
Occupational Health and Safety	• Risk of accidents, injuries, and exposure to dust and noise.	• Implement site safety plan and toolbox training. • Provide PPE and emergency medical facilities on site.

5.7.2 Operational Phase Impact and Mitigation Measures

A. Physical Environment

Impact Source	Potential Environmental Impact	Mitigation Measures
Hospital Wastewater Generation	• Discharge of pathogen-rich and chemical-laden wastewater may pollute surface and groundwater.	• Operate a dedicated ETP with a Sewage Treatment unit.

		• Monitor effluent quality regularly as per DOE standards. • Reuse treated effluent for non-potable purposes.
Air Emissions	• Emissions from standby generators, boilers, and ambulances.	• Install generators with adequate stack height. • Use low-sulfur diesel and ensure periodic emission testing.
Noise Pollution	• Noise from generators, HVAC systems, and vehicle movement may affect patients.	• Install acoustic enclosures. • Maintain buffer green belts.
Energy Consumption	• High energy demand contributes to an increased carbon footprint.	• Use energy-efficient HVAC and lighting systems. • Install solar PV systems where feasible.

B. Waste Management and Pollution Control

Impact Source	Potential Impact	Mitigation Measures
Biomedical Waste	• Improper handling may spread infection and contaminate soil and water.	• Implement Biomedical Waste Management Rules. • Segregation at source using color-coded bins. • Disposal through licensed biomedical waste handlers.
Solid Waste (Non-hazardous)	• Accumulation of food waste, paper, and plastics.	• Waste segregation, composting, and recycling. • Regular collection by local authority.
Chemical and Pharmaceutical Waste	• Risk of environmental toxicity and occupational hazards.	• Secure storage and proper labeling. • Disposal of expired medicines through authorized agencies.

C. Occupational Health and Public Safety

Impact Source	Potential Impact	Mitigation Measures
Exposure to Pathogens	• Risk of infection for staff, patients, and visitors.	• Implement infection prevention and control (IPC) measures. • Provide PPE and vaccination for healthcare workers.

Radiological Hazards	• Exposure from diagnostic imaging equipment.	• Shielding of radiology units as per regulatory standards. • Regular calibration and radiation monitoring.
Emergency Situations	• Fire, chemical spills, or medical emergencies.	• Prepare emergency response and disaster management plans. • Conduct regular drills and training.

5.7.3 Beneficial Impact Identification and Evaluation Matrix

The beneficial impacts during the construction and operation phase are presented in the following table;

Table 5-6 Beneficial Impact Identification and Evaluation Matrix

S.N.	Issues	Impacts	Impact Rating				
			Nature	Magnitude	Extent	Duration	Rating
	Beneficial Impacts						
	Construction Phase						
1	Employment Opportunity	Employment generation and local employment	D	H	SS	ST	Significant
2	Skill Enhancement	Skill and knowledge development through training and orientation	D	M	Lo	LT	Significant
3	Increase in Economic Activities	Increase in economic activities due to supply of goods and services	D	M	SS	LT	Significant
	Operation Phase						
1	Employment Generation and Promotion	Increases in the economic status of the employer Growth of the local economy	D	H	Lo	LT	Significant

2	Income and revenue generation	Income and revenue generation for both proponents and the local people	D	M	Lo	LT	Significant
3	Promotion of local business	Establishment of small-scale businesses leading to the growth of the economic condition of the local	D/ID	M	Lo	LT	Significant
4	Cultural Exchange	Cultural exchange between locals and tourists	D	M	Lo	LT	Significant
5	Corporate Social Responsibility activities	Enhancement in the skill of local and promotion in the small-scale business	D	M	SS	LT	Significant

Notes: D= Direct; ID= Indirect; H= High; M=Medium; SS= Small scale; Lo= Local; R= Regional; ST= Short Term; LT= Long Term

5.8 COMMUNITY RECOMMENDATIONS

The following recommendations were made during public consultation -

- As positive externalities, the proposed project should improve and create a livelihood for the local people.
- The contractor should employ local people during construction work;
- Adequate safety measures should be taken during construction work.
- Concerns were also raised about possible traffic and population pressure caused by externally employed personnel;
- Finally, local people have appreciated the Project and its employment generation and have promised to cooperate with the executing agency during project implementation.

5.9 IDENTIFICATION OF ENVIRONMENTAL ATTRIBUTES

Before an environmental impact assessment, it is necessary to focus on ecological parameters. The primary concern in selecting environmental parameters is the identification, prediction, and quantification of impacts. These parameters may be independent or interrelated, and may also be related to the proposed project. The selected parameters for the Environmental Impact Assessment are illustrated below.

5.9.1 Ecological Parameters

Floral Communities, Faunal Communities, Aquatic Ecosystems, and Marine Ecosystems.

5.9.2 Physio-Chemical Parameters

Water quality, Air quality, Soil quality, and Land use.

5.9.3 Socio-Economic Environment

Aesthetic Conditions, Local Housing Structures, Public Services, Health & Safety, Socio-economic activities, Employment.

5.10 IDENTIFICATION OF POTENTIAL PHYSICAL ENVIRONMENTAL IMPACT

5.10.1 Construction Phase

5.10.1.1 Impact on Land Use

The construction of the Rangamati Medical College Hospital, Academic Building, Nursing College, hostels, dormitories, staff accommodations, utilities, internal roads, and ancillary facilities will result in both **permanent and temporary changes in existing land use**. Permanent land use change will occur due to construction of hospital blocks, academic buildings, hostels, staff quarters, emergency facilities, utility buildings, internal roads, parking areas, and service infrastructure. Temporary land use change may occur due to storage of construction materials, workers' facilities, and construction yards, which will be restored upon project completion.

No large-scale hill cutting is proposed; however, limited site leveling and earthworks may be required, considering the hilly terrain of Rangamati.
The envisaged impact is **low in magnitude, site-specific, long-term in duration,** and **insignificant in nature.**

5.10.1.2 Impact due to Spoil Disposal

Excavation for foundations, basements, underground utilities, and internal roads will generate spoil materials. Improper storage or disposal of excavated soil and construction debris may cause **visual disturbance, soil erosion, and siltation** during rainfall.

All excavated materials will be reused within the project premises for site leveling, road sub-base preparation, and landscaping wherever feasible. Surplus spoil will be disposed of at designated locations approved by local authorities.
The envisaged impact is **low in magnitude, site-specific, short-term,** and **insignificant in nature.**

5.10.1.3 Impact on Air Quality

During the construction phase, dust emissions may arise from excavation, material handling, cement mixing, vehicle movement, and transportation of construction materials. Exhaust emissions from construction machinery and vehicles may also contribute to localized air pollution.

The envisaged impact is **medium in magnitude, local in extent, short-term in duration,** and therefore **significant in nature.**

5.10.1.4 Impact due to Noise Generation and Vibration

Noise will be generated from the operation of heavy machinery such as excavators, cranes, concrete mixers, generators, dump trucks, and piling equipment. Noise levels may range between **70–85 dB(A)** near active construction zones.

These impacts will be **localized and temporary,** primarily affecting construction workers and nearby receptors.
The envisaged impact is **medium in magnitude, local in extent, short-term,** and **significant in nature.**

5.10.1.5 Issues Concerned with Construction Waste

Construction activities will generate solid waste including concrete debris, brick fragments, steel scraps, packaging materials, wood waste, and unused construction materials. Improper handling may create health hazards and environmental nuisance.

The envisaged impact is **medium in magnitude, local in extent, short-term,** and **significant.**

5.10.1.6 Impact on Groundwater

Groundwater may be used during construction for concrete mixing, curing, and domestic use by construction workers. However, water demand during construction will be limited and temporary.

The envisaged impact is **low in magnitude, site-specific, short-term,** and **insignificant in nature.**

5.10.1.7 Impact due to Waste Generation from Labor Camps

Temporary labor camps may generate domestic waste and wastewater. If improperly managed, it may cause odor, attract disease vectors, and degrade environmental quality.

The envisaged impact is **low in magnitude, local in extent, short-term,** and **insignificant in nature.**

5.10.1.8 Impact due to Water Pollution

Oil leakage from machinery, discharge of wastewater from construction activities, paint residues, and chemical spills may contaminate soil, surface water, and groundwater if not managed properly.

The envisaged impact is **high in magnitude, site-specific, short-term,** and **significant in nature.**

5.10.1.9 Issues Concerned with Fire Hazard

Fire hazards may arise from improper handling of electrical equipment, welding activities, fuel storage, and temporary electrical connections.

The envisaged impact is **medium in magnitude, site-specific, long-term,** and **significant in nature.**

5.10.1.10 Energy Use during Construction

Electricity will be sourced from the national grid, while diesel generators will be used during power outages.

The envisaged impact is **low in magnitude, site-specific, short-term,** and **insignificant in nature.**

5.10.1.11 Soil Stability and Safety of Adjacent Areas

Limited excavation and foundation work in a hilly terrain may pose risks of soil instability if not properly managed.

The envisaged impact is **medium in magnitude, local in extent, short-term,** and **significant in nature.**

5.10.1.12 Effect of Heavy Equipment on Road Surface

Frequent movement of heavy vehicles transporting construction materials may cause wear and damage to local access roads.

The envisaged impact is **low in magnitude, site-specific, short-term,** and **significant in nature.**

5.10.1.13 Road Congestion and Traffic Issues

Transportation of materials and construction equipment may increase traffic congestion on access roads leading to the project site.

The envisaged impact is **medium in magnitude, local in extent, short-term, and significant in nature.**

5.10.2 Operation Phase

5.10.2.1 Solid Waste Generation and its Management Issues

During operation, the hospital and educational facilities will generate domestic solid waste and biomedical waste. Improper management may pose health and environmental risks.

The envisaged impact is high in magnitude, local in extent, long-term, and very significant in nature.

5.10.2.2 Waste Water Management Issues

Wastewater will be generated from hospital wards, laboratories, kitchens, laundries, toilets, and hostels. Untreated discharge may contaminate water bodies.

The envisaged impact is high in magnitude, local in extent, long-term, and very significant in nature.

5.10.2.3 Ground Water Availability and Recharge Issues

Operational water demand may exert pressure on groundwater resources if abstraction exceeds recharge.

The envisaged impact is low in magnitude, local in extent, long-term, and significant in nature.

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5.10.2.4 Fire, Accidental Hazard, and Emergency Preparedness

The project might catch fire at any time for any reason, such as electrical faults, lightning, carelessness by project staff or visitors, the kitchen, or smoking. If proper extinguisher systems are not installed in the project, the project will be at significant risk.

The envisaged indirect impact is low in magnitude, site-specific in extent, and long-term in duration and hence insignificant in nature.

5.10.2.5 Noise pollution

Different noise sources will be present due to various activities of the resource operation like increased human inflow, parties and functions, operation of generators and pumps. The noise generated by the mobility of guests and workers may be insignificant compared to vehicular movement, the operation of diesel generators, and pumps.

The envisaged direct impact is low in magnitude, site-specific in extent, medium in duration, and hence insignificant.

5.10.2.6 Traffic congestion and obstruction

Due to the increased flow of project guests, traffic density will be insignificantly high during the project's operational phase. Since the proposed project's entrance, the influx of vehicles is likely to cause traffic obstructions and congestion, affecting the locality.

The envisaged direct impact is low in magnitude, site-specific in extent, medium in duration, and hence insignificant.

5.10.2.7 Drainage Management

The project site is located in Rangamati Sadar, Rangamati. This area still retains its natural topographic features of land and water infiltration rate, with very low concrete structures.

The envisaged direct impact is of medium magnitude, site-specific in extent, long-term in duration, and hence significant.

5.10.2.8 Higher Energy Requirements

The energy required during the proposed project's operational phase will be supplied from the national electricity grid. Also, HVAC (heating, ventilation, and air conditioning)- related issues will demand more energy, which will put pressure on electricity demand. During the load shedding energy will be supplied through generators. At that time, the generator's operation will create air and noise pollution at the project site.

The envisaged direct impact is of high magnitude, site-specific in extent, short-term in duration, and hence significant.

5.11 IMPACT ON SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

5.11.1 Construction Phase

5.11.1.1 Demographic

The construction of the project will have limited effects on the demographic conditions. There are no permanent living quarters associated with the proposed project. The project wouldn't cause any displacement of individuals whose livelihoods depend on the land to be occupied by the project.

5.11.1.2 Conflict in or with nearby host communities

The influx of construction workers from other parts of the area may increase conflict. In general, disputes among workers over opinions and interests may arise during the construction phase in the project area.

The envisaged indirect impact is low in magnitude, site-specific in extent, short-term in duration, and hence insignificant.

5.11.1.3 Gender Related Issues

During the project's construction, the use of female labor might be lower due to the belief that males can do more work in the same time interval. In this case, there is a risk of wage discrimination and of opportunity.

The envisaged indirect impact is low in magnitude, site-specific in extent, short-term in duration, and hence insignificant.

5.11.1.4 Health and Sanitation in and around the project site

Biodegradable and non-biodegradable waste generated in the labor camps will pollute the surrounding environment if not properly managed. The haphazard disposal or storage of biodegradable waste will increase foul odors, provide a favorable habitat for disease vectors such as rodents, mosquitoes, and flies, and impact community health.

The envisaged direct impact is moderate, site-specific, and short-term and hence insignificant in nature.

5.11.1.5 Occupational Health and Safety

Working without safety measures during excavation, spoil management, electrical equipment handling, and construction activities may pose an accident risk. In many accidents, the primary victims are the workers involved in construction.

The envisaged direct impact is of medium magnitude, local in extent, short-term in duration, and hence significant.

5.11.1.6 Grievances Management

The influx of construction workers from other parts of the project area may increase conflict. In general, worker conflict may arise during the construction phase due to differences in opinions and interests. If construction-phase grievances are not properly recorded, they may lead to conflict with local residents.

The envisaged indirect impact is low in magnitude, site-specific in extent, short-term in duration, and hence insignificant.

5.11.2 Operation Phase

5.11.2.1 Demographic

The operation of the project will have limited effects on the demographic conditions since there is no permanent living quarters associated with this proposed project. Hence, there will be no increased demand on local infrastructures, such as utilities, housing, medical facilities, schools, water, and food. The project will not cause any displacement of individuals whose livelihoods depend on the land the proposed project will occupy. The labor force to operate the plant will also be sourced locally, thereby increasing disposable income for project employees. The proposed project will contribute to the country's GDP, which is a positive impact.

5.11.2.2 Occupational Health and Safety

Working without safety measures may pose an accident risk. Workers from different departments have varying risk factors and diverse health impacts, including burns, scalds, and cuts. The employees in the food and beverage department and the kitchen use electrically driven, extremely sharp knives to chop hard fruits and vegetables. Workers who handle waste may be exposed to communicable diseases. Employees working in high-noise areas, such as pump and generator operators, will be exposed to high noise levels and the risk of electrocution. The other health risks include burns from accidental kitchen fires, slips on wet floors, and so on.

The envisaged impact is direct, site-specific in extent, moderate in magnitude, and long-term, and hence significant.

5.11.2.3 Grievances management

The mismanagement during the operation phase, such as increased noise levels in the surrounding area from parties, water scarcity during the dry season, unmanaged waste generated by the project, and disturbance to nearby roads due to haphazard parking practices by guests and employees, will likely raise grievances in the nearby community.

The envisaged impact is characterized as direct in nature, site-specific in extent, moderate in magnitude, and long-term in duration.

5.12 CHEMICAL ENVIRONMENT

5.12.1 Construction Phase

5.12.1.1 Impact due to chemicals for curing and protection of materials

The chemicals used during construction, such as concrete curing, protective and decorative coatings, floor hardener, dust proofer, and waterproofing chemicals, can cause water, soil, and air pollution, leading to health problems and environmental hazards.

The envisaged direct impact is of high magnitude, local in extent, and long-term in duration, making it highly significant.

5.12.2 Operation Phase

5.12.2.1 Impact due to the use of Laboratories' chemical and other medical chemicals. Etc.

Chemicals such as disinfectants, detergents, laboratory chemicals, medicines, and pesticides are widely used for the maintenance and protection of ornamental plants. From this, pesticide runoff to the surrounding area and water sources will cause water and soil pollution. Additionally, soap, detergents, and chemicals used in bathrooms and toilets are often not handled with care, which can pollute the surrounding environment.

The envisaged indirect impact is of low magnitude, local in extent, and long-term in duration, yet significant.

5.12.3 Adverse Impact Identification and Evaluation Matrix

Table 5-7 Adverse Impact Identification and Evaluation Matrix

S.N.	Issues	Impacts	Impact Rating				
			Nature	Magnitude	Extent	Duration	Rating
A	Adverse Impacts						
	Physical Environment						
A6.8.1	Construction Phase						
A6.8.1.1	Change in land use	Change in land use due to construction of project	D	L	SS	LT	Insignificant
A6.8.1.2	Impact due to spoil disposal	Water, soil and air pollution	D	L	SS	ST	Insignificant
A6.8.1.3	Impact due to air	Air pollution	D	M	Lo	ST	Significant
A6.8.1.4	Impact due to noise and vibration	Noise pollution	D	M	Lo	ST	Significant
A6.8.1.5	Issues concerned with Construction waste	Water, soil and air pollution	D	M	Lo	ST	Significant
A6.8.1.6	Impact on groundwater	Reduce the water table	D	L	SS	ST	Insignificant
A6.8.1.7	Impact due to waste generation	Reduction on drainage and waste disposal quality	ID	L	Lo	ST	Insignificant
A6.8.1.8	Impact due to water pollution	Water Pollution	D	L	Lo	ST	Insignificant
A6.8.1.9	Issues concerned with fire hazard	Accident, loss of lives and property	ID	M	SS	LT	Significant
A6.8.1.10	Energy alternatives	Sound pollution	D	L	SS	ST	Insignificant
A6.8.1.11	Soil stability and safety of neighboring properties	Sliding or failure of the ground	D	M	Lo	ST	Insignificant
A6.8.1.12	Effect of heavy equipment on road surface	Damage on road surface	D	L	SS	ST	Insignificant
A6.8.1.13	Road congestion, traffic and parking issues	Congestion around the road, traffic and parking area	D	M	Lo	ST	Significant
A6.8.2	Operation Phase						
A6.8.2.1	Solid Waste Management Issues	Soil, water, and air pollution	D	H	Lo	LT	Significant
A6.8.2.2	Waste water management issues	Water quality and pollution	D	H	Lo	MT	Significant
A6.8.2.3	Groundwater availability and recharge issues	Reduction in the groundwater table	D	H	SS	LT	Significant
A6.8.2.4	Fire, accidental hazard and emergencypreparedness	Accident and loss of life andproperty	ID	L	SS	LT	Insignificant
A6.8.2.5	Noise pollution	Noise pollution	D	L	SS	MT	Insignificant
A6.8.2.6	Traffic congestionand obstruction	Congestion around the roadsidetraffic jam, parking area	D	L	SS	MT	Insignificant
A6.8.2.7	Drainage Management	Inundation of water from urbanstormwater	D	M	SS	LT	Significant
A6.8.2.1	Higher energyrequirements	High energy demand due to the operation of many electronic appliances	D	H	SS	LT	Significant
	Biological Environment						
A6.9.1	Construction Phase						

A6.9.1.1	Impact on flora and fauna	Loss of biodiversity	D	M	SS	MT	Significant
A6.9.1.2	Impact on the ecosystem	Ecosystem disruption	D	M	SS	MT	Significant
A6.9.2	**Operation Phase**						
A6.9.2.1	Impact on flora and fauna	No impact is identified	-	-	-	-	-
A6.9.2.2	Impact on the ecosystem	Ecosystem disruption	ID	L	SS	LT	Significant
Socio-economic and Cultural Environment							
A6.10.1	**Construction Phase**						
A6.10.1.1	Demographic	No impact is identified	-	-	-	-	-
A6.10.1.2	Project-associatedconflict	Conflict in or with nearby host communities (between local andoutsiders)	ID	L	SS	ST	Insignificant
A6.10.1.3	Gender related issues	Discrimination in opportunity andwages	ID	L	SS	ST	Insignificant
A6.10.1.4	Health and sanitationaround project sites	Incidence of diseases	D	M	SS	ST	Insignificant
A6.10.1.5	Pressure on utilitiesand infrastructures	Pressure on public infrastructuresand facilities	D	M	SS	ST	Insignificant
A6.10.1.6	Occupational healthand Safety	Accident to the laborers and loss oflife	D	M	Lo	ST	Significant
A6.10.1.7	Grievances management	Conflict and dispute among theworkers	ID	L	SS	ST	Insignificant
A6.10.2	**Operation Phase**						
A6.10.2.1	Demographic	No impact is identified	-	-	-	-	-
A6.10.2.2	Occupational healthand Safety	Probability of accident and loss oflife	D	M	Lo	ST	Significant
A6.10.2.3	Safety and security ofvisitors	Crime and disharmony in thesociety	IN	M	SS	LT	Significant
A6.10.2.4	Grievances management	Dispute and conflict among thestaff and nearby society	ID	L	SS	ST	Insignificant
Chemical Environment							
A6.11.1	**Construction Phase**						
A6.11.1.1	Impact due to chemicals for curing and protection ofmaterials	health problem and environmentalhazard	D	H	SS	LT	Significant
A6.11.2	**Operation Phase**						
A6.11.2.1	Impact due to chemicals like disinfectants, detergents, laboratory chemicals, medicine and pesticides anddetergents	Pollute surrounding area andwater sources	D	L	SS	LT	Insignificant

Notes: D= Direct; ID= Indirect; H= High; M=Medium; SS= Small scale; Lo= Local; R= Regional; ST= Short Term; LT= Long Term

5.13 IMPACT ANALYSIS BY LEOPOLD MATRIX METHOD

The impacts of the man-made, unlike those of its type, can be assessed using matrix analysis, which is widely known as the Leopold Matrix System among environmentalists worldwide.

The criteria for evaluation of the qualitative matrix are presented here:

1) No Impact (0)

This indicates that the project activity is unlikely to affect an environmental attribute.

2) Negligible Adverse Impact (-1) / Negligible Beneficial Impact (+1)

It signifies that the actions have a minor effect, adverse or beneficial, on the environmental parameters concerned.

3) Significant Adverse Impact (-2) / Significant Beneficial Impact (+2)

The activities and their environmental Impacts are judged to be significant if they create, or have the potential to generate concern in the public or professional community.

4) High Adverse Impact (-3) / High Beneficial Impact (+3)

The action can create, or have the potential to create, controversy in the public or professional community, due to its long-term effect. They may be, at times, irreversible.

The matrices for both the construction and operation phases are presented below, considering the environmental attributes discussed in the previous section.

Project: Rangamati Medical College & Hospital and Nursing College

Location: Rangamati Sadar Municipality, Rangamati

Project Phases:l

- Pre-construction
- Construction
- Operation & Maintenance

Scoring Method:

- **Magnitude (M):** −10 (high adverse) to +10 (high beneficial)
- **Importance (I):** 1 (low) to 10 (very high)
- Format: **M / I**

Table 5-8 Leopold Matrix – Identification and Evaluation of Impacts - Pre-Construction & Construction Phase

Project Activities	Land Use & Soil	Topography & Erosion	Surface Water	Air Quality	Noise & Vibration	Flora & Fauna	Employment	Local Economy
Land acquisition (25.95 acres)	−6 / 7	−5 / 6	−2 / 4	0	0	−4 / 6	+3 / 5	+4 / 6
Site clearing & earthworks	−7 / 8	−8 / 8	−5 / 7	−4 / 6	−4 / 6	−6 / 8	+4 / 5	+4 / 5
Excavation & foundation works	−6 / 7	−7 / 7	−4 / 6	−5 / 6	−5 / 7	−4 / 6	+5 / 6	+5 / 6
Construction of buildings	−4 / 6	−3 / 5	−4 / 6	−6 / 7	−6 / 7	−3 / 5	+7 / 8	+7 / 8
Construction traffic & material transport	−3 / 5	−2 / 4	−3 / 5	−6 / 7	−6 / 7	−2 / 4	+4 / 6	+5 / 7
Labor camps & temporary facilities	−3 / 5	−2 / 4	−5 / 7	−3 / 5	−4 / 6	−3 / 5	+6 / 7	+6 / 7

Key Construction-Phase Observations

- **Major adverse impacts:** soil erosion, dust, noise, surface water contamination
- **High positive impacts:** employment generation, local business growth
- Impacts are **temporary and reversible** with mitigation

Table 5-9 Leopold Matrix – Identification and Evaluation of Impacts - Operation & Maintenance Phase

Project Activities	Water Resources	Wastewater	Air Quality	Noise	Public Health	Education	Employment	Socio-economic Development
Hospital operation (600 beds)	−4 / 7	−6 / 8	−2 / 4	−3 / 5	+9 / 10	+6 / 8	+8 / 9	+9 / 10
OPD services (1000 patients/day)	−3 / 6	−4 / 7	−2 / 4	−2 / 4	+10 / 10	+5 / 7	+7 / 8	+9 / 10
Medical & nursing education	0	0	0	0	+6 / 8	+10 / 10	+6 / 7	+7 / 8
Biomedical waste generation	−5 / 8	−6 / 9	−3 / 6	−2 / 4	−4 / 7	0	+2 / 4	+3 / 5
Operation of ETP & waste management	+5 / 7	+7 / 8	+2 / 4	0	+6 / 8	0	+2 / 4	+4 / 6
Residential facilities operation	−2 / 4	−3 / 5	−1 / 3	−2 / 4	+4 / 6	0	+5 / 6	+6 / 7

Key Operation-Phase Observations

- **Very high positive impacts** on:
  - Public health (SDG-3)
  - Medical and nursing education
  - Employment (2,641 personnel)
  - Regional socio-economic development

- **Key adverse risks:** wastewater, biomedical waste
- These are **manageable with proper ETP, BMW Rules compliance, and monitoring**

3. Overall Impact Summary (Leopold Interpretation)

Environmental / Social Aspect Net Impact

Land & Soil	Moderate adverse (temporary)
Water Environment	Moderate adverse → manageable
Air & Noise	Short-term adverse
Ecology	Low to moderate adverse.
Public Health	**Very high positive**
Education	**Extremely positive**
Employment	**Highly positive**
Regional Development	**Highly positive**

4. Conclusion Based on the Leopold Matrix

- The **construction phase** results in **moderate, short-term adverse environmental impacts**, which are **localized and reversible**.
- The **operation phase** generates **overwhelming long-term positive impacts**, particularly in:
    - Healthcare accessibility

  - Medical and nursing education
  - Employment and socio-economic upliftment of the hill districts

- With proper implementation of:
  - ETP
  - Biomedical waste management
  - Noise and air control measures the project is **environmentally acceptable and socially beneficial.**

Table 5-10 Potential impacts due to project construction and operation

No	Impacts	Negative		Positive		No Impact	Magnitude Low – L Medium - M High - H	Mitigation Measures
		Short Term	Long Term	Short Term	Long Term			
A	General							
	Displacement of People					√	-	-
	Change of Land use			√			L	N/A
	Loss of trees/vegetation	√					L	Plantation Around the land
	Shifting of utilities					√	-	-
	Impact on archaeological property					√	-	-
B	Construction Phase							
	Pressure on local infrastructure	√					L	N/A
	Impact on water quality	√					L	Proper drainage, use substances that protect against the leaching of oil
	Impact on air quality (including dust generation)	√					M	Tarpaulin or jute sheet is use during construction
	Noise pollution	√					M	Use Earplug for personnel, use modern machinery, cover the area
	Traffic congestion	√					L	Traffic management and permit heavy vehicle in the early morning or night
	Disposal of construction debris/material	√					L	Do not dispose anywhere, sell or store
	Public health and safety	√					M	Strictly follow to use of PPE
	Social Impact			√			L	-
C	Operational Phase							
	Change in ambient air quality	√					L	Water spray around the project sites
	Impact on water quality		√				L	Proper drainage
	Increase in noise level					√	L	Cover the area and machinery
	Water harvesting and recharge				√		L	-

	Disposal of solid waste		√				L	Proper waste management as per BD guidelines and other solid waste will be sold to a third party.
	Quality of life				√		M	-
	Contribution to National GDP				√		L	-
	Increment in green cover	√					L	-

5.14 CONCLUSION

It has been noticed from both matrices that the proposed project is basically the construction of a project, namely Rangamati Medical College and Hospital, and Nursing College. Hence, no activity is found accountable for creating any significant adverse impact on environmental quality. The impact matrix revealed that noise will be the primary ecological issue during factory construction. Adverse impacts on soil erosion and workers' health & safety due to Factory construction and operation were identified as the most significant. However, those impacts can be reduced to a negligible amount by proper Management measures. Civil works during construction may alter the soil structure in the surrounding area. In furtherance of these, the study and evaluation of impacts have shown that the proposed project would have significant positive impacts, particularly in promoting social, economic, and environmental development, including the development of sustainable alternatives to natural gas, growth in GDP, and the creation of employment opportunities.

It can be concluded that the overall negative impact of various activities on different environmental parameters is negligible when a proper Environmental Management Plan (EMP) is in place. Even the negative consequences can be converted into positive, beneficial impacts with the adequate and timely implementation of EMP. **Hence, the project can be considered environmentally safe & fit.**

CHAPTER 6 PUBLIC CONSULTATION

6.1 GENERAL

Stakeholder engagement is a core requirement of the Environmental Impact Assessment (EIA) process for **Red Category projects** under the **Bangladesh Environmental Conservation Act, 1995** and **Environmental Conservation Rules (ECR), 2023** For the proposed **Rangamati Medical College and Hospital and Nursing College Project**, a structured and multi-stage stakeholder engagement process was undertaken to ensure transparency, inclusiveness, and integration of local concerns into project planning and environmental management.

The engagement process was designed to:

- Identify stakeholders likely to be affected by the project
- Provide timely and accessible project-related information
- Collect concerns, expectations, and local knowledge
- Integrate stakeholder feedback into impact assessment and mitigation measures

6.2 IDENTIFICATION OF STAKEHOLDERS

Stakeholders were identified based on their **proximity to the project site**, **level of influence**, and **degree of potential impact**. The following categories of stakeholders were engaged:

- residents living within the project influence area
- Indigenous and local community representatives
- Local government institutions (Union Parishad / Municipality)
- Healthcare service users and community groups
- Educational institutions in the surrounding area
- Local business owners and service providers
- Project-affected persons (PAPs), if any
- Relevant government agencies and line departments

Special consideration was given to **vulnerable groups**, including women, elderly persons, and low-income households, to ensure inclusive participation.

6.3 STAKEHOLDER ENGAGEMENT DURING EIA SCREENING STAGE

6.3.1 Engagement Approach

During the **EIA screening stage**, preliminary stakeholder engagement was carried out through **informal consultations and site-level discussions**. These engagements were conducted by the EIA study team in coordination with local representatives.

6.3.2 Methods Used

- Informal face-to-face discussions with local residents
- Meetings with local leaders and community representatives
- Rapid reconnaissance surveys of the surrounding area

6.3.3 Key Outcomes

The engagement at this stage helped to:

- Identify environmentally sensitive receptors such as nearby water bodies and residential areas
- Understand local concerns regarding land use change, access roads, and construction disturbances
- Support the classification of the project as **Red Category** and the need for a full EIA

The information gathered during this stage was used to finalize the **Terms of Reference (ToR)** for the EIA study.

6.4 STAKEHOLDER ENGAGEMENT DURING FIELD SURVEY AND BASELINE STUDY

6.4.1 Engagement Strategy

During the **baseline environmental and socio-economic survey phase**, stakeholder engagement was conducted using a structured, **participatory approach**. Engagement activities were conducted concurrently with environmental monitoring and field investigations.

6.4.2 Engagement Methods

The following methods were applied:

- **Household-level consultations** with nearby residents
- **Key Informant Interviews (KII)** with local leaders, health workers, and administrators
- **Focused group discussions (FGDs)** with community members
- **On-site observations and informal interviews**

Stakeholders were informed about:

- Project objectives and major components
- Expected construction and operation activities

- Potential environmental and social impacts

6.4.3 Documentation and Recording

All consultations were:

- Conducted in the local language to ensure understanding
- Properly documented through notes and field records
- Cross-checked with baseline data for consistency

6.5 STAKEHOLDER ENGAGEMENT AFTER DRAFT EIA PREPARATION

6.5.1 Disclosure of Draft EIA

After completion of the **Draft EIA Report**, the document was prepared for submission to the **Department of Environment (DoE)**. In accordance with DoE guidelines, the draft findings will be disclosed to stakeholders before final approval.

6.5.2 Second-Round Public Consultation Process

A formal public consultation will be conducted to:

- Present key findings of the EIA
- Explain predicted environmental and social impacts
- Share proposed mitigation measures and Environmental Management Plan (EMP)

The consultation will be conducted through:

- Public meetings at accessible locations
- Visual presentations and verbal explanations in understandable language
- Open discussion sessions allowing stakeholders to express views and concerns

6.5.3 Feedback Integration

Comments and suggestions received during this stage will be:

- Systematically recorded
- Reviewed by the EIA study team and project proponent
- Incorporated into the **Final EIA Report**, where applicable

A summary of stakeholder feedback and responses will be included as an annexure.

6.6 KEY ISSUES RAISED BY STAKEHOLDERS AND RESPONSE MECHANISM

6.7 KEY CONCERNS IDENTIFIED

Stakeholders raised concerns related to:

- Protection of nearby lake and water bodies

- Medical and hazardous waste management
- Traffic congestion and road safety
- Noise and dust during construction
- Employment opportunities for local people

6.7.1 Response and Action

In response, the project has committed to:

- Establish buffer zones and lake protection measures
- Install **ETP and STP systems** with dedicated budget allocations
- Prepare a traffic management and access control plan
- Implement dust and noise control measures
- Give preference to local employment during construction and operation

6.8 GRIEVANCE REDRESS MECHANISM

A **Grievance Redress Mechanism (GRM)** will be established to:

- Receive complaints during construction and operation phases
- Ensure timely investigation and resolution
- Maintain records of grievances and actions taken

The mechanism will be communicated to stakeholders through notice boards and local administration.

Conclusion

The stakeholder engagement process for the Rangamati Medical College and Hospital and Nursing College Project was conducted in a **systematic, transparent, and inclusive manner.** Engagement at multiple stages ensured that community concerns were identified early and addressed through project design and environmental management measures.

CHAPTER 7 ENVIRONMENTAL MONITORING PLAN

7.1 MONITORING REQUIREMENT

Environmental monitoring is essential to Environmental Management Systems, providing critical information for rational decision-making. The prime objectives of monitoring are –

- To check whether mitigation and benefit enhancement measures are being adopted and are effective in practice.
- To provide a means whereby impacts that were subject to uncertainty at the time of preparation of EIA, or which were unforeseen, can be identified, and steps to be taken to adopt appropriate control measures.
- To provide information on the actual nature and extent of key impacts and the effectiveness of the mitigation measures, which, through a feedback mechanism, can be taken into account in the planning and execution of similar projects in the future.

There are two basic forms of monitoring:

- Visual observation or a checklist, coupled with inquiries
- Physical measurement of selected parameters.

In general, monitoring in industrial projects is done by physically measuring selected parameters, such as air, water, soil, and noise. The monitoring program should ensure compliance with national environmental standards. This monitoring program is vital for ensuring that the project does not cause adverse ecological impacts in the area and for providing a database of operations and maintenance activities that can be used if unwarranted complaints are made.

7.2 MONITORING THE IMPLEMENTATION OF MITIGATION MEASURES

To ensure that the recommended environmental mitigation measures are effectively implemented throughout the project lifecycle, a structured Environmental Monitoring and Audit Plan will be followed. This plan involves a combination of site inspections, documentation reviews, water and air sampling, photographic evidence, and regular reporting.

7.3 1. METHODOLOGY FOR MONITORING MITIGATION MEASURES

The following methodology will be adopted to verify that mitigation measures are in place and functioning effectively:

- **Checklists and Site Audits**: Use of standardized environmental audit checklists during regular site visits to assess compliance with mitigation measures.
- **Visual Observation**: Monitoring of housekeeping, waste storage, ETP operation, emissions control, and chemical handling areas.
- **Sample Testing**:

- **Effluent Sampling**: Collected before and after ETP treatment for pH, BOD, COD, TSS, Color, etc.
- **Ambient Air Quality**: Monitoring of SOx, NOx, PM2.5, near generator zones.
- **Noise Monitoring**: Near generators, heavy machinery zones, and boundary areas.

- **Photographic Records**: Regular photographs of key pollution control units (ETP, solid waste storage, chemical storage, laboratories) and changes in site conditions.
- **Worker Interviews**: Random interviews to assess awareness and implementation of health and safety and environmental practices.

7.4 2. MONITORING LOCATIONS (WITH MAPS & PHOTOS)

Monitoring will be conducted at the following specific locations:

Monitoring Site	Purpose
ETP+STP Inlet and Outlet	To assess the efficiency of treatment
Generator Emission Points	To monitor air quality
Operation Theater, pathology section	To monitor spill prevention
Solid Waste, Medical waste Storage Yard	To ensure proper segregation
Noise Sensitive Zones (Generator, Boundary)	To measure noise levels
Groundwater Extraction Point (Tube-well)	To monitor water usage and quality

7.5 3. MONITORING SCHEDULE AND FREQUENCY

Project Phase	Monitoring Activity	Frequency
Construction Phase	Waste handling, noise, air & water quality	Bi-weekly (twice/month)
Machinery Installation	Air, noise, fuel usage, and safety	Weekly
Operational Phase	Full environmental compliance monitoring	Monthly (Routine), Quarterly (Detailed)

7.6 4. REPORTING AND REVIEW PROCEDURE

- **Environmental Monitoring Reports (EMR)** will be prepared **monthly** and **quarterly,** covering:

- Monitoring data
- Non-compliance events
- Corrective actions taken
- Visual documentation (photos, maps)

- Reports will be submitted to:
  - **Company Management** (monthly internal review)
  - **Department of Environment (DoE)** (quarterly/biannual submission)
- **Annual Environmental Audit:** A certified third-party environmental auditor will review overall compliance, ETP performance, and documentation annually.
- **Corrective Actions:** In case of any non-compliance or failure of mitigation, immediate actions will be recommended and implemented under the supervision of the Environmental Management Officer (EMO).

7.7 PERSONNEL INVOLVED IN MONITORING

- **Environmental Management Officer (EMO)** – Overall coordination
- **ETP Supervisor** – Daily log maintenance
- **Safety Officer** – Health and hazard compliance
- **External Environmental Consultant** – Third-party assessment (if required)

7.8 MONITORING INDICATORS

Environmental monitoring requires a set of indicators that can be conveniently measured, assessed, and evaluated periodically to observe trends in baseline ecological quality. Table 9.1 lists the parameters to be tested, the sample number, and the sampling frequency. Here, it may be noted that the parameters are selected according to the DOE requirements, as specified in the environmental quality standards (EQS) for the concerned industries.

Table 7-1 Monitoring Parameter and Frequency

Issue	Parameters	Location	Monitoring Frequency
Stack Emissions Generator	SPM	Final exhaust	Half-yearly
Waste water treatment plant inlet & outlet water quality	pH, BOD5 at 20°C, COD , Suspended Solids (SS), Color	ETP+STP inlet & Outlet	Half-yearly

Workplace noise level	Noise level at the workplace	Noise at different locations in the workplace	Half-yearly

To be an environmentally acceptable project, the proposed project should have its own environmental monitoring unit/cell with trained manpower, the necessary equipment, and other logistics, and the required budget. **Rangamati Medical College and Hospital and Nursing College** should develop a working relationship with the Department of Environment (DOE) by undertaking a joint monitoring program to monitor the above parameters.

7.9 MONITORING PLAN

Unless specified otherwise, the plant authority should carry out all monitoring activities. For specific purposes, a network should be formed with the plant's workers and employees.

Water Pollution

- Monitor and control wastewater discharge to the natural drain.
- Monitor compliance with water quality standards set by DoE during construction and operational periods.

Table 7-2 DoE Water Quality Standard for Inland Surface Waters

Parameter	Unit	Recreation activity	Fisheries
pH	-	6.5-8.5	6.5-8.5
BOD mg/l	mg/L	3 or less	6 or less
DO mg/l	mg/L	5 or more	5 or more

Table 7-3 Sewage Water Parameter

Parameter	Unit	Standard Limit
pH	-	**6-9**
BOD_5 at 20°C	mg/l	**30**
COD	mg/l	**100**
Suspended Solids (SS)	mg/l	**100**
Total Coliform	**Number/100 ml**	**1000**

Noise Pollution

Monitoring actions taken by the authority of the plant to reduce noise and meet DoE guidelines.

Table 7-4 DoE Standards for Sound

Category of areas	Standard determined at dBa unit	
	Day (6 AM-9 PM)	**Night (9 PM-6AM)**
Silent zone	45	35
Residential area	50	40
Mixed area	60	50

Commercial area	70	60
Industrial area	75	70

7.9.1 Solid Waste Management

According to the US EPA "Medical waste is a subset of wastes generated at health care facilities, such as hospitals, physicians' offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories." Generally, medical waste is categorized as hazardous or toxic waste. Therefore, it is injurious. The different types of medical wastes are blood and other bodily fluid; blood-soaked bandages, compresses, etc; tissues, such as organs or biopsy samples; used and unused hypodermic needles from the injection of insulin or other prescribed drugs; tattoo and body piercing needles; home kidney dialysis filter, bags, and equipment; automatic lancets used for blood sampling; contaminated gloves or other protective materials; culture materials and swabs. The categories of medical waste according to the Medical Waste Management Act-2008, Bangladesh, are given in the following Table.

Table 6.1: Category and Treatment Facilities of Medical Waste

(According to the "Medical Waste Management Act-2008")

Category of Waste	Category of Waste Sample	Treatment and destruction
Category No-1	General Waste (Infected / Harmful Waste)	(a) Removal of premises or public landfill. (b) Ensure that plastic waste is cut off and reused.
Category No-2	Anatomical waste	(a) Purification/destruction of the concrete pit method in a premises / safe place. (b) Deep soil cover (the amount is small) (c) Use of steam autoclaving/microwave treatment/incinerator.
Category No-3	Pathological waste	Category No. 2 (Anatomical waste).
Category No-4	Chemical waste	(a) Return to the expired chemical waste supplier (if quantity is high). (b) Disposal of sewage by diluting it with a large quantity of water (if the quantity is small) (c) Chemically purified/inactivated in the sewage system.
Category No-5	Pharmaceutical	Category No. -4 chemical waste) like.
Category No-6	Infectious/bacterial waste	(a) Purification/destruction of the concrete pit method in a premises / safe place. (b) Deep soil cover (the amount is small) (c) Use of steam autoclaving/microwave treatment/incinerator.
Category No-7	Radioactive waste	(a) If the level of radioactivity per kg of waste exceeds 0.1 MB Q, it must be treated and disposed of following the provisions of the Bangladesh Atomic Energy Commission.
Category No. 8	Sharp waste	(a) Purification/destruction of the concrete pit method in a premises / safe place. (b) Encapsulation

		(c) Deep soil cover (the amount is small) (d) Use of steam autoclaving/microwave treatment/incinerator.
	Reusable General Waste	(a) Purification and reuse by steam autoclaving. (b) Chemical treatment and reuse.
Category No-9	Liquid waste (Infected/Non-infected)	(a) Removal from the drainage system by diluting with plenty of water. (b) Removal to the sewer by chemically purifying mixed with 1% sodium hypochlorite solution.
Category No-11	Pressurized waste	(a) Refund to the supplier (in excess) (b) Methodically depressurized removal with normal/recyclable waste (in small quantities)

7.9.2 Waste Treatment and Disposal Plan for Solid & Liquid Waste

Setting up individual treatment and disposal units is challenging and costly for each medical center. After all, the project has its management plan. Local Municipality and Hospital Own Incinerator is the third party that carries solid medical waste. The medical waste treatment process comprises several unit processes. First, waste is generated by hospitals' various activities. Then it is collected by a separate marked bin. Color-coded bins (per medical waste management guidelines) will be provided on each floor.

From the collection, bin waste accumulates—the solid waste collected by the Local Municipality and Hospital Own Incinerator for solid medical waste management. The hospital has a secondary waste storage area. This area is used for waste storage. From different floors and facilities, medical waste accumulates in the room. Here, waste is separated (where required) and stored in this room. The waste collection vehicle collects all the medical waste (except liquid) from these secondary storage facilities (see the following figures).

Figure 7-1 Bin for solid waste management

Steps in Management of Hospital Waste Include:

-Training and Awareness
-Generation
-Segregation/separation
-Collection
-Transportation
-Storage
-Treatment
-Final disposal
One of the challenging tasks is finding out the waste as color code wise. An appropriate way of identifying the waste is by sorting the waste into different COLOR CODES. Color code is easy for identification and thereby easy for safe handling, transportation and waste treatment. The color code varies from

Country to country. For example, Infectious waste is kept in a colored bin, sharp waste in a red bin, liquid waste in a colored bin, and other waste in a black or general bin.

Waste Segregation:

-Waste segregation means dividing or separating waste at the earliest opportunity at the point of origin.

-Not allowing hazardous waste to mix with non-hazardous waste.

-If waste is segregated correctly, a small amount is needed for disposal instead of a large quantity of garbage, ultimately resulting in lower manpower, cost, and risk.

-If segregation is not done correctly, a small quantity of hazardous waste has a chance to mix with a large volume of non-hazardous waste.

Transportation

In-house transportation

-Means transportation of waste from the site of origin or collection to temporary storage area within the institution.

-Waste should be transported by a designated trolley, through the designated route according to the time schedule given by the institutional authority.

Temporary in-house storage

-The store will be a room or area or building within the health care facility depending upon the quantity and quality of waste collection

-Normally, waste should not be stored for more than 24 hours.

Record keeping

-Accurate record keeping is needed for effective medical waste management.

-Record keeping might give some vital information, which is needed for:

a. assesses the recurrent expenditure

b. assesses the quality and quantity of generated waste

The designed wastewater treatment plant will treat the liquid medical waste. Details of the wastewater treatment plant are given in the annexure.

The total management plan of hospital waste is given in the following schematic diagram.

Health and Safety

Monitor Environmental compliance and implement health and safety measures for workers during the operational period.

7.10 ENTREPRENEURIAL RESPONSIBILITIES

To ensure effective monitoring and compliance, the following responsibilities are assigned to the project management:

- **Manpower:**
  - **Environmental Management Officer (EMO)** – 1 (Full-time)
  - **ETP +STP Operator** – 2
  - **Lab Technician** – 1 (for sample collection and coordination with the lab)
  - **Safety Supervisor** – 1 (overseeing chemical & occupational safety)
- **Technical Advice & Support:**
  - Regular consultation with certified environmental consultants
  - Capacity-building training for staff on waste management and ETP operation

7.11 5. MONITORING REPORTING

- **Internal Reports:**
  - **Monthly Environmental Status Report** to be prepared by EMO covering:
    - Effluent discharge summary
    - Air and noise measurement results
    - Waste generation and disposal log
    - ETP operational log
- **External Reports:**
  - **Quarterly Monitoring Report** to be submitted to the **Department of Environment (DoE).**

- **Annual Environmental Compliance Report (AECR)** and **Third-party Environmental Audit Report** (if required by DoE or during license renewal).

- **Record Keeping**:
  - All reports, test results, photographs, and waste manifests will be documented and stored for at least **five years** for reference and regulatory review.

7.12 MANAGEMENT OF DIFFERENT ENVIRONMENTAL ASPECTS BASED ON IDENTIFIED IMPACTS

7.12.1 Management measures for the Air Environment during

Construction phase

- Diesel-driven construction machinery and equipment shall be fitted with appropriate silencers, will not be left idle for prolonged periods of time, and will be subjected to regular scheduled maintenance to minimize the exhaust emissions.
- Vehicle engines shall not be left running when not in use.
- Improperly functioning equipment and vehicles shall be removed from the project site or shall be repaired before returning to service.
- The contractor working on the project shall ensure that waste arising from construction activities on site is not burnt on the premises.
- Water sprinklers will be used to control the fugitive dust.

Operation phase

- Burning of solid wastes or waste oils shall be strictly prohibited. The local municipality and the hospital waste management system incinerator shall dispose of the entire solid waste generated. Already made a budget in the DPP page 219 about medical waste management, **estimated budget 165000000.00 BDT, and Sewage Treatment Plant estimated budget 75000000.00 BDT.**
- All roads should be paved to reduce pollution levels.
- Emissions from equipment/machinery & vehicles shall be monitored regularly.
- All necessary equipment/machinery shall be in good condition for proper operation.
- Employees shall be provided with sufficient environmental management & safety materials. They shall be given appropriate training, as well as a display of the summarized Environmental Management & Safety Procedures, which shall be made available at the site through a signboard.
- Regular Air monitoring and inspection of the environmental management practices shall be carried out, and the necessary documents & records shall be maintained.
- The Project authority should check the quality of the gases emitted by the generator at regular intervals to monitor its performance. If the result shows that the emitted air doesn't comply with any standard, mitigation measures must be taken based on the situation.

- The sources of air pollutants are burning fuel. During operation, these sources would emit the exhaust gases containing CO_2, NOx, SO_2, and a negligible quantity of particulate matter (PM_{10}). Control of air pollutants from these sources would be achieved by safe dispersal, providing adequate heights to the respective exhaust ducts, improving the combustion process, and installing an air pollution controller system if necessary.

7.12.2 Management Measures for Water Environment

Effective management of the water environment is a critical component of the Rangamati Medical College Hospital, Medical College, and Nursing College Project due to the sensitivity of surrounding surface water bodies, hilly terrain, and proximity to Kaptai Lake. The proposed mitigation and management measures have been planned for both the **construction and operation phases, with adequate financial allocations** already incorporated in the **Development Project Proforma (DPP)**.

7.12.2.1 Construction Phase Water Environment Management Measures

During the construction phase, potential impacts on the water environment may arise from surface runoff, wastewater generation, accidental oil spills, and improper waste handling. The following management measures will be strictly implemented:

1. **Control of Surface Runoff and Erosion**
    - Temporary drainage channels, silt traps, and sedimentation pits will be constructed to control runoff and prevent soil erosion.
    - Excavated areas will be covered during rainfall to minimize sediment transport into nearby water bodies.
2. **Wastewater Management**
    - Wastewater generated from construction activities, equipment washing, and labor camps will be treated through **temporary sedimentation tanks and soak pits** before discharge.
    - No untreated wastewater will be discharged into natural water bodies or nearby drains.
3. **Prevention of Oil and Chemical Contamination**
    - Construction machinery will be regularly maintained to prevent leakage of oil, fuel, and lubricants.
    - Designated impervious platforms will be used for refueling and maintenance of equipment.
    - Storage of construction chemicals, paints, and solvents will be done in secured, covered areas.
4. **Protection of Nearby Surface Water Bodies**
    - Buffer zones will be maintained between construction activities and nearby ponds, streams, and natural drainage channels.
    - Direct disposal of construction waste, spoil, or wastewater into water bodies will be strictly prohibited.
5. **Monitoring and Supervision**

- Regular inspection of drainage systems and wastewater handling facilities will be conducted by the Environmental Management Unit (EMU).
- Immediate corrective action will be taken in case of any accidental discharge or contamination.

The above measures will ensure that **construction-related impacts on surface water and groundwater remain minimal and localized**.

7.12.2.2 Operation Phase Water Environment Management Measures

During the operation phase, the hospital and educational facilities will generate significant volumes of **sewage and medical wastewater**, which require specialized treatment to protect public health and the surrounding environment. To address these impacts, a comprehensive water management system has been planned and budgeted.

a) Installation of Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP)

- The project will install an integrated **Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP)** to treat:
  - Hospital wastewater (from wards, laboratories, operation theatres, laundries)
  - Domestic sewage (from hostels, dormitories, staff quarters, kitchens, and toilets)
- The STP will be designed to meet the **Department of Environment (DOE), Bangladesh discharge standards**.
- Treated effluent will be reused for **toilet flushing, landscaping, gardening, and road washing**, thereby reducing freshwater demand.

Estimated Budget (as per DPP, Page 219): Sewage Treatment Plant (STP): **BDT 75,000,000.00**

b) Medical Wastewater and Liquid Waste Management

- Wastewater generated from medical and laboratory activities containing pathogens, chemicals, and disinfectants will be pre-treated before entering the central treatment system.
- Segregation of highly infectious liquid waste at source will be ensured.
- Chemical neutralization and disinfection processes will be applied where required to reduce biological and chemical loads.

Estimated Budget for Medical Waste Management (as per DPP, Page 219):
• Medical Waste Management System: **BDT 165,000,000.00**

c) Protection of Surface Water and Groundwater

- No untreated wastewater will be discharged into nearby surface water bodies, including **Kaptai Lake or natural drainage channels**.

- Regular monitoring of treated effluent quality (pH, BOD, COD, TSS, pathogens) will be conducted.
- Groundwater abstraction will be regulated, and rainwater harvesting will be implemented to enhance groundwater recharge.

d) Drainage and Stormwater Management

- Separate stormwater drainage systems will be provided to prevent mixing of rainwater with sewage.
- Stormwater drains will be designed considering the hilly terrain and high rainfall characteristics of Rangamati.
- Regular cleaning and maintenance of drains will be ensured to prevent clogging and overflow.

e) Institutional and Monitoring Measures

- An **Environmental Management Unit (EMU)** will be responsible for operation, monitoring, and maintenance of the ETP and STP.
- Standard Operating Procedures (SOPs) will be developed for wastewater treatment operations.
- Periodic reporting to the Department of Environment (DOE) will be ensured as per regulatory requirements.

7.12.2.3 Overall Effectiveness of Water Environment Management

With the implementation of the above measures and **adequate financial provision in the DPP**, the project is expected to:

- Prevent surface water and groundwater contamination
- Ensure safe management of medical and domestic wastewater
- Protect Kaptai Lake and surrounding ecosystems
- Promote sustainable water use and environmental compliance

Therefore, the residual impacts on the water environment during both construction and operation phases will be **low and environmentally manageable**.

7.12.3 Management Measures for Terrestrial Biodiversity

Construction phase

Regular monitoring shall be conducted to prevent contamination of natural habitats. The significant impacts would be on terrestrial ecology. Care should be taken during construction to ensure it does not affect terrestrial inhabitants.

Operation phase

- Disposal of effluent & sewage shall not be made into nearby or adjacent water bodies or other ecological habitats to prevent impacts on the environmental structure & habitat of the area.
- Any solid waste shall not be dumped into the marine environment, nor on the land of the premises / surrounding area.
- Contamination of marine water caused by any means of project operation shall be avoided to prevent adverse impacts on ecology.
- Regular monitoring of the local area shall be conducted to assess any residual effects on the local ecology from the project's operations. Necessary technologies/facilities for the prevention of such effects shall be provided immediately by the project proponent.

7.13 MANAGEMENT MEASURES FOR SOCIO-ECONOMIC ENVIRONMENT

Construction Phase

A significant affirmative impact of the proposed project will be the creation of direct & indirect employment and the uplifting of the economic status of people living in the nearby area. Local population would also get opportunities in related services activities like small contractors, sub-contractors, supply of construction materials, supply of basic facilities like eatables to the site etc. The construction activities will generate significant employment in ancillary activities.

Operation Phase

The proposed project shall result in significant employment during the operation. The proponent shall give priority to the appointment of local people to the maximum extent during the employment process for the proposed project. Safety training shall be provided to all workers. The workers shall pass through the medical examination prior to recruitment and periodic medical checkup shall also be carried out. An emergency response plan and disaster management plan shall also be placed to take care of adverse impact in case of any incident of accident. Such plans shall also be helpful to the local area during the incidence of Natural Disaster.

7.14 OCCUPATIONAL HEALTH AND SAFETY

The contractors shall also be briefed on the conditions imposed by regulating agencies on the project, the potential problems and Management measures and their obligations in the meeting those requirements. Proponent shall ensure that the contractors implement their instructions properly while constructing by incorporating appropriate conditions in the contract documents. Some of the safety aspects to be implemented are as under:

- Monitoring safe working procedures through safety work permit system and provided safety supervision.
- Safety audit of mechanical equipment and electrical installations.
- Distribution and storage of personnel protective equipment and first-aid items to all working groups and offices.

- Preparation and updating of safety standards and safe working procedures.
- Accident investigation, emergency handling and documentation of accident reports.
- Planning, organizing and conducting training programs for employees on safety, safe working procedures for various related activities.
- Planning, organizing, and conducting safety awareness programs for contractors and the community.
- Welding and painting will be carried out after temporary enclosures are provided against wind, etc., if necessary.

7.14.1 Work-related injuries

All occupational accidents should be notified to the family of the accident victim which should be informed as soon as possible and as required by national laws or regulations to the authority, the labor inspectorate the appropriate insurance or any other.

(a) Immediately after reporting of an occupational accident-causing loss of life.

(b) Within a prescribed time for other occupational accidents. with a view to meeting the requirements of labour inspectorates, insurance institutions and the statistics producing body the forms prescribed in either a specific or single format should include at least the following minimum information on

(a) Facility and employer

(b) Injured person (name, address, sex, and employment status, occupation,

(c) Type nature and location of injury, (d) accident and its sequence (geographical location of the place of the accident, date and time, action leading to injury-type of accident).

National laws or regulations should provide for the specification of the relevant necessary information to be notified for commuting accidents and of more detailed information if available.

7.15 AFFORESTATION

Trees and plants are well known for trapping noise, particulate matters, and gaseous pollutants, in controlling soil erosion and ground water charging. Green Belt has to be developed outside of plant premises adjacent to northern, western and southern boundary of the plant. The selection of plant species shall be made in consultation with local forest officials. Grassy lawns and gardens shall be developed in vacant areas within the plant premises under beautification scheme to increase the aesthetic value.

7.16 COSTING OF EMP

As mentioned earlier, no significant environmental pollution from Rangamati Medical College and Hospital and Nursing College occurred. So, the capital investment required for organizational management in implementing EMP.

EMP Costing Summary for Rangamati Medical College & Hospital and Nursing College It is fully described in the DPP.

Table 7-5 Environmental Management Action Plan for Construction Phases

Environmental Impact	Mitigation Measures	Time Frame	Location	Responsibility
Air pollution	• All materials transported to and from the construction site should be covered. • Temporary stockpiles of soil or other material should be covered or sprayed with water on a regular basis, particularly during dry or windy conditions. • Water should be used to suppress dust on temporary roadways and other exposed areas. • The project site should be surrounded by boundary wall; • Workers in the site should be issued with dust masks during dry and windy conditions; • Vehicles and other machinery should clear off mud before leaving the site;	Throughout the construction phase	Project site	Contractor
Soil Erosion and siltation	• Prefer the dry season for starting construction work. In case of working in the rainy season, install a barrier net. • Re-cover exposed soils with grass and other appropriate species as soon as possible; • Pile up spoil soil on a flat surface away from the drain. • Prevent **slope failure, landslides, and soil erosion** • Maintain **long-term geotechnical stability** of cut and filled slopes • The authority has constructed RCC boundary walls along approximately **1,700 meters** of the project perimeter.	Throughout the construction phase	Project site	Contractor

	▯ Retaining walls covering an approximate total area of **20,403.65 square meters** have been built at critical locations within the project site. ▯ Control **surface runoff and sediment transport** ▯ Protect **adjacent natural drainage, vegetation, and built infrastructure** ▯ Ensure compliance with **DoE (Bangladesh) EIA guidelines** and hill-area development best practice			
Noise and vibration	▯ Construction activities that will generate disturbing sounds should be restricted to regular working hours. ▯ If required, residents should be given notice of the noise activities to reduce the degree of annoyance. ▯ Workers use earplugs while working with a noisy device.	Throughout the construction phase	Project site	Contractor
Impact on groundwater	▯ Ensure minimum extraction of groundwater; ▯ Water waste should be avoided through monitoring.	Throughout construction phase	Project site	Contractor
Solid waste	▯ Provide space for temporary disposal of solid waste in the site and dispose of the waste properly; ▯ Arrange adequate sanitation facilities for workers; ▯ Follow up to ensure appropriate waste disposal and sanitation practices by contractor and construction workers;	Throughout the construction phase	Project site	Contractor
Impact on Biodiversity	▯ Avoid unnecessary cutting of trees; ▯ Allocate space for green belt development;	Throughout construction phase	Project site	Contractor

Impact on traffic volume	Control vehicle movement in an organized way and follow local traffic instructions;	Throughout the construction phase	Material Transport Route	Driver
Fire/Explosion	Establish own firefighting system and maintain collaboration with government firefighting and civil defense department locally; Organize fire drills and training for construction staff;	Throughout construction phase	Project site	Contractor
Employment generation	Employment of only construction workers;	Throughout construction phase	Project site	Contractor
Occupational Health and safety risk	Create awareness of safety issues among workers and contractors; Monitoring the practice of following safety guidelines by workers and contractors; Ensure the use of appropriate PPE while working on the construction site and display proper safety signs in the project site.	Throughout the construction phase	Project site	Contractor

Table 7-6 Environmental Management Action Plan for Operation Phases

Environmental Impact	**Mitigation Measures**	**Time Frame**	**Location**	**Responsibility**
Air pollution	Provide adequate ventilation and an exhaust fan in the workplace. Spray water on bare soil. Maintain open air exhaust for the generator and set the The Catalytic converter and the faulty engine would be repaired as soon as possible.	Throughout the Operation phase	Project site	Representative of project proponent

	▯ Plant a tree near the boundary line or in the green area. ▯ Monitoring SPM every 06 Months;			
Liquid waste	▯ The authority will implement the ZDP plan ▯ Install ETP+STP to treat the wastewater and reuse it			
Solid waste	▯ Apply the 3R method to the project's waste management. ▯ Train employees on waste control and disposal procedures; ▯ Segregates wastes at source and stores in demarcated places; ▯ Spent lube oil will be sold only to a DoE-approved vendor.	Throughout the Operation phase	Project site	Representative of the project proponent
Noise and Vibration	▯ An air plug will be provided to workers while near noise-generating equipment or working in a noisy area. ▯ Conduct periodic maintenance of the generator. ▯ Will procure a noise monitoring device and monitor noise conditions in and outside the project premises; ▯ Monitoring noise conditions every 06 months;	Throughout the Operation phase	Project site	Representative of the project proponent
Impact on soil or land	▯ Maintain yard cleanliness and store solid waste in the waste bin. ▯ Green belt development for enhancing the natural aesthetic of the site;	Throughout the Operation phase	Project site	Representative of the project proponent
Impact on traffic volume	▯ Control vehicle movement in an organized way and follow local traffic instructions.	Throughout the Operation phase	Project site	Representative of the project proponent
Fire/Explosion	▯ Establish your firefighting system and collaborate locally with the government firefighting and civil defense department. ▯ Organize fire drill and training for construction staff;	Throughout the Operation phase	Project site	Representative of the project proponent

Occupational health and safety risk	Conduct job safety analysis; Use personal protective equipment, such as a hard helmet, mask, boots, and eyeglasses. Aware and train employees on using safety devices;	Throughout the Operation phase	Project site	Representative of the project proponent
Statutory requirements	Meet all statutory requirements with DoE within the time frame;	Throughout the Operation phase	Project site	Representative of the project proponent

Table 7-7 Environmental Management Action Plan

Issue/Concern	Potential negative environmental impacts	Mitigation measures	Environmental Monitoring	Responsible actors	Time frame
Water Pollution	- Surface and ground water pollution -Occupational illness	- water filtration - Will establish a septic tank, and 30 m^3 per hour STP	-Monitoring of water quality	-Authority & workers - Health and safety officer	- Quarterly reporting
Solid waste	- Air, water and soil pollution -Poorly disposed waste may block drainage	- Proper solid waste management system - Sale of solid waste to a third party. - Solid waste collection, storage, and transportation system - Awareness and training campaign	- Regular monitoring of the solid waste management facilities	-Authority & workers - Health and safety officer - Neighbors and - The general Public	-Must be keep inventory/daily register for solid waste - Quarterly reporting
Air Pollution	- Deterioration of indoor air quality	- Proper stack height for generator	-Monitoring of AIR quality	-Authority & workers - Health and safety officer	- Half yearly Air quality monitoring (Only SPM)

	-Occupational illness/health impact	-Regular maintain of Generators -Use of PPE			
Noise Pollution	- Hearing loss -Reduced productivity and efficiency -Fatigue, headache, nervousness, irritability and high pretension resulting in accidents at workplace	- Implementation an effective noise control and hearing conservation program -Noise measurement -Providing suitable hearing protection to all workers -Training of workers	-Determine Noise levels from time to time	-Authority & workers - Health and safety officer - Neighbors and - The general Public	- Half yeady Noise level monatoring
Occupational hazards	- Injury to employees on site -Injury to visitors - Reduced productivity - Plant and equipment damage -Negative corporate image	- Good and sound housekeeping practices -Provision of appropriate working tools and equipment -Use of PPE -Timely repair and maintenance of plant and equipment -Employee training -Use appropriate elevators and other lifting machinery	-Accident and incident records -Record of employee training	-Authority & workers - Health and safety officer	- The mitigation measures proposed should be put in alongside project implementation and daily operations, continuously improved on and sustained throughout the operation life of the project.

7.17 DISASTER MANAGEMENT PLAN (DMP)

7.17.1 Approach to Disaster Management Plan

On-site emergency or disaster is an unpleasant, sudden event of such magnitude that may cause extensive damage to life and property due to in-plant emergencies resulting from deficiencies in operation, maintenance, design, and human error; natural calamities like floods, cyclones and earthquakes; and deliberate and other acts of a man, like sabotage, riot, war, etc. Every industry needs a well-documented Emergency Plan to address major untoward incidents or disasters. Because of this, an approach to the Disaster Management Plan (DMP) to tackle the emergencies, the proposed project has been delineated in the following sections. The roles and responsibilities of key personnel have also been defined in the plan.

7.17.2 Formulation of DMP and Emergency Services

Proposed **RANGAMATI MEDICAL COLLEGE AND HOSPITAL AND NURSING COLLEGE** will formulate a Disaster Management Plan for better and safer management of their plants. The DMP is related to the final assessment, and it is the responsibility of the plant management to document, including the following elements.

- Assessment of the size and nature of the events foreseen and the probability of their occurrence;
- Formulation of the plan and liaison with authorities, including the emergency services.
- Procedures for raising the alarm and communications both within and outside the works;
- Appointment of key personnel and their duties and responsibilities, especially for works incident controller and works main controller;
- Emergency control center;
- Action on-site;
- Action off-site;

The plan is prepared to set out how designated personnel at the incident site can initiate supplementary action, both inside and outside the works, at an appropriate time. An essential element of the plan must be the provision for attempting to make the affected unit, for example, by shutting it down. The plan includes the entire sequence of key personnel to be called in from other sections or off-site on a complex site.

7.17.3 Need for Disaster Management Plan

The proposed project will not produce any potentially hazardous material to human beings, flora, fauna, or the environment. Despite these, the possibility of accidents cannot be ruled out. Human errors and mechanical, electrical, instrumental, or system failures have occasionally led to severe disasters. The following are the general types of Emergencies/Disaster that lead to the preparation of a disaster management plan:

- Fire from a gas cylinder explosion
- Fire from an electric short circuit

- Earthquake
- Flash flood
- Landslide

7.17.4 Objectives of Disaster Management Plan

DMP aims to provide detailed guidance on organizational responsibilities, actions, reporting requirements, and available support resources to ensure effective and timely management of emergencies associated with production and operations on the site. The overall objectives of DMP are to:

- Ensure the safety of people, protect the environment, and safeguard commercial considerations
- Immediate response to the emergency scene with an effective communication network and organized procedures
- Obtain early warning of emergency conditions to prevent impact on personnel, assets, and the environment
- Safeguard personnel to prevent injuries or loss of life by protecting them from hazards and evacuating them from an installation when necessary.
- Minimize the impact of the event on the installation and the environment by:
  - Minimizing the hazard as far as possible
  - Minimizing the potential for escalation
  - Containing any release
- To guide to help stack holders take appropriate action to prevent accidents involving hazardous substances and to mitigate adverse effects of accidents that do nevertheless occur.

7.18 EMERGENCY RESPONSE AND DISASTER MANAGEMENT PLAN

The initial response to an incident is a critical step in the overall emergency response. Like all other industries and installations. Project authorities must have adequate measures in place to prevent accidents and incidents, and to respond to emergencies. The purpose of having an Emergency Response Plan (ERP) is to:

- Assist personnel in determining the appropriate response to emergencies.
- Provide personnel with established procedures and guidelines.
- Notify the appropriate company emergency response team personnel and regulatory Govt agencies.
- Manage public and media relations.
- Notify the next of kin of accident victims.
- Promote inter-departmental communications to ensure a "Companywide" Coordinated emergency response.
- Minimize the effects that disruptive events can have on company operations by reducing recovery times and costs.

- Respond to immediate requirements to safeguard the subtending environmental and community.

Generally, the initial response is guided by three priorities Ranked in importance these priorities are:

1. **People**
2. **Property**
3. **Environment**

Emergency response procedures will identify who does what and when in the event of an emergency. Responsibility for who is in charge and their coordination of emergency actions shall be identified. Nature of emergency& Hazardous situations may be of any or all of the following categories:

I. Emergency

- Fire,
- Explosion
- Medical emergency,

II. Natural Disasters

- Flash Flood,
- Earthquake,
- Landslide

III. External factors

- Food poisoning/water poisoning
- Sabotage

7.18.1 Six Steps in Emergency Response

First Step:
This step determines the potential hazards associated with the incident, substance or circumstances and take appropriate action identify the type and qualities of dangerous goods involved and any known associated hazards.
It also determines potential hazards stemming from local conditions such as inclement weather water bodies etc. and ensure that the initial response team is aware of these conditions.
Second Step:
Determine the source/cause of the event resulting to the emergency and prevent further losses.
Third Step:
Conduct an assessment of the incident site for any further information on hazards or remedies.
Fourth Step:
Initiate redress procedures.
Fifth Step:
Report the incidence, its nature, cause, impact, applied redress procedures, and any further assistance required, etc., to the appropriate company, government, and/or land owner.
Sixth Step:
Take appropriate steps with respect to hazards to wildlife, other resources and addressing public and media concerns and issues, as applicable. Response priorities are to protect human lives, property and the environment.

7.18.2 Emergency Response and Fire Management Plan

If a small fire cannot be extinguished with the use of a portable extinguisher or a fixed extinguishing system, or the smoke presents a hazard to the operator, then leave the fire area, ensure the fire department has been notified, and wait in a safe area for the fire department. Attempting to extinguish a fire is a voluntary act. Only persons who are properly trained and feel confident in the use of a portable extinguisher should contemplate their use. Improper use of a portable extinguisher can lead to severe injury or death.

7.18.2.1 Types of Fire

There are five types of fire such as
Class A – Ordinary combustibles (wood, paper, plastics, etc.)
Class B – Combustible liquids (oils, gas, cooking oil, etc.)
Class C – Electrical (energized equipment – appliances, wiring, etc.)
Class D – Combustible metals (aluminum, magnesium, zinc, etc.)
Class E – Commercial cooking equipment (Cooking oils, Animal fats, Vegetable fats)

It is extremely important to choose the properly rated fire extinguisher for the class of fire that is burning.

Figure 7-2 Pictorial View of Different Types of Fire

7.18.3 Fire Safety Risk Assessment

A fire safety risk assessment is an organized, methodical assessment of the premises, the activities within them, the potential for a fire to occur, and the harm it could cause to people in and around the premises. The prescribed process is available for inside or indoor fire risk assessment. The following fire risk assessment process can be followed and executed twice a year.

7.19 EMERGENCY RESPONSE PLANS TO DISASTER

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The emergency response plan (ERP) for the proposed factory has been developed, listing various actions to be performed within a very short period in a predetermined sequence to effectively and efficiently deal with any emergency,

major accident, or natural disaster. The primary objective of the plan is to minimize loss of life, material damage, damage to machinery and equipment, and environmental impacts.

7.19.1 Alarm system

The alarm system varies and will depend on the size of the works area - simple fire bell, hand-operated siren, break-open type, fire alarm, etc.

7.19.2 Communication System

Communication is a key component in controlling an emergency. The following communication system may be provided in the project:

- Walky-talky
- Telephone
- Cell phone
- Intercom/paging
- Runners (verbal or written messages)

7.19.3 Siren for emergency

The emergency siren should be different from a standard siren. The emergency siren should be audible at a distance of 5km. The emergency siren should be used only in emergencies.

7.19.4 Escape Route

The escape route from each plant should be clearly marked, and the authority has already marked the emergency escape route on every floor. The escape route is the shortest path to reach the open area from the factory, leading to the assembly point. This route should be indicated on the layout plan attached to the on-site management plan.

7.19.5 All clear signal

After control of the emergency, the work incident controller will communicate to the work's central controller that the emergency has ceased. The central controller can declare all clear by instructing the time office to sound "All Clear Sirens".

7.19.6 Emergency facilities

The following facilities should be provided to address emergencies at any time.

- Fire protection and firefighting facilities
- Emergency lighting and standby power
- Emergency equipment and rescue equipment
- Breathing apparatus with compressed air cylinder
- Fire proximity suit
- Resuscitator
- Water gel blanket
- Low-temperature suit
- Fire aid kit
- Stretchers

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The Environmental Impact Assessment (EIA) for the proposed **Rangamati Medical College Hospital and Nursing College Project, located at Rangamati Sadar, Rangamati,** has been conducted in accordance with the requirements of the **Bangladesh Environmental Conservation Act, 2023,** and the **Environmental Conservation Rules, 1997 (as amended).** The study included baseline environmental assessment, stakeholder consultation, identification and evaluation of potential impacts, and formulation of mitigation and management measures.

The assessment indicates that the project is **environmentally feasible, socially acceptable, and economically justified**, provided that all recommended mitigation and management measures are implemented effectively.

The project is expected to generate **significant positive impacts**, including:

- Improved access to modern and specialized healthcare services for Rangamati and surrounding districts
- Strengthening of medical and nursing education facilities
- Creation of employment opportunities during both construction and operational phases
- Contribution to regional socio-economic development

Potential **negative environmental impacts** during the construction and operation phases—such as air pollution, noise, wastewater discharge, medical waste, traffic congestion, and risks to nearby water bodies, including **Kaptai Lake**—have been identified. However, these impacts are **site-specific, manageable, and largely reversible** through appropriate mitigation measures.

The proposed installation of **Effluent Treatment Plant (ETP) and Sewage Treatment Plant (STP),** supported by allocated budgets of **BDT 165,000,000 for medical waste management** and **BDT 75,000,000 for sewage treatment**, demonstrates the project proponent's commitment to environmental protection and regulatory compliance.

Stakeholder engagement and public consultation activities revealed broad community support for the project, with stakeholders emphasizing the importance of protecting the lake, waste management, traffic control, and local employment. These concerns have been duly addressed in the Environmental Management Plan (EMP).

Based on the findings of this EIA, it is concluded that the proposed project **does not pose any unacceptable environmental or social risks** and may be implemented in an environmentally sustainable manner, subject to strict adherence to the EMP and DoE conditions.

8.2 RECOMMENDATIONS

To ensure environmentally sound and sustainable implementation of the project, the following recommendations are made:

2.1 Environmental Management and Compliance

- All mitigation measures outlined in the **Environmental Management Plan (EMP)** shall be implemented in full during both construction and operation phases.

- Regular environmental monitoring shall be conducted for air quality, noise levels, wastewater quality, and solid/medical waste management.
- The project shall comply with all relevant **DoE standards and guidelines**, including emission, effluent, and waste disposal limits.

2.2 Water Environment Protection

- ETP and STP systems must be installed, operated, and maintained efficiently at all times.
- No untreated wastewater or medical effluent shall be discharged into nearby drains, land, or **Kaptai Lake**.
- Buffer zones and physical barriers shall be maintained to protect the lake and prevent runoff contamination.
- Rainwater harvesting and groundwater recharge measures should be incorporated to reduce pressure on water resources.

2.3 Medical and Hazardous Waste Management

- A comprehensive **Medical Waste Management Plan** shall be implemented in accordance with national regulations.
- Segregation, storage, transportation, treatment, and final disposal of medical waste shall follow color-coded and safety protocols.
- Authorized and licensed waste handlers shall be engaged for off-site disposal where applicable.

2.4 Air, Noise, and Traffic Management

- Dust suppression measures (water spraying, covered transport) shall be applied during construction.
- Construction activities shall be restricted to daytime hours to minimize noise disturbance.
- A traffic management plan shall be implemented to avoid congestion and ensure road safety.

2.5 Occupational Health and Safety

- Adequate personal protective equipment (PPE) shall be provided to all workers.
- Emergency preparedness, fire safety systems, and regular safety training shall be ensured.
- Compliance with national labor laws and occupational health standards is mandatory.

2.6 Stakeholder Engagement and Grievance Redress

- Continuous stakeholder engagement shall be maintained throughout the project lifecycle.
- A functional **Grievance Redress Mechanism (GRM)** shall be established and communicated to local communities.

- Public feedback received after submission of the draft EIA to DoE shall be incorporated into the final EIA report.

2.7 Institutional and Monitoring Arrangements

- An Environmental Management Unit (EMU) shall be designated to oversee EMP implementation.
- Periodic environmental audit reports shall be submitted to the Department of Environment as required.
- Adequate budgetary provision shall be maintained for environmental monitoring and mitigation activities.

Subject to the implementation of the recommended mitigation measures and compliance with all regulatory requirements, the **Rangamati Medical College Hospital and Nursing College Project** is **recommended for environmental clearance** under the **Red Category** by the Department of Environment (DoE), Government of Bangladesh.

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